

**Proceedings of the
National Nanotechnology Meet
on Energy & Environment
NAMEE - 2012**

3rd-5th September, 2012

Sponsored by



**MINISTRY OF EARTH SCIENCES
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- Precision Cutting Machine (Accutom 50) - Struers, Denmark
- Polishing Machine- (Tegramin-25) - Struers, Denmark
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Research Activities

Nanobiotechnology

- Thin Film Coating to control Biofouling
- Antimicrobial activities of Nanoparticles
- Biocorrosion
- Bionanomaterials
- Controlled Drug Delivery
- Nanomedicine
- Bionanosensor

Material Science

- Synthesis of Thin Films
- Characterization of Nanomaterials
- Microstructural and Compositional Analysis
- Mechanical and Magnetic Property Characterization

Physics

- Synthesis of Nanomaterials
- Nano Semiconductors
- Nano Surface Modification by Ion Implantation
- Physics of Carbon Nanotubes

Chemistry

- Synthesis of Polymer Nanoparticles
- Nanoparticles Surface Modification
- Processing of Polymer Nanocomposites
- Polymer Nanocomposites Characterization Behavior & Performance
- Polymers for Nanosensors

Nanoelectronics

- Nanosensors
- Nano Electronic Devices
- Quantum Dots
- VLSI & Nanoelectronics

Nano Education

- Awareness programmes
- Workshops
- Popular Lecture Series\
- Short term courses
- Conferences

**Proceedings of the National Nanotechnology Meet on Energy & Environment (NAMEE-2012),
September 3rd to 5th, 2012 sponsored by Ministry of Earth Sciences, New Delhi.**

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Dr. JEPPIAAR, M.A, B.L, Ph.D
Founder & Chancellor



Chancellor's Message

I am indeed happy that Centre for Nanoscience & Nanotechnology, Sathyabama University is organizing a 3 day National Nanotechnology Meet on Energy & Environment (NAMEE-2012) from September 3rd to 5th, 2012 sponsored by Ministry of Earth Sciences, New Delhi and the conference proceedings will be released on the occasion.

This conference provides an opportunity to research scholars, students and scientists to get together and discuss with an open mind about the latest trends in Nanotechnology for Energy, Environment & innovative Technologies. I always encourage research as it opens new avenues for invention & advancement.

I am sure that the organizers have given a strenuous effort to make this National Conference a grand success & interactive. I wish this conference a grand success and my best wishes to all participants & delegates to share their experience.

Dr. JEPPIAAR, M.A, B.L, Ph.D
Founder & Chancellor



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Dr. Marie Johnson

B.E, MBA, M.Phil, Ph.D



Er. Mariazeena Johnson

B.E, MBA, M.Phil, (Ph.D)

MESSAGE FROM DIRECTORS

We are glad that Centre for Nanoscience & Nanotechnology, Sathyabama University is conducting the National Nanotechnology Meet on Energy & Environment (NAMEE-2012) from September 3rd to 5th, 2012 sponsored by Ministry of Earth Sciences, New Delhi . Due to the explosion in research activities, the goal of the conference is to provide an opportunity to academicians and researchers from various universities and research institutions in India to discuss the divergent issues related to application of Nanotechnology in Energy and Environment. This three day National conference will help researchers, educationalists and industrialists to get together and expand the boundaries of innovation. We wish the delegates and organizers a purposeful and successful conference.

DIRECTOR

DIRECTOR

National Nanotechnology Meet on Energy & Environment (NAMEE-2012)

September 3rd to 5th, 2012

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ABOUT SATHYABAMA UNIVERSITY

Sathyabama University, formerly known as Sathyabama Engineering College was established by **JEPPIAAR EDUCATIONAL TRUST** in 1987. It is a pioneering institute in imparting knowledge in the areas of engineering, science, technology and education. The institution's progress and contribution in the field of technical education for over two decades made the Ministry of Human Resources Development, Govt. of India to grant Deemed University status on 16th July 2001 and University status on 13th September 2006 under section (3) of the UGC Act, 1956. Sathyabama University strengthens its development activities under the dynamic leadership of Honorable Chancellor **Dr. JEPPIAAR**, Madam Chancellor **REMIBAI JEPPIAAR**, with the able support and valuable guidance of the Directors **Dr. Marie Johnson** and **Er. Mariazeena Johnson**. The University offers 17 courses at the UG level and 15 courses at PG level in various branches of Engineering in addition to UG & PG programmes in Science and Humanities. It also offers MBA, MCA, M.Phil., and Ph.D programmes in all disciplines. The University has excellent infrastructural facilities, well equipped laboratories, Central library, Department libraries and the entire campus is attached with 12 mbps internet connectivity. The University has been accredited by National Assessment and Accreditation Council (NAAC) and ISO 9001: 2008 certification for professional quality management. The University has undertaken various sponsored and collaborative Research and Development projects funded by national organizations such as Indian Space Research Organization (ISRO), Department of Science and Technology (DST), Indira Gandhi Centre for Atomic Research (IGCAR), Defence Research and Development Organization (DRDO), Department of Bio-Technology (DBT), Ministry of Environment and Forests (MoEF) etc., The University holds great promise to expand the applications of space technology, benefiting the common man and enriching the quality of life in association with Indian Space Research Organization (ISRO). A step towards this, the University is successfully conducting non formal education programmes through 18 Village Resources Centre (VRCs) all over the State.

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ABOUT CENTRE FOR NANOSCIENCE & NANOTECHNOLOGY
(A Joint Initiative of IGCAR, Kalpakkam & Sathyabama University)

The Centre for Nanoscience and Nanotechnology was established in January 2006 at the University campus to accomplish the goal of enhancing advanced research in the areas of Nanoscience and Nanotechnology. The centre is a joint initiative of Indira Gandhi Centre for Atomic Research (IGCAR), Govt. of India and Sathyabama University. The leading area of research includes nanomaterials, nanotechnology, nanocomposites, nanoelectronics, nanofabrication. In addition to research, the centre also conducts training and awareness programmes, workshops, national and international conferences on recent trends and developments of Nanoscience on various themes of national interests. The centre is undertaking research and development projects from various agencies and is offering consultancy services to industries and research organizations in India and abroad.

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ABOUT NAMEE-2012

National Nanotechnology Meet on Energy & Environment (NAMEE-2012) invites researchers in the area of Nanotechnology Applications in Energy and Environment for a constructive forum to address the latest issues and challenges in the area of energy and environment. The national forum will give effective impact on the young researchers in the area of energy and will broaden their vision of clean and green energy production and technologies. The themes of the conference include Nano Materials, Nano energy, Nanoparticles and Applications, Thinfilm coatings and Applications, Application of Nanotechnology in Energy and environment etc.

National Nanotechnology Meet on Energy and Environment [NAMEE-2012]

OVERALL TECHNICAL PROGRAMME SCHEDULE	
3 rd – 5 th September, 2012	
DAY 1 (3 rd SEP, 2012)	
8.00 AM -10.00 AM	Registration (Mini Auditorium- Admin Building)
10.00 AM - 10.30 AM	Inauguration by Dr. R Venkatesan (Mini Auditorium- Admin Building)
10.30 AM - 11.15 AM Invited Talk-I	Dr. R Venkatesan , Group Head- Ocean Observation Systems, NIOT Chennai Advanced materials for marine applications
11.30 - 11.45PM Business Talk	Mr. Abhishek Mangalick , Director and Varsha Mohan, Business Development Manager, EcoSense Sustainable Solutions Pvt. Ltd. Ecosense – An Overview
11.45 PM – 12:30 PM Invited Talk-II	Prof. M V Shankar , Head, Material Science and Nanotechnology- Yogi Vemana University, Kadappa Nanotechnology - The Driving force for cheap solar fuels
SESSION-I (Session Chair- Dr. M. V Shankar, Head- Nanotechnology, YVU, Kadappa)	
1.30 PM – 2.45 PM (GNT1-GNT10)	Green Nanotechnology (GNT) (Mini Auditorium- Admin Building)
SESSION-II (Session Chair- Dr. Vinita Vishwakarma, Scientist-E)	
2.45 PM - 4.15 PM (NFM1-NFM10)	Nanotechnology in Food and Medicine (NFM) (Mini Auditorium- Admin Building)
DAY 2 (4 th SEP, 2012)	
10.00 AM - 10.45 AM Invited Talk-III	Dr. K Santhanam, Senior Scientist, CWR, Sathyabama University, Chennai Environmental Impact Assessment in a River Basin and Remedial Measures (Mini Auditorium- Admin Building)
SESSION-III ((Session Chair- K Santhanam, Senior Scientist, CWR)	
11.00 AM – 12.30 PM (AON1-AON11)	Applications of Nanotechnology (AON) (Mini Auditorium- Admin Building)
1.30 AM - 2.30 PM Invited Talk-IV	Dr. R Jayavel, Director, Centre for Nanoscience and Technology, Anna University Organic/Inorganic Nano hybrid Systems for Solar Energy Applications
SESSION-IV (Session Chair- Mr. Subhranshu Sekhar Samal, Scientist-D)	
2.30 PM – 4.00 PM (NIS1-NIS10)	Nano-Insight (NIS) (Mini Auditorium- Admin Building)
DAY 3 (5 th SEP, 2012)	
10.00 AM - 10.45 AM Invited Talk-V	Dr. S S Dawn, Head, Centre for Waste Management, Sathyabama University, Chennai (Senate Hall, International Research Centre)
SESSION-V (Session Chair- Dr. S S Dawn, Head -CWM)	
11.00 AM - 12.30 PM (NSC1-NSC11)	Nanosynthesis and Characterization (NSC) (Senate Hall, International Research Centre)
SESSION-VI (Session Chair- Mrs. J Josephine Therasa, Scientist-C)	
1.30 PM – 3.00 PM (NIE1-NIE10)	Nano in Energy (NIE) (Senate Hall, International Research Centre)
3.00 PM – 4.00 PM	Panel Discussion and Valedictory (Prize/ Certificate Distribution)
4.15 PM – 4.30 PM	NANOTECHNOLOGY LAB VISIT

INVITED TALKS

Nanotechnology - The Driving Force for Cheap Solar Fuels

M.V.Shankar

Associate Professor

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ABSTRACT

Nanoporous TiO_2 has emerged as a promising and economically viable material for solar energy conversion process such as photocatalysis and dye-sensitized solar cells. The progress in photocatalysis is often challenged by its low efficiency and poor light utilization. The porous structure has demonstrated its superiority over nanoparticles by enhanced semi-conductor properties and surface reaction sites. There is a growing awareness on interdisciplinary research that catalysis and nanotechnology can provide solutions for a wide range of energy applications and sustainable society. Hydrogen production from water under artificial solar light irradiation was performed over a series of Pt- and Au/ TiO_2 (anatase/rutile) nanoporous photocatalysts. Different TiO_2 supports with varying anatase/rutile contents were compared, either based on sol-gel synthesized or on commercially TiO_2 . The influence of template promotion on sol-gel TiO_2 synthesis has been investigated, using different nature of porogens or templates. Amongst various factors influencing the hydrogen evolution efficiency, it was pointed out that the following parameters were crucial to enhance H_2 evolution: i) the nature and content of the metallic co-catalyst, ii) the surface, crystallographic and porosity properties of the TiO_2 anatase/rutile support, iii) the anatase/rutile ratio, iv) the metal-support interactions and v) the relative amount of methanol added as sacrificial reagent. The influence of these different factors was studied in details. In optimized conditions, high H_2 production efficiency can be obtained over days without deactivation and with very low amounts of methanol (Fig.1).

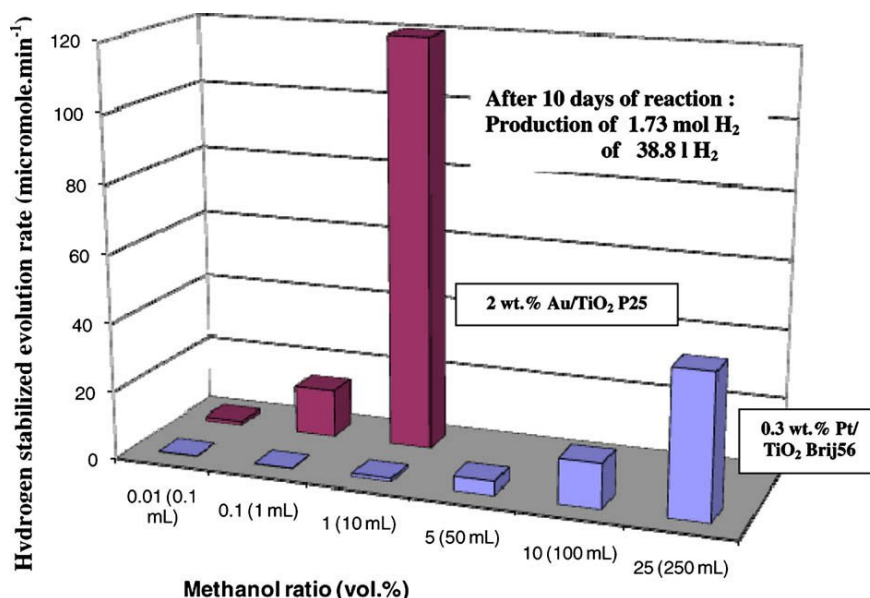


Fig.1. Comparison of hydrogen evolution rate ($\text{mol} \cdot \text{min}^{-1}$) on 2 wt.% Au/ TiO_2 -P25 and 0.3 wt.% Pt/ TiO_2 -Brij56 photocatalysts as a function of the relative ratio of methanol sacrificial reagent. Stabilized value over more than 42 h of reaction.

ENVIRONMENTAL ASPECTS OF WATER RESOURCES DEVELOPMENT IN RIVER BASINS

K. Santhanam, Senior Scientist, Centre for Water Research

Environmental issues related to water resources encompass a wide range of concerns, increasing health problems, pollution of surface and groundwater, lowering of ground water levels and salt water intrusion, erosion in flood plains, reduction of wet land area and increased riverbed erosion.

In upper Palar River Basin of Tamil Nadu, several types of environmental issues are identified. Surface water runoff in the Palar River is only for 14 days in a year. As the thickness of sand column (alluvium) is more than 20 to 25 m, more ground water is stored in the aquifer. The eastern tip of the Upper Palar Basin is having a natural dyke and one anicut. The water is prevented to go to downstream. As many tanning industries are located in both the banks of Palar River, they let out untreated or partially treated effluent inside river bed so that the riverbed & flood plains are contaminated and groundwater of the aquifer gets polluted.

Due to monsoon failure, Inter State problems, there is groundwater over draft. Year by year groundwater level depletion occurred. Due to insufficient water supply productive wetlands become waste lands. Even though common effluent treatment plants are established, the TDS value of common effluents are greater than 8000 mg/lit where standard limits is 2000 mg/lit. Due to consumption of poor quality of water, people suffer from skin deceases, tooth cavity and spinal cord problems.

Mr. K. Santhanam has 34 years of Service in both Remote Sensing & Ground Water Department in State Government of Tamil Nadu and Retired as Join Director of Remote Sensing. Worked as GIS Specialist (Consultant) in World Bank projects. Since 2007 he was working as Senior Scientist in Centre for Water Research, Sathyabama University, Chennai.

Organic/inorganic nano hybrid systems for solar cell applications

R. Jayavel^{*a}, G. Mohan Kumar^a, Jin Kawakita^b

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Recently, nanostructures of the inorganic semiconducting materials are looked upon for energy conversion aspects along with their organic counterparts. Fabrication of new class of hybrid organic/inorganic material systems has envisaged a new dimension into the field of photovoltaics. The study on such systems could be of great help in improving the device performance and lowering their fabrication cost considerably. In this regard, a systematic approach has been made on the development of PPy/TiO₂ and PPy/ZnCoO hybrid layers. Undoped and Co doped ZnO nanocrystallite were prepared through a simple two-step chemical approach [1]. The hybrid layers have been fabricated at room temperature through electro-polymerization reactions (assisted by UV radiations). FT-IR and Raman spectroscopy have been used to ensure the formation of polypyrrole deposits initially. Morphology studies revealed the tendency of polymer molecules to cover up the spherical surface of TiO₂ nanoparticles and the nanorod like structure in case of ZnCoO, resulting in their agglomeration with the other smaller particles, presumably due to the weaker inter-particle interactions [2].

Pure TiO₂ layers exhibit an unstructured emission with very low intensities, which might be due to the continuous decrease in the vicinity of Fermi energy as observed. The flat band potential for the hybrid systems assimilated from the Mott Schottky plots was observed to shift towards the negative direction, presumably due to the higher concentration of the polymer composites, which gives rise to a more negative potential [3]. Preliminary photovoltaic studies were carried out under AM1.5, 1 sun condition for these photoelectrodes. The studies showed a photovoltage of 0.45 V and further studies are in progress to evaluate other I-V parameters.

[1] G. Mohan Kumar, P. Ilanchezhian, Jin Kawakita, M. Subramanian and R. Jayavel, *Cryst. Eng. Comm.*, 12 (2010) 1887-1892.

[2] G. Mohan Kumar, V. Raman, Jin Kawakita, P. Ilanchezhian and R. Jayavel *Dalton Trans.*, 39 (2010) 8325–8330.

[3] Ganesan Mohan Kumar, Jin Kawakita, and Ramasamy Jayavel, *J. Nanosci. Nanotechnol.* 11 (2011) 3867-3874.

ECOSENSE – An overview

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ECOSENSE is an organization founded by a group of highly trained (IIT, MIT) and experienced professionals from across the world. The objective of our organization is to create awareness about sustainable technologies and also implement innovative technologies to reduce carbon footprint. We are working with various technical institutions in building their capacity to do research and training in the field of Renewable Energy.

As the first step towards our vision, Ecosense has delved into developing cutting edge products to create skilled human resource for renewable energy sector. With the guidance of experts from IIT Delhi, IIT Bombay and Industry experts, Ecosense has developed three unique and high-end products, which facilitates Training and Research in the field of Solar Energy. The products aim at providing the students with hands-on training and help with the understanding of the conceptual nuances related to Solar PV and Thermal systems. Our products have been installed in more than 50 institutions in the country now and are successfully helping these institutions in building the skills of their students.

Our product line includes:

Insight Solar PV Training Kit: – A mini Solar PV plant in form of a lab model, which can help one to build an in-depth understanding of real-life working of a Solar PV Power plant and the various aspects of Design Engineering, Operation and Maintenance of it.

“Insight Solar” Solar Resource Assessment System: It is extremely important to obtain the local data of temperature, wind, solar radiation and humidity to predict the performance of a Solar Power Plant. “Insight Solar” Solar Resource Assessment System will help Solar Power Plant Design Engineers in measuring these specific parameters accurately and will allow monitoring of the parameters online anywhere across the world through GPS module.

Insight Solar Thermal Training Kit: - A solar water heating system in the form of a working laboratory model, to evaluate the performance of the system under different conditions like temperature, pressure, wind, radiation etc. in both Thermosyphonic and Force flow modes.

CONTENTS

SESSION-I: GREEN NANOTECHNOLOGY (GNT)

S.No	Paper Code	TITLE	PageNo.
1	GNT1	The Role of Green Technology and its Applications <i>Sounderya, Kopavani, Shanoora</i>	1-4
2	GNT2	Green Technologies and its Application - Solar Energy for Buildings <i>M. M. Vijayalakshmi, E. Natarajan, D. Soundar Rajan</i>	5-13
3	GNT3	Environmental Application Energy Conservation Used for Reduction of Stack Gas Emmissions in the Petrochemical Industry <i>K. Sridhar</i>	14-17
4	GNT4	Advanced Technologies for Industrial Wastewater Treatment – A Review <i>T. R. Kalaivani</i>	18-25
5	GNT5	Nanotechnology: To Secure Our Environment <i>Dinesh Rohilla, Ramesh Singh</i>	26-27
6	GNT6	“Green Our Planet”- with Green Technology <i>Jyotika Kaushik, Kiran Sachdeva</i>	28-32
7	GNT7	Green Technologies and their Applications <i>Shashwat S. Khandayatray,</i>	33-40
8	GNT8	Biogenic Process and Antibacterial Efficiency of Gold Nanoparticles <i>B. Mahitha, Manoj L</i>	41-43
9	GNT9	Selenium Induced Oxidative Stress, Histological Alterations in Testis of Swiss Albino Mice <i>Kishore .S</i>	44-48

SESSION-II: NANOTECHNOLOGY IN FOOD and MEDICINE (NFM)

S.No	Paper Code	TITLE	Page No.
1	NFM1	Nanorobots- The Heart Surgeon <i>D. Chandramohan, C. Dayananthan</i>	49-52
2	NFM2	Preparation of Chitosan/ Poly (Lactic Acid) Nanoparticles: A Potential Role of Piceatannol for Anti-Cancer Drug Delivery Applications <i>Jeevitha. D</i>	53-57
3	NFM3	Nanoparticles and its Application in Cryosurgery <i>M. Chandran</i>	58-60
4	NFM4	Nanomedicine by Nanorobotics <i>P. Preetha</i>	61-62
5	NFM5	Review of Nanotechnology in Nano Medicine <i>V. R. Sakthi Kumar</i>	63-70
6	NFM6	Nano Food <i>R. Nirmalvincy, R. Pavithra, R.</i>	71-76
7	NFM7	Nanotechnology in Biotechnological Field <i>S. Kumaravel V. P. Karthikeyan, C. Madan Kumar, N. R. Ajay Kumar</i>	77-82
8	NFM8	Nanotechnology: Accept New Challanges in Field of Food and Medicine <i>Amit Kumar</i>	83-85
9	NFM9	Preparation, Characterization and Cytotoxicity Study on Superparamagnetic Nanoparticles for Drug Delivery <i>Kanimozhi. S</i>	86-88
10	NFM10	Nanotechnology in Medicine <i>Yaminiyadla</i>	89-95

SESSION-III: APPLICATION OF NANOTECHNOLOGY (AON)

S.No	Paper Code	TITLE	Page No.
1	AON1	Applications of Nano Quantum Dots <i>M. Mariammal, A. Mariammal</i>	96-98
2	AON2	Nanomaterials-Graphene and its Engineering Applications <i>S. Divakar, D. Naveen Kumar</i>	99-102
3	AON3	Nanotechnology and Space Elevator <i>K. Saravanan, Ayyavu Udaya Sooriyan</i>	103-106
4	AON4	Smart Dust Nanosensors and Other Applications of Nanosensors <i>B. MariaValentina, S. Karpagam</i>	107-110
5	AON5	Study of Carbon Nano Structures and Devices <i>Sridevi.R, Licy Precilla M. S, Aluri Mallikadevi</i>	111-114
6	AON6	Importance of Carbon Nano Structures in Aerospace Technology <i>D.Bharath</i>	115-120
7	AON7	Carbon Nanotubes Sensors for Gas Detection <i>Litty John</i>	121-126
8	AON8	Nanoparticles and their Applications <i>M. Gopinath, Arun Immanuel</i>	127-130
9	AON9	Carbon Nanotubes Enhancing Aerospace Composite Materials <i>Jasleen Josan</i>	131-135
10	AON10	The Effect of Nano Particles and its Applications in Nano Technology <i>Talluri Yamini</i>	136-140
11	AON11	Nanomaterials for Aviation Industry <i>Jerrin Jose</i>	141-145

SESSION-IV: NANO-INSIGHT (NIS)

S.No	Paper Code	TITLE	Page No.
1	NIS1	Thrust Force Studies in Drilling of Wood Composite Panels <i>T. N. Valarmathi</i>	146-149
2	NIS2	Polymer Nanotechnology <i>G. Sai Sidharth</i>	150-153
3	NIS3	The Importance of Composite Interfaces in Nanotechnology <i>Vedashree Abhyankar</i>	154-160
4	NIS4	Role of Biotechnology <i>Sundarapandian. P. S, Sankar Tharan Kumar. S</i>	161-168
5	NIS5	Ethylamine Induced Tall Mutants in Jute (Corchorus Olitorius L.) <i>P. K. Ghosh</i>	169
6	NIS6	Ethylmethane Sulphonate Induced Bushy Head Mutants in Jute (Corchorus Olitorius L.Variety Jro-632) <i>P. K. Ghosh</i>	170-171
7	NIS7	Induced Crumple Leaf Mutant in Jute (Corchorus Olitorius L.Variety-Jro-632) <i>P. K. Ghosh</i>	172
8	NIS8	Importance of Nano Materials in Nano Technology <i>M. Sai Raghava</i>	173-176

SESSION-V: NANOSYNTHESIS and CHARACTERIZATION (NSC)

S.No	Paper Code	TITLE	Page No.
1	NSC1	Synthesis, Characterization and Antimicrobial Activity of Zinc Oxide Nanoparticles <i>M. Harshiny, E. Indumathi</i>	177-180
2	NSC2	Investigation on Enhanced Photocatalytic Activity Of Heterogeneous Nanoparticle for the Degradation of Organic Contaminants in Textile Effluent <i>Prabha. I, S. Lathasree</i>	181-185
3	NSC3	Synthesis And Characterization of Trisodium Citrate Capped Silver Nanoparticles <i>B. Ajitha, A. Divya, K. Siva Kumar, P. Sreedhara Reddy</i>	186-189
4	NSC4	Preparation and Characterization of Rutile TiO ₂ Nanoparticles Using Sol-Gel Method <i>Manoj L, Priya Madhuri. K</i>	190-192
5	NSC5	Synthesis and Characterization of Noble Metal Nanoparticles by Soft Chemical Route <i>Priya Madhuri. K, Parul Garg</i>	193-197
6	NSC6	Study of Nano Materials <i>Maheshwaran. M. Pillai, Joel Gabriel, Harihara Veera Vignesh</i>	198-205
7	NSC7	Study of Composites and Interfaces <i>A. Sai Prudhvi Raj, S. Srinath</i>	206-209
8	NSC8	The Influence of Using Different Substrates on Structural and Optical Properties of ZnO Thin Films Grown by RF Magnetron Sputtering <i>G. Anil Kumar</i>	210-212
9	NSC9	Thin Film Coatings and Applications <i>G. Lalithapriya, S. Meghana</i>	213-217
10	NSC10	Nanoparticles and its Implementation <i>M. Sriharsha</i>	218-224
11	NSC11	Analysis of Dropwise Condensation Using Nano Fluids as Coolant <i>R. Senthil Kumar</i>	225-230
12	NSC12	Carbon Nanostructure and Devices <i>J. Arun Kumar, P. Joel Andrews</i>	231-236
13	NSC13	Nano Materials <i>M. J. Deepakreddy, Sumesh. K. S</i>	237-242

SESSION-VI: NANO IN ENERGY (NIE)

S.No	Paper Code	TITLE	Page No.
1	NIE1	Synthesis and Thermal Energy Storage Analysis of CuO Nanofluid for Heating Application <i>S. Magesh, K. Deepak, Sree</i>	243-247
2	NIE2	ZnO Nano Particles : Effective Catalyst for the Photo Degradation of Acid Yellow 110 <i>S. Sunitha</i>	248-252
3	NIE3	Carbon Nanostructures for Energy Conservation <i>Alan Shaji Samuel</i>	253-258
4	NIE4	Nano Technology in Renewable Energy <i>R. Senthil Kumar</i>	259-263
5	NIE5	Experimental Studies on Enhancement of Heat Transfer in a Solar Dryer Incorporating PCM Containing Nanoparticles <i>R. Senthil Kumar</i>	264-267

6	NIE6	A Detailed Survey on Behavioral Characteristics of Quantum Dot Infrared Detectors <i>A. Lekhya, V. Susrutha, G.</i>	268-270
7	NIE7	Review of Investigation on Performance of Quantum Well Laser <i>Meenu Sunny, Maria Kuruvilla, T. Joy Prasanna,</i>	271-274
8	NIE8	Composites and its Interfaces <i>Dexter Yesudas,</i>	275-279
9	NIE9	Green Synthesis of Palladium Nanoparticles Using Anti-Cancer Potent Piper Longum Leaves Broth and Their Spectroscopic Studies <i>K. Mallikarjuna</i>	280
10	NIE10	Palladium Nanoparticles: Single-Step Biological Preparation Using Karpuravalli Leaves Broth and their Characterization <i>K. Mallikarjuna</i>	281
11	NIE11	A Study of Wideband Code Division Multiple Access Codes <i>P. Kavipriya</i>	282
12	NIE12	The Effect of Nano Materials in the Development of Nano Technology <i>R. Karthickeyan</i>	283
13	NIE13	Recent Developments in Nano Materials <i>Satyam</i>	284



The role of green technology & its applications

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Abstract— With the network traffic increasing, the energy consumption of network equipments is growing greatly. Under the background of serious greenhouse effect, the excessive energy consumption has become a major barrier of developing the future information society. For this reason, the issue of saving energy followed by the grooming and optical bypass technology has become particularly important. In this paper, in order to perform the energy-saving for multicast demands, we present the multicast grooming policies and also develop a new auxiliary graph to support the multicast routing in green optical network. Based on the proposed auxiliary graph, a novel Multicast Green Grooming (MGG) approach by using the energy-efficient optical bypass technology and the effective grooming policy combination is proposed to reduce the occupied energy-consuming equipments that mainly include the core router ports, optical transceivers and amplifiers. Simulation results show that, compared to the traditional approach, MGG not only can obtain the lower blocking probability but also is able to save significant energy.

KEYWORDS: Green technology, sustainability, innovation.

I. INTRODUCTION

Environmental technology (abbreviated as envirotech) or green technology (abbreviated as greentech) or clean technology (abbreviated as cleantech) is the application of one or more of environmental science, green chemistry, environmental monitoring and electronic devices to monitor, model and conserve the natural environment and resources, and to curb the negative impacts of human involvement. The term is also used to describe sustainable energy generation technologies such as Photovoltaic's, Wind Turbines, Bioreactors, etc. Sustainable development is the core of environmental technologies. The term

environmental technologies is also used to describe a class of electronic devices that can promote sustainable management of resources

II. GOALS

- Sustainability
- Innovation
- Source reduction
- Green chemistry
- Green building
- Energy

(A). SUSTAINABILITY

For U.S. agriculture to continue along a sustainable path of economic development, further production increases must be generated by technologies that are both profitable and more environmentally benign. In this context, we assess the role of these green or sustainable technologies in steering agriculture along a more sustainable path. However, the lack of markets for the environmental attributes associated with green technologies can limit their development. In addition, simply making a technology available does not mean it will be adopted. Experience with green technologies such as conservation tillage, integrated pest management, enhanced nutrient management, and precision agriculture demonstrates that even when technologies are profitable, barriers to adopting new practices can limit their effectiveness.

(B). INNOVATION

Developing alternatives to technologies, whether fossil fuel or chemical intensive agriculture that



has been demonstrated to damage health and the environment.

(C) .SOURCE REDUCTION

Reducing waste and pollution by changing the patterns of consumption and production.

(D). GREEN CHEMISTRY

The invention, design and application of chemical products and processes to reduce or to eliminate the use and generation of hazardous substances.

(E). GREEN BUILDING

Green chemistry encompasses everything from the choice of building materials to where a building is located.

(F).ENERGY

May be the most urgent issue for green technology, this includes the development of alternative fuels, the new means of the generating energy and energy efficiency.

IV.AERAS OF GREEN TECHNOLOGY

- Green nanotechnology
- Green IT
- Green energy
- Green chemistry
- Green building

V.GREEN CHEMISTRY

Utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products.

A) PRINCIPLES COVERING GREEN CHEMISTRY:

- Design of processes to maximize the amount of raw material that ends up in the product.
- Use of safe environment including solvents whenever possible.
-
- Design of energy efficient processes.

- Best form of waste disposal: not to create it in the first place.

B) THE 12 PRINCIPLES OF GREEN CHEMISTRY

- Prevention
- Atom economy
- Less hazardous chemical synthesis
- Designing safer chemicals
- Safer solvents and auxiliaries
- Design for energy efficiency
- Use of renewable feed stocks
- Reduce derivatives
- Catalysis
- Design for degradation
- Real time analysis for pollution prevention
- Inherently safer chemistry for accident prevention

C) MAJOR USES OF GREEN CHEMISTRY

- Global change
- Resource depletion
- Food supply
- Toxics in the environment

VI.GREEN NANOTECHNOLOGY:

Green nanotechnology refers to the use of nanotechnology to enhance the environmental sustainability of processes currently producing negative externalities. Its aim is to minimize potential environmental and human health risks associated with the use of nanotechnology products and to encourage replacement of the existing products with new nanoproducts that are more eco friendly throughout their life cycle.

A) APPLICATION OF GREEN NANOTECHNOLOGY

- Health
- Energy
- Information and communication
- Heavy industry
- Consumer goods

VII.GREEN BUILDINGS

Green building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle:



from sitting to design, construction, operation, maintenance, renovation, and demolition. This requires close cooperation of the design team, the architects, the engineers, and the client at all project stages.^[1] The Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.^[2]

Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution^[2]

Green building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from sitting to design, construction, operation, maintenance, renovation, and demolition. This requires close cooperation of the design team, the architects, the engineers, and the client at all project stages.^[1] The Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.^[2]

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- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution

VIII.GREEN ENERGY

GREEN energy is the sustainable provision of energy that meets the needs of the present without compromising the ability of future generations to meet their needs. Technologies that promote sustainable energy include renewable energy sources, such as hydroelectricity, solar energy, wind energy, wave

power, geothermal energy, and tidal power, and also technologies designed to improve energy efficiency.

IX.GREEN MARKETING

According to the American Marketing Association, green marketing is the marketing of products that are presumed to be environmentally safe.^[1] Thus green marketing incorporates a broad range of activities, including product modification, changes to the production process, packaging changes, as well as modifying advertising. Yet defining green marketing is not a simple task where several meanings intersect and contradict each other; an example of this will be the existence of varying social, environmental and retail definitions attached to this term.^[1] Other similar terms used are Environmental Marketing and Ecological Marketing.

Green, environmental and eco-marketing are part of the new marketing approaches which do not just refocus, adjust or enhance existing marketing thinking and practice, but seek to challenge those approaches and provide a substantially different perspective. In more detail green, environmental and eco-marketing belong to the group of approaches which seek to address the lack of fit between marketing as it is currently practiced and the ecological and social realities of the wider marketing environment.^[2]

The legal implications of marketing claims call for caution. Misleading or overstated claims can lead to regulatory or civil challenges. In the USA, the [Federal Trade Commission] provides some guidance on environmental marketing claims.^[3] This Commission is expected to do an overall review of this guidance, and the legal standards it Contains, in 2011.^[4]

X.CONCLUSION:

As we've mentioned in our mini-conclusions, both renewable energy and recycling cannot improve our environment in short term. It implies that green technology is not able to improve our environment or solve the problems that we are facing like, global warming in short. What green technology brings us in short term is inconvenience, high cost, low efficiency and etc. That's why people start to criticize whether we should keep investing in the green technology, and rely on it for solving the problems that we are facing. Although there are some defects of green technology, everything done should have both positive impacts and negative impacts. Since we are now still at a starting stage of developing green technology, some defects are due to its immature. For example, defects like low



efficiency can be solved, when we keep on putting effort in doing research and improvement. In fact, one of us will agree that problems like global warming and energy crisis cannot be solved within one or two years. It really requires our determination and continues effort in improving the situation. Green technology will definitely be the solution that gets the potential in helping us to solve those problems and improve our environment. Although these two technologies still have room for improvement, their merits are more important than the defects in long term.

- With the increasing demand of energy and waste production, these two technologies will be the main component of green technology. We should give our full support for developing the

technologies.

- We should go with others, for a better world.
- Potential in helping us to solve those problems and improve our environment. Although these two technologies still have room for improvement, their merits are more important than the defects in long term.
- With the increasing demand of energy and waste production, these two technologies will be the main component of green technology. We should give our full support for developing the technologies.
- We should go with others, for a better world.



Green Technologies and its Application - Solar Energy for Buildings

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Abstract—Energy is an vital necessity for society. The steady rise in living standards of the world populace is accompanied by the increased energy consumption in buildings. Energy required per capita continuously increases and it results in serious implications on pollution, climatic change and resource depletion. In many countries, energy consumed by the buildings exceeds 45% of the total energy generated.

Extensive use of fossil fuels led to its depletion and serious environmental pollution. Energy generation through newer methods can ease the pressure of buildings on the conventional energy sources. Among the newer sources of energy, solar energy is the most convenient and promising source of energy with green technologies for applications in building sector. This paper analyses the both passive and active applications of solar energy for building applications, with their relative merit and demerits.

Key Words: Solar Energy, Buildings, passive solar and active solar systems.

Introduction

The building sector can be divided into civil and industrial sub-sectors. The civil sub-sector can further be sub-divided into residential and public buildings. Public buildings include commercial structures such as departmental

stores, supermarkets, office buildings, apartments, hotels, restaurants, banks, post offices, airports, railway stations, and buildings used for education, science, research, medicine, sports, and communication services. All buildings have considerable heat transfer with the surroundings (heat loss in cold climate and heat gain in hot climate). When the internal heat generation is considerable in public buildings due to higher intensity of people, increased activity, higher level of illumination and ventilation; the same is considerably small in residential buildings. The energy consumed by the residential buildings can be considerably

reduced by controlling the heat gain from or heat loss to the surrounding.

Residential buildings are usually designed to provide comfortable shelter for the occupants with minimal variation in indoor conditions and minimal requirements for space conditioning by external means. The performance of buildings is quantified by important parameters like thermal performance, spatial performance, visual performance, acoustic performance, indoor air quality and building integrity. The actual range of values for each parameter depends on the type of building, kind of occupants, type of activity and ambient conditions.



The thermal performance of the building is mainly influenced by the thermal capacity of building envelope (to control the thermal delay between the environment and indoor space), the thermal insulation of the building envelope (to restrict heat transfer through conduction), the heat storage within the building due to high interior mass capacities and the rate of ventilation or infiltration.

Thermal comfort in residential buildings is a basic requirement for pleasant life. The thermal comfort of the human body primarily depends on indoor temperature, relative **humidity** and air velocity, in the order of importance. People feel comfortable if the indoor temperature is between 24°C and 30°C and relative humidity between 30% and 70% and wind velocity about 0.25 m/s.

1. Solar Energy

Solar energy is derived from the sun in the form of solar radiation. Solar technologies can be broadly characterized into passive solar or active solar method, depending on the way it is captured, converted and distributed. Active solar techniques include the use of gadgets like photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a existing building to the Sun, or selecting different materials with favorable thermal mass for the existing components so as to have naturally possible comfortable living space through proper design

2. Solar Passive Techniques

Passive solar design of a building aims to maintain sufficient indoor thermal comfort throughout the daily and annual cycles and to reduce the requirement for active heating and cooling systems. Passive solar building design is one part of green building design, and does not include active systems such as mechanical ventilation, solar thermal or photovoltaics.

It uses the concepts of climatology, heat transfer and selective material to achieve necessary human thermal comfort, at minimal cost. Specific attention is focused to the site and location of the dwelling, the prevailing climate, design and construction, solar orientation,

placement of glazing-and-shading elements, and incorporation of thermal mass.

The thermal design of a building involves an estimation of required indoor thermal conditions conducive to safe and comfortable living of the occupants. The thermal design of a building by selecting suitable building materials with appropriate physical and thermal properties can ensure the improved indoor thermal environment at possibly low external energy consumption.

The main factors determining the thermal response of a building are the heat gains or losses through various structural elements (i.e., walls, windows, roof and floor), the internal heat loads and the rate of ventilation.

The heat gain or loss by the structural element depends on its certain properties, like, their thermophysical nature, the colour of the outside surface, outside and inside air velocity and reflectivity of the surrounding ground surface.

Heat may be absorbed and stored either in the form of sensible heat or latent heat. When heat is stored (or recovered) due to temperature difference in the material, without any phase change, it is called sensible heat storage (or recovery). Latent heat is the form of thermal energy storage (or recovery) associated with the change in phase (i.e., state) without change in temperature.

Heat transfer is an important requirement in engineering applications. It is primarily related to many applications like, buildings, furnaces, refrigerators and air conditioners. Heat transfer rate is the quantity of heat flow per unit time into or out of the building under the conditions prevailing at that time. It is expressed in W or kW. The rate of heat transfer per unit area is called heat flux and expressed in W/m^2 or kW/m^2 .

The surface convective heat transfer coefficient (simply called surface coefficient) indicates the quantity of heat transmitted by convection, conduction and radiation from unit area of the surface when unit temperature difference is maintained between the surface and the surrounding medium. It is expressed in W/m^2-K or $W/m^2-^{\circ}C$. It depends on orientation and position of the surface, emissivity of the surface, temperature difference and air velocity. Surface convective heat transfer resistance (simply called surface resistance) is the reciprocal of surface coefficient. For example, outside film coefficient for cement plastered wall at an air velocity of 8 kmph is about $19.86 W/m^2.K$ and inside film coefficient at still air is about $9.36 W/m^2.K$.



Thermal conductivity is the heat flow rate through a slab of unit area and unit thickness when unit temperature difference is maintained between its surface area. It is expressed in $\text{W/m}\cdot\text{K}$ or $\text{W/m}^2\cdot^\circ\text{C}$. It depends on material density, porosity, moisture content, fibre diameter, pore size, gas properties in the pore, mean temperature and outside temperature range. The reciprocal of thermal conductivity is called thermal resistivity.

Thermal conductance is the heat flow rate in a single layer structure per unit area of whole thickness when unit temperature difference is maintained between its surfaces. It is expressed in $\text{W/m}^2\cdot\text{K}$. It is applied to a single layer of material and not to a composite insulation or to a structure of several layers of material.

Thermal resistance is the reciprocal of thermal conductance. When heat passes through two or more components of building unit, the individual resistances can be added to get the total resistance of the composite structure.

It is the heat flow rate per unit area and per unit temperature difference between the outside air temperature and inside room air temperature under steady state conditions. It is the reciprocal of the thermal resistance under the same conditions, including the surface resistance on both sides of the solid material. It may be noted that the thermal conductance is calculated based on surface temperatures of both sides, while the thermal transmittance (also called overall heat transfer coefficient) is calculated between outer air temperature and indoor air temperature.

Specific heat is the quantity of heat required to raise the temperature of the body of unit mass by one degree K and is expressed in $\text{J/kg}\cdot\text{K}$ or $\text{J/kg}\cdot^\circ\text{C}$.

Thermal capacity is defined as the product of density and specific heat of the body. It indicates the amount of heat that will be absorbed by the body before it reaches steady state condition. In other words, it is an indication of its heat storing capacity. It is expressed in J/K or $\text{J}/^\circ\text{C}$.

In buildings located in hot and dry climates with significant diurnal temperature swings, thick walls constructed from envelope materials with high density, such as adobe and masonry, are traditionally employed. Openings on the north and west facades are limited, and large southern openings are detailed to exclude direct sun in the summer and admit it in winter. A building material with high thermal mass and adequate thickness will lessen and delay the impact of temperature variations from the outside wall on the wall's interior. The material's high thermal capacity allows heat to penetrate slowly through the wall or roof. Because the temperature in hot and dry climates tends to fall considerably after sunset, the heavy building envelope produces a thermal flywheel effect and thereby maintaining the building interior cooler than the exterior during the day and warmer than the exterior at night.

In hot and moist climates, the night-time temperatures do not drop considerably below daytime average temperature and the light materials with low thermal capacity are generally preferred. Roofs and walls should be protected by plant materials or overhangs. Large openings protected from the summer sun should be located primarily on the north and south sides of the envelope to catch breezes or encourage stack ventilation.

The internal surface temperature of the wall changes with time due to change in solar radiation on wall, outer air temperature, thermo-physical properties of wall material and the inner environmental conditions. The solar radiation and outer air temperature causes a continuous change in the temperature distribution through the wall.

Thermal time lag (Fig. 1) is the time delay between the occurrence of maximum temperature at the inside and outside of wall surface during periodic flow of heat. It is expressed in hours. It increases with increase in wall thermal capacity.

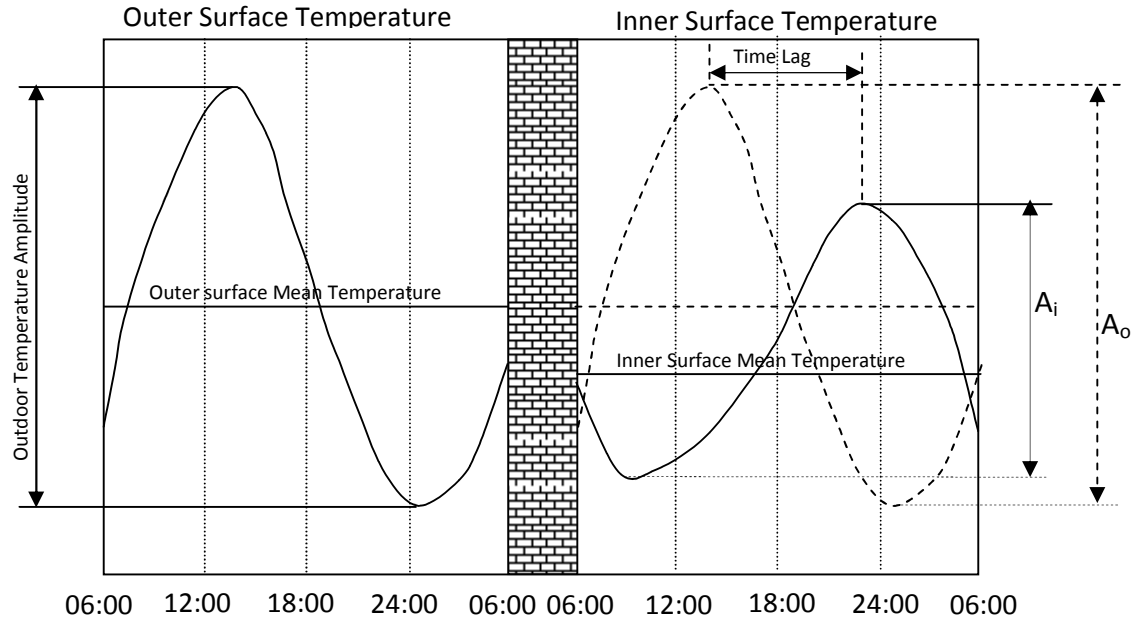


Figure 1 Indoor and Atmospheric Temperature Variations

The decrement factor (also known as attenuation factor) is the ratio between the amplitude of the inner surface temperature and that of outer surface temperature.

$$\text{Decrement factor}(DF) = \frac{\text{Amplitude of the inner surface Temperature}(A_i)}{\text{Amplitude of the outer surface Temperature}(A_o)}$$

It indicates the ability of the building element to reduce the amplitude of the temperature

$$DR = \left(\frac{A_o - A_i}{A_o} \right) \times 100 = \left(1 - \frac{A_i}{A_o} \right) \times 100 = (1 - DF) \times 100$$

variation.

Damping Ratio is defined as the ratio of difference in outside and inside temperature range to that of the outside temperature range. It is expressed in percentage. Thermal damping (D) in percentage is given as

It is the ratio of heat stored (Q) to the thermal transmittance (U) of the structure. It is expressed in

hour (h). The thermal time constant (TTC) of a composite structure is calculated as

$$TTC = \sum \frac{Q}{U} = \left(\frac{1}{f_{0a}} + \frac{L_1}{2K_1} \right) (L_1 \rho_1 c_1) + \left(\frac{1}{f_{0a}} + \frac{L_1}{K_1} + \frac{L_2}{2K_2} \right) (L_2 \rho_2 c_2) + \left(\frac{1}{f_{0a}} + \frac{L_1}{K_1} + \frac{L_2}{K_2} + \frac{L_3}{2K_3} \right) (L_3 \rho_3 c_3) + \dots$$

It indicates the time taken for the structural element to reach steady state conditions under constant thermal boundary conditions. Here, f, L, K, ρ and c represents surface convective heat transfer coefficient, thickness, thermal conductivity, density and specific heat respectively.

The thermal performance index (TPI) of a non-air-conditioned building is given by



$$TPI = \frac{(T_{is} - 30)}{8} \times 100$$

T_{is} is the peak inside surface temperature. In this equation, a temperature drop 8°C over a base temperature of 30°C is taken as a reference.

3. Thermal Performance Requirements

Indoor thermal conditions can be improved up to certain extent by judicious selection of construction materials for building components providing proper orientation for the building layout,

The main design approach is to minimize solar heat gain and to reduce wall and roof surface temperatures. Certain standard thermal performance requirements for building components in three main climatic zones of India is given in the Table 1, as recommended in BIS, 1987.

The thermal performance of a building is determined by the thermo physical properties of the constituent wall, roof, window, door, outer surface finish, orientation and climatic conditions.

4. Traditional Techniques

In ancient times, buildings had been designed to have many inbuilt passive features to create comfortable thermal environment. The components of the building were generally shaped, located and oriented to take the maximum advantage of the climate. The trees, vegetation and water bodies around the building were given vital role in determining the thermal performance of the buildings.

The design of the buildings must concentrate on passive features for optimal energy utilization. It can be achieved by suitable building orientation, insulation, window sizes and exterior colour. Passive features control the transfer of heat between the ambient atmosphere and the building by utilizing the natural processes of conduction, convection, radiation and evaporation. Passive design strategies often include: conservatories, atria, natural ventilation, thermal mass, shading etc.

The energy consumed for environmental control in the buildings represents an important sector of the gross energy. Therefore, the potentials of energy

savings by better designs of the buildings are very promising. Energy efficient measures should be borne in mind from the very beginning of building-design stages in order to achieve the best results.

The main concept of the energy efficient approach is to have the building elements acting as a specific passive filter. They must allow or impede the flow of heat to or from the building spaces, and may encourage natural cooling or heating. It would be more favourable if the heat flow could be shifted time-wise, i.e. accelerated or retarded in such a way as to be synchronized with internal heating and/or cooling requirements. In the Thar Desert of Western Rajasthan, India, the thick mud and stone walls were predominantly used to sufficiently delay the entry of daytime heat into the building interior. The entry of heat is usually delayed until night when it is least bothersome or often welcome.

The concept of building clusters were exploited by the ancient Iranian architecture for decreasing surface-to-volume ratio, thick walls for increasing the thermal storage and smoothening the temperature fluctuations, developing plantation for shading and large thermal storage capacity of the ground by building the structure under the ground. They also used the concept of wind tunnels to cool the air by the surrounding earth and in addition, evaporative cooling to ensure comfort in summer. But in the design of modern buildings, these proven passive concepts have been ignored and mechanical systems are being used for heating and cooling of the buildings. However, with the advent of energy crisis, there has been a renewed interest in passive concepts of heating and cooling of the buildings.

5. Thermo-physical Properties of Building Elements

The outer envelope of the house is made of opaque surface like walls, doors and roofs and transparent surfaces like windows. The inner surface temperature of the building envelope changes with time, since the solar radiation and outer air temperature cause a continuous change in the temperature distribution of the inner surface of the wall. It depends on solar radiation on the wall, outer air temperature, the indoor conditions and thermo-physical properties of wall and roof material. The thermo-physical properties of the elements of the residential building decide the thermal comfort of the interior space.



Wall Elements: Outer walls separate the indoor living space from the surroundings and the inner walls provide separation for different rooms. East to west facing wall accentuates a daily rhythm, while north to south facing wall emphasizes seasonal rhythm. Walls can be made of concrete or brick or

mud. Concrete block walls with suitable insulation are used in cold countries to avoid heat loss. Burnt brick, hollow brick or cavity walls are popular in many tropical countries. The inner and outer surfaces are plastered with cement mortar for the required surface finish.

Table 1 Thermal Performance Standards for India as recommended in BIS, 1987.

Building Component	Hot Dry and Humid Zones				Warm Humid Zone			
	U_{\max}	TPI_{\max}	TTC_{\min}	D_{\min}	U_{\max}	TPI_{\max}	TTC_{\min}	D_{\min}
	$W/m^2.K$	-	hrs	%	$W/m^2.K$	-	hrs	%
Roof	2.33	100	20	75	2.33	125	20	75
Exposed Wall	2.56	125	16	60	2.91	175	16	60

The thermal resistance of the building controls the quantity of heat gain or heat loss from the building. Thermal mass of the wall should be suitably decided to reduce the influence of heat gain in the structure by delaying the entry of heat into the building (generally until the indoor temperature becomes sufficiently low). Structural mass stores excess heat from the sun or from the internal sources of the building, and then releases it during the cooler periods.

The thermal mass of the material mainly influences the time lag, which is the time delay between the moment at which the outdoor temperature reaches its peak and that at which the indoor temperature reaches its peak. The time lag required for each wall orientation and roof is different as each peak heat gain occurs at a different time.

In general, Northern wall has little need for time lag due to the fact that it has very limited heat gain, if the latitude of the location of the building (in the northern hemisphere) is above tropic of Cancer. Eastern wall should not delay the morning heat load to reach the indoor in the afternoon, which will

worsen the indoor comfort. Hence eastern wall must use material with sufficiently long thermal delay.

The southern wall receives heat from morning to evening during winter and it should be delayed until sunset by using mass with medium time lag (about 8 h). The heavy thermal mass wall could retain more

heat during the winter day to warm up the room during the winter nights. Western wall may have to be designed to delay the afternoon heat to the early or late night.

Building thermal mass plays a more significant role in dry climates with high daily summer temperatures and large diurnal (daily) ranges. Insulation is more critical than thermal mass in humid climates with high summer temperatures and humidity, and small daily variations.

Colour and texture of the building surface significantly controls the heat gain through its absorptivity and reflectivity. The colour of the building surface determines its absorptivity, which is expected to be low to avoid heat gain (as required in



tropical countries) and high to promote heat gain (as required in cold countries). The absorptivity of the external surface painted in dark colour is about 0.7 and it is about 0.3 for the surface painted in light colour. Consequently, for external use, light colours are recommended in tropical climates and dark colours in cold climates.

Accumulation or absorption of moisture on the wall or roof or thermal insulation should be prevented, because it will not only affect its performance by increasing its thermal conductivity but also lead to physical damage.

Roof Elements: The roof is the protecting and closing surface on the top of the building. It is heated by the sun from the sunrise to sunset. The room with its roof exposed to the solar radiation has high heat gain. About 50% of the heat gain in the building is from the roof. The actual heat gain through the roof depends on the heat transmittance factor of the roof. The heat transfer through the roof can be reduced with suitable insulation embedded in the roof or suspended insulation on the inner side of the roof.

The roof can also be cooled by evaporative cooling, roof pond cooling and reflective cooling. Insulating roof is more important, compared to wall due to its prolonged exposure to sunlight. The roof must have a very long time lag so as to delay the entry of heat into the room till the late evening, when it is relatively cool. As it is both expensive and impracticable to place heavy mass on the roof, additional insulation may be provided for the roof. The use of suitable insulation material in the roof can greatly reduce the heat gain. Thermal load is found to be decreased by 35% when the ceiling is properly insulated.

Thermal Insulation Materials: Thermal insulation is a material or combination of materials, which is used to resist heat transfer across the building envelope by conduction, convection, and radiation. The use of building insulation is compulsory in European countries for the last thirty years to ensure improved thermal behavior.

Thermal insulation can play a major role in controlling the heat transfer (gain or loss) between the indoor space and the environment, especially in envelope-load dominated buildings (like residential buildings) located in sites with harsh climatic conditions. Therefore, enough attention must be paid at the design stage to select suitable material for building envelope and to integrate them into the

building components. Selection of suitable thermal insulation is more critical in climates with extreme seasonal variations and small daily variations.

The thermal mass of a building is the basic requirement for damping the indoor temperature fluctuations. It is indicated by thermal capacity of the building material and it is the product of the mass and specific heat of the material. It is responsible for delaying heat transfer through the building structure over a period of time.

A suitable value of thermal mass for a building structure is determined by the seasonal and daily temperature variations, which determine the need for thermal resistance and mass of the building structure. Thermal mass of the building plays a vital role in reducing the fluctuations in the indoor temperatures of hot-dry climates with large diurnal ranges, by suitably altering the time lag.

6. Solar Active Techniques

Solar powered electrical generation can be realized through solar thermal collector and photovoltaic technology. Other solar applications include space heating and cooling through solar architecture, day lighting, solar hot water, solar cooking, and high temperature process heat for industrial purposes.

Solar water heating or solar hot water (Fig. 2) is water heated by the use of solar energy. Solar heating systems are generally composed of solar thermal collectors, a water storage tank or point of usage, interconnecting pipes and a fluid system to move the heat from the collector to the tank. The water can be heated for a wide variety of uses, including home, business and industrial uses. Heating swimming pools, under floor heating or energy input for space heating or cooling are common examples of solar water heating. A solar water heating system can form part of a solar thermal cooling system, promoting efficient temperature control of buildings or parts thereof. During cool conditions, the same system can provide hot water.

Solar thermal technologies have been considered and developed over decades. Most of the technical problems have been resolved. However, thermal losses from heat storage are usually greater than expected. Even if they use quality collectors and products, systems may not work properly if not installed carefully – and this requires a different



knowledge than installing other water heaters, not to mention central heating systems. Another technical barrier is the lack of trained and competent installers in most markets.

A solar cell is a device to convert solar light directly into electricity by the photoelectric effect. Number of cells is assembled to make solar panels, solar modules, or photovoltaic arrays. Photovoltaic is the field of technology and research related to the application of solar cells to generate electricity, which is also known as solar power (Fig. 3).



Fig.2 solar hot water system mounted on the roof

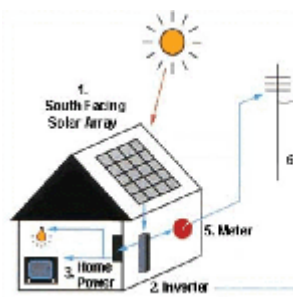


Fig. 3 Solar Photovoltaic panels mounted on the roof to produce electrical energy.

As of October 2009, the largest photovoltaic (PV) power plants in the world is at Olmedilla (municipality in Cuenca, Castile-La Mancha, Spain) Photovoltaic Park (60 MW). It is built in 2008 and uses more than 160,000 solar photovoltaic panels to generate 60 megawatts (peak). It produces enough electricity to power more than 40,000 homes.

7. Construction Activities and Environmental Issues.

Construction activities in India have been pursued without giving much attention on environmental issues. This has resulted in pressure on its finite natural resources, besides creating impacts on human health and well-being. Unplanned and unsustainable urban development has lead to severe environmental pressures. The green cover and ground water resources have been severely depleted to give way to urban centres.

Modern buildings in our cities have high levels of energy consumption because of requirements of air-conditioning and lighting. At national level, domestic and commercial buildings account for more than 30% of annual electricity consumption. Many studies show that air-conditioning and lighting are two most energy consuming end-uses in the building sector. About 50–60% of energy consumed in a fully air-conditioned building is by air-conditioning followed by 20% by lighting. During the past quarter of a century, a significant thrust has been given to the development, trial and inclusion of a variety of technologies which can meet our energy needs on a sustainable basis and are environmentally acceptable.

8. Conclusion

Application of the new green technologies, which are combination of traditional energy and modern science, can provide a means for reducing the demand on our energy supply system by buildings constructed throughout the country, while at the same time providing a high level of indoor-living-comfort. Such a modern approach to blend the modern science with traditional knowledge helps to come up with a structure that is pleasant and at the same time aesthetically attractive as well as climatically attuned to its surroundings for providing comfort to its occupants. A blend of techniques which could be a combination of modern science and traditional knowledge must be used to make the modern structures into energy efficient buildings.

A thermal envelope deals with everything about the house that serves to shield the living space from the outdoors. It includes the wall, roof assemblies, insulation and windows. The Optimum Value Engineering can be used to optimize the use of building materials to get maximum effective results with better savings, without compromising a structurally sound house.

An energy-efficient building balances all aspects of energy use in a building including energy required for lighting, space-conditioning, and ventilation. It can generally achieved by providing an optimized mix of passive solar design strategies, energy-efficient equipments, and renewable sources of energy, besides the use of materials with low embodied energy.

Passive Houses are buildings which ensure a comfortable indoor climate in summer and in winter



without needing a conventional heating system. A generally accepted way of building passive houses has been to have small windows facing north and large windows to the south. This is to minimize unwanted heat gain during summer on the north side while gaining as much solar heat as possible on the south during winter. Heat losses during winter can be miniized by well insulating the building envelope.

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Environmental Application and Energy Conservation Used For Reduction of Stack Gas Emmissions in the Petrochemical Industry

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INTRODUCTION

ABSTRACT-Flue gas desulfurization (FGD) is the current state-of-the art technology used for removing sulfur dioxide (SO₂) from the exhaust stack gases in petrochemical refineries that burn coal or oil to produce steam for the steam turbines that drive their electricity generators. Before flue gas desulfurization was installed, the emissions from plant are in excessive amounts of sulfur dioxide. Sulfur dioxide is responsible for acid rain formation. Tall flue gas stacks disperse the emissions by diluting the pollutants in ambient air and transporting them to other regions. Sulfur dioxide exhaust should be removed, rather than emitted high into the atmosphere where it affects many more people. A number of countries now have regulations limiting the height of flue gas stacks. As a result of stringent environmental protection regulations regarding SO₂ emissions that have been enacted in a great many countries. For a typical coal-fired power station, FGD will remove 95 percent or more of the SO₂ in the flue gases. The flue gas temperature must be measured in the hottest part of the gas stream. Generally this will be in the centre of the flue, but eddy effects may cause it to be slightly displaced. It is vital to have the correct fuel programmed into the flue gas analyzer before measuring combustion efficiency. The fuel parameters have a noticeable effect on the value of combustion efficiency, and failure to follow this step will result in erroneous data.

Key words: Emissions, Desulphurization, Sulphur dioxide, Combustion

Methods for removing sulfur dioxide from boiler and furnace exhaust gases have been studied for over 150 years. Early concepts useful for flue gas desulphurization appear to have germinated in England circa 1850. With the construction of large scale power plants in England in the 1920s, the problems associated with large volumes of SO₂ from a single site began to concern the public. The SO₂ emissions problem did not receive much attention until 1929(1). Shortly thereafter a press campaign was launched against the erection of power plants. This outcry led to the imposition of SO₂ controls on all such power plants. During this period, major FGD installations went into operation. These three early large-scale FGD installations were abandoned during World War II(2). Large-scale FGD units did not reappear in commercial operation at utilities until the 1970s. As of June 1973, there were 42 FGD units, ranging in size from 5 MW to 250 MW, in operation: 36 in Japan and 6 in the United States(3). As of about 1999-2000, FGD units were being used in 27 countries and there were 678 FGD units operating on a total power plant capacity of about 229 gigawatts(4). About 45% of that FGD capacity was in the U.S., 24% in Germany, 11% in Japan and 20% in various other countries. Approximately 79% of the units, representing about 199 gigawatts of capacity were using lime or limestone wet scrubbing(5). About 18% (or 25



gigawatts) utilized spray-dry scrubbers or sorbent injection systems.

EXPERIMENTAL WORK

Fossil fuels such as coal and oil contain significant amounts of sulfur. When burned, about 95 percent or more of the sulfur is generally converted to sulfur dioxide (SO₂). This happens under normal conditions of temperature and of oxygen present in the flue gas. However, there are circumstances under which this may not be the case.

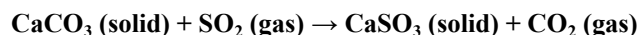
For example, when the flue gas has too much oxygen and the SO₂ is further oxidized to sulfur trioxide (SO₃). Actually, too much oxygen is only one of the ways that SO₃ is formed. Gas temperature is also an important factor. At about 800 °C, formation of SO₃ is favoured. Another way that SO₃ can be formed is through catalysis by metals in the fuel. This is particularly true for heavy fuel oil, where significant amounts of vanadium are present. However, SO₃ is formed, it does not behave like SO₂ in that it forms a liquid aerosol known as sulfuric acid mist that is very difficult to remove. Generally, about 1% of the sulfur dioxide will be converted to SO₃. Sulfuric acid mist is often the cause of the blue haze that often appears as the flue gas plume dissipates. Increasingly, this problem is being addressed by the use of wet electrostatic precipitators

SO₂ is now being removed from flue gases by a variety of methods like

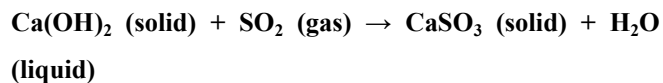
- Wet scrubbing using a slurry of sorbent, usually limestone or lime, to scrub the gases.
- Spray-dry scrubbing using similar sorbent slurries.
- Dry sorbent injection systems.

SO₂ is an acid gas and thus the typical sorbent slurries or other materials used to remove the SO₂ from the flue gases are alkaline.

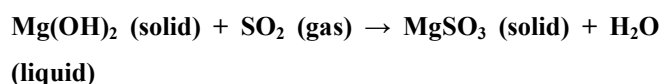
The reaction taking place in wet scrubbing using a CaCO₃ (limestone) slurry produces CaSO₃ (calcium sulfite) and can be expressed as:



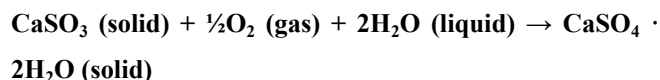
When wet scrubbing with a Ca(OH)₂ (lime) slurry, the reaction also produces CaSO₃ (calcium sulphite) and can be expressed as:



When wet scrubbing with a Mg(OH)₂ (magnesium hydroxide) slurry, the reaction produces MgSO₃ (magnesium sulphite) and can be expressed as:



Some FGD systems go a step further and oxidize the CaSO₃ (calcium sulphite) to produce marketable CaSO₄ · 2H₂O



To promote maximum gas liquid surface area and contact time, a number of wet scrubber designs have been used.

Common ones are:

- Venturi Scrubber
- Packed Bed Scrubbers
- Spray Tower

VENTURI SCRUBBER

A Venturi Scrubber is a converging/diverging section of duct. The converging section accelerates the gas stream to high velocity. When the liquid stream is injected at the throat, which is the point of maximum velocity, the turbulence caused by the high gas velocity atomizes the liquid into small droplets, which creates the surface area necessary for mass transfer to take place. The higher the pressure drop in the venturi, the smaller the droplets and the higher the surface area. The penalty is in power consumption.



PACKED BED SCRUBBERS

A packed scrubber consists of a tower with packing material inside. This packing material can be in the shape of saddles, rings or some highly specialized shapes designed to maximize contact area between the dirty gas and liquid. Packed towers typically operate at much lower pressure drops than venturi scrubbers and are therefore cheaper to operate. They also typically offer higher SO₂ removal efficiency. The drawback is that they have a greater tendency to plug up if particles are present in excess in the exhaust air stream.

SPRAY TOWER

A spray tower is the simplest type of scrubber. It consists of a tower with spray nozzles, which generate the droplets for surface contact. Spray towers are typically used when circulating a slurry (see below). The high speed of a venturi would cause erosion problems, while a packed tower would plug up if it tried to circulate a slurry.

Countercurrent packed towers are infrequently used because they have a tendency to become plugged by collected particles or to scale when lime or limestone scrubbing slurries are used.

RESULTS AND DISCUSSION

Alkaline sorbents are used for scrubbing flue gases to remove SO₂. Depending on the application, the two most important are lime and sodium hydroxide (also known as caustic soda). Lime is typically used on large coal or oil fired boilers as found in power plants, as it is very much less expensive than caustic soda. The problem is that it results in a slurry being circulated through the scrubber instead of a solution. This makes it harder on the equipment. A spray tower is typically used for this application. The use of lime results in a slurry of calcium sulfite (CaSO₃) that must be disposed of. Fortunately, calcium sulfite can be oxidized to produce by-product gypsum (CaSO₄ · 2H₂O) which is marketable for use in the building products industry(6).

Caustic soda is limited to smaller combustion units because it is more expensive than lime, but it has the advantage that

it forms a solution rather than a slurry. This makes it easier to operate. It produces a solution of sodium sulfite/bisulfite (depending on the pH), or sodium sulfate that must be disposed of. This is not a problem in a kraft pulp mill for example, where this can be a source of makeup chemicals to the recovery cycle(7).

It is possible to scrub sulfur dioxide by using a cold solution of sodium sulfite, this forms a sodium hydrogen sulfite solution. By heating this solution it is possible to reverse the reaction to form sulfur dioxide and the sodium sulfite solution.

In some ways this can be thought of as being similar to the reversible liquid-liquid extraction of an inert gas such as xenon or radon (or some other solute which does not undergo a chemical change during the extraction) from water to another phase. While a chemical change does occur during the extraction of the sulfur dioxide from the gas mixture, it is the case that the extraction equilibrium is shifted by changing the temperature rather than by the use of a chemical reagent.

The action of the electron beam is to promote the oxidation of sulfur dioxide to sulfur(VI) compounds. The ammonia reacts with the sulfur compounds thus formed to produce ammonium sulfate which can be used as a fertilizer according to the IAEA. In addition, it can be used to lower the nitrogen oxide content of the flue gas.

CONCLUSION

Flue gas desulfurization scrubbers have been applied to combustion units firing coal and oil that range in size from 5 MW to 1500 MW. Scottish Power are spending £400 million installing FGD at Longannet power station which has a capacity of over 2 GW. Dry scrubbers and spray scrubbers have generally been applied to units smaller than 300 MW.

Approximately 85% of the flue gas desulfurization units installed in the US are wet scrubbers, 12% are spray dry systems and 3% are dry injection systems.



The highest SO₂ removal efficiencies (greater than 90%) are achieved by wet scrubbers and the lowest (less than 80%) by dry scrubbers. However, the newer designs for dry scrubbers are capable of achieving efficiencies in the order of 90%.

In spray drying and dry injection systems, the flue gas must first be cooled to about 10-20 °C above adiabatic saturation to avoid wet solids deposition on downstream equipment and plugging of baghouses.

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Advanced Technologies for Industrial Wastewater Treatment – A Review

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Abstract— It is important to treat wastewater to remove bacteria, pathogens, organic matter and chemical pollutants that can harm human health, deplete natural oxygen levels in receiving waters, and pose risks to animals and wildlife. Effective wastewater collection and treatment are of great importance from the standpoint of both; environmental and public health. The use of conventional water and wastewater treatment processes becomes increasingly challenged with the identification of more and more contaminants, rapid growth of population and industrial activities, and diminishing availability of water resources and hence, introduction of newer technologies to degrade these refractory molecules into smaller molecules, which can be further oxidized by biological methods, has become imperative. Among them, Membrane technology (nanofiltration, ultrafiltration, microfiltration, reverse osmosis); Advanced oxidation processes (AOPs), and UV irradiation have been proven to successfully remove a wide range of challenging contaminants and hold great promise in wastewater treatment. This paper presents an overview of these technologies and processes which are used for wastewater treatment in order to remove the various constituents of the polluting load.

Key words: Wastewater treatment; Membrane technology; Advanced oxidation processes; UV irradiation; Membrane Bioreactor

1. Introduction

One of the most pervasive problems affecting people throughout the world is inadequate access to clean water and sanitation. Addressing these problems calls out for a tremendous amount of research to be conducted to identify robust new methods of purifying water at lower cost and with less energy, while at the same time minimizing the use of chemicals and impact on the environment. In developing and developed countries, rapid urbanization and the consequent growing demand for potable-useable and industrial water is necessitating costly, large-scale projects. Almost all countries identify the most critical part of

industrial water use with its pollution. Therefore, industrial growth is bound to impact heavily on water quality, with potentially harmful follow-up on human

health and posing severe social concerns. This impact could be enhanced by the overlapping effects of industry, urbanization and tourism, and the situation will predictably worsen if nothing is done about it.

Due to increasing awareness about the environment and more stringent environmental regulations, treatment of industrial wastewater has always been a key aspect of research. Much work has been done in developing and testing newer techniques and their combinations for wastewater treatment either individually or as a supplementary role to the conventional biological and chemical method.

2. Conventional wastewater treatment processes

Conventional wastewater treatment consists of a combination of physical, chemical, and biological processes and operations to remove solids, organic matter and, sometimes, nutrients from wastewater. It undergoes multistage treatment involving preliminary, primary, secondary, and tertiary treatment in the order of increasing treatment level.

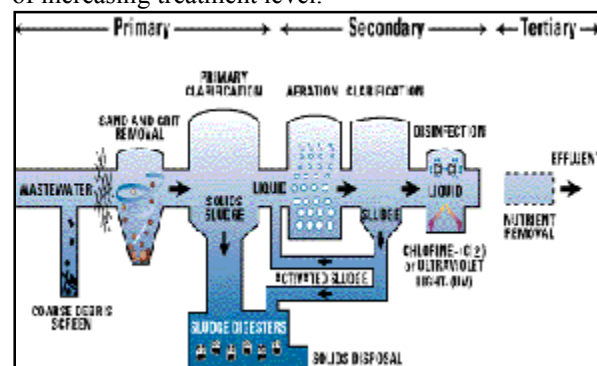


Fig1. Waste water treatment process
2-a. Preliminary treatment



The objective of preliminary treatment is the removal of coarse solids and other large materials often found in raw wastewater. Generally bar screens are used to remove the items. Another component of Preliminary Treatment is the grit channel where the velocity of the incoming wastewater is carefully controlled to allow sand, grit, and stones to settle to the bottom of the channel while keeping the majority of the suspended organic material in the water column

2-b. Primary treatment

The objective of primary treatment is the removal of settleable organic and inorganic solids by sedimentation commonly called primary clarifiers or primary sedimentation tanks, and the removal of materials that will float (scum) by skimming. Primary clarifiers are usually equipped with mechanically driven scrapers that continually drive the collected sludge towards a hopper in the base of the tank from where it can be pumped to further sludge treatment stages. The effluent from primary sedimentation units is referred to as primary effluent. The clarified water flows on to the next step of treatment.

2-c. Secondary Treatment

Secondary treatment follows primary treatment and involves the removal of 90% biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes. The two most common conventional methods used to achieve secondary treatment are attached growth processes and suspended growth processes.

Attached Growth Processes In attached growth (or fixed film) processes, bacteria, algae, fungi and other microorganisms grow and multiply on the surface of stone or plastic media, forming a microbial growth or slime layer (biomass) on the media. Attached growth process units include trickling filters, biotowers, and rotating biological contactors.

Suspended Growth Processes In suspended growth processes, the microbial growth is suspended in an aerated water mixture where the air is pumped in, or the water is agitated sufficiently to allow oxygen transfer. In the aeration tank, wastewater is vigorously mixed with air and microorganisms acclimated to the wastewater in a suspension for several hours. This allows the bacteria and other microorganisms to break down the organic matter in the wastewater. Suspended growth process units include variations of

activated sludge, oxidation ditches and sequencing batch reactors.

Lagoon Systems are shallow basins which holds the waste water for several months to allow for natural degradation of nutrients and organic matter and are used in smaller plants (<1million gallons per day)

2-d. Tertiary treatment

Tertiary treatment involves advanced treatment processes that generate a higher quality effluent than secondary treatment can produce. After biological treatment, the water is pumped to secondary clarifiers where any leftover solids and the microorganisms sink to the bottom. These solids are handled separately from the supernatant which continues on to disinfection.

Disinfection is also typically included in the definition of conventional secondary treatment. The purpose of disinfection in the treatment of wastewater is to substantially reduce the number of microorganisms in the water to be discharged back into the environment and is almost always the final step in the treatment process regardless of the level or type of treatment used.

2-e. Nutrients Removal

Advanced technologies based on Anammox processes

The removal of nitrogen from wastewater is generally carried out by the conventional processes of nitrification and denitrification. Autotrophic nitrogen removal can be achieved by the combination of the partial nitrification to nitrite of half of the ammonium in the influent and a subsequent ANaerobic AMMonium OXidation (Anammox process) step. Both processes can be carried out in a two-units configuration (i.e., Sharon and Anammox) or in a single-unit configuration. The combination of partial nitrification and Anammox to treat wastewaters with high nitrogen content and without organic matter gives some advantages compared to the conventional nitrification-denitrification process:

Phosphorus removal can also be achieved by chemical precipitation, usually with salts or iron, alum, or lime. This may lead to excessive sludge productions as hydroxides precipitates and the added chemicals can be expensive. Despite this, chemical phosphorus



removal requires a significantly smaller equipment footprint than biological removal, is easier to operate, and is often more reliable than biological phosphorus removal

3. Membrane filtration technology

Membrane filtration can be broadly defined as a separation process that uses semi permeable membrane to divide the feed stream into two portions: a permeate that contains the material passing through the membranes, and a retentate consisting of the species being left behind (Mallevialle et al. 1996). More specifically, membrane filtration can be further classified in terms of the size range of permeating species, the mechanisms of rejection, the driving forces employed, the chemical structure and composition of membranes, and the geometry of construction.

For wastewater treatment applications, membranes are currently being used as a tertiary advanced treatment for the removal of dissolved species; organic compounds; phosphorus; nitrogen species; colloidal and suspended solids; and human pathogens, including bacteria, protozoan cysts, and viruses.

The most important types of membrane filtration are pressure driven processes including microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO)

Table 1 – Membrane type and characteristics

Membrane process	Membrane type	Pore size (nm)	Hydrostatic Pressure (bar)	Product
Reverse Osmosis	Asymmetric composite with homogeneous layer	dense	>20 bars	Pure water (PW)
Nanofiltration	Asymmetric	1–5nm	4-20 bars	PW and low molecular solutes
Ultrafiltration	Asymmetric microporous	5 – 100 nm	1-9 bars	All above and macromolecules
Microfiltration	Symmetric	50n	0.5 – 5	All above

ation	ic and asymmetric microporous	m – 5µm	bars	and colloids
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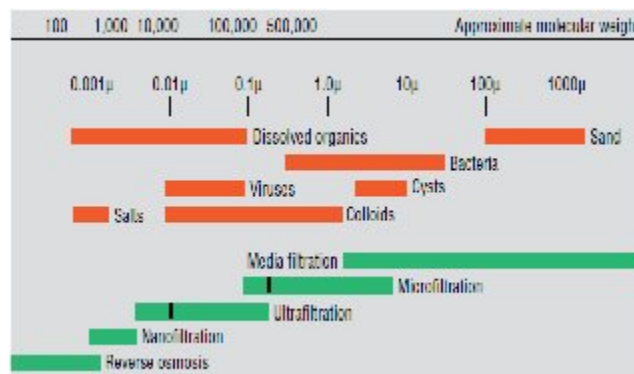


Fig2. Molecular weight cut-off (MWCO)/pore size ranges for various membrane processes

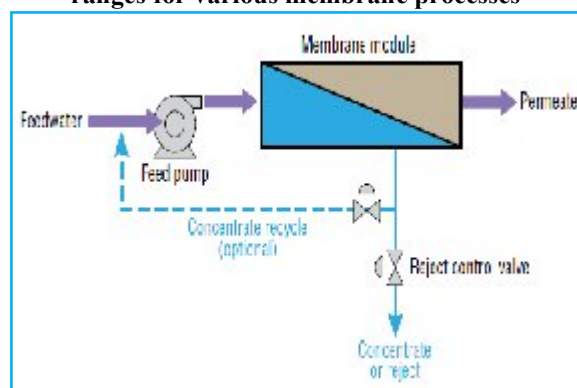


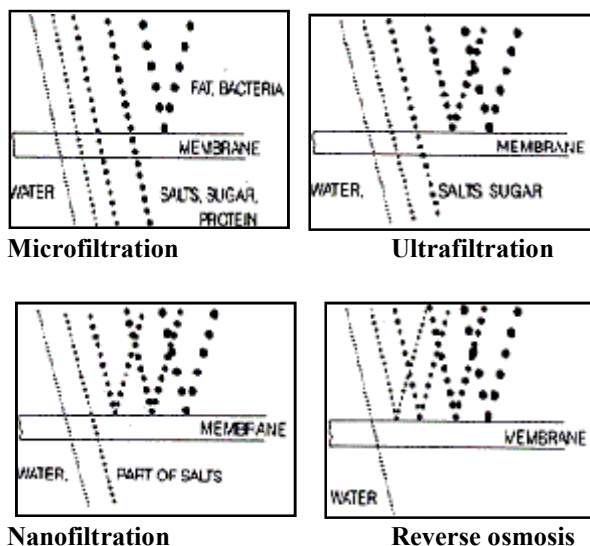
Fig3. Simplified flow schematic for pressure-driven membrane process

Membrane technologies for wastewater treatment include:

- Membrane bioreactors—usually microfiltration (MF) or ultrafiltration (UF) membranes immersed in aeration tanks (vacuum system), or implemented in external pressure-driven membrane units, as a replacement for secondary clarifiers and tertiary polishing filters.
- Low-pressure membranes—usually MF or UF membranes, either as a pressure system or an immersed system, providing a higher degree of suspended solids removal following secondary clarification. UF membranes are effective for virus removal.



- High-pressure membranes—nanofiltration or reverse osmosis pressure systems for treatment and production of high-quality product water suitable for indirect potable reuse and high-purity industrial process water. Also, recent research has shown that microconstituents, such as pharmaceuticals and personal care products, can be removed by high-pressure membranes.



3-a. Membrane Bioreactor (MBR)

Membrane Bioreactor is an effective and economic treatment process for water reuse and reclamation. Advanced membrane technology development includes membrane bioreactors and multibarrier reclamation processes using dual membrane stages. A common water reclamation process is by integrating MBR and RO (Reverse Osmosis) to produce high quality product water for reuse. Membrane Bioreactors combine conventional biological treatment processes with membrane filtration to provide an advanced level of organic and suspended solids removal.

Compared with conventional activated sludge system, the membrane bioreactor system is much simpler, as shown below.

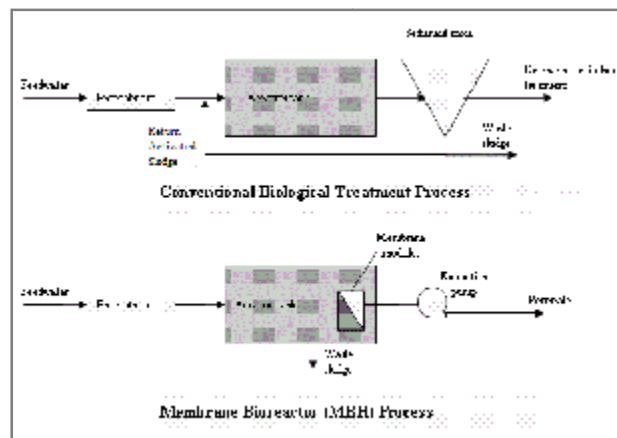


Fig4. Comparison of MBR and Conventional Biological treatment

4. Advanced Oxidation Processes (AOP)

Advanced oxidation processes (AOPs) are widely used for the removal of recalcitrant organic constituents from industrial and municipal wastewater. AOPs involve the two stages of oxidation:

- 1) The formation of strong oxidants (e.g., hydroxyl radicals) and
- 2) The reaction of these oxidants with organic contaminants in water.

However, the term advanced oxidation processes refer specifically to processes in which oxidation of organic contaminants occurs primarily through reactions with hydroxyl radicals (Glaze et al., 1987). In water treatment applications, AOPs usually refer to a specific subset of processes that involve O_3 , H_2O_2 , and/or UV light. In general, the effectiveness of an AOP is proportional to its ability to generate hydroxyl radicals

The generation of hydroxyl is highly accelerated by combining ozone (O_3), hydrogen peroxide (H_2O_2), titanium dioxide (TiO_2), heterogeneous photocatalysis, UV radiation or high electron beam radiation. Various types of AOPs include Ozone/ H_2O_2 , Ozone/UV/ H_2O_2 , Ozone/ TiO_2 / H_2O_2 , Ozone/ TiO_2 /Electron beam irradiation, H_2O_2 /UV, H_2O_2/Fe^{+2} , H_2O_2 /UV/ Fe^{+2} , Ozone/UV.

Table 2. Classification of advanced oxidation processes

Non-photochemical processes	Photochemical processes
Ozonation in an alkali medium (O_3/OH^-)	Water photolysis in vacuum ultraviolet
Ozonation with hydrogen	UV/hydrogen peroxide

peroxide ($\text{O}_3/\text{H}_2\text{O}_2$)	
Fenton and related processes ($\text{Fe}^{2+}/\text{H}_2\text{O}_2$)	UV/Ozone
Electrochemical oxidation	Photo-Fenton related processes
Ozone/Titanium dioxide/hydrogen peroxide	Titanium dioxide/UV
Ozone/Titanium dioxide	Ozone/UV/Hydrogen peroxide
Hydrodynamic cavitation	Sonochemical cavitation
	High energy electron beam irradiation

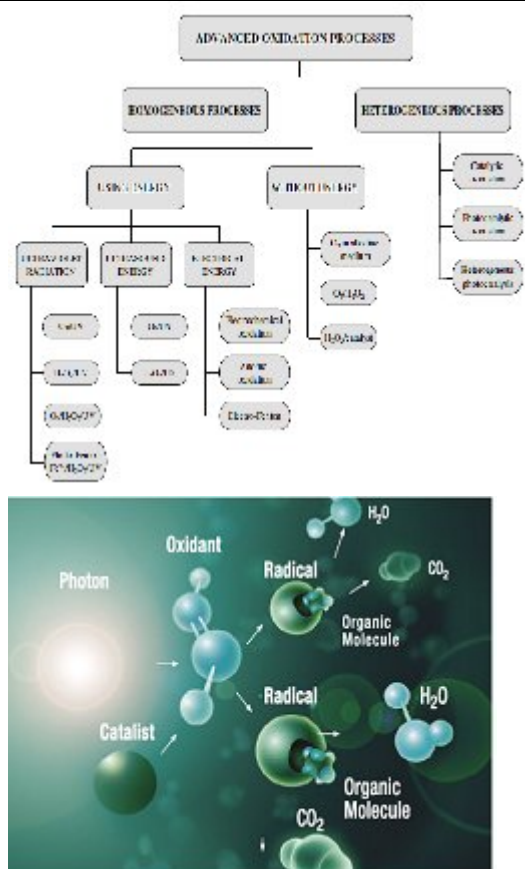


Fig 5.6. Various Processes involving Advanced Oxidation Process and its mechanism

Use of AOPs in Wastewater Treatment

4-a. Titanium dioxide/UV light process

In TiO₂/UV light process, a titanium peroxide semiconductor absorbs UV light and generates hydroxyl radicals. Specifically, during UV illumination of TiO₂, conduction band electrons and valence band holes are initially yielded (Eq. 1). Band

electrons interact with surface adsorbed molecular oxygen to yield superoxide radical anions (Eq. 2), while band holes interact with water to produce hydroxyl radical (Eq. 3) (Crittenden *et al.*, 2005):

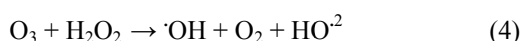


So far, TiO_2/UV light process has been extensively used for wastewater treatment. The key advantages of this process are the operation at ambient conditions, the lack of mass transfer limitations when nanoparticles are used as photocatalysts and the possible use of solar irradiation. Moreover, TiO_2 is a cheap, readily available material and the photogenerated holes are highly oxidizing. In addition, TiO_2 is capable for oxidation of a wide range of organic compounds into harmless compounds such as CO_2 and H_2O .

4-b. Ozonation with hydrogen peroxide (O_3/H_2O_2)

Ozone is a powerful oxidant. It has bactericidal properties and is commonly used for drinking water disinfection. Used with Hydrogen peroxide the combined oxidizing power may result in rapid mineralization of compounds. Ozonation of organic compounds may go through two types of pathways, molecular ozone reactions (ozonolysis) or hydroxyl radical reactions. The path taken by the reaction depends on pH

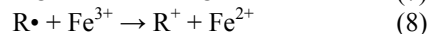
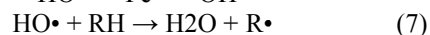
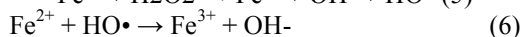
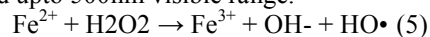
The general equation written by Domenech is



There are commercial equipments available to use this technology, which is suitable for water with high turbidity where radiation would be impeded.

4-c. Fenton and Fenton like techniques

Fenton's reagent, a mixture of ferrous iron (catalyst) and hydrogen peroxide (oxidizing agent), has been known as a powerful oxidant for organic contaminants. Ferric complexes can absorb in the near UV and upto 500nm visible range.





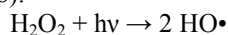
The photo Fenton process ($\text{H}_2\text{O}_2/\text{Fe}^{2+}/\text{UV}$) involves the $\text{HO}\cdot$ formation through photolysis of hydrogen peroxide ($\text{H}_2\text{O}_2/\text{UV}$) and Fenton reaction ($\text{H}_2\text{O}_2/\text{Fe}^{2+}$). In the presence of UV irradiation, the ferric ions (Fe^{3+}) produced in Equation 5 are photocatalytically converted to ferrous ions (Fe^{2+}), with formation of an additional equivalent of hydroxyl radical (Moraes et al., 2004).

In a recent study investigating COD removal from oil recovery industry wastewater using Fenton process, Dincer et al. (2008) reported that 86% reduction of COD was achieved for H_2O_2 to Fe^{2+} mass ratio equal to 8.7 (w/w) (initial COD = 21000 mg l⁻¹, reaction time = 60 min, pH = 3). When photo Fenton process was used for the treatment of diluted wastewater, COD removal equal to 81% was achieved (initial COD = 4200 mg l⁻¹, reaction time = 210 min, $\text{H}_2\text{O}_2/\text{Fe}^{2+}$ = 168 w/w, pH = 3).

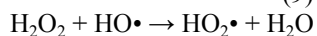
Fenton and photo Fenton processes have been used for the treatment of several types of wastewater including those produced in dye manufacture, pulp bleaching, agricultural processing and chemical manufacture. Moreover, biological wastewater treatment may be improved with the addition of a Fenton pretreatment step.

4-d. Hydrogen peroxide/UV light process

Photolysis of hydrogen peroxide is achieved using mercury UV lamps of low or moderate pressure. This process includes H_2O_2 injection and mixing followed by a reactor that is equipped with UV light (200 to 280 nm). During this process, ultraviolet radiation is used to cleave the O-O bond in hydrogen peroxide and generate the hydroxyl radical. The reactions describing UV/ H_2O_2 process are presented below (Buxton et al., 1988):



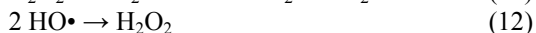
(9)



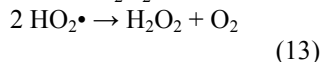
(10)



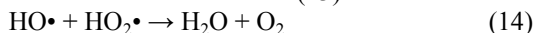
(11)



(12)



(13)



(14)

UV/ H_2O_2 process is efficient in mineralizing organic pollutants. A disadvantage of this process is that it cannot utilize solar light as the source of UV light due to the fact that the required UV energy for the photolysis of the oxidizer is not available in the solar spectrum (Niaounakis and Halvadakis, 2006).

5. UV Irradiation - UV as an effective technology for water disinfection

UV disinfection of wastewater has become an accepted alternative to chemical methods of disinfection for secondary and tertiary quality wastewater. Ultraviolet (UV) is that part of electromagnetic light bounded by the lower wavelength extreme of the visible spectrum and the X-ray radiation band. Using the CIE classification the UV spectrum is subdivided into three bands: UVA (long-wave) from 315 to 400 nm, UVB (medium-wave) from 280 to 315 nm and UVC (short-wave) from 100 to 280 nm.

A strong germicidal effect is provided by radiation in the short-wave UVC band, with 265 nm being the optimum wavelength. UV-C is known to deactivate (break the DNA of) germs. Once the DNA of a microbe is broken it loses its ability to reproduce. Bacteria and viruses that cannot reproduce are rendered harmless. Bacteria, protozoa and viruses are also susceptible to UV-C radiation.

An Ultraviolet (UV) disinfection system transfers electromagnetic energy from a mercury arc lamp to an organism's genetic material (DNA and RNA). When UV radiation penetrates the cell wall of an organism, it destroys the cell's ability to reproduce.

UV radiation, generated by an electrical discharge through mercury vapor, penetrates the genetic material of microorganisms and retards their ability to reproduce.

The main components of a UV disinfection system are mercury arc lamps, a reactor, and ballasts. The source of UV radiation is either the low-pressure or medium-pressure mercury arc lamp with low or high intensities. There are two types of UV disinfection reactor configurations that exist: contact types and noncontact types. In both the contact and the noncontact types, wastewater can flow either perpendicular or parallel to the lamps. In the contact reactor, a series of mercury lamps are enclosed in quartz sleeves to minimize the cooling effects of the wastewater. Figure 6. shows two UV contact reactors with submerged lamps placed parallel and perpendicular to the direction of the wastewater flow

The effectiveness of UV disinfection is directly related to the dose absorbed by the target microorganisms. The UV dose delivered within a reactor is defined as the product of the average UV intensity within the reactor multiplied by the contact time of the liquid passing through the reactor. Dose units are often given as milliwatt-seconds per square centimeter (mW-s/cm²). The required UV dosage for any specific treatment plant will vary depending upon the treatment



process, quality of water being disinfected and the targeted microorganisms. Table 2-1 summarizes the estimated amount of UV dosage required to achieve 3-log (99.9%) inactivation of several common types of microorganisms.

Table 3: UV Dose to Achieve 3-Log (99%) Inactivation of Various Microorganisms

Microorganism	Dose (mW-s/cm ²)	Microorganism	Dose (mW-s/cm ²)
Bacteria		Viruses	
Bacillus anthracis	8.7	Bacteriophage	6.6
Bacillus subtilis, spores	58	Hepatitis virus	8
Bacillus subtilis, vegetative	11	Influenza virus	6.6
Clostridium tetani	22	Polio virus	21
Corynebacterium diphtheriae	6.5	Rota virus	24
Escherichia coli	7	Protozoa	
Legionella pneumophila	3.8	Nematode eggs	92
Sarcina lutea	2.6	Paramecium	200
Mycobacterium tuberculosis	10	Yeast	
Pseudomonas aeruginosa	10.5	Baker's yeast	8.8
Salmonella enteritidis	7.6	Saccharomyces	17.6
Salmonella typhosa	6		
Shigella dysenteriae	4.2		
Staphylococcus aureus	3.4		
Vibrio cholerae (V.comma)	6.5		

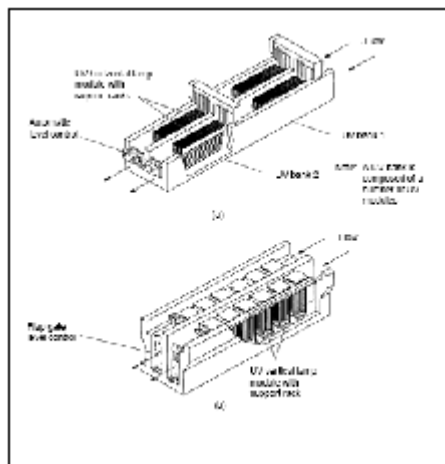


Fig7. shows two UV contact reactors with submerged lamps placed parallel and perpendicular to the direction of the wastewater flow

Conclusion:

Understanding the nature of wastewater is fundamental to design appropriate wastewater treatment process, to adopt an appropriate procedure, determination of acceptable criteria for the residues, determination of a degree of evaluation required to validate the procedure and decision on the residues to be tested based on toxicity therefore, it is necessary to ensure the safety, efficacy and quality of the treated wastewater.

These technology processes must be developed in order to enhance treatment in an industrial scale instead of laboratory scale. In general, AOPs are cheap to install but still expensive to operate owing to the usage of costly chemicals such as H₂O₂, increased energy consumption, etc. Cutting down treatment costs will make AOPs attractive to the water industry; a step in this direction is the use of renewable energy sources to power the processes as exemplified in the case of solar photocatalysis. Different AOP techniques have been developed thus allowing to make choices the most appropriate for the specific treatment problems



The comparison between the conventional processes and the membrane bioreactor has shown that the use of varying combinations of different processes for different applications in varying environments is the best option economically, socially, environmentally and sustainably.

Wastewater utilities can also consider implementing UV disinfection for WWTP effluent in lieu of chlorine, particularly where a treatment plant must implement dechlorination and uses an existing chlorine contact chamber. UV was shown to effectively disinfect WWTP filtered water and bioclarifier effluent while mitigating the effluent toxicity concerns associated with residual chlorine.

Selection of the most appropriate UV disinfection technology depends on several factors, including flow, existing WWTP configuration, discharge limitations, unit power cost and required UV dose

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Nanotechnology: To Secure Our Environment

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Abstract— In today's modern era of Science and Technology, we need to choose those Technologies, which are future based and can be proved useful in tackling the difficult situations like there are various diseases which still don't have any solutions in this present age. We have to adhere to those solutions which have the power to save the universe from such deadly problems. In this paper we present such an alternative technology called as Nanotechnology to solve these types of problems. Nanotechnology presents a wide range of problems and opportunities: not just diverse issues, but different kinds of issues. These issues must be addressed by more than one kind of organization, based on more than one system of ethics. The Nano world is very very small as here we talk about the atoms, molecules and etc. behind which there lie untraced mysteries. Here we will try to uncover these hidden myths. Nanotechnology has the potential to be the solutions of present needs of the fast moving world.

I. INTRODUCTION

Nano means one billionth of something. It has been derived from the Greek word Dwarf. Technology means systematic scientific and engineering knowledge related to manufacturing knowing how to make something and why it works. Meter is a length that is approximately 39 inches. By simple mathematics a nanometer is one billionth of a meter, a very small length indeed. It can make a world of a difference in our lives.

II. NANOTECHNOLOGY SCOPE FOR ENERGY

The production and use of oil and other fossil fuels continues to rise on a yearly basis to record new levels. At the same time, fewer new oil fields are being identified which means that sometime over the next few decades oil production will not be able to satisfy demand.

Not only are we running out of oil, but our use of fossil fuels is putting an increasing burden on the environment in terms of greenhouse gases and global warming.

Alternative energy sources are known, but their efficiency based on cost is poor. Nanotechnology advances can improve this. Various scientific studies have demonstrated that nano scale techniques involve nanotubes and nanoparticles leads to increase the efficiency.

Nanotechnological approaches like light emitting diodes or quantum caged atoms could lead to significant reduction in energy consumption for illumination.

According to a 2006 Nano energy conference: “There is a growing awareness that nanoscience and nanotechnology can have a profound impact on energy generation, storage and utilization by exploiting the significant differences of energy states and transport in nanostructures and macrostructures.

Nanotechnology-based solutions are being developed for a wide range of energy problems such as: solar electricity, hydrogen generation and storage, batteries, fuel cells and thermoelectricity.”

Nano Energy is a multidisciplinary, rapid-publication forum of original peer-reviewed contributions on the science and engineering of nanomaterials and nanodevices used in all forms of energy harvesting, conversion, storage, utilization and policy. Through its mixture of articles, reviews, communications, research news, and information on key developments, Nano Energy provides a comprehensive coverage of this exciting and dynamic field which joins nanoscience and nanotechnology with energy science.

Energy storage such as:

- Batteries
- Fuel Cells
- Hydrogen generation and storage
- Light emitting diodes
- Optoelectronic devices for efficient energy usage
- Photovoltaic
- Piezoelectric nanogenerators
- Policy and perspectives in energy
- Self-powered nanodevices/nanosystems
- Super capacitors
- Thermoelectric

Development of nanotechnology in solar cells. Solar cells are more efficient as they get tinier and solar energy is a renewable resource. The price per watt of solar energy is currently lower.

III. GREEN NANOTECHNOLOGY

A. Green Nanotechnology has two goals:

The first goal of Green Nanotechnology producing nanomaterials and products without harming the environment or human health and producing nano-products that provides solutions to environmental problems. It uses existing principles of Green Chemistry and Green Engineering to make nanomaterials and nano-products without toxic ingredients, at low temperatures using less energy and renewable inputs wherever possible, and using lifecycle thinking in all design and engineering stages.

The second goal of Green Nanotechnology involves developing products that benefit the environment either directly



or indirectly. Nanomaterials or products directly can clean hazardous waste sites, desalinate water, treat pollutants, or sense and monitor environmental pollutants. Indirectly, lightweight nanocomposites for automobiles and other means of transportation could save fuel and reduce materials used for production; nanotechnology-enabled fuel cells and light-emitting diodes (LEDs) could reduce pollution from energy generation and help conserve fossil fuels; self-cleaning nanoscale surface coatings could reduce or eliminate many cleaning chemicals; and enhanced battery life could lead to less material use and less waste. Green Nanotechnology takes a broad systems view of nanomaterials and products, ensuring that unforeseen consequences are minimized and that impacts are anticipated throughout the full life cycle.

IV. NANOTECHNOLOGY HELP IN ENVIRONMENT

Generating less pollution during the manufacture of materials. The use of silver nanoclusters as catalysts can significantly reduce the polluting byproducts generated in the process used to manufacture propylene oxide. Propylene oxide is used to produce common materials such as plastics, paint, detergents and brake fluid.

Producing solar cells that generate electricity at a competitive cost. Silicon nanowires embedded in a polymer results in low cost but high efficiency solar cells. Using nanotechnology to improve solar cells, may result in solar cells that generate electricity as cost effectively as Fossil fuel

Electricity generated by windmills: Epoxy containing carbon nanotubes is being used to make windmill blades. The resulting blades are stronger and lower weight and therefore the amount of electricity generated by each windmill is greater.

Controlling pollution in groundwater: Nanoparticles can be effective in cleaning up organic solvents that are polluting groundwater. The iron nanoparticles disperse throughout the body of water and decompose the organic solvent in place. This method can be more effective and cost significantly less than treatment methods that require the water to be pumped out of the ground

Reducing carbon dioxide emission: Nanostructure membranes designed to capture carbon dioxide in the exhaust stacks of power plants instead of releasing it into the air.

Reducing volatile organic compounds (VOCs) from air: Catalyst that breaks down VOCs at room temperature. The catalyst is composed of porous manganese oxide in which gold nanoparticles have been embedded.

Reducing the cost of fuel cells: Changing the spacing of platinum atoms used in a fuel cell increases the catalytic ability of the platinum. This allows the fuel cell to function with about 80% less platinum, significantly reducing the cost of the fuel cell.

Storing hydrogen for fuel cell powered cars: Using grapheme layers to increase the binding energy of hydrogen to the grapheme surface in a fuel tank results in a higher amount of hydrogen storage and a lighter weight fuel tank. This could help in the development of practical hydrogen-fueled cars.

V. CONCLUSIONS

Nanotechnology is a help as the boon for the humanity due to it's various applications like in addressing the need of fuels, manufacturing of the nanostructures that can govern the atomic variations, carbon Nanotubes that can be used to store the hydrogen as well as to increase the hardness of plastic. It also addresses the Electricity requirements in coming future, restoring the health of individuals at a very fast rate and pre saving Nanotech also governs the implementation in electronics like various chips used in the computer at micro level. All that needed is increased level of research, development, demonstration and deployment.

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GREEN OUR PLANET"- With Green Technology

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Abstract— The Term "Technology" Refers To The Application Of Knowledge For Practical Purposes. The Field Of "Green Technology" Encompasses A Continuously Evolving Group Of Methods And Materials, From Techniques For Generating Energy To Non-Toxic Cleaning Products. The Present Expectation Is That This Field Will Bring Innovation And Changes In Daily Life Of Similar Magnitude To The "Information Technology" Explosion Over The Last Two Decades. In These Early Stages, It Is Impossible To Predict What "Green Technology" May Eventually Encompass.

I. THE GOALS THAT INFORM DEVELOPMENTS IN THIS RAPIDLY GROWING FIELD INCLUDE:

Sustainability - meeting the needs of society in ways that can continue indefinitely into the future without damaging or depleting natural resources. In short, meeting present needs without compromising the ability of future generations to meet their own needs.

"Cradle to cradle" design - ending the "cradle to grave" cycle of manufactured products, by creating products that can be fully reclaimed or re-used.

Source reduction - reducing waste and pollution by changing patterns of production and consumption.

Innovation - developing alternatives to technologies - whether fossil fuel or chemical intensive agriculture - that have been demonstrated to damage health and the environment.

Viability - creating a center of economic activity around technologies and products that benefit the environment, speeding their implementation and creating new careers that truly protect the planet.

II. EXAMPLES OF GREEN TECHNOLOGY SUBJECT AREAS

Energy

Perhaps The Most Urgent Issue For Green Technology, This Includes The Development Of Alternative Fuels, New Means Of Generating Energy And Energy Efficiency.

Green Building

Green Building Encompasses Everything From The Choice Of Building Materials To Where A Building Is Located.

Environmentally Preferred Purchasing

This Government Innovation Involves The Search For Products Whose Contents And Methods Of Production Have The Smallest Possible Impact On The Environment, And Mandates That These Be The Preferred Products For Government Purchasing.

Green Chemistry

The Invention, Design And Application Of Chemical Products And Processes To Reduce Or To Eliminate The Use And Generation Of Hazardous Substances.

Green Nanotechnology

Nanotechnology Involves The Manipulation Of Materials At The Scale Of The Nanometer, One Billionth Of A Meter. Some Scientists Believe That Mastery Of This Subject Is Forthcoming That Will Transform The Way That Everything In The World Is Manufactured. "Green Nanotechnology" Is The Application Of Green Chemistry And Green Engineering Principles To This Field.

WHAT IS GREEN TECHNOLOGY?

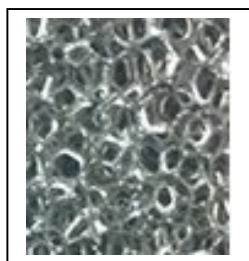
The Term "Green Technology" Has Been Adopted Over The Last 8 Years To Identify A Group Of Industries And Industrial Applications Which Exploit The Commercial Value Of Technologies That Benefit The Environment; Particularly As It Impacts The Human Condition. This Basket Of Effected Industries Is Quite Diverse And Includes Businesses As Far A Field As Energy And Agriculture. Some Predict Every Consumer Product Will Someday Be Affected. Unlike The Technological Waves In Recent Decades, Green Technology Is Almost Entirely Materials Science Based. An Excellent Discussion On This Fact Can Be Watched On The New PBS NOVA Video On The Nexus Between Materials Science And Green Technology Called "Making Stuff: Cleaner". Ventures Such As Google And Facebook Do Not Primarily Rely On Advances In Material Science For Their Success. But Solar Energy Panels And Pollution-Free Recyclable Automobiles Do.

Much Of The Coming Green Revolution Also Relies On The Availability Of "Alternative Energy" Sources To Both



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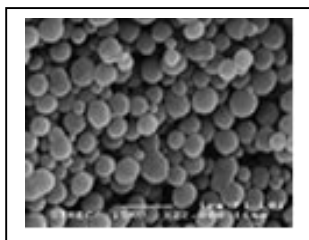
Eliminate The Emission Of Green House Gases That Cause Global Warming And To Make The Limited Resources We Have On The Planet Perpetually "Sustainable". Alternative Energy Is Defined As Both Energy Sources Other Than Mined Hydrocarbons (E.G. Solar Energy In Replacement Of Oil And Natural Gas) As Well As Alternative Methods To Process Mined Hydrocarbons That Are More Efficient Than Current Means (E.G. Use Of Fuel Cells In Replacement Of Combustion Engines).



WHAT ARE THE RAW MATERIALS OF GREEN TECHNOLOGY?

As Stated, Nearly All Green Technologies Rely On The Use Of New Advanced Materials. Below Is A Detailed Discussion Of Many Of The New Technologies Relying On Nanomaterials. These New Materials Vary From Metals Commonly Used Today In Many Ways. First, Elements On The Periodic Table Such As Copper, Tin, Iron And Carbon Are Stepping Aside In Favor Of Less Common Metals, Such As Zirconium, Yttrium, Tellurium And The 14 Elements That Make Of The Group Of Metals Known As The "Rare Earths". For Example, Batteries That Were Once Made Of Lead Are Now Made Of Lithium.

Silicon Nanoparticles Have Been Shown To Dramatically Expand The Storage Capacity Of Lithium Ion Batteries Without Degrading The Silicon During The Expansion/Contraction Cycle That Occurs As Power Is Charged And Discharged. Silicon Has Long Been Known To Have An Excellent Affinity For Storage Of Positively Charged Lithium Cations Making Them Ideal Candidates For Next Generation Lithium Ion Batteries. However, The Quick Degradation Of Silicon Storage Units Has Made Them Commercially Unfeasible For Most Applications. Silicon Nanowires However, Cycle Without Significant Degradation And Present The Potential For Use In Batteries With Greatly Expanded Storage Times.



Second, The Purity Of Advanced Materials Can Often Be Measured In Atoms With Ultra High Purities Up To 99.9999%.

Next, The Scale And Size Of The Raw Chemical And Metallic Powders May Be As Small As The Nanoscale. "Nano" Equals A Billionth And Therefore A Nanometer Is One-Billionth Of A Meter. To Appreciate The Size, A Human Red Blood Cell Is Over 2,000 Nanometers Long, Virtually Outside The Nanoscale Range. For A Given Amount Of Material, As Particle Size Decreases, Surface Area Increases. Since The Surface Of Any Material Tends To Be Where It Reacts With Other Materials, The More Surface Area, The Greater Effect Using Less Material. It Is Not Uncommon For One Gram Of A Nanoscale Material To Have The Surface Area Of A 60' X 30' Floor!

In Addition To The Use Of New Metallic Elements Is The Use Of These Less Common Metals With Common Metals To Form New Super Alloys With Unique Properties, Such As Scandium-Aluminum Alloy Which Can Combine Lightness, Extreme Strength And High Temperature And Corrosion Tolerance In A Single Material. Another Example Would Be Newly Developed Carbides Of Various Metals To Create Super Hard And Corrosive Resistant Materials With Interesting Properties. Similarly, The Use Of Glass And Ceramics In Functional Components Of Electronics And Energy Efficient Systems Is Giving Way To The Use Of Crystal Structures, Semiconductors And Super Conducting Materials.



HOW ARE GREEN TECHNOLOGIES USED TODAY?

The Vast Number Of "Green Technologies" Fall Into One Of Two Broad Categories. These Are:

1. Those Intended To Deal With Global Warming By Either Reducing Greenhouse Gas Emissions Or In The Alternative Its Potential Harmful Effects On The Planet, And
2. Those Technologies Associated With Establishing Economic "Sustainable Growth" Which Includes Recycling, Resource Reduction And Many Aspects Of The Biosciences.



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Each Of These Two Categories Has Several Major Associated Industries Addressing Some Aspect Of Achieving Their Goals. And Of Course Many Of The Important Industrial And Technological Revolutions Taking Place Today Touch On Both. For Example, Fuel Cells Both Decrease The Green House Gases That Cause Global Warming By Potentially Eliminating Air Pollution From Automobiles And They Also Make Our Energy Sources More "Sustainable" By Reducing The Amount Of Hydrocarbon-Based Fuel Needed To Generate The Same Amount Of Energy As Compared To Current Combustion Engines, I.E. Far Greater Miles Per Gallon



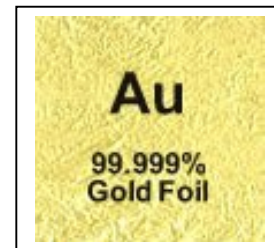
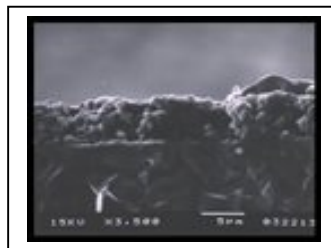
GLOBAL WARMING. There Seems To Be Little Debate That Human Activity Has Increased The Level Of Air Pollution And Co₂ In The Earth's Atmosphere And That This Will Increase Global Temperatures. The Ultimate Effect To Humanity Of This Rise In The Planet's Temperature Is A Matter Of Great Debate But The Fact That This Will Result In Significant Changes To How We Live And Work Is Not. Today There Are Essentially Two Approaches To Global Warming. The First Is Best Known From The Work Of Former Vice President And Nobel Peace Prize Winner Al Gore As Presented In His Film "An Inconvenient Truth" Holds That Global Warming Should Be Addressed At Its Root Cause By All Of Humanity Working In Consort Through Technological/Industrial Innovation And International Governmental Policy To Reduce The Quantity Of Air Pollution And Co₂ Emissions Being Generated. The Second Approach Is Best Expressed In The Work Of The Environmentalist Bjorn Lomborg As Presented In His Writings And Books, Such As "Cool It" Which Holds That A "Rational As Opposed To Fashionable" Approach To Global Warming Is To Recognize That The Least Expensive Method Of Dealing With Its Effects Is To Treat Them As They Occur Sometimes At The Very Local Level. This Is Based On The Premise That When The Actual Effects Are Examined In A Sober And Scientific Way, Policymakers Will Discover Addressing Them Piecemeal Is Significantly Less Costly In Capital Than The Effort That Would Be Necessary To Reduce Green House Gas Emissions To A Point Where The Earth's Temperature Actually Began To Fall Again.

Those Technologies That Are Intended To Deal With The Root Causes Of Global Warming As Proposed By Al Gore And The Larger Environmental Movement Work By Reducing The Emission Of The Green House Gases That Are Changing The Earth's Atmospheric Temperature. Green House Gases Are Either Of The Type We Commonly Think Of As "Air Pollution", Such No_x (Nitrous Oxide) And So_x (Sulfur Dioxide) And The Non-Pollutant Co₂ (Carbon Dioxide) Which We Exhale.

ALTERNATIVE ENERGY SOURCES. As described above with respect to global warming, even if all material resources on the planet were used in a fully recyclable manner, alternative sources of energy are also necessary since those currently powering civilization are being exhausted. Thus, the most pressing concern of the green revolution is establishing a global energy infrastructure to replace hydrocarbon fuels before the best of those sources are exhausted. Note the less valuable sources such as coal may be plentiful but in their case the challenge is the development of advanced technologies to address elimination or sequestration of the massive volume of CO₂ coal generates in its production and use.

Fuel Cells. An example of materials science playing a part in eliminating production of green house gas causing air pollutants is in the use of solid oxide fuel cells (SOFCs). SOFCs are electrochemical power plants that some believe will power automobiles in the future because they produce no air pollutants in the process. However, because they still rely on hydrocarbons as their energy source, they do not eliminate generation of CO₂ emissions. This would require the creation of a hydrogen infrastructure which is often discussed but is not being seriously proposed at this time due to both safety concerns and the cost to produce, store and transfer hydrogen.

Technologically, SOFCs are all materials science. There are no moving parts in the conversion of hydrogen to electricity. They are comprised of three layers. An electrically conductive cathode made of one of several perovskite materials such as Lanthanum Strontium Manganite (LSM), Lanthanum Strontium Ferrite (LSF), Lanthanum Strontium Cobaltite Ferrite (LSCF), Lanthanum Strontium Chromite (LSC), and Lanthanum Strontium Gallate Magnesite (LSGM), an ionically conductive electrolyte, such as Ytria Stabilized Zirconia or YSZ (Zirconium Oxide stabilized with Yttrium Oxide), Gadolinia doped Ceria or GDC (Cerium Oxide stabilized with Gadolinium Oxide, Ytria doped Ceria or YDC (Cerium Oxide stabilized with Yttrium Oxide), and Scandia Stabilized Zirconia or SCZ (Scandium Oxide stabilized with Zirconium Oxide and an electrically conductive anode which usually is Nickel Cermet compositions of nickel oxide and yttria stabilized zirconia. As hydrogen is pumped under pressure through the electrically conductive anode layer and oxygen is made available through the electrically conductive cathode layer, a circuit is completed through the ionically conductive electrolyte completing the circuit. As long as hydrogen is pumped into the system, electricity will be generated.



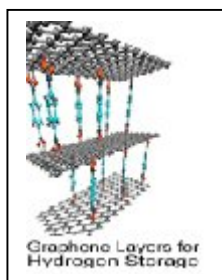


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SOLAR ENERGY. Another Example Of A Technology Intended To Reduce Both Air Pollution And CO₂ Emissions Is The Use Of Photovoltaic Cells To Generate Electricity (Actually Electrons) From Photons Emitted By The Sun. Given The Enormous Amount Of Capital Today Being Invested In Solar Energy Technologies Globally From Silicon Valley To The Nation Of Singapore, Solar Energy Will Unquestionably Play A Major Role In Reducing Green House Gas Emissions By Supplanting Hydrocarbons Such As Oil, Coal And Gas As Our Energy Source For Many Applications. From Its Start Solar Energy Has Been Essentially A Field Of Materials Science. In The 1970s The First Silicon-Based Photovoltaic (PV) Cells Were Produced. These Basic Cells Were Created By Doping Silicon To Form Two Oppositely Charged Layers.

All Silicon-Based Photovoltaic Solar Energy Collectors However Suffer Due To Their Ability To Absorb Energy Only From A Relatively Narrow Range Of The Sun's Light Wave Emission. More Recently Advanced Materials Have Been Developed That Can Either Expand This Band Gap Or Create Multiple Band Gaps In Order To Absorb A Greater Portion Of The Solar Energy Spectrum. This Has Lead To The Development Of PV Cells Based On Copper Indium Selenide (CuInSe₂) Or "CIS" Absorption Layers Which Can Capture Energy From Portions Of The Light's Spectrum Not Collected By Silicon-Based PV Cells. Doping CIS With Gallium Increases The Band Gap Even Further And As Such Most PV Cells Are Now Based On Copper Indium Gallium Selenide (CuInGaSe₂) And Are Referred To As "CIGS".

Other Promising Designs Include Cells Based On III-IV Nitride Materials And Research On Zinc Manganese Telluride, Cadmium Telluride (CdTe) And Gallium Selenide P-Type Layers. The Band Gap For III-IV Nitride Materials, Such As Gallium Indium Nitride, Covers Nearly The Entire Energy Spectrum Of The Sun Because Of Multiple Band Gaps In The Semiconductor Materials. Similarly, Zinc Manganese Telluride Crystals Have Three Band Gaps Which Can Absorb Greater Than 50% Of The Solar Energy Spectrum. Further Important Research Involves Nanotechnology Approaches Using Nanoparticles Of The Above Materials.



HYDROGEN STORAGE. Hydrogen Can Easily Be Generated From Renewable Energy Sources Making It A Primary Focus In The Area Of Alternative Energy Research. Hydrogen Is The Most Abundant Element In The Universe And Is Produced From Various Sources Such As Fossil Fuels, Water And Renewables.

Hydrogen Storage Is Non -Polluting And Forms Water As A Harmless Byproduct During Use. The Challenges Associated With The Use Of Hydrogen As A Form Of Energy Include Developing Safe, Compact, Reliable, And Cost-Effective Hydrogen Storage And Delivery Technologies. Currently, Hydrogen Can Be Stored In These Three Forms: Compressed Hydrogen, Liquid Hydrogen And Chemical Storage.

BATTERY TECHNOLOGY. Battery Technology Has Grown Rapidly Due To The Wide-Spread Use Of Rechargeable Solid-State Batteries In Computers, Vehicular Applications And Portable Electronics. Batteries Contain A Number Of Voltaic Cells; Each Voltaic Cell Consists Of Two Half Cells Connected In Series By A Conductive Electrolyte Containing Anions And Cations. The Type Of Chemical Reaction That Can Be Used In An Electrochemical Cell Is Known As An Reduction-Oxidation Reaction Which Means, A Reaction In Which One Chemical Species Gives Electrons To Another. Anions, Which Are Negatively Charged Ions, Oxidize At The Anode In The Reduction-Oxidation Reaction While Cations Which Are Positively Charged Ions, Are Reduced At The Cathode. By Controlling The Flow Of Ions Between The Two Species Through Separation, Battery Engineers Make Devices In Which Virtually All Of These Electrons Can Be Made To Flow Through An External Circuit, Thereby Converting Most Of The Chemical Energy To Electrical Energy During The Discharge Of The Cell.

WIND ENERGY. Converting Wind Energy Into Electricity Using Various Blade And Turbine Systems Has Been Utilized Since The Mid-1970s When Tax Incentives Were Written In Many States To Encourage Public Utilities To Purchase The Power Generated. Many Of These Earlier Systems Failed To Deliver Efficient Energy And Were Only Financially Viable As Tax Shelters. More Recently Advanced Materials Particularly Advanced Ceramic, Such As Ytria Stabilized Zirconia (YSZ) And Composites, Have Played A Part In The Development Of Light, Less Costly And More Efficient Wind Turbines. Additionally, The Decades Of Experience With Wind As An Energy Source Has Allowed For The Design Of Better Overall Wind Generator "Farms" Placed In Strategically Determined Locations, Such As The 4,000 Megawatt Farm Proposed By T. Boone Pickens In Texas.

THE NUCLEAR POWER DILEMMA. One Source Of Energy That Is Entirely Free Of Green House Gas Emissions And That Could Be Used Widely Today Is Nuclear Fission Of Enriched Radioactive Isotopic Materials To Produce Electricity. Nuclear Generators Are The Single Greatest Source Of Energy That In No Way Impacts Global Warming. They Fully Achieve The Goal Of Environmentalists As A Massive Source Of Energy Capable Of Sustaining Our Present Standard Of Living And Reducing Planetary Temperatures. However, The Second Goal Of The Green Revolution Is Sustainable Growth (Discussed Below) Which Requires That Human Activity Not Produce Waste Products That Cannot Be Perpetually Reused Or Recycled To Something Useful. All Nuclear Fission Systems Generate Some Form Of Radioactive



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Waste Which Must Be Disposed Of. Given The Lengthy Half Life Of The Waste Materials, "Disposal" Actually Means Perpetual Storage. However, Public Policy May Come To View Storage Of Nuclear Waste A Better Alternative Than Allowing For The Continual Rise In Global Temperatures.

GEOTHERMAL. Another Possible Solution To The Problem Of Global Warming Is Geothermal Energy, That Is Power Extracted From Heat Stored In The Earth. It Originates In The Formation Of The Planet, Radioactive Decay Of Minerals, And From Solar Energy Absorbed At The Surface. Geothermal Energy Has Been Used For Bathing Since Paleolithic Times, In The Form Of Hot Springs And Other Natural Formations, And For Living Space Heating Since Ancient Roman Times. The Earliest Industrial Exploitation Of Geothermal Energy Began In 1827 With The Use Of Geyser Steam To Extract Boric Acid From Volcanic Mud In Larderello, Italy. Lord Kelvin Invented The Heat Pump In 1852, And Heinrich Zoelly Had Patented The Idea Of Using It To Draw Heat From The Ground In 1912. But It Was Not Until The Late 1940s That The Geothermal Heat Pump Was Successfully Implemented. The 1979 Development Of Polybutylene Pipe Greatly Augmented The Heat Pump's Economic Viability.

Today Geothermal Energy Is Now Better Known For Generating Electricity. Worldwide, Geothermal Plants Have The Capacity To Generate About 10 Gigawatts Of Electricity As Of 2007, And In Practice Supply 0.3% Of Global Electricity Demand. An Additional 28 Gigawatts Of Direct Geothermal Heating Capacity Is Installed For District Heating, Space Heating, Spas, Industrial Processes, Desalination And Agricultural Applications. The Earth's Internal Heat Naturally Flows To The Surface By Conduction At A Rate Of 44.2 Terawatts, (TW,) And Is Replenished By Radioactive Decay Of Minerals At A Rate Of 30 TW. These Power Rates Are More Than Double Humanity's Current Energy Consumption From All Primary Sources, But Most Of It Is Not Recoverable. In Addition To Heat Emanating From Deep Within The Earth, The Top Ten Metres Of The Ground Accumulates Solar Energy (Warms Up) During The Summer, And Releases That Energy (Cools Down) During The Winter.

Geothermal Power Is Cost Effective, Reliable, Sustainable, And Environmentally Friendly, But Has Historically Been Limited To Areas Near Tectonic Plate Boundaries. Recent Technological Advances Have Dramatically Expanded The Range And Size Of Viable Resources, Especially For Applications Such As Home Heating, Opening A Potential For Widespread Exploitation. Geothermal Wells Release Greenhouse Gases Trapped Deep Within The Earth, But These Emissions Are Much Lower Per Energy Unit Than Those Of Fossil Fuels. As A Result, Geothermal Power Has The Potential To Help Mitigate Global Warming If Widely Deployed In Place Of Fossil Fuels. Methods Have Been Developed To Remove Silica From High-Silica Reservoirs. In Some Plants Silica Is Being Put To Use Making Concrete, And Hydrogen Sulfide Is Converted To Sulphur And Sold. At Power Plants In The Imperial Valley Of California, A Facility

Is Being Constructed To Extract Zinc From The Geothermal Water For Commercial Sale.

Metallic Foams. Metallic Foams Are Becoming Increasingly Important In The Treatment Of Environmental Pollutants. Metallic And Ceramic Foams Are Cellular Structures Consisting Of A Solid Metal Or Ceramic Material Containing A Large Volume Fraction Of Gas-Filled Pores. The Pores Can Be Sealed, Closed-Cell Foam, Or They Can Form An Interconnected Network, Open-Cell Foam. The Defining Characteristic Of These Foams Is A Very High Porosity, Typically 75-95% Of The Volume Consisting Of Void Spaces. Metallic And Ceramic Foam Is Often Used In Green Technology Applications Because The High Surface Area Facilitates The Adsorption Of Environmental Pollutants And Other Chemicals. It Is Also Used For Thermal And Acoustic Insulation, And As A Substrate For Other Catalysts Requiring Large Internal Surface Area.

SUSTAINABLE GROWTH. In The 1960s American's First Became Aware That Their Massive Increase In Consumption After World War II Was Causing An Equally Massive Generation Of Waste Products For Which There Was Little Technology Or Public Policy To Address. This Spawned The Original Environmental Movement With It's Emphasize On Reducing Ground, Air And Water Pollution. As Policies And Technologies Were Created To Address Pollution, It Became Clear That The Real Long Term Goal Must Be To Ultimately Establish A Fully Sustainable Planet; One That Could Perpetually Sustain Itself In Its Present Form Through Better Management Of Its Resources. This Would Require Efforts On Several Technological Fronts. First, Products Needed To Be Designed And Built With An Eye Towards (1) Eliminating Wasteful Materials Use And (2) The Reuse And Recycling Of The Materials That Are Used Once The Product Has Exhausted Its Useful Life. Second, Reliance On Difficult To Replenish Resources From Timber To Oil Needed To Be Drastically Reduced Through The Development Of New Recyclable Advanced Materials.

REFERENCES

- PVC – Substitute of wood :
PVC – Poly vinyl chloride , can be used as substitute of wood . Hence saving trees / forests .
- Reduce the use of CFC's and replace it with HCFC'S : Hydro-chloro-flouro-carbons. HCFC'S deliver less reactive chlorine to the stratosphere where the " ozone layer is present".
- CNG/ Eco – friendly fuels : CNG { compressed natural gas } should be used for replacement of high carbon evolving fuels such as petroleum products.
- Use more conventional process for power generation

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Green Technologies and Their Applications

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Abstract- The paper aims at evaluating the importance and efficacy of the green technologies in the present day world.

As hypothesis, the paper presents that the green technologies are the most viable and potent devices essential for the sustainable development of mankind on earth.

We are living in an increasingly dangerous world, where ecological balance is gravely threatened and natural resources are rapidly depleted owing to some foolish activities undertaken in the name of development. Hence, the importance of green technologies and their applications is felt more seriously today than ever before. The core of green technologies is sustainable development. This can be achieved by using energy generation technologies like photovoltaic, bio-reactor, solar power, wind power and ocean thermal energy conversion. This paper deals with some essential features of green technologies like air-purification, sewage treatment, environmental remediation, waste management and energy conservation. It draws some of the important techniques used in green technologies like biosphere technology, wave power and thermal depolymerisation. Besides, this brief review emphasizes green technologies as the ultimate alternatives and clean power. Furthermore, it draws our attention to some applications of green technologies.

Keywords- Sustainable Development; Photovoltaic; Bio-reactor; Solar Power; Wind Power; Ocean Thermal Energy Conversion; Air-Purification; Sewage Treatment; Environmental Remediation; Waste Management; Energy Conservation; Biosphere Technology; Thermal Depolymerisation; Wave Energy.

I. INTRODUCTION

Green Technology, also known as Clean Technology is the application of one or more of environmental science, green chemistry, environmental monitoring and electronic devices to monitor, model and conserve the natural environment and resources, and to curb the negative impacts of human involvement.

The term is also used to describe sustainable energy generation technologies. This is an eco friendly technology which produces no or negligible pollution. Some basic features of this technology are Renewable Energy, Air Purification, Sewage Treatment, Environmental Remediation, Waste Management and Energy Conservation.

A. Renewable Energy

Renewable energy is energy that can be replenished easily. For years we have been using sources like wood, sun, water, etc. for means for producing energy. Energy that can be produced by natural objects like wood, sun, wind, etc. is considered to be renewable. ^[1]



View across a reverse osmosis desalination plant.

B. Air Purification

Air Purification: basic and common green plants can be grown indoors to keep air fresh because all plants remove CO₂ and convert it into oxygen. The best examples are: *Dypsis lutescens*, *Sansevieria trifasciata*, and *Epipremnum aureum*.

C. Sewage Treatment

Sewage treatment is conceptually similar to water purification. Sewage treatments are very important as they purify water per levels of its pollution. The more polluted water is not used for anything, and the least polluted water is supplied to places where water is used affluently. It may lead to various other concepts of environmental protection, sustainability etc.



D. Environmental Remediation

Environmental remediation is the removal of pollutants or contaminants for the general protection of the environment. This is accomplished by various chemical, biological, and bulk movement methods, in conjunction with environmental monitoring. (encyclopedia of medical concepts)

E. Waste Management



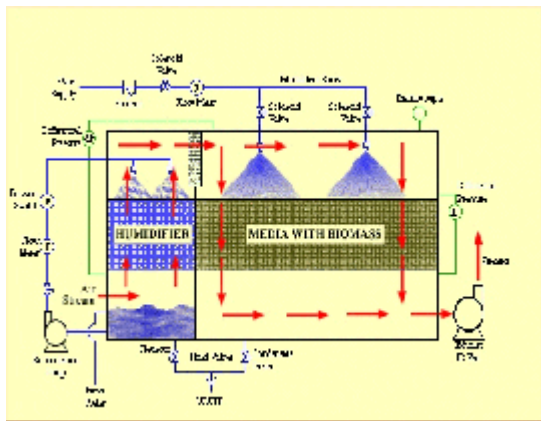
Solid waste management is the purification, consumption, reuse, disposal and treatment of solid waste that undertaken by the milk government or the ruling bodies of a city/town.

Two examples of waste management are as follows:

- *Biofiltration*
- *Anaerobic Digestion*

Biofiltration

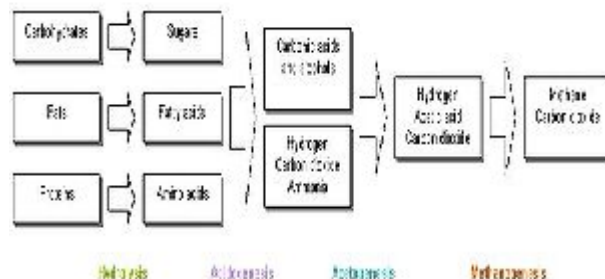
Biofiltration is a pollution control technique using living material to capture and biologically degrade process pollutants. Common uses include processing waste water, capturing harmful chemicals or silt from surface runoff, and microbiotic oxidation of contaminants in air.



Anaerobic Digestion

Anaerobic digestion is a series of processes in which microorganisms break down biodegradable material in the absence of oxygen. It is used for industrial or domestic purposes to manage waste and/or to release energy.^[2]

Process stages:



The key process stages of anaerobic digestion There are four key biological and chemical stages of anaerobic digestion:

1. Hydrolysis
2. Acidogenesis
3. Acetogenesis
4. Methanogenesis

In most cases, biomass is made up of large organic polymers. For the bacteria in anaerobic digesters to access the energy potential of the material, these chains must first be broken down into their smaller constituent parts. These constituent parts, or monomers, such as sugars, are readily available to other bacteria. The process of breaking these chains and dissolving the smaller molecules into solution is called hydrolysis. Therefore, hydrolysis of these high-molecular-weight polymeric components is the necessary first step in anaerobic digestion. Through hydrolysis the complex organic molecules are broken down into simple sugars, amino acids, and fatty acids.

II. GREEN TECHNOLOGY AS AN ALTERNATIVE AND CLEAN POWER



The Tesla Roadster is the only all-electric sports car for sale and in serial production. It can be plugged into conventional outlets and can be charged fully or partially on renewable energy, including solar, hydroelectric, geothermal or wind power.

A. Energy Conservation

Energy conservation is the utilization of devices that require smaller amounts of energy in order to reduce the consumption of electricity. Reducing the use of electricity causes less fossil fuels to be burned to provide that electricity.

B. Basic Principles:

- *Green syndicalism*

Green syndicalism or eco-syndicalism has been used as a name for the philosophy of the green guild or sustainable trades movement. Green syndicalists are, however, often willing to adopt new technologies, ethical traditions and to work with other, similar groups worldwide.

- *Sustainability*

Sustainability is the ability to sustain or endure. Some basic principles are as follows:

1. Reduce dependence upon fossil fuels, underground metals, and minerals
2. Reduce dependence upon synthetic chemicals and other unnatural substances
3. Reduce encroachment upon nature
4. Meet human needs fairly & efficiently.

- *Sustainable design*

Sustainable design (also called environmental design, environmentally sustainable design, environmentally conscious design, etc.) is the philosophy of designing physical objects, the

built environment, and services to comply with the principles of social, economic, and ecological sustainability.

- *Sustainable engineering*

Sustainable engineering is the process of designing or operating systems such that they use energy and resources sustainably, i.e., at a rate that does not compromise the natural environment, or the ability of future generations to meet their own needs.

Scientists continue to search for clean energy alternatives to our current power production methods. Some technologies such as anaerobic digestion produce renewable energy from waste materials. The global reduction of greenhouse gases is dependent on the adoption of energy conservation technologies at industrial level as well as this clean energy generation. That includes using unleaded gasoline, solar energy and alternative fuel vehicles, including plug-in hybrid and hybrid electric vehicles.

Since electric motors consume 60% of all electricity generated, advanced energy efficient electric motor (and electric generator) technology that are cost effective to encourage their application, such as the brushless wound-rotor doubly fed electric machine and energy saving module, can reduce the amount of carbon dioxide (CO₂) and sulfur dioxide (SO₂) that would otherwise be introduced to the atmosphere, if electricity is generated using fossil fuels. Greasestock is an event held yearly in Yorktown Heights, New York which is one of the largest showcases of environmental technology in the United States.^{[3][4]}

III. ENERGY GENERATION

Here are a few energy generation techniques which comes under the Green Technologies.

A. Solar Energy

Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar energy technologies include solar heating, solar photovoltaics, solar thermal electricity and solar architecture, which can make considerable contributions to solving some of the most urgent problems the world now faces. Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of



photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air and does not cause any pollution.



B. Wind Power



Wind power is the conversion of wind energy into a useful form of energy, such as using: wind turbines to make electricity, windmills for mechanical power, windpumps for water pumping or drainage, or sails to propel ships. Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation and uses little land. Any effects on the environment are generally less problematic than those from other power sources. As of 2011, 83 countries around the world are using wind power on a commercial basis. As of 2010 wind energy was over 2.5% of total worldwide electricity usage, growing at more than 25% per annum. The monetary cost per unit of energy produced is similar to the cost for new coal and natural gas installations. Although wind power is a popular form of energy generation, the construction of wind farms is not universally welcomed due to aesthetics.

C. Ocean Thermal Energy Conversion



Ocean thermal energy conversion (OTEC) uses the temperature difference between cooler deep and warmer shallow or surface ocean waters to run a heat engine and produce useful work, usually in the form of electricity. However, the temperature differential is small and this impacts the economic feasibility of ocean thermal energy for electricity generation. A heat engine gives greater efficiency and power when run with a large temperature difference. In the oceans the temperature difference between surface and deep water is greatest in the tropics, although still modest ocean energy options such as wave power¹²⁰ to 25 °C. It is therefore in the tropics that OTEC offers the greatest possibilities. OTEC has the potential to offer global amounts of energy that are 10 to 100 times greater than other. OTEC plants can operate continuously providing a base load supply for an electrical power generation system.

D. Photovoltaics

Photovoltaics (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. Materials presently used for photovoltaics include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenide/sulfide. Due to the growing demand for renewable energy sources, the manufacturing of solar cells and photovoltaic arrays has advanced considerably in recent years. Solar photovoltaics is growing rapidly, albeit from a small base, to a total global capacity of 69 GW at the end of 2011. The total power output of the world's PV capacity run over a calendar year is equal to some 80 billion kWh of electricity.



Photovoltaic SUDI shade is an autonomous and mobile station in France that replenishes energy for electric vehicles using solar energy.

IV. BIOSPHERE TECHNOLOGY

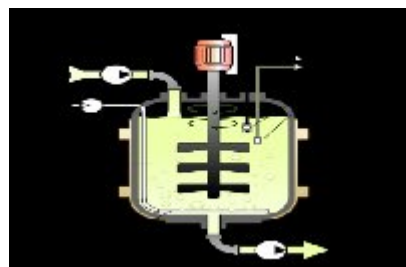
Biosphere Technology was invented and developed by Dr. Chris McCormack, the author of numerous original contributions in scientific literature and also the Chairman and CEO of GEECF (Global Environmental Energy Corporation). Biosphere Technology or BioSphere Process (patent pending) was developed and employed in manufacturing of clean energy disposal also known as the "Biosphere MK-V".

This green technology is a gasification process that harnesses the combustibility of solid wastes to create a heat source that produces an extremely hot steam that will then generate green electricity. It is done in a limited – oxygen environment thereby significantly limiting atmospheric emissions. The entire process starts at the biosphere chamber wherein the solid wastes are entered for thermal transformation to generate the combustible gas, referred as “syngas” or synthesis gas. This gas consists primarily of carbon monoxide, carbon dioxide and hydrogen and has less than half of this energy density of natural gas. The syngas is then used to produce electricity in a combined cycle gas/steam turbine.

E. Bioreactor

A bioreactor may refer to any manufactured or any engineered device or system that supports a biologically active environment. In one case, a bioreactor is a vessel in which a chemical process is carried out which involves organisms or biochemically active substance

s derived from such organisms. This process can either be aerobic or anaerobic. A bioreactor may also refer to a device or system meant to grow cells or tissues in the context of cell culture. These devices are being developed for use in tissue engineering or biochemical engineering.

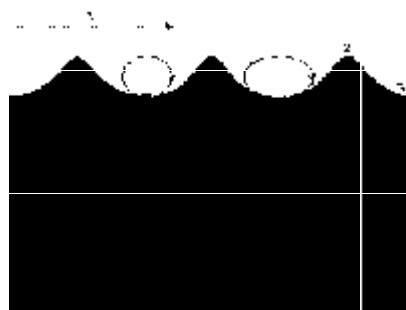


V. WAVE POWER

Wave power is the transport of energy by ocean surface waves, and the capture of that energy to do useful work — for example, electricity generation, water desalination, or the pumping of water (into reservoirs). Machinery able to exploit wave power is generally known as a wave energy converter (WEC). Wave power is distinct from the diurnal flux of tidal power and the steady gyre of ocean currents. Wave power generation is not currently a widely employed commercial technology although there have been attempts at using it since at least 1890. In 2008, the first experimental wave farm was opened in Portugal, at the Aguçadoura Wave Park.^[5]



When an object bobs up and down on a ripple in a pond, it experiences an elliptical trajectory





Motion of a particle in an ocean wave.

A = At deep water. The orbital motion of fluid particles decreases rapidly with increasing depth below the surface.

B = At shallow water (ocean floor is now at B). The elliptical movement of a fluid particle flattens with decreasing depth.

1 = Propagation direction.

2 = Wave crest.

3 = Wave trough.

VI. THERMALDEPOLYMERISATION

Thermal depolymerization (TDP) is depolymerization process using hydrous pyrolysis for the reduction of complex organic materials (usually waste products of various sorts, often biomass and plastic) into light crude oil. It mimics the natural geological processes thought to be involved in the production of fossil fuels. Under pressure and heat, long chain polymers of hydrogen, oxygen, and carbon decompose into short-chain petroleum hydrocarbons with a maximum length of around 18 carbons.

The process can break down organic poisons, due to breaking chemical bonds and destroying the molecular shape needed for the poison's activity. It is likely to be highly effective at killing pathogens, including prions. It can also safely remove heavy metals from the samples by converting them from their ionized or organometallic forms to their stable oxides which can be safely separated from the other products.

VII. APPLICATIONS OF GREEN TECHNOLOGY

A. Green Building

Green building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. [6] This requires close cooperation of the design team, the architects, the engineers, and the client at all project stages. The Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.

Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the

overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation



A similar concept is natural building, which is

usually on a smaller scale and tends to focus on the use of natural materials that are available locally. Other related topics include sustainable design and green architecture. Sustainability may be defined as meeting the needs of present generations without compromising the ability of future generations to meet their needs. Green building does not specifically address the issue of the retrofitting existing homes.

B. Energy Saving Module

Energy Saving Module(s)(ESM) represent a green technology that reduces the electricity consumption (kWh) and maximum demand (kW) of air conditioning and refrigeration compressors. The concept was first developed in Australia in 1983 by Abbotly Technologies and is now distributed by Smartcool Systems Inc. The system works in conjunction with existing HVAC controls ensuring that the compressors work at maximum efficiency, while maintaining preset temperature levels. By preventing over-cycling by a process, known as 'Compressor Optimisation' consumption of electricity is cut by between 15% and 25% in each case, thereby improving operating costs and cutting emission of greenhouse gases.

D. Composting Toilet

A composting toilet is a dry toilet that uses a predominantly aerobic processing system that treats excreta, typically with no water or small volumes of flush water, via composting or managed aerobic



decomposition. Composting toilets may be used as an alternative to flush toilets in situations where there is no suitable water supply or waste treatment facility available or to capture nutrients in human excreta as humanure. They are in use in many of the roadside facilities in Sweden, in National Parks both in the United States and the United Kingdom.

The human excrement is normally mixed with sawdust, coconut coir, peat moss to support aerobic processing, absorb liquids, and to reduce the odor. The decomposition process is generally faster than the anaerobic decomposition used in wet sewage treatment systems such as septic tanks.

C. Electric Vehicle

An electric vehicle (EV), also referred to as an electric drive vehicle, uses one or more electric motors or traction motors for propulsion. Three main types of electric vehicles exist, those that are directly powered from an external power station, those that are powered by stored electricity originally from an external power source, and those that are powered by an on-board electrical generator, such as an internal combustion engine (a hybrid electric vehicle) or a hydrogen fuel cell. Electric vehicles include electric cars, electric trains, electric lorries, electric aeroplanes, electric boats, electric motorcycles and scooters and electric spacecraft.

Electric vehicles first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time.



E. Biofuel

A biofuel is a type of fuel whose energy is derived from biological carbon fixation. Biofuels include fuels derived from biomass conversion, as well as solid biomass, liquid fuels and various biogases. Biofuels are gaining increased public and scientific attention, driven by factors such as oil price hikes, the need for increased energy security, and concern over greenhouse gas emissions from fossil fuels.

Green diesel is produced through hydrocracking biological oil feedstocks such as vegetable oils and animal fats. Hydrocracking is a refinery method that uses elevated temperatures and pressure in the presence of a catalyst to break down larger molecules, like those found in vegetable oils, into shorter hydrocarbon chains used in diesel engines. It may also be called renewable diesel, hydro-treated vegetable oil or hydrogen-derived renewable diesel (HDRD). Green diesel has the same chemical properties as petroleum-based diesel. It does not require new engines, pipelines or infrastructure to distribute and use, but has not been produced at a cost that is competitive with petroleum. Gasoline versions are also being developed. Green diesel is being developed in the Louisiana and Singapore by ConocoPhillips, Neste Oil, Valero, Dynamic Fuels, and Honeywell UOP.

F. Green Computing

Green computing, green IT or ICT Sustainability, refers to environmentally sustainable computing or IT. In the article *Harnessing Green IT: Principles and Practices*, San Murugesan defines the field of green computing as "the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems — efficiently and effectively with minimal or no impact on the environment." The goals of green computing are similar to green chemistry; reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste. Many corporate IT departments have Green Computing initiatives to reduce the environmental impacts of their IT operations.^[7] Research continues into key areas such as making the use of computers as energy-efficient as possible, and designing algorithms and systems for efficiency-related computer technologies.

VIII. CONCLUSION

Green Technologies provide a fascinating avenue for the sustainable development of mankind. They are not only the alternatives but the only ways to be undertaken if we want to save our planet earth, which is the only planet we have to live in. Hence, it is vital for us to draw our attention, as it is easy to solve some of the burning problems like global warming, air pollution, soil pollution, water pollution, etc. Though it has been found that green technology in short term brings us inconvenience, high cost, low



efficiency, but since it is in immature stage, those defects can be solved. Thus, green technology will definitely be the solution that will help us solve those problems and improve our environment and save the nature. This is possible if contribution and awareness are spread by environmentalists, celebrities and political leaders, hopefully green technology will be the only technology used in the near future.

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Biogenic Process and Antibacterial Efficiency of Gold Nanoparticles

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Abstract— The biological synthesis of gold nanoparticles (AuNPs) using *Bacopa monniera* plant extract as reducing agent is reported. Stable gold nanoparticles were formed by treating an aqueous HAuCl₄ solution using the plant extract as reducing agent. The nanoparticles obtained are characterized by UV-Vis spectroscopy, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and Fourier transform Infrared spectroscopy (FT-IR). Furthermore these biologically synthesized nanoparticles were found to be highly effective against different multidrug resistant human pathogens such as *E.Coli*, *Staphylococcus aureus*, *Bacillus subtilis* and *Enterococcus*.

Keywords: *Bacopa monniera*, gold nanoparticles, UV-visible spectroscopy, FT-IR,

I. INTRODUCTION

Nanotechnology offers unique approaches to control a wide variety of biological and biomedical processes due to their nanometer length i.e, 1nm-100nm in size (West and Halas 2000). Nanoparticles have received considerable aid because of their structure and properties which differ significantly from those of bulk materials (Rosei 2004). Moreover, ultra transition metal nanoparticles have attracted great interest due to their unique physical, chemical and thermodynamic properties that have made them useful in such diverse fields as catalysis, (Narayanan and El-sayed 2005) electronics, (Cui and Lieber et al., 2001) optics (Eychmuller et al., 2000) and even in biological and medical sciences (Salata et al., 2004). Nanoparticles of noble metals such as gold, silver, palladium and platinum are widely applied in products that directly come in contact with the human body such as shampoos, soaps, detergents, shoes, cosmetic products and toothpaste, besides medical and pharmaceutical applications. Among the above four, gold nanoparticles being inert and less cytotoxic are extensively used in the field of drug and gene delivery (Connor et al., 2005; Ghosh et al., 2008; Pissuwan et al., 2009). Gold has a

long history of use, red colloidal gold has been used as medicine for revitalization in China and India (Southam et al., 2006). Gold nanoparticles (AuNPs), an emerging nanomedicine is renowned for its promising therapeutic possibility high surface reactivity, resistance to oxidation and plasmon resonance (Guo et al., 2005). The role of gold nanoparticles invading the treatment for various inflammatory diseases and other relative disorders that are content dependent, in orientation with the evidences towards the anti-oxidative effect of traditional gold in treatment of several diseases. There is great interest in the development of nanoparticle-based vectors that decrease the toxicity of free drugs and ensure targeted delivery directly to tumor cells (Paciotti et al., 2004; Chen et al., 2007; Wang et al., 2007; Patra et al 2008). Both silver and gold NPs are excellent nanomaterials providing a powerful platform in biomedical applications of biomolecular recognition, biosensing, drug delivery and molecular imaging (Sperling et al 2008; Wilson, 2008). Biosynthesis of nanoparticles has received considerable attention due to the growing need to develop environmentally benign technologies in nanoparticles synthesis. Plant extracts have been found to be ecofriendly and cost effective for the large scale synthesis of nanoparticles (Sastri et al., 2003).

The use of environmentally benign materials like plant extracts offers numerous benefits of eco-friendliness and compatibility for pharmaceutical and other biomedical applications as they do not use toxic chemicals for the synthesis protocol. Moreover, plant-based nanoparticle syntheses can be advantageous over other biological methods (microbial) since the reaction rate for the synthesis of nanoparticles is very high and there is no need to grow microbes (Kalishwaralal et al., 2010). *Bacopa monniera* belongs to Scrophulariaceae family commonly known as Brahmi found throughout the Indian subcontinent in wet and marshy places. In Ayurvedic medicine, it is used as a nerve tonic to mend intelligence, memory and functioning of sense organs (Das et al., 2002). *Bacopa monniera* have been used in

the treatment of various nervous systems ailments such as insomnia, anxiety, epilepsy, hysteria etc (Nadkarni 1976). Its ethanolic extract contains a mixture of triterpenoids, steroids, saponins designated as Bacosides A and B (Jyoti ., 2006 ; Roodenrys., 2002). The present study was aimed to rapid synthesis of AuNPs using ethanol extract of *Bacopa monniera* and evaluates its antibacterial activity.

II. MATERIALS AND METHODS

A. Preparation of *Bacopa monniera* extract

The whole plant of *B. monniera* was thoroughly washed with double distilled water and dried in shade, in dust free condition for one week at room temperature before being ground to a fine powder. Finely powdered plant material (10g) was extracted with ethanol (100 ml). The mixture solution was left on constant magnetic stirring at room temperature for 24 hrs. The extract was filtered and stored at 4°C for further experiments.

B. Synthesis of gold nanoparticles

0.001M aqueous solution of HAuCl₄ was prepared and used for the synthesis of AuNPs. 5 ml of plant extract was added to 120 ml of aqueous solution of 0.001M HAuCl₄ for reduction into Au⁺ ions and kept at room temperature for one hour.

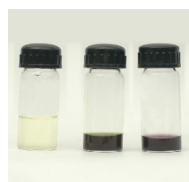


Fig. 1 Aqueous solution of 0.001M Aqueous solution of HAuCl₄ with *B. monniera* extract before adding the extract and after addition of extract at 1hr.

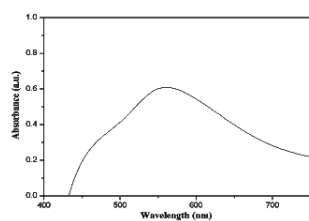


Fig. 2 UV-Vis absorption spectra of gold nanoparticles synthesized by exposure of *B. monniera* with 0.001M Aqueous solution of HAuCl₄

C. UV-Vis spectral analysis

The reduction of pure Au⁺ ions was monitored by measuring the UV-Vis spectrum of the reaction medium after diluting a 0.5ml aliquots of the sample into 5 ml distilled water. UV-Vis spectral analysis was done by using Genesis 10S UV-Vis spectrophotometer (Thermo Scientific).

D. Transmission Electron Microscopy (TEM) measurements

The sample was first sonicated for 10 minutes. A drop of this solution was loaded on carbon coated copper grid and solvent was allowed to evaporate under Infrared light for 30 minutes. TEM measurements were performed on Philips Model CM 200 instrument operated at an accelerating voltage at 200KV.

E. FTIR analysis of dried residue after bioreduction

To remove any free biomass residue or compound that is not capping ligand of the nanoparticles, the residual solution of 100 ml, after reaction was centrifuged at 9000 rpm for 30 min. The obtained pellet was washed with ethanol for three times. Thereafter the purified suspension was air dried to obtain dried powder. Finally the dried nanoparticles were analyzed by FTIR.

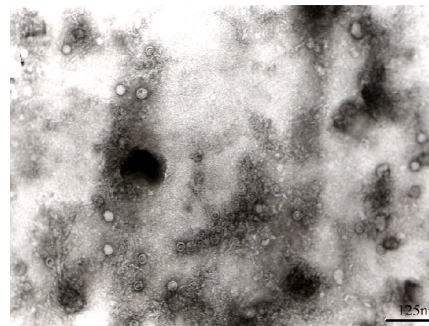


Fig.3. TEM image of the gold nanoparticles formed by the reaction of 0.001M HAuCl₄ and *B. monniera* extract at room temperature.

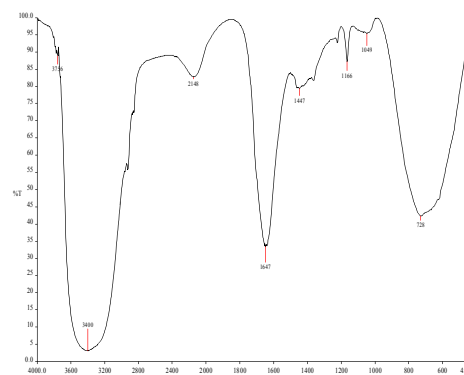


Fig. 4. FTIR spectra of the gold nanoparticles synthesized by the reduction of Auric chloride with the *B. monniera* extract.

F. Antimicrobial activity

The antimicrobial activity of gold nanoparticles was evaluated against *Staphylococcus aureus*, *Escherichia coli*, *Enterococcus* and *Bacillus subtilis* by disc method. The 24 hrs old cultures were prepared in nutrient broth (composition

(gm/L) peptone 15.0; yeast extract 3.0; sodium chloride 6.0; D (+) glucose (1.0). Two replicas of respective microorganisms were prepared by spreading 100µl of revived culture on the nutrient agar plate (composition (gm/litre) peptone 15.0; yeast extract 3.0; sodium chloride 6.0; D (+) glucose 1.0; agar-agar (12.0) with the help of spreader. Discs were prepared by using Whatmann No.1 filter paper and placed on agar plates. The sample of synthesized gold nanoparticles is placed on the disc with the help of micropipette. The plates were incubated at 37°C overnight. Gentamycin disc was used as reference drug.

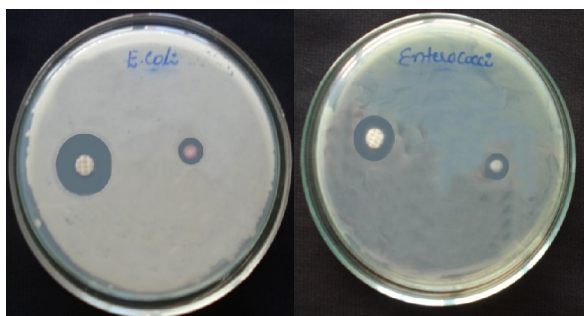


Fig. 5. Antimicrobial activities of gold nanoparticles by using *B. monniera* extract and 0.001M aqueous solution of HAuCl₄. Gentamycin as standard.

Table 1 Inhibitory activity of gold nanoparticles on bacteria

S. No.	Organism	Zone of inhibition(cm) Ref. drug Gentamycin	Nanoparticle
1	Staphylococcus	0.9	0.5
2	aureas	0.9	0.6
3	Bacillus subtilis	0.9	0.35
4	Escherichia coli Enterococci	0.6	0.3

All values represented in the table are average of results of two separately conducted experiments.

III. RESULTS AND DISCUSSION

Gold nanoparticles were fabricated using *Bacopa monniera* extract at room temperature. Reduction of the gold nanoparticles during exposure to the plant extract could be detected by the colour change. The appearance of ruby red colour was observed with in 15 min after the adding of extract to the AuCl₄ solution and the solution changed from ruby red to steel grey in about 1 h (Fig.1).

The strong surface Plasmon resonance absorption peak at 557 nm shows the formation of AuNps at room temperature (Fig. 2). It is thought that phenols, alcohols and proteins present in the ethanolic extract of *B. monniera* are responsible for the reduction of gold ions, and also for the stabilization of nanoparticles throughout by electrostatic attraction (Vilchis-Nestor et al., 2008). The proteins present in the extract act as a capping agent for AuNPs. Especially in the case of AuNPs bioencapsulation would be one of the method for stabilizing these nanoparticles (Padma and Dhara 2010)

TEM visualization provides an extraordinary opportunity for the morphological evaluation of nanoparticles. The typical TEM micrograph of the synthesized AuNPs is presented in Fig.3. It is observed that most of the AuNPs were spherical in shape . There is a variation in particle sizes and the average size estimated was 21 nm, most of the particles are ranged from 15 to 35 nm in size.

FT-IR analysis was used for the characterization of the synthesized nanoparticles and the spectrum provides the information about the chemical change of the functional groups

involved in bioreduction. Fig 4. shows the FT-IR absorption spectrum of AuNPs. The intense broad absorbance at 3400 cm⁻¹ is the characteristic of the hydroxyl functional group in alcohols and phenolic compounds. The band at 2148 cm⁻¹ correspond to C=C stretch vibration of alkynes. The band at 1647 cm⁻¹ corresponds to N-H bend of primary amines and the bands observed at 1447, 1166, 1049 and 728 cm⁻¹ indicates C-C stretch of aromatic carboxylic acids, esters, ethers and primary and secondary amines respectively. This indicates the synthesized AuNPs using the *Bacopa monniera* extract are surrounded by some proteins and metabolites having functional groups of amines, alcohols, aldehydes and carboxylic acids.

Further the nanoparticles synthesis by green route was found highly toxic against 4 bacterial species at a concentration of 20 µl AuNPs. It revealed higher antibacterial activity against *Bacillus subtilis*, where as intermediated activity was revealed against *Escherichia coli*, *Staphylococcus aureus* and *Enterococci* (Fig.5). The inhibitory activities in culture media of the AuNPs reported in Table 1. Gentamycin was taken as reference drug

Metal nanoparticles are harmful to bacteria and fungi (Chwalibog et al., 2010). Gold nanoparticles possess well developed surface chemistry, chemical stability and appropriate smaller size, which make them easier to interact with the micro organisms (Nirmala and Pandian 2007). The enhanced activity might be due to the nano size of gold nanoparticles, large surface area and high penetrating power hence such nanoparticles could effectively bind to the substrates on the outer membrane and cell membrane of organisms.

IV. CONCLUSION

Green synthesis provides advancement over chemical and physical methods as it is cost effective, eco friendly, easily scaled up for large scale synthesis. Using plant and plant extract for nanoparticle synthesis can be advantageous over other biological methods. In this study *Bacopa monniera* extract have been used as a reducing agent for synthesis of gold nanoparticles. It is used as an ayurvedic herb to treat neurological disorders. These biologically synthesized AuNPs shows antibacterial activity against 4 strains of bacteria.

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Selenium Induced Oxidative Stress, Histological Alterations in Testis of Swiss Albino Mice

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Abstract— Selenium (Se) is present in the earth’s crust, often in association with sulfurcontaining minerals. It is normally found in concentrations of 50–90 µg/kg, but higher concentrations can be associated with some volcanic, sedimentary and carbonate

rocks. Selenium has long been recognized as essential trace element and is important in many biochemical and physiological processes. On the other hand, selenium showed a toxic effect depending on its concentration. Inorganic and organic selenium compounds have been showed to have chemo preventive and anticancer effects against mammary gland, colon, lung, pancreas, and skin tumors. Selenium has adverse reproductive and developmental effects (decreased rates of conception, increased rates of fetal resorption, the present study was planned to investigate the histopathological effects of selenium in the form of sodium selenite on the testicular tissues of Swiss albino mice. Selenium was orally administered at a dose level of 1/10 LD50 daily for 6 weeks. Testes of animals treated with selenium showed reduction in the diameter of the seminiferous tubules as well as the germinal epithelial height. Moreover, the treatment induced many histopathological alterations including degeneration of the spermatogenic cells, destruction of intertubular connective tissue and hemorrhage revealed marked reduction in the spermatogenic cells. Both histopathological and histochemical alterations were time-dependent. The result of the oxidative stress and antioxidant enzymes in the present work indicated that there was a significant increase in the oxidative stress, malondialdehyde which is lipid peroxidation marker and a significant decrease in the level of serum antioxidant enzymes, superoxide dismutase and catalase activity in testes of sodium selenite-treated albino mice. It is concluded that the oxidative stress induced by sodium selenite may be responsible for the histological and histochemical alterations induced in testis of albino mice.

Key words: Sodium Selenite, histopathological alterations, haemorrhage, Albino Mice, oxidative stress.

I. INTRODUCTION

Selenium is a trace element with antioxidative activity and is associated with the control of lipid peroxidation because this trace element is a component of selenoenzymes contributing to the antioxidant system (Jendryezko and Drozd, 1993). Selenium has long been recognized as both essential nutrient and a hazardous element (Gan et al.2002). It is important in

many biochemical and physiological processes including the biosynthesis of coenzyme Q (a component of mitochondrial electron transport systems), regulation of ion fluxes across membranes, maintenance of the integrity of keratins, stimulation of antibody synthesis, and activation of glutathione peroxidase (EL-Tayeb et al., 2004). Inorganic and organic selenium compounds have been showed to have chemopreventive and anticancer effects against mammary gland, colon, lung, pancreas, and skin tumours (Fleet, 1997; Patterson and Levander, 1997; Yu et al., 1997). Its role in prevention of prostate and other human cancers was reported by Thirunavukkarasu and Sakthisekar (2003). On the other hand, selenium showed a toxic effect depending on its concentration (Gan et al., 2002). Clinical signs of acute selenium toxicity in domestic animals are accompanied by blindness, abdominal pain, respiratory failure, paralysis, loss of appetite and eventually starvation (Koppel et al.1986). Chronic selenosis is associated with emaciation, loss of body hair, soreness and lameness (Wilson et al., 1983). Many histopathological changes were observed in different organs of animals treated with selenium ((Vadhanavikit and Ganther, 1988).Damage to the liver and kidneys and impaired immune responses have been reported to occur in rodents following subchronic and/or chronic oral exposures (Beem and van Beek,1985, Shearer et al.1992, Barbosa et al.1998). Selenium have adverse reproductive and developmental effects (decreased rates of conception, increased rates of fetal resorption, and reduced fetal body weights) for domesticated and laboratory animals (Schroeder and Mitchener., 1971 and Harr and Muth , 1972). The present study aimed to evaluate the histological and histochemical effects of selenium, in the form of sodium selenite, on the testis of albino mice.

II. MATERIALS AND METHODS

A. Animals

Sexually mature male swiss albino mice weighted 30 ± 5 g and aged 15 weeks were purchased from the breeding center of experimental animals at Sri Venkateswar veterinary university tirupati. The animals were kept in the laboratory under constant temperature ($27 \pm 1^\circ\text{C}$) for at least one week before and along the period of the experimental work. They were maintained on a standard rodent diet composed of 20%



casein, 15% corn oil, 55% corn starch, 5% salt mixture and 5% vitaminized starch. Water available ad libitum.

B. Experimental design

The animals were divided into 2 groups. Group1: animals of this group (12) were orally given 1/10 LD50 of sodium selenite (0.7mg /kg body weight) dissolved in water, daily for 6 weeks (Sakr et al.2008). Animals in the second group (12) were given water and served as control. All the experiments were done in compliance with the Guide for the Care and Use of Laboratory animals. The treated animals were sacrificed by cervical decapitation after 6 weeks of treatment.

III. SOMATIC AND REPRODUCTIVE TISSUE INDEX

The body weight of the mice was taken before decapitation and the tissue like kidney, liver testes, and reproductive organs were isolated. The organs were weighed to the nearest milligram, using a Shimadzu electronic balance (model No: BL-220H). The tissue indices were calculated using the following formula:

$$\text{Tissue Somatic Index} = \frac{\text{Weight of Tissue in Gms}}{\text{Weight of the body in Gms}} \times 100$$

IV. HISTOLOGICAL EXAMINATION

A. Histological study of testes:

Selinum exposed males were used in the present study. The mice were autopsied and the testes were dissected out. The testicular tissue was fixed in aqueous Bouins fluid for 24 hours and dehydrated in alcoholic series, cleared in xylol and embedded in paraffin wax. Sections of 5µM thickness were made and stained in Harries haemato xylin–eosin and examined using microscope. Ten mice were weighted and sacrificed from treated and control groups after 4 and 6 weeks. Their testes were excised and weighted. For histological study testes were fixed in alcoholic Bouin’s fluid, dehydrated in ethyl alcohol, cleared in xylol and embedded in paraffin wax. Sections of five micrometers thickness were cut and stained with haematoxylin and eosin for histological examination. For histochemical study specimens were fixed in Carnoy’s fluid. Periodic acid Schiff’s reaction (Kiernan , 1981) was used for demonstration of polysaccharides. Total proteins were detected using the mercury bromophenol blue method (Pearse, 1972) .Nucleic acids (DNA&RNA) were determined using Feulgen-methylene blue method (Garvin et al., 1979). The mean diameter of the seminiferous tubules and the height of the germinal epithelia were determined using an ocular micrometer.

B. Biochemical assays

For biochemical assays, supernatant obtained after centrifugation of testicular tissue homogenates was used. Malondialdehyde was assayed as described by Ohkawa et al., (1979), superoxide dismutase activity was determined according the method of Rest and Sptznagel(1977) and

catalase activity was determined using Aebi et al., (1974) method.

C. Statistical analysis

Statistical analyses were necessary to determine the level of significance of the effect of treatment on the experimental group of animals.

The mean, standard deviation (SD), Coefficient of variations (CV) and probability test (Analysis of variance-ANOVA, Students-Newman Keruls) were carried out according to Steel and Torrie (1960) for different parameters using SPSS 16.0 version software package for windows. The ‘p’ value of more than 0.05 was considered as not significant.

V. RESULTS

Effect of selenium on total body and testes weight:

Table (1) showed the changes in total body and testes weight of mice in control and selenium-treated group. In control group the total body weight reached its highest value after 6 weeks. On the other hand, treating mice with sodium selenite caused significant decrease in total body weights after the period of 6 weeks of treatment. Similarly, a significant decrease was recorded in testes weight of animals treated with selenium for weeks in comparison with control groups (table 1).

Table (1): Changes in body and testes weight of mice treated with sodium selenite.

Body weight (g)		Testes weight (g)	
control	experimental	control	experimental
36.21 ± 4.45	22.43 ± 3.39	0.70 ± 0.07	0.52 ± 0.08

Data represented as mean ±SD, n=8. ^ap<0.05 versus normal control

Morphometric results:

Results in table (2) revealed that the diameter of the seminiferous tubules was decreased in mice treated with selenium and this reduction became significant (P < 0.05) after 6 weeks of treatment in comparison with control groups. A significant decrease in the height of the tubule epithelium was recorded in testes of animals during all periods of treatment.

Table (2): Effect of sodium selenite on the diameter and the height of the epithelium of seminiferous tubules of testis.

Diameter in µ m		Epithelial height in µ m	
control	experimental	control	experimental
251.8 ± 14.36	199.7 ± 12.7*	111 ± 4.8	39.4 ± 1.4*



Data represented as mean \pm SD, n=8. $p < 0.05$ versus normal control

Histological results

Examination of the testes of control mice showed that the seminiferous tubules contained all spermatogenic cells (spermatogonia, primary spermatocytes, secondary spermatocytes and spermatids) as well as Sertoli cells. The seminiferous tubules were separated by intertubular connective tissue, in which interstitial Leydig cells present (Fig. 1). Examination of the testes of mice after 4 weeks of treatment with selenium revealed that seminiferous tubules appeared with irregular outlines. The spermatogenic cells were reduced in number and most of them showed vacuolated cytoplasm and pyknotic nuclei (Fig.2). The rupture of the intertubular connective tissue and intertubular haemorrhage were observed in most of the examined specimens (Fig.3). These histopathological alterations became more prominent in specimens treated with selenium for 6 weeks. The spermatogenic cells were less abundant and many of them were degenerated while others contained darkly stained nuclei. Most of the tubules were devoid of sperms and in others the sperms were scattered randomly in the tubules and appeared with short and irregular tails (Fig.4). The intertubular connective tissue was degenerated.

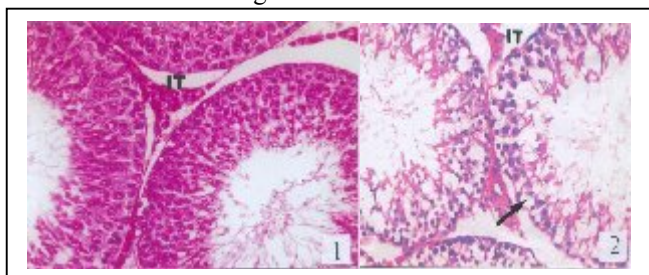


Fig. 1: Seminiferous tubules of a control rat showing normal spermatogenic cells, IT: intertubular connective tissue ,X 400.

Fig. 2: Specimen obtained from an animal treated with selenium for 4 weeks showing irregular seminiferous tubule boundaries, degeneration of the intertubular connective tissue, (IT) and vacuolated spermatogenic cell (arrow), X400.

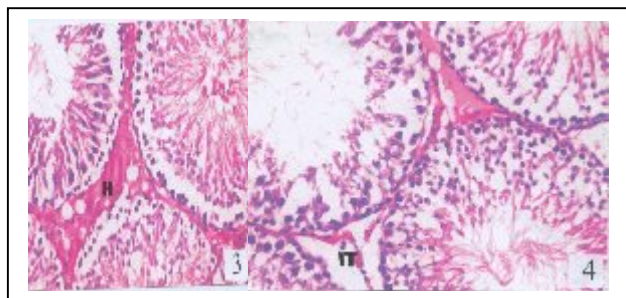


Fig. 3: Seminiferous tubules of an animal treated for 4 weeks showing intertubular haemorrhage (H), x 400.

Fig. 4: Specimen obtained from an animal treated with selenium for 6 weeks showing reduction of spermatogenic cells and rupture of intertubular connective tissue (IT), X400

VI. DISCUSSION

Administration of sodium selenite to mice in the present study induced significant decrease in body weight. This result was previously reported by Shamberger, (1983) and Whanger and Butler, (1988). They correlated the decrease of body weight with a decrease in food intake. In addition, Thorlacius-ussing et al. (1988) revealed that the growth retarding effect of selenite is due to depression of both growth hormone and somatomedin C secretion. There was significant decrease in testes weight of treated animals. Similarly, Chowdhury and Venkatakrishna-Bhatt (1983) observed that daily i.p. administration of selenium dioxide produced testicular atrophy in mice. The reduction in the diameter of the seminiferous tubules and the germinal epithelia were recorded after 6 weeks of treatment together with the histological evidence provided that spermatogenesis was inhibited. Intertubular hemorrhage was observed in the treated testis. In agreement with this result, Buck et al.1976 reported that hemorrhage resulted from vascular damage induced in both acute and chronic selenium poisoning. The effect of selenium on testis was studied by some investigators. Rosenfeld and Beath (1964) reported that congestion and atrophy of seminiferous tubules were observed in cattle and sheep died from chronic selenium poisoning. Hidiogrou (1982) reported that selenium has been shown to accumulate in mammalian testes and influenced the motility of spermatozoa. Nebbia et al.(1987) found that treating mice with sodium selenite induced many testicular changes such as intertubular oedema , oligospermia and degeneration of spermatids. Kaur and Bansal (2004) reported that feeding mice with sodium selenite caused decrease of germ cell population with increase of testicular selenium level. Moreover, lactate dehydrogenase-X activity was significantly decreased in mouse testis.

Histochemical results revealed that PAS-positive materials decreased in the testicular tissues of selenium-treated mice. This agrees with the findings of some investigators who found that carbohydrates, especially glycogen decreased in animal tissues post-treatment with selenium salts (Kolodziejczyk et al. 2000 , Tos-Luty et al., 2003). These authors attributed the decrease of glycogen to inhibition of glycogenesis by the used selenium salts.Total proteins, RNA as well as DNA-containing particles were reduced in the testes of the treated mice. The decrease in total protein were reported by Jaffe and Mondragon (1975) in mice treated with organic selenium and was attributed to the reduction of protein synthesis or increased proteolytic activity or degradation (Verine et al.,1979). A decrease of total proteins was recorded in mice exposed to sodium selenite (Smetanova et al. 2000). The loss of RNA inclusions observed in the present work in selenium-treated mice could account for the marked diminution of proteins in such cases. This is attributed to the close parallelism existing between the level of RNA and proteins in most of animal cells either in normal or pathological



conditions. Depletion of DNA resulting from selenium treatment is compatible with the observations of some investigators. Ranawat and Bansal (2008) found that sodium selenite induced apoptosis and DNA damage in testicular cells in vitro. Santos et al. (2009) reported that exposure of leukocytes to (S)-tert-butyl 1-diselenide-3-methylbutan-2-ylcarbamate, (S)-tert-butyl 1-diselenide-3-phenylpropan-2-ylcarbamate, (S)-2-amino-1-diselenide-3-methylpropanyl, (S)-2-amino-1-diselenide-3-phenylpropanyl, 3',3'-ditrifluoromethyl diphenyl diselenide, 4',4'-dimethoxy diphenyl diselenide, 4',4'-dichloro diphenyl diselenide and 2',2',4',4',6',6'-hexamethyl diphenyl diselenide, induced a significant increase in DNA Damage. Machado et al. (2009) recorded significant DNA damage in Chinese hamster lung fibroblasts V79 cells after treatment with organoselenium compound, diphenyl diselenide.

Oxidative stress occurs when production or exposure to reactive oxygen species (ROS) outstrips the ability of the cell to remove them. This can occur by an increase in ROS production or a decrease in the ability of the cell to metabolize them (Cerutti, 1985). Excess production of ROS in cells resulted in several biological effects. ROS are involved in the peroxidative damage of human spermatozoa which may cause male infertility (Aitken and Clarkson, 1987). The result of the oxidative stress and antioxidant enzymes in the present work indicated that there was a significant increase in the oxidative stress, malondialdehyde which is lipid peroxidation marker and a significant decrease in the level of serum antioxidant enzymes, superoxidase and catalase activity in testes of sodium selenite-treated mice. In agreement with this result, Dougherty and Hoekstra, (1982) reported that selenite ions may have an oxidative effect. This proposal was based on the observation of increased formation of free radicals. Kaur et al. (2003) indicated that selenosis caused oxidative stress as evidenced by a 3-fold increase in lipid peroxidation and decrease in activities of glutathione-S-transferase; glutathione reductase, superoxide dismutase, and catalase. El-Tayeb et al. (2004) and Vijaya Bhaskar Reddy et al. (2010, 2011) reported that overexposure to selenium caused decrease capacity of the antioxidant system leading to lipid peroxidation and tissue injury. Ranawat and Banas (2008) reported that sodium selenite causes apoptosis in spermatogenic cells and the toxicity of selenium is mediated by increase in ROS. In conclusion, the oxidative stress induced by selenosis may be responsible for the histological and histochemical alterations induced in testis of albino mice.

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Nanorobots- The Heart Surgeon

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Abstract— Competition grows everyday. Today man is forced to compete against machines. This develops stress and human body is subjected to various levels of trauma. The heart attacks become so common and the affected rate increases till date. Main reasons for this would be improper diet, tension and excess of cholesterol, which blocks the arteries and not allowing the blood to pass through them hence causing heart attack. This usually occurs when a blood clot forms inside a coronary artery at the site of an atherosclerotic plaque (blood clots on the roughened plaque). It is difficult to estimate exactly how common heart attacks are because as many as 200,000 to 300,000 people in the United States die each year before medical help is sought. It is estimated that approximately 1 million patients visit the hospital each year with a heart attack. About 1 out of every 5 deaths are due to a heart attack. Present day treatment includes surgeries which are considered outdated when compared to today's technology.

I. INTRODUCTION

A. Nanorobots

These nanoscale devices are able to perform higher with reduced time researches in nanotechnology brought newer approaches in the field of medicine. This paper focus on the employment of nanorobots for removing the heart blocks in more effective and accurate manner. Nanotechnology promise to be a pathway for the future.

B. Main Paper

Heart blocks are caused due to the reason above. Current diagnostic measures include painful processes like the angiogram. The treatment for the block is also extremely dangerous, time consuming and painful. Angioplasty, although having the higher success rate, is old fashioned. Today's technology promises a lot more than the insertion of a thin tube into the blood vessels. Nanorobots can be used in this process of curing heart blocks.

This paper focuses the causes of heart blocks, the current process of diagnostics and therapy. Later the idea of curing these heart blocks using nanorobots is discussed in a theoretical and imaginative approach.

C. Cholesterols

Cholesterols are biochemical compound which are carried by lipoproteins found in blood and are essential for the normal

functioning of the body to a certain extent. Cholesterol is fat like substance (lipids). These are chemical compounds of glycerol and unsaturated acid. Cholesterols found in the human body are of two types. They are

- a) Low Density Lipids (LDL)
- b) High Density Lipids (HDL)

a. HDLS

- Harmless, highly stable and are disposed off from the body effectively.
- They don't stick to the walls of the blood vessels.
- Actually HDLs help in carrying the bad cholesterols from the blood stream to the liver from where it gets disposed.
- These contain more of proteins and less fat.

b. LDLS

- Contain more fat and less protein.

What determines the blood level of LDL and why is the level dangerous?

Answer emerge from the study of specified proteins called LDL receptors that projects from the surface of animal cells. The receptors bind LDL particals and extract them from the fluid that bathes the cells, the LDL is taken into the cells and broken down yielding its cholesterol to serve each cells need.

II. FUNCTIONS OF THE CHOLESTEROL

- Assists in manufacture of hormones or vitamin D.
- Break down carbohydrates and proteins.
- Help from a protective coating around nerves.
- Build cell walls and to produce bile.



RECOMMENDED STANDARD FOR THE DESIRED BLOOD

Cholesterol of low risk contains:

- Total blood cholesterol (TBC) level to be less than 200 mg/dl and
- Total HDL to be 40 mg/dl or higher

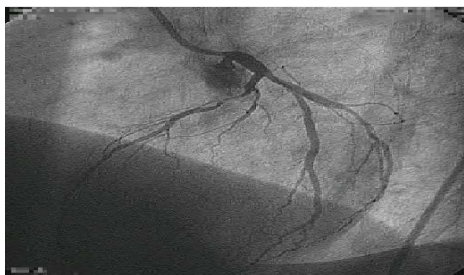
HIGH CHOLESTEROL

- Level ranges for TBC > 240 mg/dl

PRESENT DAY TREATMENT (angiogram and angioplasty)

LDL on lump of deposition closes into the diameter of the blood vessel. So as the concentration increases, the diameter of the blood vessel decreases. Hence the blood transportation to or from the heart is affected.

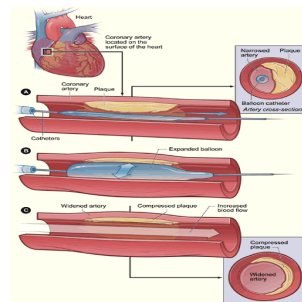
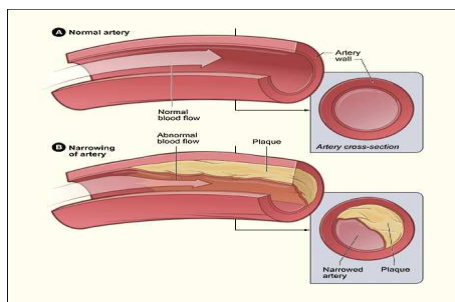
ANGIOGRAM



The above problems intensity is measured by a method known as angiogram. here a small tube of diameter of about few micrometer with a catheter (flexible tube inserted into the body for injecting or draining away fluid) at the end is used. This is introduced into the veins at the thigh and up to the pericardium.

This catheter injects a radioactive fluid into the blood stream, the flow of which is monitored by a continuous X-ray. When this fluid flows through the block, there will be a contraction in the thickness of the fluid line monitored by the X-ray. This contraction indicates the location of the block. Once the block is located, it is removed by a method known as angioplasty.

ANGIOPLASTY



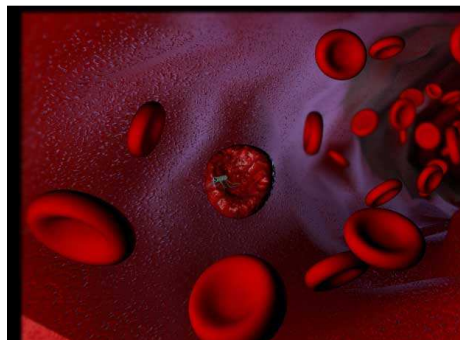
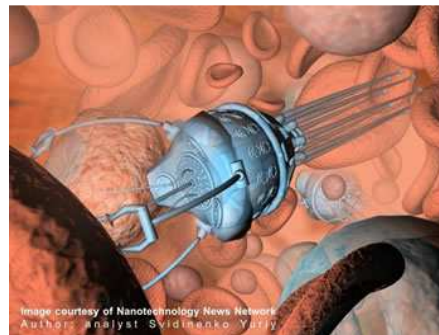
Here the end of the catheter has a deflated balloon. This balloon is positioned under the block and inflated, so that the block bursts and is carried away through the blood stream. The blocked area is covered with a one way inflatable metal cylinder that is attached on the outside of the balloon to prevent the recursion of the block.

As the balloon is inflated the cylinder attains shapes and locked on attaining maximum expansibility. This method is known as balloon angioplasty.

NANOROBOTS

Nanorobots are nano devices that may be about 3 to 5 microns in size. The individual parts used to make those nanorobots may be of 1 to 200 nm in size. Mainly made of carbon and may be given a coating of diamond, which is the most and toughest material ever known. The nanorobots can be used for variety of purposes

DIAGRAM OF NANOROBOTS WHEN COMPARED WITH RBC'S





Nanorobots as a heart surgeon should carry out certain steps and finally solve the problem. The concepts involve three steps. They are

- Locate the block
- Serve the block
- provide molecular synthesis

Nanorobots with nanosensors to locate the block. These robots will need four kinds of nanosensors

- pressure sensors
- acoustic sensors
- chemo sensors
- smart sensors

Nanorobots equipped with nanolasers to serve the block after confirmation in order to prevent the recurrence of the block, molecular synthesis is carried out (i.e.) nanorobots fills the burnt gap with fresh flawless cells synthesized by the robots themselves. This process is known as molecular synthesis.

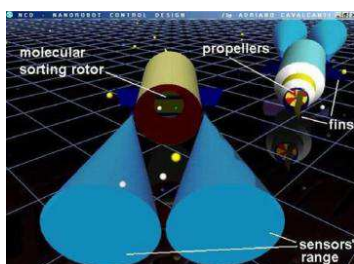
THE ACTUAL PROCESS

Sensor robots that navigates other robots through the blood stream:

- All the three types of nanorobots needed for the process are suspended in a liquid matrix and injected into blood vessels of the patient.
- Acoustic sensors in sensor robots get activated soon and begin navigating the army of robots through the blood stream to the pericardium.
- Simultaneously, the smart sensors present in the sensor robots, get activated and form a closed ad-hoc network connecting all the robots.
- This is very essential in order to guide all the nanorobots to the desired location.

III. SOPHISTICATED METHOD

The most sophisticated type of diagnosis is done here by the sensor robots i.e. diagnosis inside the human body. These sensors on reaching the periphery of the heart scan the pericardial vessels for blocks and locate the spot exactly.



Sensor robots that navigate the other robots through the blood stream.

A. OPERATIONS:

a. Operation Starts:

- The pressure sensors mounted on the sensor robots, scan the blood vessels for variation in the blood pressure.
- This will act as the first confirmation.
- This scanning for pressure variations is necessary as in the region of the block, there will be a constriction of blood vessel and hence a rise in the blood pressure compared to that existing in the nearby areas.
- These sensors will generate a report of the potential areas of heart block. Based on the pressure mapping of the blood vessels.

b. Operation Proceeds

- The second confirmation comes from chemo sensors.
- These sensors scan the region they traverse for the chemical composition of the cholesterols. That is. The sensors differentiate the cholesterol compounds accumulated on the walls of the blood vessels from the actual composition of the tissues of the blood vessels. In this way the block can be identified accurately.
- All these information are transmitted through the ad-hoc network formed by all the smart sensors and can be constantly viewed by the doctors monitoring the entire process.
- After successful location of the block the second type of nanorobots those equipped with nanoscalars comes into picture.
- These lasers like the robots themselves can be powered by the body itself by means of kinetic energy of the flowing blood, pressure of the blood flow etc thus laser can be powered by the most ingenious ways imaginable.
- These laser robots on activation based on the information flow through the network effectively burn down the block.

c. Operation Succeeds

- The final leg of the operation is the responsibility of the molecular synthesizers.



- These nanorobots, take the required biochemical substances from the blood or surrounding tissues, and the synthesize the cells of the blood vessels in order to seal the area of the block.
- These cells are placed in the affected region.
- And as a result, we have a whole new region of blood vessel that is completely free from the threat of another block.

ADVANTAGES

- Fast process
- Results are accurate, as the scale of operation is small.
- Involves less psychological strain compared to angioplasty.
- Harmful ray attack is reduced.
- Advanced and reliable technology.

- Aftereffects are eliminated.

DISADVANTAGES

- Expensive technology
- Practical implementation is some what difficult.
- Technology problems such as artificial reconstruction and artificial intelligence which results in robots going out of control of humans.

IV. CONCLUSION

The influence of nanorobots in the performance heart surgery is found to be effective and a reliable means of treatment. As the construction of nano robots is under progress, the ideas explained here could not be implemented at present. But it is sure that ideas will be put into action within a period, which is too far!



Preparation of Chitosan/ Poly (Lactic Acid) Nanoparticles: A Potential Role of Piceatannol for Anti-Cancer Drug Delivery Applications

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Abstract— Interest in biomedical applications of biopolymers is growing quickly mainly due to their remarkable biocompatibility and biodegradability properties, among many others. Nano sized drug delivery vehicles formulated from biocompatible, biodegradable polymers constitute an evolving approach to phytochemical delivery and tumor targeting. Biodegradable piceatannol (PIC) (a phytochemical of grape seed extract) carriers are being purposely engineered and constructed with nanometer dimensions. In this study, we aimed to describe about synthesis, characterization of nano-piceatannol. Chitosan (CS) – poly (lactic acid)(PLA) complex nanoparticles, which are well dispersed and stable in aqueous solution, have been prepared by dropping method of PLA in chitosan solution. The prepared nanoparticles were characterised by SEM and FT-IR. The in vitro release and encapsulation efficiency of the drug loaded Chitosan/PLA nanoparticles were studied using UV-spectrophotometer. The in-vitro drug release studies showed that drug release rate was lower in the acidic pH when compared to alkaline pH. This may due to repulsion between H⁺ ions and cationic groups present in the polymeric nanoparticles. Drug release rate was found to be higher in the pH 3 drug loaded formulation when compared to pH 4.5 and pH 7.4 drug loaded formulation. Such approaches made it possible to develop smart materials like nano-piceatannol with chitosan/PLA for enhanced and sustained release. The properties of PLA and chitosan encapsulated PIC molecule pave way for encapsulating various therapeutically less useful highly active antioxidant molecules towards the development of better therapeutic compounds. The prepared nanoparticles also showed improved physical properties and further cytotoxicity study will be conducted on the above formulations.

Keywords – Chitosan, PLA, Piceatannol, Drug release, Encapsulation efficiency

I. INTRODUCTION

In recent days, cancer plays a major role in public health problem and the existing treatment approaches and surgical

techniques have not been able to cope effectively with this dreaded disease. Because of this, chemoprevention is a valid approach to reduce the incidence of cancer [1]. As an effective cancer chemopreventive agent, Polyphenol are known to be strong antioxidants and anticarcinogenic activities [2]. In vitro and animal studies provide strong evidence that polyphenols derived from plants may possess the bioactivity to inhibit tumorigenesis in a variety of animal models of carcinogenesis [3]. Grape polyphenols has been shown to inhibit the development of cancer in animal models of oral, esophageal, fore stomach, stomach, intestinal, colon, skin, liver, bladder, prostate, and breast cancer [4-5].

In the last few years, stilbene-based compounds have attracted the attention of many researchers due to their wide range of positive biological effects. Piceatannol (E-3,5,3',4'-tetrahydroxystilbene) is a derivatives of resveratrol which possesses an extra hydroxyl group adjacent to the active 4'-OH of resveratrol. It is present in low quantity in grapes [6], peanuts [7], Euphorbia lagascae [8] and Vaccinium berries [9] and, like resveratrol, it is a phytoalexin. Piceatannol has known anticancer and anti leukemic properties, inducing apoptosis in several cell lines and animal models; it inhibits a variety of tyrosinase kinases involved in cell proliferation [10,11]. Piceatannol is hydrophilic in nature and thus scarcely soluble in aprotic solvents, oils and emulsions. Consequently, their application in the food, pharmaceutical and cosmetic fields is strongly limited.

The main shortcomings of polyphenols are its hydrophilicity, hence, results in low bioavailability, degradation at alkaline pH and photodegradation. Lipophilic nature of polyphenols makes susceptible to RES uptake and hence it can't reach the therapeutic target with less concentration. To overcome these disadvantages and to improve chemotherapeutic activity, researchers have focused on the development of nano-sized drug carriers. To increase its aqueous solubility and bioavailability, attempts have been made through encapsulation in liposome, polymeric



nanoparticles, lipid-based nanoparticles, biodegradable microsphere, cyclodextrin and hydrogel [12-17].

One of the promising and exciting drug delivery system which can meet the above lacking requirements in polyphenols is polymeric nanoparticles. Chitosan is a natural mucopolysaccharide of marine origin having structural characteristics similar to glycosaminoglycans that is present in the exoskeleton of crustacean [18], arthropod and fungi. Chitosan has been used for a wide variety of biomedical applications, such as in the drug delivery system [19], charcoal encapsulated chitosan beads for toxin removal [20], dental and orthopaedic materials. This is primarily due to its biodegradable, non toxic and biocompatible features. Other applications in biomedical field includes fibers for fat blocker, digestible sutures, liposome stabilization, anti bacterial, anti viral and anti tumor agents, haemostatic and hypocholesteremic and hypolipidemic agent. In spite of these advantages, both its poor mechanical and processing properties and its insolubility in common organic solvents have delayed its basic research and various biofabrication applications [21,22]. Thus chemical modifications of CS are preferred to improve the polymer process ability as well as to alter some properties such as solubility, antimicrobial activity and the ability to interact with other substances [23].

Among the various promising polymers like PLA, PLGA, polycaprolactone, polymethylidene malonate, poly(butyl) cyanoacrylate (PBCA) nanoparticles meet ideal requirements for controlled drug delivery and passive targeting such as biodegradability, low toxicity, ability to alter the biodistribution of drugs and easy to synthesize and purify [24-27]. However, the high crystallinity, the strong hydrophobicity, and especially the lack of bioactive functions of the PLA matrix often resulted in an uncontrollable biodegradation rate and an undesirable biological response to cells and/or tissues. Therefore, it is promising to combine the bioactive functions of Chitosan with the good mechanical properties of PLA to generate a new kind of biohybrid amphiphile [28].

Thus in this study, we have synthesised and characterized Piceatannol loaded Chitosan/PLA nanoparticles by FTIR and SEM. Drug loading, encapsulation efficiency and in vitro drug release studies were examined for the effective solubilisation of drug inside the polymeric nano-piceatannol and thereby it proves the sustained delivery for drug administration.

II. MATERIALS AND METHODS

A. Materials

Chitosan, poly (Lactic Acid) and Piceatannol were purchased from Sigma Corporation, USA. Chitosan was refined twice by dissolving it in dilute acetic acid solution, filtered, precipitated with aqueous NaOH, and finally dried in vacuum at room temperature. The degree of deacetylation was about 90%, and the average molecular weight of chitosan was 80 kDa. All other chemicals used were of analytical reagent

grade and without further purification; Ultra pure water was used for the preparation of all solutions.

B. Preparation of Chitosan-PLA Nanoparticles

CS-PLA nanoparticles were prepared by mixing positively charged CS and negatively charged PLA by dropping method. In detail, 1ml 0.02% PLA (Mw=60 kDa) solution was added dropwise into 5ml 0.02% CS solution under magnetic stirring until the opalescent suspension was formed. The obtained suspension was then filtered by filter paper, the filtered suspension was incubated in a buffer solution of pH 4.5 for 24 h using a dialysis membrane bag for characterization.

C. Preparation of PIC loaded CS-PLA Nanoparticles (CS/PLA-PIC)

The drug loaded nanoparticles were prepared by dissolving 50mg of piceatannol in 50ml of CS - PLA solution prepared by dropping method and incubated for 48 hours. Then, these nanoparticles were separated from the aqueous phase by ultracentrifugation with 50,000rpm at 4°C for 40 min. Then the obtained PIC loaded CS - PLA nanoparticles were washed by acetone 3 times, frozen by liquid nitrogen and lyophilized by freeze dryer to obtain dried PIC loaded CS/PLA nanoparticles for characterization.

III. CHARACTERIZATION OF CS/PLA-PIC NANOPARTICLES

A. Fourier Transform Infrared Spectroscopy (FT-IR)

Fourier Transform Infrared (FT-IR) spectroscopy deals with the vibration of chemical bonds in a molecule at various frequencies depending on the elements and types of bonds which were used to characterize the structure and interaction of CS, PIC, PLA, CS-PLA and CS/PLA-PIC by KBr method. FT-IR spectra were measured by a Bruker IFS 66V vacuum-type spectrometer. The nanoparticles were frozen by liquid nitrogen and lyophilized by free dryer system to obtain as dried particles.

B. Scanning Electron Microscopy (SEM)

The surface morphology of the synthesized nanoparticles were analyzed with SEM developed by Hitachi, the specimen was prepared by placing a drop of CS/PLA-PIC nanoparticles on carbon coated copper grid and subsequently drying air, before transferring it into the microscope operated at an accelerated voltage of 150 kv.

C. Drug Loading and Encapsulation Efficiency

In order to determine the loading efficiency of the process, 2mg of freeze dried nanoparticles was extracted with 1ml acetone. The polymer was precipitated by addition of 5ml methanol. After centrifugation at 16,000xg for 10 min, 3ml clear supernatant was drawn out and the solvent was evaporated. The residue was then diluted with 10ml physiological saline and PIC concentration was determined by



UV spectrophotometer at 540nm. The drug loading and drug entrapment efficiency were defined by the following formulas respectively:

$$\% \text{ Drug content} = A-B/C \times 100$$

$$\% \text{ Encapsulation efficiency} = A-B/A \times 100$$

Where A is the total drug present in the nanoparticles pellet, B is the amount of free drug in the supernatant and the C is the weight of nanoparticles measured after freeze drying.

D. *In vitro* Drug Release from the Polymeric Nanoparticles

100 mg PIC loaded CS/PLA nanoparticles were redispersed in 10 ml distilled water and placed in a dialysis membrane bag with a molecular cut-off of 10 kDa, tied and placed into 300 ml of water medium with various pH values on sink conditions. The entire system was kept at 37°C with continuous magnetic stirring. After a predetermined period, 5 ml of the medium was removed and the amount of PIC was analyzed by fluorescence measurement. The released PIC was determined by a calibration curve. In order to maintain the original volume, each time, 5ml of the medium was replaced with fresh water. The PIC release experiments were repeated three times.

IV. RESULTS AND DISCUSSION

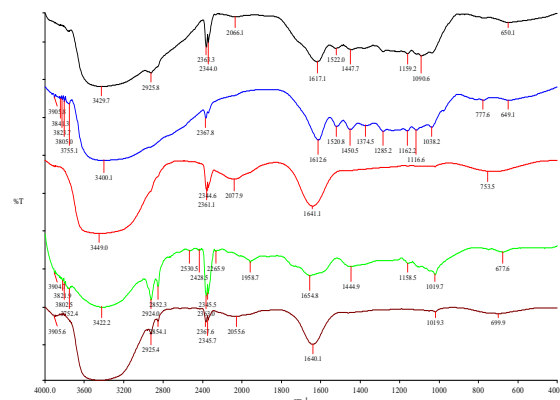
A. *Synthesis of CS/PLA-PIC Nanoparticles*

Grafting of hydrophilic polymers like poly (lactic acid) (PLA) onto chitosan is a well-known strategy to improve the solubility and biocompatibility of chitosan as well as to achieve lower recognition by the host immune system and increased blood circulation time. To improve hydrophobic nature of PIC and its potential utility in cancer therapy, we have initiated the encapsulation of PIC into CS/PLA nanoparticle formulations via by dropping method. Chitosan owing to the strong intermolecular hydrogen bonding affix to PLA surfaces forming a hydrophilic-hydrophobic biodegradable material that could be applied as drug carriers. Moreover, the amino groups in CS molecule, has higher ionic conductivity which contributes to the increase in the charge density of the polymer during the preparation process [28-30].

B. *FT-IR studies*

FT-IR spectroscopy is a common technique for investigating the intermolecular and intramolecular interactions in polymers. FT-IR spectra of pure PLA, pure Chitosan, CS/PLA, pure PIC & CS/PLA-PIC complex (Fig. 1). Several characteristic bands of PLA are located at 754 and 872 cm⁻¹ (CH bend); 1045–1211 cm⁻¹ (C–O stretch); 1456 cm⁻¹ (CH₃ bend); 1759 cm⁻¹ (C=O stretch, ester group); 2945 cm⁻¹ (CH stretch); 2997 cm⁻¹ (CH₃ stretch); and 3504 cm⁻¹ (OH stretch, end group). The main bands in the IR spectrum of CS can be seen as follows: a broad and strong overlapped band at around 3448 cm⁻¹ (OH and NH stretches);

a weak band at 2854 cm⁻¹ (CH stretch); two middle strong bands at 1640 and 1558 cm⁻¹ (amide I and amide II); 1381 and 1325 cm⁻¹ (deformation of C–CH₃ and amide III); 1153, 1122 and 1030 cm⁻¹ (saccharide structure). Compared with each component, two noticeable changes occur in the spectrum of PLA/CS complex. An original strong band of the PLA component at 1958 cm⁻¹ for the ester group becomes significantly weaker and markedly wider. The intensity of the stretching bands overlapped and centered near 3449 cm⁻¹ for the hydroxyl and amino groups pronouncedly decreases. All these registered events indicate that there are obvious interactions among the amino, carboxyl, and hydroxyl groups of the two components. Similar results were also reported by Wan et al. in their study of polylactide/chitosan blend membranes and they attributed this to the hydrogen bonds possibly formed between amino (in chitosan) and carboxyl groups (in PLA) or hydroxyl (mainly in chitosan) and carboxyl groups, because there is no covalent interaction between PLA and chitosan chains. Additionally the basic characteristics of PIC are: 3422cm⁻¹ (strong and wide O–H stretch), 1654–1444cm⁻¹ (C–C stretch), 1158cm⁻¹ (C–O stretch). However, The FT-IR of PIC showed a sharper peak at 2924cm⁻¹, which was not observed in the CS/PLA and CS/PLA-PIC NPs. This peak was found to overlap with the peaks in a broad band ranging from 2926 to 2530 cm⁻¹. This indicated interaction between the hydroxyl groups of the polyphenols and the amine functionality of the CS/PLA molecule. The appearing of these peaks was an indication of nanoparticles formation [31, 32].



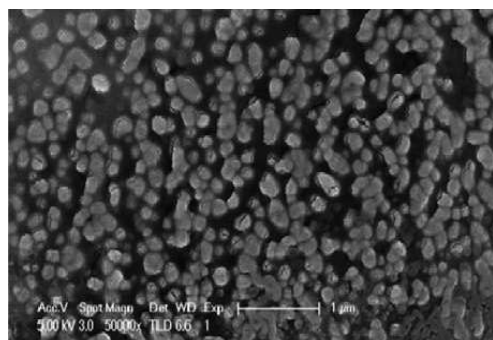


Fig. 2 : SEM image of CS/PLA-PIC nanoparticles

D. Effect on Drug Loading and Encapsulation Efficiency

The effort to enhance the loading of PIC in CS nanoparticles had unremarkable effect in the present work. As shown in Table 1, the maximum drug content was lower than 4.8% even when the theoretical loading efficiency reached 50%. The addition of PLA significantly improved the drug loading efficiency of the nanoparticles due to the stronger hydrophobic interaction between PIC and PLA. The actual drug loading efficiency increased with the concentration of PIC, and finally reached the equilibrium at 20–34%.

Table 1: Chemical parameters of CS/PLA-PIC nano-formulations

Nano-Formulation	PIC (mg)	Loading Efficiency (%)	Encapsulation Efficiency (%) \pm SE (%)
CS/PLA	5	1.6 ± 1.3	4.3 ± 2.4
CS/PLA	10	16.5 ± 1.2	91.2 ± 4.2
CS/PLA	15	20.4 ± 1.5	86.4 ± 2.2
CS/PLA	10	32 ± 2.1	80.1 ± 7.3

E. Piceatannol Release – In Vitro

In order to investigate the feasibility of using CS-PLA nanoparticles as hydrophilic drug carriers PIC as a model peptide was loaded by CS-PLA nanoparticles which showed the release profiles of PIC from CS-PLA nanoparticles with an encapsulation efficiency of 98% (Fig. 3) (7.94% Wt/Wt) for various time intervals in various pH values release media at 37°C. An initial burst release followed by a slow release of PIC occurred in pH values of 4.5 and 7.4. Moreover, these nanoparticles provided a continuous release of the entrapped peptide for up to 10 days. On the other hand, at pH values of 3.0, the PIC release rate was very fast and about 95% of the loaded PIC was released from CS-PLA nanoparticles within 5 h (Fig. 3). It is obvious from the results that the release of the PIC depends on pH values of the release medium. The release profile at a pH of 4.5 has the slowest release rate (Fig 3). This can be explained by the fact that the release of the PIC depends greatly on the swelling of the nanoparticles. At a pH of 4.5,

there is very limited swelling, and the PIC entrapped in the nanoparticles cannot be released easily. However, at a pH of 7.4 (Fig. 3), the nanoparticles are swollen to a great extent, resulting in a fairly fast release of PIC compared with the nanoparticles at pH of 4.5. This result is also in good agreement with the effect of the pH values on nanoparticles morphology as mentioned above. At strong acidic condition, for example, pH value 4.0, the nanoparticles will dissolve quickly, which leads to the very fast release effect. These results suggest the possibility to adjust the drug release rate of the CS-PLA nanoparticles by changing the pH values.

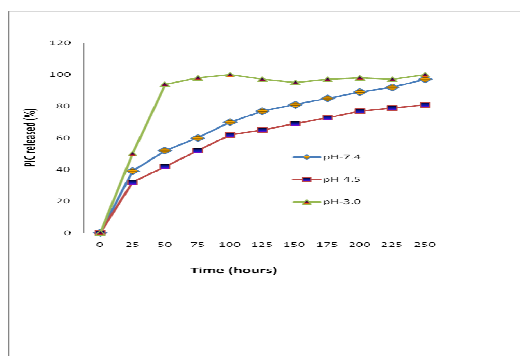


Fig 3: in vitro drug release from polymeric nanoparticles

V. CONCLUSION

Nanoparticle based drug delivery approaches thus have the potential for rendering hydrophilic agents like PIC dispersible in aqueous media, thus circumventing the pitfalls of poor solubility. In this study, PIC, a lipophilic drug, was successfully encapsulated on CS-PLA nanoparticles using dropping method with encapsulation efficiency of 80.1% and 32% actual drug loading. FT-IR studies showed the interaction between polymers and polyphenol. The mean diameter of CS-PLA nanoparticles and PIC loaded CS-PLA nanoparticles revealed its morphological analysis by SEM. These nanoparticles are stable under acidic and neutral conditions ranging from 4 to 8 and aggregate at pH>9. Thus the preliminary study proves to be a promising vehicle for the drug administration. The prepared nanoparticles also showed improved chemical properties and further study will be conducted on the above formulations.

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Nanoparticles and Its Application in Cryosurgery

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Abstract— A new technique called cryonanosurgery is introduced to solve the main problem in cryosurgery. In cryonanosurgery nanoparticle are injected with cryogenic surgery to maximize the freezing and there by minimize the surrounding healthy tissues being frozen. This was done with the help of a tool called cryospray or cryogun with different types of cryoprobes, till ice ball is formed. Nanoparticles are loaded with functional solution and injected into the target tissue. Addition of nanoparticle into biological environment increases the tissue conductivity and significantly increases freezing effects and results in more ice nucleation and also helps to get better image at the edge of tumor which are very much needed for the successes cryosurgery. Many heat transfer mechanisms occur during cryonanosurgery. Penné's Bioheat equations are used to find the heat transfer. The results show a significant enhancement in the freezing heat transfer. Both ice volume and surface area of heat transfer can be increased using cryobrobes with large diameter.

key words cryosurgery, tumor cryosprays, tissue, nanoparticle

I. NANOTECHNOLOGY

Nanotechnology has the potential impact to surgical practice. Nanomedicine is the medical application of nano technology. Nano medicine ranges from the medical applications of nanometer's to nonelectric biosensors, and even possible future applications of molecular technology. Current problems for nano medicine involve understanding the issues related to toxicity and environmental impact of nano scale materials. Molecular nanotechnology is speculative subfield of nanotechnology. Molecular nanotechnology is highly theoretical one. The proposed elements of molecular nanotechnology is molecular assemblers and nano robot. Nanotechnology is nothing but a technology which uses atom with a view to creating desired product. It has wider applications in all the field. The important application of nanotechnology is Cryonics. Nanotechnology will enable manipulation of matter at the molecular level. Nano nephrology is a branch of nano medicine and nanotechnology that seeks to use nano-materials and nano-devices for the diagnosis, therapy, and management of renal diseases.

II. NANOPARTICLES

Nanoparticles are promising tools for advancement of drug delivery, medical imaging and as diagnostic sensors. Nanoparticles are stable, solid colloidal particles consisting of biodegradable polymer or lipid materials. Nanoparticles are sized between 100 and 1000 nanometers and they're used to treat cancer. The small size of nanoparticles endows them with properties that can be very useful in oncology, particularly in imaging. Quantum dots (nanoparticles with quantum confinement properties, such as size-tunable light emission), when used in conjunction with MRI (magnetic resonance imaging a success of cryogenic engineering), can produce exceptional images of tumor sites. These nanoparticles are much brighter than organic dyes and only need one light source for excitation. This means that the use of fluorescent quantum dots could produce a higher contrast image and at a lower cost than today's organic dyes used as contrast media. Nanomedicine is the medical application of nano technology. Nano medicine ranges from the medical applications of nanometer's to nonelectric biosensors, and even possible future applications of molecular technology. Current problems for nano medicine involve understanding the issues related to toxicity and environmental impact of nano scale materials.

III. CRYOSURGERY (FREEZING)

Cryosurgery is also called cryotherapy or cryodestruction or cryoablation is a surgical technique that employs freezing at cryogenic temperatures to destroy undesirable tumor cells. Cryosurgery is effected by means of a cryosurgery device called cryoprobes either by placing its continuously cooled tip on or into the tissues to be destroyed. Cryosurgery can also be done with the help of swab and spray. Cryo surgery is accepted and approved by many countries. This technique is used to treat cancerous tumors, control pain, control bleeding, and reduce brain tumors. Cryosurgery has been used to treat skin lesions for approximately 100 years. The first cryogens were liquid air and compressed carbon dioxide snow. Liquid nitrogen became available in the 1940's and currently is the most widely used cryogen. Liquid nitrogen, which boils at -196°C (-320.8°F), is the most effective cryogen for use in a clinical setting. To



destroy diseased tissue, the tissue is cooled to -20°C to -30°C (-4°F to -22°F). Temperatures of -25°C to -50°C (-13°F to -58°F) can be achieved within 30 seconds if a sufficient amount of liquid nitrogen is applied by spray or probe. Cryosurgery is a minimally invasive procedure, and is often preferred to more traditional kinds of surgery because of its minimal pain, scarring, and cost. Cryosurgery has a typical success rates compared to other success rates for traditional open surgery. Imaging technology is one of the major developments in cryosurgery. Apart from the practical and economic advantage, it has physiological advantages also.

IV. CRYOSURGERY FOR THE TREATMENT OF CANCER

Cryosurgery is used to treat several types of cancer such as Bladder cancer, bone, breast, colon, esophageal, gallbladder, gastric, liver, lung, nasopharyngeal, ovarian, pancreatic, prostate, rectal, renal, skin, testicular, thyroid, uterine vaginal, head and neck, cancer. Some precancerous or non-cancerous conditions. Cryosurgery is also used to treat some types of low-grade cancerous and non-cancerous tumors of the bone. It may reduce the risk of joint damage when compared with more extensive surgery, and help lessen the need for amputation. The treatment is also used to treat AIDS-related Kaposi's sarcoma.

V. CRYO NANOSURGERY

The concepts of cryonanosurgery may offer new opportunities for future tumor treatment. Cryonanosurgery is closely related to the advanced Nano-technologies. The Nano cryosurgery is deeply rooted in the test advancement of a nanotechnology. Experiments and theoretical analysis indicate that, once nano particles are implanted into target area, not only the maximum freezing rate inside the target could be increased during cryosurgery compared with the conventional approach, but most importantly, the possibilities of ice nucleation could also be significantly improved which would induce an enlarged death of tumor cells. Such innovation is quite beneficial to raise the curative effectiveness of conventional cryosurgery and decrease the recurrence rate of post-cryosurgery. In addition, introduction of nanoparticles during cryosurgery could also help better image the edge of tumor as well as the margin of the ice ball. This is very important in guaranteeing a successful cryosurgery. Such merits may lead to a highly "green" therapy on tumor. Nano particles would further improve the effective killing rate of tumor cell with the combination of cryosurgery, except for adopting the highly conductive nano materials. Nano particles with lowered thermal conductivity can also have unique virtue in cryosurgery.

VI. METHODOLOGY

Cryosurgical treatment for cancer is performed with mini cryogun or cryojet (model Inc-196) liquid nitrogen storage devices adapted to different types of cryoprobes used in the cryosurgery till ice ball is formed. Nanoparticle (Au-gold) solution is loaded for administering the cryonanosurgery that is nanoparticles are mixed with functional solution and injected into the target tissue. Depends on the type of tumor. Addition of nanoparticle into a wet biological environment will increase the tissue conductivity, good biological compatibility and thus significant freezing effects and more efficient ice formation. Cryonanosurgery can be tested with mice and human trials will also be held.

VII. BIO HEAT EQUATIONS

$$\frac{\partial(Ph)}{\partial t} = \nabla \cdot (\nabla kt) + \rho_b C_b \frac{\partial}{\partial t} (T_b - T) + q_{met}$$

where ρ is the density of the tissue, and where ρ_b is the density of the blood; h , enthalpy; t , time; ω_b the blood perfusion rate ($\text{ml} \cdot \text{s}^{-1} \cdot \text{ml}^{-1}$, the volumetric blood flow rate per unit volume of tissue); T_b , the blood temperature and T , the tissue temperature; c_b , the specific heat capacity of blood; q_{met} , the metabolic heat generation ($\text{W} \cdot \text{m}^{-3}$). The second and the third terms of Equation are the heat source contributions from blood perfusion and metabolic heat generation respectively. The sum of the two terms is the total heat source, marked as " Q ". Equation is based on the assumption that blood in the biological tissue is supplied with an isotropic capillary network and it enters the tissue at the blood temperature of the major supplying artery and leaves the tissue at tissue temperature.



Fig 1 Cryoprobes tips



Temp vs time

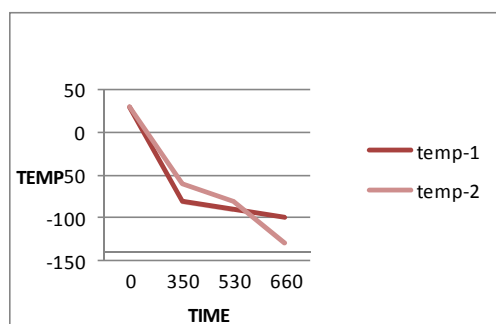


Table 1. Thermal properties of soft biological tissue

parameter	unit	value
Blood perfusionrate	ml.s ⁻¹ ml	≤0.011
Metabolic heat generation	KWm ⁻³	33.8
latenheat	MJ.m ⁻³	250
specific heat of frozen tissue	MJ.m ⁻³ °C ⁻¹	1.8
specific heat of unfrozen tissue	MJ.m ⁻³ °C ⁻¹	3.6
Thermal conductivity of frozen	w.m ⁻¹ °C ⁻¹	0.5
Thermal conductivity of unfrozen	w.m ⁻¹ °C ⁻¹	2
Blood temperature	°C	37

CONCLOUSION

Common skin lesions normally require treatments that are lengthy, painful and require post-operative care. They may be

time consuming and complicated but cryonanosurgery is very simple, flexible, quick, indispensable and relatively comfortable and also gives better results .It is just a beginning to investigate cryonanosurgery but a lot of work is needed to understand cryonanosurgery in future since many critical and complex factors still not clear are to be studied and investigated .Further study and investigations would be on both the basic mechanisms and practical issues.

ACKNOWLEDGMENT

We thank *PRESIDENT of Dr M.G.R.E&RI UNIVERSITY chennai-92.*

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Nanomedicine by Nanorobotics

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Abstract— Nanomedicine is the process of diagnosing, treating and preventing diseases, traumatic injury and improving human health, using molecular tools and molecular knowledge of the human body. One such approach to nanomedicine would be making use of microscopic mobile devices built using molecules manufacturing equipment, capable of performing complicated macroscopic and microscopically task using nano robotics. It will be the most advance and efficient type of method using nanorobotics in nanomedicine field. Nanorobots are small in size and are close to the scale of a nanometer. A cream packed with nanorobotics could remove the right amount of dead skin's , remove excess oils and apply the right amount of natural moisturizing compounds into the human body. Usage of nanorobotics in mouth wash, destroys pathogenic bacteria, Immune machine can be designed for use in the blood stream or the digestive tract , which will respond only to invading organisms , and its operation can be monitored using laser beams or optical microscope. Nanorobots can be used to deal with tuberculosis, strep throat, leprosy, malaria and cancer and even athlete's foot .Nanorobots can be used to inject new DNA into cells using a tiny needle. Nanorobots are small in size and would be 80 times more efficient as phagocytic agents, due to its flexibility, precision and low cost. As nanorobots for medical purpose can be built to last only a few minutes in the body, its usage is harmless also.

Keywords- Nanotechnology - Nanomedicine -Nanorobotics

I. INTRODUCTION

Nanotechnology provides a wide range of new technologies for developing customized solutions that optimize the delivery of pharmaceutical products .Today ,harmful side effects of treatment such as chemotherapy are commonly result of drug delivery methods, since it doesn't pin point their intended target cells accurately. But the nanorobots may join the medical armamentarium, giving the physicians the most potent tools imaginable to conquer human disease, ill health and even ageing, by targeting the accurate cell. In the medical world, nanotechnology by nano robotics will be seen as a boon, since these can help with creating Smart drugs.

A. Nanorobots

Nanorobots are tiny machines used to cure diseases in human or in any organisms. Performs task at nano scale dimensions. Nanorobotics is concerned with interactions with atomic and molecular sized objects and are called as molecular robotics. As nanorobots can be built to have shorter life time, it act as a warrior only to the invalid organism and decay's within

a short commercial time. Hence it is harmless to human body. A nanorobot acts as a Pharmacy in a cell.

There are three main considerations need to focus on when looking at nanorobots moving through the body by navigation, power and locomotion

B. Application of Nanorobots:

Application of nano robotics for the human treatment is the novel one. The future development of nano medicine by nano robotics used to cure the human health problem like Cancer treatment, Skin treatment, DNA replacement, Blood stream and Future first aid box

C. Cancer treatment:

A doctor offers the patient an injection of nanorobots, Seeks out cancer cells and destroys them.Dispels the disease at the source, leaving the healthy cells untouched. The patients has no awareness of devices working inside them

D. Skin treatment:

The skin is the body's largest organ and its exposed position subjects it to a lot of abuse, cream packed with nanomachines will apply right amount of natural moisturizing in human body by means of “deep pore cleaning method”. Nanorobots can be even used to control the hormones secretion which is responsible for ageing.

E. DNA replacement:

Cells are made of billions of molecules each built by molecular machines.DNA is the most complicated biological information source. But a single defective gene can cause a serious genetic disease. Nanotechnology can solve this problem by using grab like nanorobots which scans the nucleotides, seek for damaged part and then remove the invalid fragments .Thus DNA is repaired.

F. Mouth wash:

The mouth, teeth and gums are tha amazing and essential parts for primary digestion. A mouth wash full of smart nanorobots could rectify all the gum defects and help to keep our teeth more strong.

G. Blood stream:

Immune machine can be designed for use in the blood stream or in the digestive tracts rectify the blocks and to sensor the existence of invalid organism . They could float and circulate as antibiotics When an invader is identified it can be



removed by using the signal obtained from the bar coder present in nanorobotics by using the laser beam.

H. Future first aid box:

Powdered form of nanorobotics (capable of penetrating through the skin pores and mixes with the blood easily) can be used in first aid boxes to heal the wounds and also to check the pulse rate and other defects in human mechanism during the time of injury. So that it will be easy to collect the data of particular person within a few minutes as soon as he/she arrives the hospital. Life can be saved by diagnosing their problem.

II. CONCLUSIONS

The major advantage of nanorobots is thought to be their achievability in future. They can remain operational for years, decades or centuries. Nanorobots also produce copies of themselves to replace worn-out units, a process called self-

replication. Since cellular defects and sensible organ damages can be rectified by using nanorobots commercial usage will become more in future. Due to its harmless quality and easy application on all living organisms, it plays the vital role in nanomedicine field presently. In future within ten years several advancement technologies will be made from this nanorobotics, especially in medical field.

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Review of Nanotechnology in Nano Medicine

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to make complete, high performance products.
Nanotechnology (sometimes shortened to

Abstract— Nanotechnology is developed by the FEYNMAN in the year 1960. Nanotechnology is the creation of functional materials, devices and system through control of matter on the nanometer length scale, exploiting novel phenomena and properties (physical, chemical, biological) present only at that length scale. *Nanomedicine* is the medical application of nanotechnology. Nanomedicine is a term that is often used to define biological drugs. Nano medicine ranges from the medical applications of nano materials, to nano electronic biosensors, and even possible future applications of molecular nanotechnology. One nanometer is one-millionth of a millimeter. Nanomedicine is an important and rapidly growing field which is emerging from the application of nanotechnology to healthcare. The aim of the nanomedicine is the improvement of healthcare for the benefit of the patient. High impact can be expected if the major diseases are addressed first, which impose the high burden on the aging population, cardiovascular diseases, cancer, musculoskeletal conditions, neurodegenerative and psychiatric diseases, diabetes and viral infection. Future healthcare will make use of sensitive new diagnostics for an improved personal risk assessment. At the onset of a disease indicator, patient will be supported by diagnosis and disease location and follow-up monitoring phase. Nanotechnology has the potential to make healthcare more effective in terms of clinical outcome and also it is more affordable to the society. Current problems for nanomedicine involve understanding the issues related to toxicity and environmental impact of nanoscale materials. The contents that are briefly explained in this topic are drug delivery, protein delivery, cancer treatment, clinical use, nanonephrology, medical applications, merits and demerits.

Keywords:- Drug delivery, protein delivery, cancer treatment, clinical use and medicinal applications.

1. INTRODUCTION

Nanotechnology is the engineering of functional systems at the molecular scale. This covers both current work and concepts that are more advanced. In its original sense, 'nanotechnology' refers to the projected ability to construct items from the bottom up, using techniques and tools being developed today

"nanotech") is the manipulation of matter on an atomic and molecular scale. Generally, nanotechnology works with materials, devices, and other structures with at least one dimension sized from 1 to 100 nanometers. Quantum mechanical effects are important at this quantum-realm scale. With a variety of potential applications, nanotechnology is a key technology for the future and governments have invested billions of dollars in its research. Through its National Nanotechnology Initiative, the USA has invested 3.7 billion dollars. The European Union has invested 1.2 billion and Japan 750 million dollars.

Nanotechnology is very diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nanoscale to direct control of matter on the atomic scale. Nanotechnology entails the application of fields of science as diverse as surface science, organic chemistry, molecular biology, semiconductor physics, micro fabrication, etc

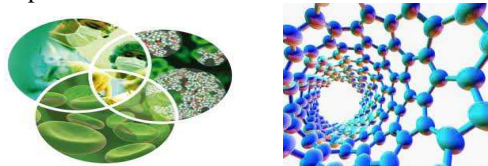
2. DEFINITION OF NANOMEDICINE

Nanomedicine is the application of nanotechnology (the engineering of tiny machines) to the prevention and treatment of disease in the human body. This evolving discipline has the potential to dramatically change medical science.

Nanomedicine is the medical application of nanotechnology. Nano medicine ranges from the medical applications of nanomaterials, to nanoelectronic biosensors, and even possible future applications of molecular nanotechnology. Current problems for nanomedicine involve understanding the issues related to toxicity and environmental



impact of nanoscale materials. One nanometer is one-



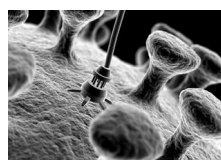
3. NANOMEDICINE AND DRUG DELIVERY

Nanomedical approaches to drug delivery center on developing nanoscale particles or molecules to improve drug bioavailability. Bioavailability refers to the presence of drug molecules where they are needed in the body and where they will do the most good. Drug delivery focuses on maximizing bioavailability both at specific places in the body and over a period of time. This can potentially be achieved by molecular targeting by nanoengineered devices.

Using nanoparticle contrast agents, images such as ultrasound and MRI have a favorable distribution and improved contrast. The new methods of nanoengineered materials that are being developed might be effective in treating illnesses and diseases such as cancer. What nanoscientists will be able to achieve in the future is beyond current imagination. This might be accomplished by self assembled biocompatible nanodevices that will detect, evaluate, treat and report to the clinical doctor automatically.

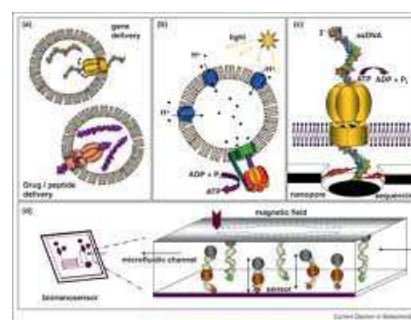
Drug delivery systems, lipid- or polymer-based nanoparticles, can be designed to improve the pharmacological and therapeutic properties of drugs. The strength of drug delivery systems is their ability to alter the pharmacokinetics and biodistribution of the drug. When designed to avoid the body's defence mechanisms, nanoparticles have beneficial properties that can be used to improve drug delivery. Where larger particles would have been cleared from the body, cells take up these nanoparticles because of their size. Complex drug delivery mechanisms are being developed, including the ability to get drugs through cell membranes and into cell cytoplasm. Efficiency is important because many diseases depend upon processes within the cell and can only be impeded by drugs that make their way into the cell. Triggered response is one way for drug molecules to be used more efficiently. Drugs are placed in the body and only activate on encountering a particular signal. For example, a drug with poor solubility will be replaced by a drug delivery system where both hydrophilic and hydrophobic

environments exist, improving the solubility. Also, a drug may cause tissue damage, but with drug delivery, regulated drug release can eliminate the problem. If a drug is cleared too quickly from the body, this could force a patient to use high doses, but with drug delivery systems clearance can be reduced by altering the pharmacokinetics of the drug. Poor biodistribution is a problem that can affect normal tissues through widespread distribution, but the particulates from drug delivery systems lower the volume of distribution and reduce the effect on non-target tissue. Potential nanodrugs will work by very specific and well-understood mechanisms; one of the major impacts of nanotechnology and nanoscience will be in leading development of completely new drugs with more useful behavior and less side effects.



4. NANOMEDICINE AND PROTEIN DELIVERY

Protein and peptides exert multiple biological actions in human body and they have been identified as showing great promise for treatment of various diseases and disorders. These macromolecules are called biopharmaceuticals. Targeted and/or controlled delivery of these biopharmaceuticals using nanomaterials like nanoparticles and Dendrimers is an emerging field called nanobiopharmaceutics, and these products are called nanobiopharmaceuticals.



5. NANOMEDICINE AND CANCER TREATMENT

The small size of nanoparticles endows them with properties that can be very useful in oncology, particularly in imaging. Quantum dots (nanoparticles



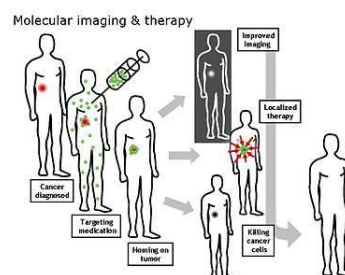
with quantum confinement properties, such as size-tunable light emission), when used in conjunction with MRI (magnetic resonance imaging), can produce exceptional images of tumor sites. These nanoparticles are much brighter than organic dyes and only need one light source for excitation. This means that the use of fluorescent quantum dots could produce a higher contrast image and at a lower cost than today's organic dyes used as contrast media. The downside, however, is that quantum dots are usually made of quite toxic elements.

Another nanoproperty, high surface area to volume ratio, allows many functional groups to be attached to a nanoparticle, which can seek out and bind to certain tumor cells. Additionally, the small size of nanoparticles (10 to 100 nanometers), allows them to preferentially accumulate at tumor sites (because tumors lack an effective lymphatic drainage system). A very exciting research question is how to make these imaging nanoparticles do more things for cancer. For instance, is it possible to manufacture multifunctional nanoparticles that would detect, image, and then proceed to treat a tumor? This question is under vigorous investigation; the answer to which could shape the future of cancer treatment. A promising new cancer treatment that may one day replace radiation and chemotherapy is edging closer to human trials. Kanzius RF therapy attaches microscopic nanoparticles to cancer cells and then "cooks" tumors inside the body with radio waves that heat only the nanoparticles and the adjacent (cancerous) cells.

Sensor test chips containing thousands of nanowires, able to detect proteins and other biomarkers left behind by cancer cells, could enable the detection and diagnosis of cancer in the early stages from a few drops of a patient's blood. The basic point to use drug delivery is based upon three facts: a) efficient encapsulation of the drugs, b) successful delivery of said drugs to the targeted region of the body, and c) successful release of that drug there. Nanoparticles of cadmium selenide (quantum dots) glow when exposed to ultraviolet light. When injected, they seep into cancer tumors. The surgeon can see the glowing tumor, and use it as a guide for more accurate tumor removal.

In photodynamic therapy, a particle is placed within the body and is illuminated with light from the outside. The light gets absorbed by the particle and if the particle is metal, energy from the light will heat the particle and surrounding tissue.

Light may also be used to produce high energy oxygen molecules which will chemically react with and destroy most organic molecules that are next to them (like tumors). This therapy is appealing for many reasons. It does not leave a “toxic trail” of reactive molecules throughout the body (chemotherapy) because it is directed where only the light is shined and the particles exist. Photodynamic therapy has potential for a noninvasive procedure for dealing with diseases, growth and tumors.

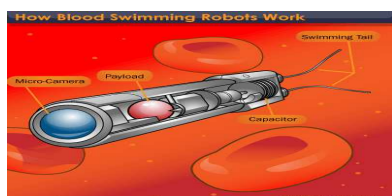


6. NANOMEDICINE AND NANOSURGERY

Nanosurgery can be done through nanorobots surgical nanorobots could be introduced into the body through the vascular system or at the ends of catheters into various vessels and other cavities in the human body. Nanorobots are programmed, guided and operated by a human surgeon, could act as an semi-autonomous on-site surgeon inside the human body. The earliest forms of cellular nanosurgery are already being explored today. For example, a rapidly vibrating (100 Hz) micropipette with a <1 micron tip diameter has been used to completely cut dendrites from single neurons without damaging cell viability. Axotomy of roundworm neurons was performed by femtosecond laser surgery, after which the axons functionally regenerated. A femtolaser acts like a pair of “nano-scissors” by vaporizing tissue locally while leaving adjacent tissue unharmed. Femtolaser surgery has performed: localized nanosurgical ablation of focal adhesions adjoining live mammalian epithelial cells, microtubule dissection inside yeast cells, noninvasive intratissue nanodissection of plant cell walls and selective destruction of intracellular single plastids or selected parts of them, and even the nanosurgery of individual chromosomes (selectively knocking out genomic nanometer-sized regions within the nucleus of living Chinese hamster ovary cells). This type of nanosurgery will not kill any cells in the human body. The future is everything for nanotechnology. Since nothing has been built, there are many opportunities for the scientists working with them to develop nanobots with a variety of



different uses. They have potential usage in medicine, chemistry, energy, information and communication, heavy industry, and even consumer goods.



7. NANOMEDICINE IN CLINICAL USE

Everyone agrees that some of the key applications of nanotechnology will be in medicine. Within medicine, drug delivery is an obvious target. The answer, as usual, depends on what you mean by nanotechnology. Many people have welcomed Abraxane, which received FDA approval for use for breast cancer earlier this year, as the first nano-drug. But a number of other drugs already in clinical use have just as much right to the *nano-* label. A useful list of nano-medicines in current clinical use in an article in Nano Today – Nanomedicine gets clinical. The key functions that nano-engineering confers on these products as *packaging* and *targeting* – the active drug molecules need to be protected from the body’s systems for repelling foreign materials, and if possible they need to be actively targeted to the parts of the body at which the therapy is directed. For the anti-cancer therapeutics that dominates this list, this target is the tumour.

One approach to targeting is to wrap the molecule up in a liposome – a nanoscale container that is formed, by self-assembly, when soap-like lipid molecules form a bilayer sheet which folds over on itself to make a bag. These are the same structures that are already incorporated in some cosmetics. DaunoXome consists of the anti-cancer drug daunorubicin encapsulated in liposomes, and is used for the treatment of HIV-related Kaposi’s sarcoma. Doxil® and Caelyx are liposomal preparations of the related drug doxorubicin, and are used for advanced ovarian cancers. Simple liposomes have quite a short lifetime in the body; in Doxil the surfaces of the liposome are modified by being coated by the water soluble polymer polyethylene glycol. Rather than putting the drug in a liposome, and then coating the liposome with polymer, it is possible simply to attach polyethylene glycol directly to the drug. This is the basis of “polymer therapeutics” (this is Ruth Duncan’s own field). Examples in clinical use include Oncaspar, for acute lymphoblastic leukemia,

and Neulasta, used to decrease infection in patients receiving chemotherapy. Both these drugs consist of a protein drug molecule which is disguised from the body by being coated in a diffuse cloud of polyethylene glycol (PEG). How PEG works is still not entirely clear, but the basis of the effect is that it forms a diffuse layer which resists protein adsorption. Military, a drug licensed in the USA for acute myeloid leukemia, is a (currently rather rare) example of a targeted drug. The drug itself – a potent anti-tumor antibiotic – is chemically linked to an antibody – a protein molecule which specifically binds to chemical groups on the outside of the target cells. In Abraxane, it is the drug molecule itself, paclitaxel, that is nanoengineered – it is prepared in a nanoparticulate form to improve its solubility; the nanoparticles are coated with the blood protein albumin. So what we see now are a number of products which use individual tricks of nanoengineering to improve their effectiveness. What we will probably see in the future is the combination of more than one of these functions in a single product – moving beyond clever formulation to integrated nanodevices m.



8. MEDICAL USES OF NANOMATERIALS

Two forms of nanomedicine that have already been tested in mice and are awaiting human trials are using gold nanoshells to help diagnose and treat cancer, and using liposomes as vaccine adjuvants and as vehicles for drug transport. Similarly, drug detoxification is also another application for nanomedicine which has shown promising results in rats. A benefit of using nanoscale for medical technologies is that smaller devices are less invasive and can possibly be implanted inside the body, plus biochemical reaction times are much shorter. These devices are faster and more sensitive than typical drug delivery.



9. MEDICAL APPLICATIONS OF NANOMATERIALS

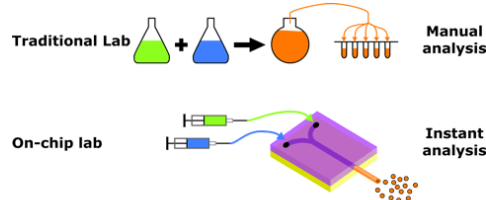
Molecular nanotechnology is a speculative subfield of nanotechnology regarding the possibility of engineering molecular assemblers, machines which could re-order matter at a molecular or atomic scale. Molecular nanotechnology is highly theoretical, seeking to anticipate what inventions nanotechnology might yield and to propose an agenda for future inquiry. The proposed elements of molecular nanotechnology, such as molecular assemblers and nanorobots are far beyond current capabilities.

Nanomaterials are also being considered for use in improving diagnosis and detection of diseases. Advances in microelectronics and nanotechnology have the potential to greatly reduce the size of medical diagnostic equipment. Engineers have created pill-sized video cameras to take pictures inside the body. These non-invasive imaging techniques can go to places doctors currently have trouble viewing. The battery inside the camera lasts for six hours, enough time to travel throughout the entire digestive system. The camera has already been successfully tested on humans and animals; researchers hope to further reduce the size of the device using nanomaterials. Some of the medical applications are

Nanostructural implants in drug delivery

1. Nanostructured scaffolds for tissue engineering.
2. Nanostructuring for cell expansion.
3. Disease diagnosing by targeted nano particles.
4. Nanoparticle for efficient, highly sensitive, and high throughput bio assays.
5. Improving efficacy, reduction in dose and side effects by formulating into nano drug form
6. Nanofibrils in development of rapid wound healing dressings.

Traditional labs and Lab-on-a-Chip devices



Redrawn from: Brivio, M., Verboom, W., & Reinhoudt, D. N. (2006). Miniaturized continuous flow reaction vessels: influence on chemical reactions. *Lab on a Chip*, 6, p. 329.

10. CELL REPAIRING MACHINES

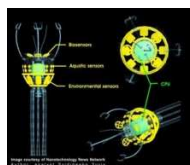
Using drugs and surgery, doctors can only encourage tissues to repair themselves. With molecular machines, there will be more direct repairs. Cell repair will utilize the same tasks that living systems already prove possible. Access to cells is possible because biologists can insert needles into cells without killing them. Thus, molecular machines are capable of entering the cell. Also, all specific biochemical interactions show that molecular systems can recognize other molecules by touch, build or rebuild every molecule in a cell, and can disassemble damaged molecules. Finally, cells that replicate prove that molecular systems can assemble every system found in a cell. Therefore, since nature has demonstrated the basic operations needed to perform molecular-level cell repair, in the future, nanomachine based systems will be built that are able to enter cells, sense differences from healthy ones and make modifications to the structure. The healthcare possibilities of these cell repair machines are impressive. Comparable to the size of viruses or bacteria, their compact parts would allow them to be more complex. The early machines will be specialized. As they open and close cell membranes or travel through tissue and enter cells and viruses, machines will only be able to correct a single molecular disorder like DNA damage or enzyme deficiency. Later, cell repair machines will be programmed with more abilities with the help of advanced AI systems.

Foreseeable developments include the use of synthetic growth factors and morphogens for inducing complex tissue regeneration, and even the introduction of novel genetic programs for reversing cellular and tissue injuries for which natural healing mechanisms do not exist (Cell Repair Machines). This new "ultimate medicine" will allow us to: modify cell DNA in sophisticated ways to achieve virtually any desired growth objectives, repair cellular injuries caused by the hours of absent blood flow, increase our physical strength hundreds of times, and theoretically expanding our lifespan to up to 600years.minimal. Since infrared lasers are used to heat the coated nanoshells that cause the fusion, welding of the flesh can occur without the fear of burning the patient's organs.

Nanocomputers will be needed to guide these machines. These computers will direct machines to examine, take apart, and rebuild damaged molecular structures. Repair machines will be able to repair



whole cells by working structure by structure. Then by working cell by cell and tissue by tissue, whole organs can be repaired. Finally, by working organ by organ, health is restored to the body. Cells damaged to the point of inactivity can be repaired because of the ability of molecular machines to build cells from scratch. Therefore, cell repair machines will free medicine from reliance on self repair alone.

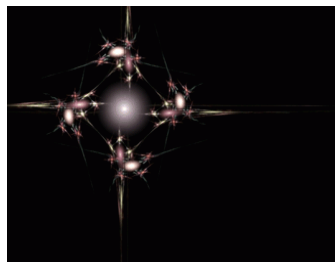


11. NANONEPHROLOGY

Nanonephrology is a branch of nanomedicine and nanotechnology that seeks to use nano-materials and nano-devices for the diagnosis, therapy, and management of renal diseases. It includes the following goals:

1. the study of kidney protein structures at the atomic level
2. nano-imaging approaches to study cellular processes in kidney cells
3. nano medical treatments that utilize nanoparticles to treat various kidney diseases

Advances in Nanonephrology are expected to be based on discoveries in the above areas that can provide nano-scale information on the cellular molecular machinery involved in normal kidney processes and in pathological states. By understanding the physical and chemical properties of proteins and other macromolecules at the atomic level in various cells in the kidney, novel therapeutic approaches can be designed to combat major renal diseases. The nano-scale artificial kidney is a goal that many physicians dream of. Nano-scale engineering advances will



permit programmable and controllable nano-scale robots to execute curative and reconstructive procedures in the

human kidney at the cellular and molecular levels. Designing nanostructures compatible with the kidney cells and that can safely operate in vivo is also a future goal. The ability to direct events in a controlled fashion at the cellular nano-level has the potential of significantly improving the lives of patients with kidney diseases

12. CURRENT STATUS OF NANOTECHNOLOGY

Nanotechnology applications are a reality today. American car manufacturers have been using nanotubes to improve the safety of fuel-lines in passenger vehicles for over a decade, and the electronics industry has been relying on nanotubes in its packaging material to better protect goods and to aid the removal of any electrical charges before they can build to disruptive levels. Japan, Korea, Taiwan, and European countries including Scotland and the Netherlands have also played influential roles in the development of nanotechnology capabilities - and the technology continues to be of world-wide interest.

The potential for more broad-based nanotechnology applications will come from a better understanding of how particles operate on a nanoscale and how biological and non-biological particles can be integrated - research and development continues in these fields and many others. There is still a way to go before we fully understand the workings and potential applications of the assembly of atoms and how to make these processes scalable, profitable and standardized (and therefore able to produce predictable and consistent outputs).

Around US\$2 billion is being invested annually in nanotechnology developments around the world, with nearly 40% of this in the USA. Japan is a major contributor, as are the European Governments and major industrial economies such as Singapore, Taiwan, and China.

13. FUTURE DEVELOPMENTS OF NANOTECHNOLOGY

Nanotechnology is part of a predicted future in which dentistry and periodontal practice may become more high-tech and more effective looking to manage individual dental health on a microscopic level by enabling us to battle decay where it begins with bacteria. Construction of a comprehensive research



facility is crucial to meet the rigorous requirements for the development of nanotechnologies.

Researchers are looking at ways to use microscopic entities to perform tasks that are now done by hand or with equipment. This concept is known as nanotechnology. Tiny machines, known as nanoassemblers, could be controlled by computer to perform specialized jobs. The nanoassemblers could be smaller than a cell nucleus so that they could fit into places that are hard to reach by hand or with other technology. Used to destroy bacteria in the mouth that cause dental caries or even repair spots on the teeth where decay has set in, by use of computer to direct these tiny workers in their tasks. Nanotechnology has tremendous potential, but social issues of public acceptance, ethics, regulation, and human safety must be addressed before molecular nanotechnology can be seen as the possibility of providing high quality dental care to the 80% of the world's population that currently receives no significant dental care.

Trends in oral health and disease also may change the focus on specific diagnostic and treatment modalities. Increasingly preventive approaches will reduce the need for cure prevention a viable approach for the most of them Diagnosis and treatment will be customized to match the preferences and genetics of each patient. Treatment options will become more numerous and exciting. All this will demand, even more so than today, the best technical abilities, professional skills those are the hallmark of the contemporary dentist and periodontist. Developments are expected to accelerate significantly.

14. MERITS OF NANOTECHNOLOGY

To enumerate the merits and demerits of nanotechnology, let us first run through the good things this technology brings:

- Nanotechnology can actually revolutionize a lot of electronic products, procedures, and applications. The areas that benefit from the continued development of nanotechnology when it comes to electronic products include nano transistors, nano diodes, OLED, plasma displays, quantum computers, and many more.
- Nanotechnology can also benefit the energy sector. The development of more effective energy-producing, energy-absorbing, and energy storage products in smaller and more

efficient devices is possible with this technology. Such items like batteries, fuel cells, and solar cells can be built smaller but can be made to be more effective with this technology.

- Another industry that can benefit from nanotechnology is the manufacturing sector that will need materials like nanotubes, aerogels, nano particles, and other similar items to produce their products with. These materials are often stronger, more durable, and lighter than those that are not produced with the help of nanotechnology.
- In the medical world, nanotechnology is also seen as a boon since these can help with creating what is called smart drugs. These help cure people faster and without the side effects that other traditional drugs have. You will also find that the research of nanotechnology in medicine is now focusing on areas like tissue regeneration, bone repair, immunity and even cures for such ailments like cancer, diabetes, and other life threatening diseases.

15. DEMERITS OF NANOTECHNOLOGY

When tackling the merits and demerits of nanotechnology, you will also need to point out what can be seen as the negative side of this technology:

- Included in the list of disadvantages of this science and its development is the possible loss of jobs in the traditional farming and manufacturing industry.
- You will also find that the development of nanotechnology can also bring about the crash of certain markets due to the lowering of the value of oil and diamonds due to the possibility of developing alternative sources of energy that are more efficient and won't require the use of fossil fuels. This can also mean that since people can now develop products at the molecular level, diamonds will also lose its value since it can now be mass produced.
- Atomic weapons can now be more accessible and made to be more powerful and more destructive. These can also become more accessible with nanotechnology.
- Since these particles are very small, problems can actually arise from the inhalation of these minute particles, much



like the problems a person gets from inhaling minute asbestos particles.

- Presently, nanotechnology is very expensive and developing it can cost you a lot of money. It is also pretty difficult to manufacture, which is probably why products made with nanotechnology are more expensive.

16. CONCLUSION

Nanomedicine is a new age phenomenon which the international medical community is eagerly looking forward to come into full swing. The ever increasing demands and challenges that the present medicine field is posing can be met by nanomedicine. The stakes are high and the need is ours, so all we need is to embrace innovations. This technology can revolutionize the entire medical field if given proper attention and importance, with proper government intervention in aspects like funding. Attracting young talents to the research field can also boost its growth. Let us hope that nanomedicine is going to be put to the maximum use and its benefits reach every sections of the society thereby alleviating the pains of millions of people around the world.

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Nano Food

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Abstract— Nanotechnologies enable food ingredients to be managed at a molecular level. Nanotechnology helps in better protection of food or to detect how fresh it is. Nanotechnology has the potential to generate new food products and new food packaging. This review focuses on the use of nanotechnologies in food processing and packaging with special attention to their reflection on food quality and safety. It also includes application of nanotechnology in food processing, application of nanotechnology in food packaging and food contact materials, nanotechnology and food safety as well as regulation of nanotechnologies to ensure food safety. Nanotechnology has potential applications in all aspects of food sectors including food processing, food packaging, food monitoring, production of functional foods, development of foods capable of modifying their colour, flavour or nutritional properties according to a person's dietary needs as well as production of stronger flavourings, colourings and nutritional food additives. Development of food analytical methods for the detection of tiny amounts of a chemical contaminant, virus or bacteria in food system is another potential use of nanotechnology. This will result in more safety for the food processing system.

Keywords: Food hazards, Nanotechnology, Risk perception, new technologies, Nanofoods, Packaging, Safety, and Biodegradable.

I.Introduction:

The term “nanofood” describes food which has been cultivated, produced, processed or packaged using nanotechnology techniques or tools, or to which manufactured nanomaterials have been added. Examples of Nano-ingredients and manufactured nanomaterial additives include nanoparticles of iron or zinc, and nanocapsules containing ingredients like co-enzyme Q10 or omega 3.

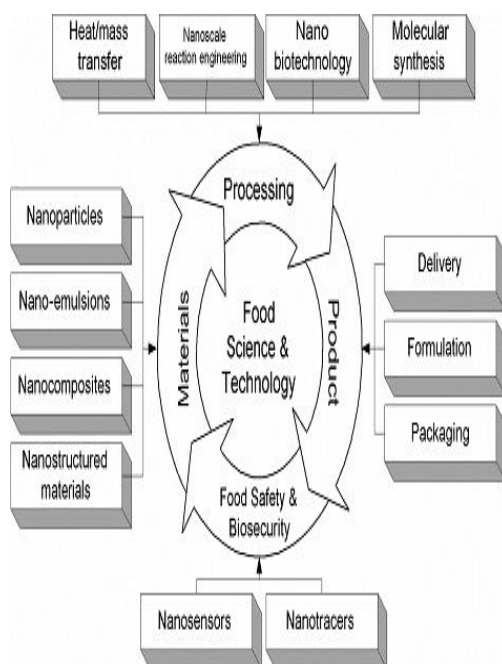


II.What is happening with nanofood?

Back in the early 2000's, food nanotechnology seemed to be a very hot topic and large industrial food companies were eager to explore new opportunities offered by nanotechnology applications. Here is an overview of what nanotechnology applications are currently being researched, tested and in some cases already applied in food technology:

A.Food processing:

- Nanocapsules to improve bioavailability of nutraceuticals in standard ingredients such as cooking oils.
- Nanoencapsulated flavor enhancers.
- Nanotubes and nanoparticles as gelation and viscosifying agents.
- Nanocapsules infusion of plants based steroids to replace meats cholesterol.
- Nanoparticles to selectively bind and remove chemicals and pathogens from food.
- Nanoemulsions and particles for better availability and dispersion of nutrients.



C. supplements:



B. Food packaging:

- Antibodies attached to fluorescent nanoparticles to detect chemicals or foodborne pathogens
- Biodegradable nanosensors for temperature, moisture and time monitoring.
- Nanoclays and nanofilms as barrier materials to prevent spoilage and oxygen absorption.
- Electrochemical nanosensors to detect ethylene.
- Antimicrobial and antifungal surface coatings with nanoparticles (silver, magnesium, zinc).
- Lighter, stronger and more heat-resistant films with silicate nanoparticles.
- Modified permeation behavior of foils.

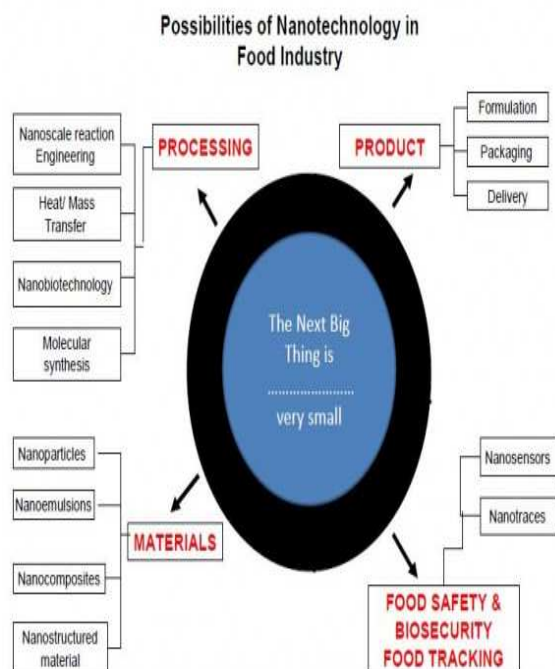
- Nanosize powders to increase absorption of nutrients.
- Cellulose nanocrystal composites as drug carrier.
- Nanoencapsulation of nutraceuticals for better absorption, better stability or targeted delivery.
- Nanochleates (coiled nanoparticles) to deliver nutrients more efficiently to cells without affecting color or taste of food.
- Vitamin sprays dispersing active molecules into nanodroplets for better absorption.

III. Nanotechnology in the Food Industry:

Nanotechnology is having an impact on several aspects of the food industry, from how food is grown to how it is packaged. Companies are developing



nanomaterials that will make a difference not only in the taste of food, but also in food safety, and the health benefits food delivers.



IV. Nanomaterials in Food Packaging:

Use of nanomaterials in food packaging is already a reality. Bottles made with nanocomposites that minimize the leakage of carbon dioxide out of the bottle; this increases the shelf life of carbonated beverages without having to use heavier glass bottles or more expensive cans. Nanosensors in plastic packaging can detect gases given off by food when it spoils and the packaging itself changes color to alert you to food gone bad. Plastic films are being developed that will allow the food to stay fresher longer. These films are packed with silicate nanoparticles to reduce the flow of oxygen into the package and the leaking of moisture out of the package.



Nanosensors are being developed that can detect bacteria and other contaminants such as salmonella on the surface of food at a packaging plant, which reduces the chance of contaminated food reaching grocery store shelves. There are nanosensors being developed to detect pesticides on fruit and vegetables.

V. Nanomaterials Changing Food Characteristics:

Nanoparticles are being used to deliver vitamins or other nutrients in food and beverages without affecting the taste or appearance. They encapsulate the nutrients, and carry them to the stomach and thereon to the blood stream, so that the nutrient value is not lost. Some nutrients lose their value before they reach the stomach, as they are not coated or encapsulated. “Interactive” foods made of nanomaterials are being developed that would allow you to choose which flavor and color a piece of food has. Nanocapsules contain color enhancers that get triggered when consumed. Finally, nanoparticles emulsions are being used in ice cream and various spreads to improve the texture and uniformity.

There are four key focus areas for nanotechnology food research:

- Nano-modification of seed and fertilisers/ pesticides.
- Food ‘fortification’ and modification.
- Interactive ‘smart’ food.
- ‘Smart’ packaging and food tracking.

A. Food ‘fortification’ and modification:

Nanotech companies are working to fortify processed food with nano-encapsulated nutrients, its appearance and taste boosted by nano-developed colours, its fat and sugar content removed or disabled by nano-modification, and ‘mouth feel’ improved. Food



'fortification' will be used to increase the nutritional claims that can be made about a given processed food – for example the inclusion of 'medically beneficial' nano-capsules will soon enable chocolate chip cookies or hot chips to be marketed as or artery cleansing. Nanotechnology will also enable junk foods like ice cream and chocolate to be modified to reduce the amount of fats and sugars that the body can absorb. This could happen by using nanoparticles to prevent the body from digesting or absorbing these components of the food. In this way, the nano industry could market vitamin and fibre-fortified, fat and sugar-blocked junk food as health promoting and weight reducing.



VI. The future of nanofood:

By the year 2040 there will be the common use of nano produced food, which has the correct nutritional composition and the same taste and texture of organically produced food, means that the availability of food is no longer affected by limited resources, bad crop weather, water problems or others.

Nanotechnology will have an impact on the food industry, from how food is grown and produced, processed to how it is packaged, transported and consumed and also in food safety, and the health benefits food delivers.

Nanotechnology can provide for the future development of far more precise and effective methods of, and other forms of manipulation of food polymers and polymeric assemblages to provide tailor-made improvements to food quality and food safety.

VII. Some example applications:

- Nanocapsules and nano-objects are being used for "on demand" preservatives, enriched food, flavour, smell, taste and colours.

- Interactive food: attractive surface treatment, glaziers and colours, Improvement of food safety and quality, Extension of products shelf-life .
- Nanocontrol of healthy digestion tube and micro-flora, digestion more compatible food.
- Improved cooking, control of food ingredients.
- Special Food: Hospital Food, Space Food, Hot and Cold areas Food Controlled extraction and release nanoparticles.
- Nanocarriers for food and deliver of nutrients.

VIII. Preparation of propolis nanofood and application to human cancer:

Propolis has well-known antimicrobial activity as well as antioxidant, antitumoral, anti-inflammatory, and regenerative properties, but its effects on the immune response are not well understood. Furthermore, clinical application of this relatively efficacious agent in cancer and other diseases has been limited due to poor aqueous solubility and, consequently, minimal systemic bioavailability. Nanoparticles-based delivery approaches have the potential to render hydrophobic agents like propolis dispersible in aqueous media, thus overcoming the pitfalls of poor solubility. A polymeric nanoparticles-encapsulated formulation of propolis (propolis nanofood) utilizing random copolymers of N-isopropylacrylamide (NIPAAm) with N-vinyl-2-pyrrolidone (VP) and poly(ethyleneglycol) monoacrylate (PEG-A) has been synthesized. Physico-chemical characterization of the polymeric nanoparticles by dynamic laser light scattering and transmission electron microscopy confirms a narrow size distribution in the 50-nm range. Propolis nanofood, unlike free propolis, is readily dispersed in aqueous media. Propolis nanofood demonstrates comparable in vitro therapeutic efficacy to free propolis against a panel of human pancreatic cancer cell lines, as assessed by cell viability and clonogenicity assays in soft agar.

IX. Functional nanofoods:

In the near future, a cholesterol-lowering burger is not impossible. Nanoscience, defined by some as the restructuring of food to atomic or molecular level, aimed at obtaining nano ingredients with better properties, is a reality in which both government and private sector invest in research and development.

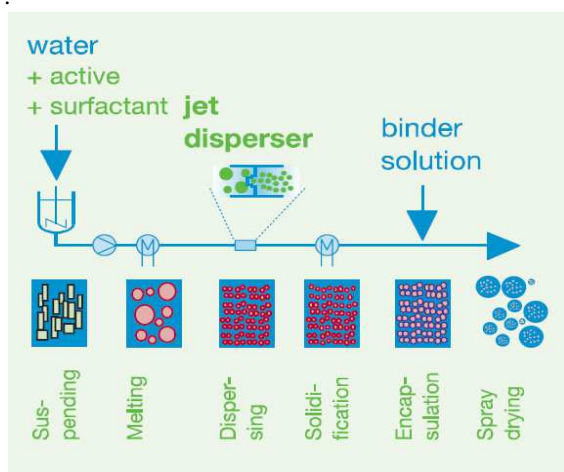


Without necessarily having to refer to their order of importance, it is possible to define at least two basic functions of a food:

- **Hedonic:** From this point of view, food satisfies the expectations to the sensory attributes of the same through the perception of flavors, aromas, colors and textures; along with the appropriate intake to appetite
- **Physiological:** It has been found that many traditional foods like fruits, vegetables, whole grains, cereals and milk contain components that come under a food group called “functional”. These nutrients must possess specific attributes of physical and chemical stability and bio-availability such as to ensure absorption, biologically active even at the point where they should be partakers of the corresponding metabolic reactions. From this, the synergy between Functional Foods and Nanotechnology, giving rise to the innovative concept of “Functional nanofoods or Interactive”.

X. Nanotechnology applied to food design:

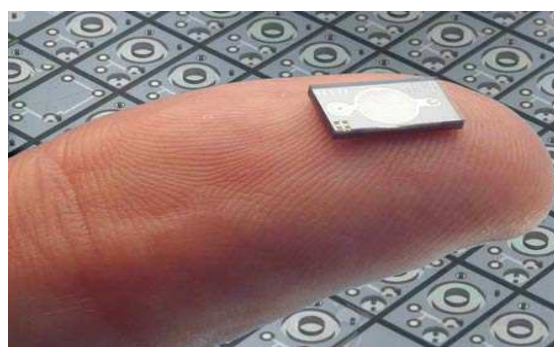
Electron microscopy and probe microscopes have provided unprecedented opportunities to understand the heterogeneous structure of food in the sub-levels of its molecular structure. This has provided new solutions to previously intractable problems in science and food technology to offer new approaches for the rational selection of raw materials or processing of these materials to improve the quality of foodstuffs.



The potential impact of nanotechnology applied to the design of food, is no stranger to the governments

of major developed countries, who so far of the decade have substantially increased investment in research and development in the area nanofoods. It would be feasible to produce burgers that may lower cholesterol or modify according to taste or nutritional requirements of the consumer, in addition to packaging in packaging that its composition “intelligent” detect and inactivate deteriorative microorganisms that may have contaminated the product, avoiding the effects or warning of their presence in it.

XI. Disadvantages:



Insulin Pump

However there are some issues, particularly those relating to accidental or deliberate use of nanoparticles in food contact materials or food that can cause consumer concern. Ingredients used in these applications include iron or zinc nanoparticles, nanocapsules containing coenzyme Q10 and omega 3 nanoadditives or stabilizers. It also has carotenoids nanoparticles soluble in water and improving its bioavailability in aseptic fruit juices and synthetic lycopene approved as GRAS.

We can find applications of the concept of functional nanofoods products prepared from canola oil, baking, food additives and supplements, margarine and canned juices. A canola oil-containing nanodroplet (micelles) with vitamins, minerals and phytochemicals and antioxidants has been developed. And also, a baking company has designed nanocapsules containing fish oil high in Omega 3, which is incorporated into their products so that ingested the same it is not released until the product into the stomach by removing the negative perception of the distinctive flavors of fish oils during consumption of bread.



Antioxidants including nanoparticles are prepared by encapsulation process and added to different products thus achieving level avoid inactivation in the stomach and first part of the gastrointestinal tract, which are incorporated into the bloodstream until concentrations above 70%, thus increasing the effectiveness of its function at the cellular level.

XII.Conclusion:

At present there are clear opportunities for nanoscience and nanotechnology in food technology. Some applications can be anticipated and can result in targeted advances in technology. However, new scientific advances usually lead to new technological innovations that might not have been predicted at the outset. At present the food industry is at a crossroads. It can pass by and hope to exploit developments in

nanotechnology as they emerge serendipitously or otherwise.

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Nanotechnology in Biotechnological field

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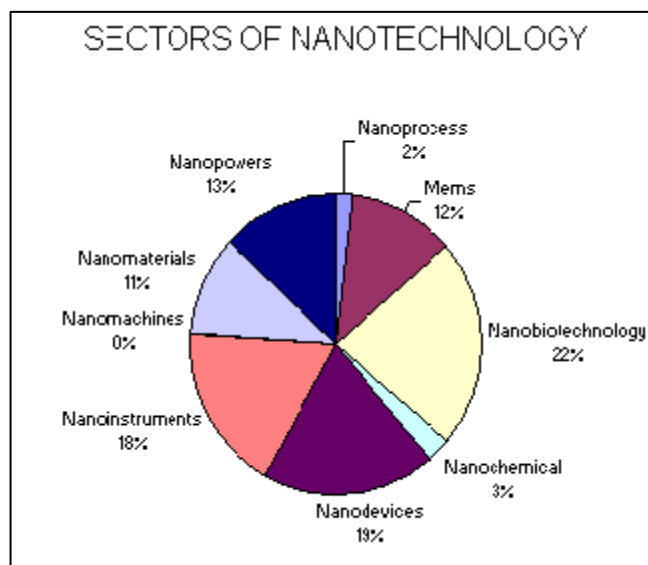
Abstract— Nanotechnology, often referred to as the "science of small," is the engineering of materials at the atomic and molecular levels to create electronic devices and other devices, making it possible to build machines on the scale of human cells. Among the growing sectors of nanotechnology like, nanomachines, nanopowders, nanoinstruments, & nanobiotechnology. Nanobiotechnology has developed a lot. Nanobiotechnology with the help of nanomachines and nanodevices are coming out with flying colors. Nanodevices with the help of computer science do a lot in the medical field by the following ways.

- ❖ As a metal propellers to kill the cancerous cells.
- ❖ To provide oxygen and mitochondria.
- ❖ As biosensors to sense the changes taking place in the body.
- ❖ As nanocopters and biorobots roam inside the body to perform the task as programmed to heal the disease.
- ❖ To find the viruses present in the body.
- ❖ For the logical control of gene expression
- ❖ As nanoscissors to cut the nerve cells without causing any damage tissues.
- ❖ Carbon nanotube in x-ray for thermionic rays which are used at present
- ❖ In veterinary field.
- ❖ Real world application of Nanotech.

These nanodevices are programmed by the computer, which are very small and they sent into the human body and animals. They perform the particular task as being programmed; check the inputs and it gives the precise output. After performing the given task, they disintegrate and they pass into the blood stream as waste products and thereby they leave the body.

1.INTRODUCTION

Nanotechnology, "the manufacturing technology of the 21st century," should let us economically build a broad range of molecular machines. Nanotechnology is going



to be flourishing in various sectors especially in the medical field which is shown in the following pie chart. So let us see them in detail.

Computer technology has developed a lot in the field of nanotechnology with the help of nanodevices programmed; they are inserted into the body, do miracles and save thousands and thousands of mankind without causing any harm to them. It will let us build fleets of computer controlled molecular tools much smaller than a human cell and built with the accuracy and precision of drug molecules. Such tools will let medicine, for the first time; intervene in a sophisticated and controlled way at the cellular and molecular level. They could remove obstructions in the circulatory system, kill cancer cells, or take over the function of sub cellular organelles. Just as today we have the artificial heart, so in the future we could have the artificial mitochondrion.

Until recently, nanotechnology was primarily based in electronics, manufacturing, supercomputers and data storage. Already, nonscientists are manufacturing new kinds of coatings for windows, cars, machines, planes, new materials for making fabric, and new circuits for computers.



Scientists say the most immediate impact of nanotechnology will be the development of technology in the area of biomedical science, such as new drug delivery techniques, early detection of cancers, new diagnostic and treatment technologies and much more.

2. NANODEVICES IN THE BIOTECHNOLOGICAL FIELD

Nanomachines offer humanity hope for the future. The idea that we could one day cure diseases, fix the atmosphere, and reduce poverty in the world is an exciting one. If scientists can overcome the technical difficulties involved in producing nanomachines capable of these goals, then the fruits of their efforts will benefit us all. Let's see the nanodevices developed in this field.

3. SMALL COMPUTER KILLING CANCEROUS CELLS

With the help of a small device we will be able to kill cancer cells. The device would have a small computer, several binding sites to determine the concentration of specific molecules, and a supply of some poison which could be selectively released and was able to kill a cell identified as cancerous.

The cancer killing device suggested here could incorporate a dozen different binding sites and so could monitor the concentrations of a dozen different types of molecules. The computer could determine if the profile of concentrations fit a pre-programmed "cancerous" profile and would, when a cancerous profile was encountered, release the poison. Beyond being able to determine the concentrations of different compounds, the cancer killer could also determine local pressure.

As acoustic signals in the megahertz range are commonly employed in diagnostics (ultrasound imaging of pregnant women, for example). The cancer killer could readily be reprogrammed to attack different targets (and could, in fact, be reprogrammed via acoustic signals transmitted while it was in the body). This general architecture could provide a flexible method of destroying unwanted structures (bacterial infestations, etc).

4. A DEVICE FOR PROVIDING OXYGEN

A second application would be to provide metabolic support in the event of impaired circulation. Poor blood flow, caused by a variety of conditions, can result in serious tissue damage. A major cause of tissue damage is inadequate oxygen. A simple method of improving the levels of available oxygen despite reduced blood flow would be to provide an "artificial red blood cell."

As oxygen is being absorbed by our artificial red blood cells in the lungs at the same time that carbon dioxide is

being released, and oxygen is being released in the tissues when carbon dioxide is being absorbed, the energy needed to compress one gas can be provided by decompressing the other. The power system need only make up for losses caused by inefficiencies in this process. These losses could presumably be made small, thus allowing our artificial red blood cells to operate with little energy consumption.

5. ASPHYXIA

Reciprocates make breathing possible in oxygen-poor environments or in cases where normal breathing is physically impossible. Prompt injection with a therapeutic dose, or advance infusion with an augmentation dose, could greatly reduce the number of choking deaths (~3200 deaths/yr in U.S.) and the use of emergency tracheostomies, artificial respiration in first aid, and mechanical ventilators.

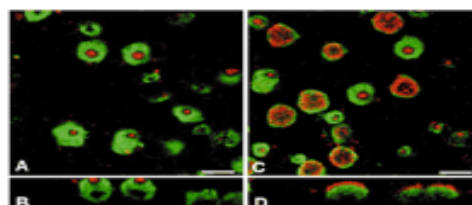


Some scientists envisage tiny machines roaming the body to cure disease

The device provides an excellent prophylactic treatment for most forms of asphyxia, including drowning, strangling, electric shock (respiocytes are purely mechanical), nerve-blocking paralytic agents, carbon monoxide poisoning, underwater rescue operations, smoke inhalation or firefighting activities, anesthetic/barbiturate overdose, confinement in airtight spaces (refrigerators, closets, bank vaults, mines, submarines), and obstruction of breathing by a chunk of meat or a plug of chewing tobacco lodged in the larynx, by inhalation of vomitus, or by a plastic bag pulled over the head of a child. Respiocytes augment the normal physiological responses to hypoxia, which may be mediated by pulmonary neuroepithelial oxygen sensors in the airway mucosa of human and animal lungs.

6. A DEVICE FOR PRODUCING ARTIFICIAL MITOCHONDRIA

"Every cell of the body contains many tiny organelles called mitochondria. These mitochondria produce most of the energy used by the body."





While providing oxygen to healthy tissue should maintain metabolism, tissues already suffering from ischemic injury (tissue injury caused by loss of blood flow) might no longer be able to properly metabolize oxygen. In particular, the mitochondria will, at some point, fail. The cellular function must be restored. The devices restoring metabolite levels, are injected into the body, are able to operate autonomously for many hours (depending on power requirements, the storage capacity of the device and the release and uptake rates required to maintain metabolite levels).

Autonomous molecular machines, operating in the human body, could monitor levels of different compounds and store that information in internal memory. They could determine both their location and the time. Thus, information could be gathered about changing conditions inside the body, and that information could be tied to both the location and the time of collection.

These molecular machines could then be filtered out of the blood supply and the stored information could be analyzed. This would provide a picture of activities within healthy or injured tissue. This new knowledge would give us new insights and new approaches to curing the sick and healing the injured.

7. BIOSENSORS

A team of Australian researchers managed to build a functioning nanomachine, a biosensor, a combination of biology and physics, designed to detect substances with extreme sensitivity. It consists of a synthetic membrane chemically tethered to a thin metal film coated onto a piece of plastic. This membrane behaves like the outer skin of the cells of the human body in its ability to sense other molecules. The central component of the device is a tiny electrical switch, an ion-channel, only 1.5 nanometers in size.

Being cheap and easy to use, the biosensors have a huge range of potential uses, e.g. detecting drugs, hormones, viruses, pesticides, gene sequences, drugs, medically-active compounds, and more.

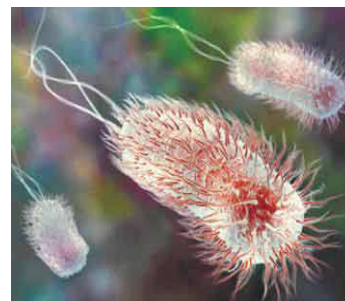
8. TEST-DRIVE FOR NANOCOPTERS

The first microscopic "helicopters", which could one day carry out medical tasks inside the body, have been built and test-driven by scientists at Cornell University. The devices are no bigger than a virus particle. They consist of metal propellers and a biological component attached to a metal post. The biological component converts the body's biochemical fuel, ATP (protein synthesis), into energy. This is used to turn the propellers at a rate of eight rotations per second. In tests the nano-helicopters' propellers for up to 2 1/2 hours. This is an important first step towards producing

miniature machines capable of functioning inside living cells.

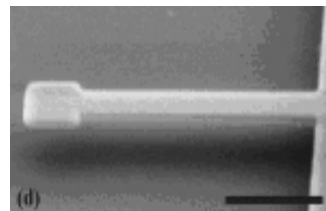
9. BIOROBOTS

"An engineered full-genome DNA, once synthesized, could be placed inside an empty cell membrane - most likely a living cell from which the nuclear material had been removed. Used in medicine, these artificial biorobots could be designed to produce useful vitamins, hormones, enzymes or cytokines in which a patient's body was deficient, or to selectively absorb and metabolize into harmless end products harmful substances such as poisons, toxins, or indigestible intracellular detritus, or even to perform useful mechanical tasks.

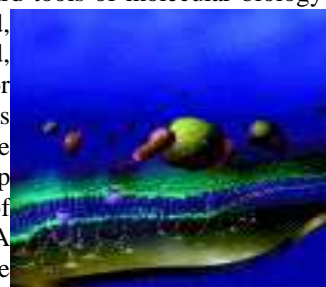


10. CLONABLE STRAND OF DNA THAT FOLDS INTO AN OCTAHEDRON

A group of scientists at The Scripps Research Institute has designed, constructed, and imaged a single strand of DNA that spontaneously folds into a highly rigid, nanoscale octahedron that is several million times smaller than the length of a standard ruler and about the size of several other common biological structures, such as a small virus or a cellular ribosome.



Making the octahedron from a single strand was a breakthrough. Because of this, the structure can be amplified with the standard tools of molecular biology and can easily be cloned, replicated, amplified, evolved, and adapted for various applications. This process also has the potential to be scaled up so that large amounts of uniform DNA nanomaterials can be produced. These octahedra are potential building blocks for future projects, from new tools for basic biomedical science to the tiny computers of tomorrow.





Folding the DNA into the octahedral structures simply required the heating and then cooling of solutions containing the DNA, magnesium ions, and a few accessory molecules. And, indeed, the DNA spontaneously folded into the target structure. Possible applications include using these octahedra as artificial compartments into which proteins or other molecules could be inserted

11. NANODEVICES TARGET VIRUSES

By chemically coating the cantilever with a layer of antibodies that are sensitive to a specific virus, the Cornell team has now used the same device to detect viruses. To do this, the cantilevers are immersed in a liquid containing the virus particles, which then stick to the device. The device is then removed from the liquid and the frequency is measured again. "The sensitivity is high and just a few virus particles can be identified and detected rapidly."

Meanwhile, Lieber's team converted an array of nanowire-based field effect transistors (FETs) into a virus detector by coating the surfaces of the transistors with antibody receptors [17]. Viruses were then introduced into arrays using micro fluidic channels. Since viruses are charged particles, they change the current flowing through the transistor of the FET because they change the concentration of charge carriers when they bind to the nanowires (figure). Moreover, modifying the different nanowires within the array with receptors that are specific for different viruses allows multiple virus strains to be detected at the same time.

Nanostructures such as cantilever beams and nanowire sensors will also play a large role in the early detection of disease and in gauging therapeutic efficacy, Ferrari said. Cantilever beams, which act as microelectronic mechanical systems on the nanoscale, can detect the tiny forces that occur with binding events. The beams and the nanowire sensors can be used to detect the presence of certain proteins and/or quantify amounts that may indicate diseases.

12. AN AUTONOMOUS MOLECULAR COMPUTER FOR LOGICAL CONTROL OF GENE EXPRESSION

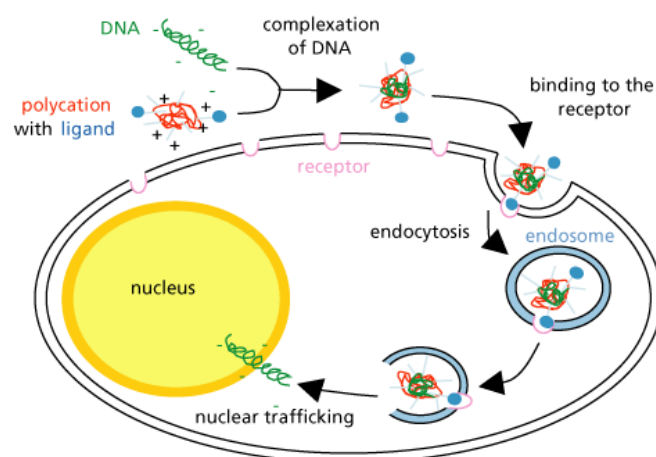
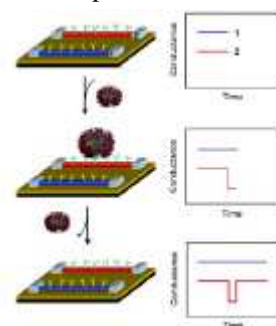
Early biomolecular computer research focused on laboratory-scale, human-operated computers for complex computational problems. Recently, simple molecular-scale autonomous programmable computers were demonstrated allowing both input and output information to be in molecular form. Such computers, using biological molecules as input data and biologically active molecules as outputs, could produce a system for 'logical' control of biological processes. Here we describe an autonomous biomolecular computer that, logically analyses the gene therapy.

Gene-therapy has focused the attention of the scientific community since it could be an efficient new way to cure several major human diseases such as cancer, AIDS, cystic fibrosis, anemia or progeria. The concept of gene therapy is the substitution in the cell nucleus of abnormal genes causing diseases by normal healthy DNA sequences.

The main challenge in gene therapy is the design of specific carriers, which allow efficient delivery of the healthy genes in the cell (transfection). Such carriers should be able to transport DNA in the bloodstream, to cross efficiently cell membranes and to free the genetic material near the cell nucleus.

The goal of this project is to study the synthesis, characterization and clinical applications of new non-viral polymer gene carriers based on cationic polymers such as polyethyleneimine (PEI) or poly (vinyl amine). Such polycations form soluble complexes with DNA in aqueous solution, and

therefore allow to transfer genetic materials inside cells. The chemical modification of the raw polymer (modification with specific cell-targeting ligands or water soluble polymers) allows an improved transfection efficiency and gene expression



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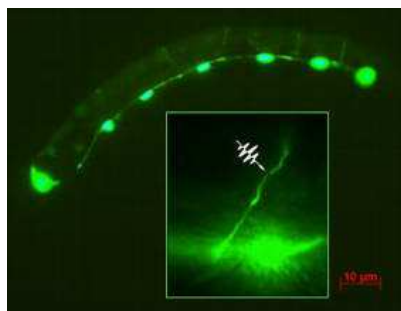
ligands or water soluble polymers) allows an improved transfection efficiency and gene expression.

13. NANOPORE SENSOR

Applied voltage draws a DNA strand and surrounding ionic solution through a pore of nanometer dimensions. The various DNA units in the strand block ion flow by differing amounts. In turn, by measuring these differences in ion current, scientists can detect the sequence of DNA units. Atomistic scale simulations performed on the NASA Columbia supercomputer (SGI Altix-3000) allow detailed study of DNA translocation to enhance the abilities of these sequencers. Solid-state nanopores offer a better temporal control of the translocation of DNA, and a more robust template for nano-engineering than biological ion channels. The chemistry of solid-state nanopores can be more easily tuned to increase the signal resolution. These advantages will result in real-time genome sequencing. Potential applications for NASA missions including astronaut health, life detection and decoding of various genomes.

14. NANO-SCISSORS LASER SHOWS PRECISE SURGICAL CAPABILITY:

Pair of tiny "nano-scissors" is able to cut, for example, nano-sized units like nerve axons, the parts of nerve cells that



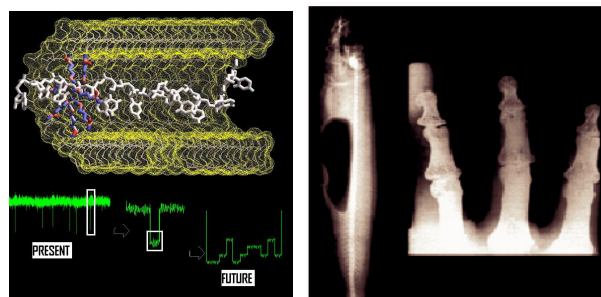
carry nerve impulses away from the cells to muscles or to other cells. "This tool opens up a new frontier for biologists studying nerve regeneration," says Ben-Yakar. "We can also apply it to many other studies that require nanosurgery, so it's a very versatile tool."

The beauty of this laser, she says, is its ability to cut organelles (parts of cells—they are what organs are to organisms) precisely, without damaging surrounding tissue. Usually, conventional lasers used in surgery heat the area to be cut, then cut it, but this heightens the risk for tissue damage. Once cut, the axons vaporized, and no other tissue was harmed. Until now, researchers have only been able to investigate nerve regeneration in mice and zebrafish, which have complex nervous systems. This laser allows researchers to study nerve cells at their most basic evolutionary form, opening the door to other experiments on genetic and molecular factors that determine whether damaged nerve cells regrow.

15. CNT -BASED X-RAY:

Most diagnostic tools require tube current in the order of 10-100 mA and operating voltage in the range of 30-150 KV which was difficult to accomplish for the field emission x-ray tubes. CNT -based -x-ray tube which can generate sufficient x-ray flux for diagnostic imaging applications. The device given above comprises a field emission cathode, a gate electrode and a metal target in a vacuum chamber with a window.

The cathode is a single walled nanotube (SWNT) film deposited on a metal substrate. A relatively low voltage is applied between the gate and the cathode to extract electrons from the cathode. The field emitted electrons are accelerated by a high voltage applied between the anode and the gate. A total emission



current as high as 30mA

is obtained from a small CNT cathode. The device can readily produce x-ray wave forms with programmable pulse width and repetition rate. Pulsed x-rays with a repetition rate up to 30 KHZ have been generated by applying an external triggering voltage on the gate. The x-ray flux is sufficient to image human extremity.

The CNT -based- x-ray sources have several advantages compared to the thermionic X-ray tubes. The lifespan of the x-ray tubes can potentially be prolonged by eliminating the thermionic cathode. The size of the x-ray tube can be reduced significantly. It has also the ability to produce focused electron beams with the very small energy spread and programmable pulse width with repetition rate. This CNT -based cold cathode x-ray technology can potentially lead to portable and miniature x-ray sources for industrial and medical applications.

16. VETERINARY FIELD:

In the veterinary field also, the nanotechnology has grown a lot just as in humans. One of the most important and promising areas of medical research of today is the study of nanomaterials known as dendrimers. They are synthetic polymers, a thousand times smaller than cells. Dendrimers can be synthesized in various predetermined sizes and can interact with biological agents by modifying their surface properties. Three very important properties of dendrimers make them an excellent candidate as pharmacological agents. First, they can hold drug's molecules in their structure and serve as a delivery vehicle. Second, they can enter cells very easily and



release drugs right on target. Third and most important, dendrimers don't trigger immune system responses.

Dendrimers have a lot to offer to the field of Veterinary Medicine. In the future one of the major contributions of these synthetic nanomaterials will be the diagnoses, treatment and eradication of malignant tumors that commonly affect the small animal geriatric population. Some scientists envision the possibility of injecting quantum dots into the animal bodies.

Quantum dots offer many technical advantages over traditional fluorescent dyes, which are commonly used to detect and track biological molecules. They not only can stay lit for a prolong period of time, they are also brighter and easier to visualize than organic dyes. They can be very helpful to visualize cell pathways, which is essential for our understanding of how certain drugs are going to behave in the animal's body.

In addition to their usefulness in identifying and tracking molecules, they promise faster, more flexible and less costly tests for clinical analysis. Those whom work in the veterinary field are familiar with immunoassay testing. Immunoassay technology capitalizes on the characteristic way that antibodies attach themselves to invading pathogens in the body.

In a routine immunoassay test we expose a solution, such as blood plasma for example, to a tray containing antibodies that bind with a specific antigen under investigation. When the antibodies bind to the antigen, the test changes color. This system is used to identify and diagnose various conditions that afflict the animal population.

17. REAL WORLD APPLICATION OF



NANOTECH:

- 1 - Organic Light Emitting Diodes (LEDs) for displays
- 2 - Photovoltaic film that converts light into electricity
- 3 - Scratch-proof coated windows that clean themselves with UV

- 4 - Fabrics coated to resist stains and control temperature
- 5 - Intelligent clothing measures pulse and respiration
- 6 - Bucky-tubeframe is light but very strong
- 7 - Hip-joint made from biocompatible materials
- 8 - Nano-particle paint to prevent corrosion
- 9 - Thermo-chromic glass to regulate light
- 10 - Magnetic layers for compact data memory
- 11 - Carbon nanotube fuel cells to power electronics and vehicles
- 12 - Nano-engineered cochlear implant

18. CONCLUSION:

Nanotechnology will be a strategic branch of science and engineering for the next century, one that will have a fundamental impact on the health, wealth and security of the world. The potential for nanotechnology to transform so many aspects of human existence is without precedent.

Scientists say the most immediate impact of nanotechnology will be the development of technology in the area of biomedical science, such as new drug delivery techniques, early detection of cancers, new diagnostic and treatment technologies and much more.

Perhaps the most commonly asked question about nanotechnology is: how long will it take to develop? Although prediction is a risky business, nanotech is likely to come about "in the 2010 to 2020 time frame." Thus in the future we can expect a instrument-free surgery without any pain, loss of blood and time. Like this everything can be nanomised with the help of programming computer.

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Nanotechnology: Accept New Challenges in Field of Food and Medicine

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Abstract— Designing and producing food by shaping molecules and atoms is the future of the food industry worldwide. 600 Companies worldwide in Research , Development and Production using nanotechnologies and molecular science in food processing and packaging. The preservation of bioactive food ingredients through product processing and storage, and their controlled release in the gastrointestinal tract is yet a major obstacle for the full exploitation of the health potential of many food bioactive components. The overall objective of the NANOFOOD project is the development and the validation of efficacy of a new generation of healthy foods based on nanocapsules technology. Tailored nanocapsules able to deliver omega-3 and butyrate fatty acid and silymarin complex into the lower gut will be designed and produced by a specialized Israeli SMEs in collaboration with Technion, Haifa. These nanocapsules will be incorporated as bioactive ingredients into dry pasta by an Italian SMEs and into typical bread products by a Turkish SMEs, supported by a food scientists operating upon RTD performers. The efficacy of the food products will be assessed by a human clinical trials on patients affected by Intestinal Bowel Disease where the anti-inflammatory properties of the selected ingredients could be highly beneficial. In recent years, rapid advances in technology have given rises to minimise the size and lightweight products with increased and more powerful functionality. The nature has also created large variety of molecular devices which are working in living system ranging from micro-organism to the human beings

I. INTRODUCTION

Nanotechnology beginning with the 1986 publication of book "Engines of creation". Nanotechnology is a key technology for the future. Both the science and economy in 21st century will require technological breakthroughs in the control of nanometer scale structure and functions where the top down approach of electronics converges with the bottom up assembly of biology.

A DNA double helix has a diameter of around 2nm. It is also for sure that Nanotechnologies could be revolutionary in the coming age since it could be implied on our health, wealth and lives.

A. Nanomedicine

Nanomedicine is the medical application of nanotechnology. Nanomedicine ranges from the medical applications of nanomaterials, to nanoelectronic biosensors, and even possible future applications of molecular nanotechnology. Current problems for nanomedicine involve understanding the issues related to toxicity and environmental impact of nanoscale materials. One nanometer is one-millionth of a millimeter.

B. Overview:

Nanomedicine seeks to deliver a valuable set of research tools and clinically useful devices in the near future. The National Nanotechnology Initiative expects new commercial applications in the pharmaceutical industry that may include advanced drug delivery systems, new therapies, and in vivo imaging. Neuro-electronic interfaces and other nanoelectronics-based sensors are another active goal of research. Further down the line, the speculative field of molecular nanotechnology believes that cell repair machines could revolutionize medicine and the medical field.

Nanomedicine is a large industry, with nanomedicine sales reaching 6.8 billion dollars in 2004, and with over 200 companies and 38 products worldwide, a minimum of 3.8 billion dollars in nanotechnology R&D is being invested every year. As the nanomedicine industry continues to grow, it is expected to have a significant impact on the economy.

C. Medical use of nanomaterials

A benefit of using nanoscale for medical technologies is that smaller devices are less invasive and can possibly be implanted inside the body, plus biochemical reaction times are much shorter. These devices are faster and more sensitive than typical drug delivery.

D. Drugs as nanotechnology

Nanomedical approaches to drug delivery center on developing nanoscale particles or molecules to improve drug

bioavailability. Drug delivery focuses on maximizing bioavailability both at specific places in the body and over a period of time. Drug delivery systems, lipid- or polymer-based



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nanoparticles, can be designed to improve the pharmacological and therapeutic properties of drugs. nanoparticles have beneficial properties that can be used to improve drug delivery. Where larger particles would have been cleared from the body, cells take up these nanoparticles because of their size. Complex drug delivery mechanisms are being developed, including the ability to get drugs through cell membranes and into cell cytoplasm. Efficiency is important because many diseases depend upon processes within the cell and can only be impeded by drugs that make their way into the cell. Triggered response is one way for drug molecules to be used more efficiently. Drugs are placed in the body and only activate on encountering a particular signal. For example, a drug with poor solubility will be replaced by a drug delivery system where both hydrophilic and hydrophobic environments exist, improving the solubility. Also, a drug may cause tissue damage, but with drug delivery, regulated drug release can eliminate the problem. If a drug is cleared too quickly from the body, this could force a patient to use high doses, but with drug delivery systems clearance can be reduced by altering the pharmacokinetics of the drug.

II. APPLICATIONS OF NANOMEDICINE

Using the biomimetic strategy, researchers demonstrated in a mouse model that the drug coated nanoparticles can dissolve blood clots by selectively binding to the narrowed regions in the blood vessels – just like the platelets do.

Nanoparticles made of polyethylene glycol (PEG) carrying payload of antibiotics at its core could swift charge thus allowing them to target bacterial infection more precisely inside the body, a group of MIT researchers reported.

A. Cancer

High surface area to volume ratio, allows many functional groups to be attached to a nanoparticle, which can seek out and bind to certain tumor cells. Additionally, the small size of nanoparticles (10 to 100 nanometers), allows them to preferentially accumulate at tumor sites (because tumors lack an effective lymphatic drainage system). A very exciting research question is how to make these imaging nanoparticles do more things for cancer. For instance, is it possible to manufacture multifunctional nanoparticles that would detect, image, and then proceed to treat a tumor? This question is under vigorous investigation; the answer to which could shape the future of cancer treatment. A promising new cancer treatment that may one day replace radiation and chemotherapy is edging closer to human trials.

The basic point to use drug delivery is based upon three facts:

- a) efficient encapsulation of the drugs,
- b) successful delivery of said drugs to the targeted region of the body, and c) successful release of that drug there

Nanoparticles of cadmium selenide (quantum dots) glow when exposed to ultraviolet light. When injected, they seep into cancer tumors. The surgeon can see the glowing tumor, and use it as a guide for more accurate tumor removal.

B. Surgery:

At Rice University, a flesh welder is used to fuse two pieces of chicken meat into a single piece. The two pieces of chicken are placed together touching. A greenish liquid containing gold-coated nanoshells is dribbled along the seam. An infrared laser is traced along the seam, causing the two sides to weld together. This could solve the difficulties and blood leaks caused when the surgeon tries to restitch the arteries that have been cut during a kidney or heart transplant.

C. Visualization:

Tracking movement can help determine how well drugs are being distributed or how substances are metabolized. It is difficult to track a small group of cells throughout the body, so scientists used to dye the cells. These dyes needed to be excited by light of a certain wavelength in order for them to light up. While different color dyes absorb different frequencies of light, there was a need for as many light sources as cells. A way around this problem is with luminescent tags. These tags are quantum dots attached to proteins that penetrate cell membranes. The dots can be random in size, can be made of bio-inert material, and they demonstrate the nanoscale property that color is size-dependent. As a result, sizes are selected so that the frequency of light used to make a group of quantum dots fluoresce is an even multiple of the frequency required to make another group incandesce.

It is greatly observed that nanoparticles are promising tools for the advancement of drug delivery, medical imaging, and as diagnostic sensors. However, the biodistribution of these nanoparticles is still imperfect due to the complex host's reactions to nano- and micro-sized materials and the difficulty in targeting specific organs in the body.

III. NANOTECHNOLOGY IN FOOD AND FOOD PROCESSING

Applications, Key Technologies, Markets and Developments of Nanotechnology in Food Production, Processing, Preservation, Safety and Packaging. Keeping leadership in food and food processing industry, you have to work with nanotechnology and nano-bio-info in the future. The markets are changing already.

Tomorrow we will design food by shaping molecules and atoms. Nanoscale biotech and nano-bio-info will have big impacts on the food and food-processing industries. More than 180 applications are in different developing stages and a few of them are on the market already. The nanofood market is expected to surge from 2.6 bn. US dollars today to 7.0 bn.

US dollars in 2006 and to 20.4 bn. US dollars in 2010. More than 200 Companies around the world are today active in



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research and development. USA is the leader followed by Japan and China. By 2010 Asian with more than 50 percent of the world population will be the biggest market for Nanofood with the leading of China.

On the one side, further genetical modified sheed, DNA decoding and analysing enable the industries to predict, control and improve the agricultural production. On the other side, with technology of manipulating the molecules and the atoms of food, the future food industry has a powerful method to design food with much more capability and precision, lower costs and sustainability.

Meanwhile, the combination of DNA and nanotechnology research generates the new nutrition delivery system, which brings the active agents more precisely and efficiently to the wanted parts of the human bodies and cells. Functional food will benefit firstly from the new technologies, followed by standard food, nutraceuticals and others.

Some companies are already aware of the impact of nanotechnology in food industry. Research facilities are established, potential applications are under study, whereas only a handful of nano food products are market available now. Nevertheless, the tremendous potential will attract more and more competitors into this still unploughed field. The number of the companies involved in this field will increase from 69 in 2002 to 2004 and to several thousand by 2010.

WHO IS AFRAID OF NANOTECHNOLOGY IN FOOD

Molecular technologies are disruptive technologies and change the conventional production faster than most scientists expect. It can make the products cheaper, the production more efficient, more safe and more sustainable using less water and chemicals. Producing less waste and using less energy. The impact for the food industry will be a change of 40 to 60 percent by 2015. The change is dramatic, the potentials are immense and the risks too. The main source of increasing the speed for these technologies within the next years are climate change, cost efficiency and population growth. But also new applications using food as drugs and nutrition.

The converging nano-bio-neural and information will be the overall revolution in the 21st century. It will open new windows for human beings, new developments and innovations change the society and human beings will live with smaller footprints and realize sustainable developments. Neural technologies and the decoding of the brain-function, DNA-based technologies and processes will determine the Molecular Future.

The Genomic is the opens a new understanding of Biotic functions, and the 'Molecular Nature'. A new window is opened.

"Nanotechnology in Life Science Industries 2003-2006-2010-2015" and now "Nanotechnology in Food and Food Processing Industry 2003-2006-2010-2015". They focus on the impacts and applications of nanotechnology in the different fields, scientifically examine, collect and evaluate all companies, markets, branches, applications, developments, state of science and expected developments worldwide, and provide prognoses for the next 15 years.

This study is finished. It will be updated annually and where it is necessary for research will be a constant update.

AIM & BENIFITS OF STUDY

Aim of the study is the analysis of the global markets and developments, research and development, the companies, organizations, branches and products. The years 2006 is the basis, as well as the further development in 2008, 2010 and 2015, and prospects for the following years.

IV. CONCLUSION

The study shows turnover, volume, potentials, product fields and products, applications, competition, companies, countries, regions worldwide, profit potentials, value chains, research expenditures, investments, factors of success, strategies, and opportunities & risks.

The strategies of countries are evaluated with expenditures, markets and potential of employment and their opportunities and risks for the next years and decades.

The study is suitable to check the state of research and development, derive innovations, check and compare the state of competitors, and develop own strategies. This applies to companies, institutes, organizations, investors and countries or states respectively.

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Preparation, Characterization and Cytotoxicity Study on Superparamagnetic Nanoparticles for Drug Delivery

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Abstract— Superparamagnetic iron oxide nanoparticles have been used for various industrial and clinical applications. In the present study, the superparamagnetic Fe₃O₄ nanoparticles were prepared by a modified chemical co-precipitation method. The morphology and size of the particle was measured through Scanning electron Microscope (SEM), the size was assessed by X-ray Diffraction (XRD) and the magnetic property was assessed by vibrating sample magnetism (VSM). The particles are spherical in shape the size was measured as an average of 15nm. The VSM data showed that the particles are superparamagnetic and the saturation magnetization is found to be 19.9 emu/g. Since the particles are prepared for the drug delivery system, the particles were tested for toxicity against human monocytes through MTT assay. The MTT assay results and microscopic data confirmed the particles as nontoxic.

Key Words: Magnetic nanoparticles, iron oxide nanoparticles, Superparamagnetism, MTT Assay

I. INTRODUCTION

In the past few years have witnessed an exponential growth in activities associated with the potential use of nanoparticles in various applications. Among the various nanomaterials, the magnetic nanoparticles possess wide range of applications in various fields like biomedical, biotechnology, engineering, material science and environmental areas etc. [1]. The use of magnetic nanoparticles offers many advantages due to their unique size and physical properties. So, currently much attention is given to the preparation of different kinds of magnetic nanoparticles with uniform size crystals because of the properties of these nanocrystals strongly depend on their size and dimensions [2]. Besides, Magnetic nanoparticles exhibits the superparamagnetism, not keeping magnetized after the action of magnetic field, provides the highest advantage of reducing risk of particle aggregation [3]. There are variety of methods have been developed for the preparation of magnetic nanoparticles such as chemical co-precipitation, micro emulsion and thermal decomposition. The production of large quantities of uniform-sized nanocrystals will become critical

for the realization of high quality nanoscale devices and many nanotechnological applications [1]. Among various magnetic nanoparticles, Fe₃O₄ nanoparticles have been considered as suitable for biological applications due to superparamagnetic behavior and low toxicity [4]. Further more, it is a promising alternative which provide outstanding support materials for the enzymes immobilization because of its striking characteristics, such as large surface area, mobility and high mass transference [5].

In this present study, the paramagnetic nanoparticle Fe₃O₄ was prepared for drug delivery system and necessary initial analysis were made. The size and shape of the particle was measured in scanning electron microscopy (SEM), the topography was analysed by X-ray diffraction (XRD) studies and the magnetization was analysed by vibrating sample magnetism (VSM) curve. The toxicity was assayed by applying on human monocytes.

II. MATERIALS AND METHODS

A. Preparation and purification of nanoparticles

A modified chemical co-precipitation method was employed for the preparation of magnetic nanoparticles (Magnetite - Fe₃O₄). The preparation was made by mixing aqueous solution of FeCl₂ (0.2 M) and FeCl₃ (0.3 M) with stearic acid in a flask. The contents were stirred vigorously for adequate mixing and mean while the aqueous solution NaOH (4 M) was added into the flask to obtain a black precipitate. The obtained black precipitate Magnetite was filtrated by What Man No.1 filter paper washed using ethanol thrice and dried by evaporating the solvent in room temperature.

B. Characterization of magnetic nanoparticle

The X ray diffraction pattern of the obtained magnetic nanoparticles were analyzed by Powder X-ray diffraction (PXRD) by model Bruker AXS D8 Advance with Cu ($K\alpha\lambda=1.5406 \text{ \AA}$) radiation, scanning range from 10°–90°. The morphology of the magnetic nanoparticles was revealed by scanning electron microscopy SEM JEOL Model JSM –



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6390LV. The paramagnetism was analyzed by keeping the particles in magnetic field and the magnetization curves of the dried particles were recorded with a VSM at room temperature.

C. *In vitro* toxicity test against human monocytes

The toxicity of the magnetic nanoparticles was tested in human mononuclear cells through MTT colorimetric assay. The human mononuclear cells were separated from the blood by density gradient centrifugation using Pan Monocyte isolation kit procured from Miltenyi Biotech, Germany. The viability of the cells was checked using trypan blue. The cell suspension which had more than 90% viability was considered for MTT assay. The cell suspension was diluted using MTT assay medium for the final concentration of 1.0×10^5 cells/ml and constant volume was dispensed in to assay plate. The plate was incubated at 37°C for overnight with 5% CO₂. The nanoparticles were dissolved in Dimethyl sulfoxide (DMSO) and different concentration of nanoparticles were added in separate wells of previously incubated cell lines. The plate further incubated for over night in the same condition and density of the cells was measured. The un inoculated cells were used as controls.

III . RESULT AND DISCUSSION

A. X-ray powder diffraction patterns

The magnetic nanoparticles were prepared by chemical co-precipitation method. The colour of the particle was grayish black and dry granular in texture. The synthesized magnetite was analyzed by XRD showed several peaks in the XRD patterns (Figure.1).

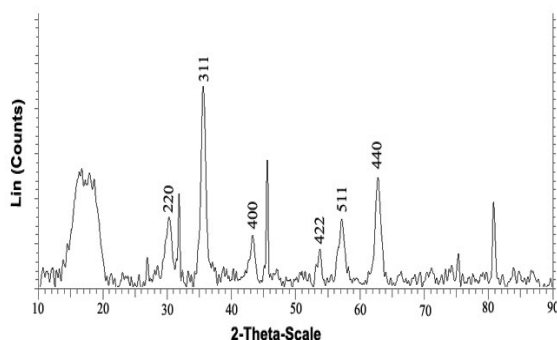


Fig.1 XRD patterns of magnetic nanoparticles

Among the peaks, six characteristic peaks for Fe₃O₄ indices ((220), (311), (400), (422), (511), and (440) at the 2θ level of 30°, 36°, 43°, 53°, 57° and 62° respectively. According to the Debye-Scherrer using (311) peak, characteristic spinel structure confirmed the Fe₃O₄ nanoparticles. The report is consisted with the previous reports [6, 7]. In both reports, the confirmation of Fe₃O₄ nano crystals has been analyzed and confirmed based the 2θ level indices and confirmed by comparing the pattern with the

database in the JCPDS file (PDF standard cards, JCPDS 88-0315).

SEM image

The Scanning electron microscopic studies revealed that surface morphology of the nanoparticles are spherical and the average size of the particles are 15 nm (Figure.2).

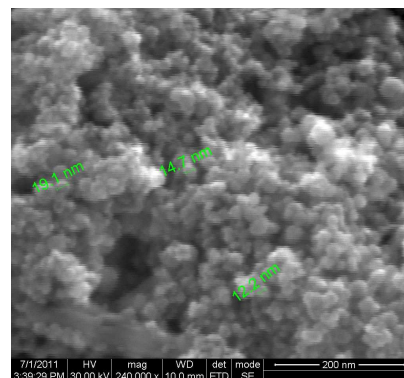


Fig. 2 SEM Image of Magnetic nanoparticles

The spherical size of the magnetic nanoparticles are quite common and it has been reported that the surface morphology of the particle may be modified without changing the particles property during coated with other components. [6] The difference in morphology between free Fe₃O₄ and chitosan coated Fe₃O₄ which clearly revealed that prepared Fe₃O₄-CS nanoparticles were spherical in shape without the magnetic field whereas, most Fe₃O₄-CS nanoparticles were formed in rod-like nanostructures under the MF.

VSM analysis

The super paramagnetism was analyzed by applying the magnetic field over the particles and the results showed that the particles were well responded for a magnetic field and loose its superparamagnetism after withdrawing the magnetic field. The magnetic properties of these samples characterized by vibrating sample magnetometer were shown in hysteresis loop of the sample (Fig.3).

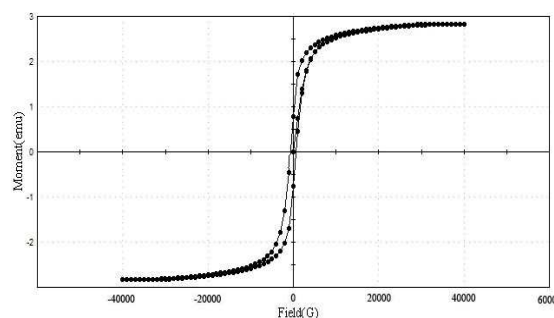


Fig. 4 Hysteresis loop of magnetic nanoparticles analysed by VSM

The sample is superparamagnetic and the saturation magnetization was found to be 19.9 emu/g. In industrial enzyme immobilization, the magnetic separation using a magnet or electricity driven magnetic field will make the



recycling of enzymes much easier, and the automation of biocatalysis can be realized with an economical advantage. In clinical applications, the particles can be accumulated inside the body by the external magnetic field due to its superparamagnetic property [4]. The electromagnetic unit may be slightly reduced during immobilization with enzymes [8] or when the particles are coated with any other binding materials like chitosan, polymers etc. [8, 6].

Cytotoxic Evaluation

For the cytotoxic evaluation, MTT reduction was used to metabolically quantify viable cells after exposure to magnetic nanoparticles. The MTT assay for cell viability evaluation has been described as a suitable method for detection of biomaterial toxicity [9]. The MTT assay relies on the mitochondrial activity of fibroblasts and represents a parameter for their metabolic activity. In the current results, the photographs showed that there was no any cell damage and lysis before and after addition nonparticles and incubation (Fig. 4 & 5).

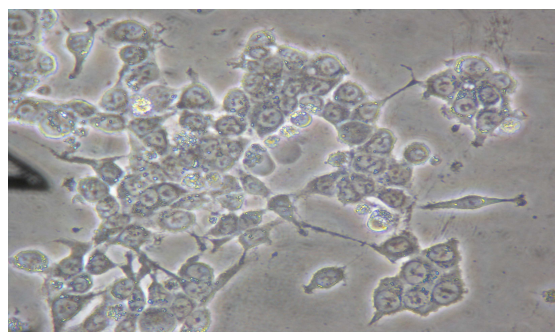


Fig. 4 Isolated human monocytes before treatment of nanoparticles

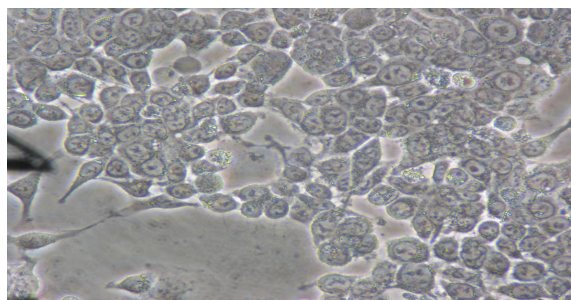


Fig. 5 Isolated human monocytes after treatment of nanoparticles

The MTT assay results revealed that there was no reduction of growth of monocytes where as the growth have been increased in all the concentration proportionately. This showed the nano particles are not toxic to the human monocytes and also it is used as growth promoting substance for its growth. As for as toxicity is concerned, the current result is agreed with several reports. Magnetic targeting is useful for intravascular or intracavitary drug delivery, including tumor chemotherapy or intraocular antiangiogenic therapy. For all such in vivo applications, the magnetic drug carrier must be biocompatible and nontoxic. But the coating of any other agents over the nanoparticles like poly ethylene glycol can induce the toxicity [10].

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Nanotechnology in Medicine

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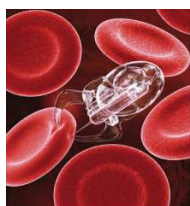
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Abstract— Disease and ill health are caused largely by damage at the molecular and cellular level. Today's surgical tools are, at this scale, large and crude. From the viewpoint of a cell, even a fine scalpel is a blunt instrument more suited to tear and injure than heal and cure. Modern surgery works only because cells have a remarkable ability to regroup, bury their dead and heal over the injury. Nanotechnology, "the manufacturing technology of the 21st century," should let us economically build a broad range of complex molecular machines and particles. It will let us build fleets of computer controlled molecular tools much smaller than a human cell and built with the accuracy and precision of drug molecules. Such tools will let medicine, for the first time; intervene in a sophisticated and controlled way at the cellular and molecular level. They could remove obstructions in the circulatory system, kill cancer cells and to improve clinical diagnostic tests for early detection of cancer, or take over the function of sub cellular organelles. The use of nanoparticles called quantum dots to dramatically improve clinical diagnostic tests for the early detection of cancer. The tiny particles glow and act as markers on cells and genes, giscientists the ability to rapidly analyze biopsy tissue from cancer patients so that doctors can provide the most effective therapy available.

KEY

WORDS: nanodevices, nanorobots, dechronification



I. INTRODUCTION

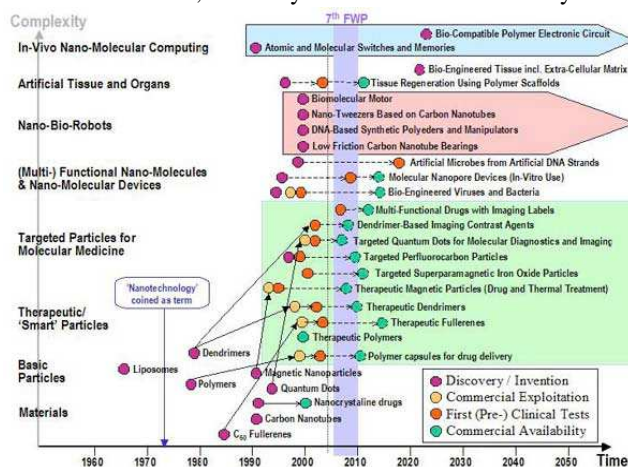
Nanotechnology is the study, design, creation, synthesis, manipulation, and application of functional materials, devices, and systems through control of matter at the nanometer scale (1–100 nanometers, one nanometer being equal to 1×10^{-9} of a meter), that is, at the atomic and molecular levels, and the exploitation of novel phenomena and properties of matter at that scale. The use of nanotechnology in the field of medicine could revolutionize the way we detect and treat damage to the human body and disease in the future. The field of nanotechnology is, in which scientists build devices and materials one atom or molecule at a time, creating structures that take on new

properties by virtue of their miniature size. The basic building block of nanotechnology is a nanoparticle, and a nanometer is one-billionth of a meter or about 100,000 times smaller than the width of a human hair. Nanotechnology in medicine involves the use of manufactured nano-robots to make repairs at the cellular level. Nanoparticles take on special properties because of their small size. For example, if you break a piece of candy into two pieces, each piece will still be sweet, but if you continue to break the candy until you reach the nanometer scale, the smaller pieces will taste completely different and have different properties. Until recently, Nanotechnology was primarily based in electronics, manufacturing, supercomputers and data storage. However it is predicted years ago that the first major breakthroughs in the field will be in medical applications, such as early disease detection, imaging, improving the clinical diagnostics tests in early detection of cancer cells and in drug delivery systems.

II. APPLICATIONS OF NANOTECHNOLOGY IN MEDICINE

A. POTENTIAL HEALTH APPLICATIONS

Already we can see potential health applications for nanotechnology. Conceptually, all are within the realm of the foreseeable future and, in many cases, are feasible. However, the ways in which we currently



envision the role of nanotechnology in helping the human condition only hint at the ultimate



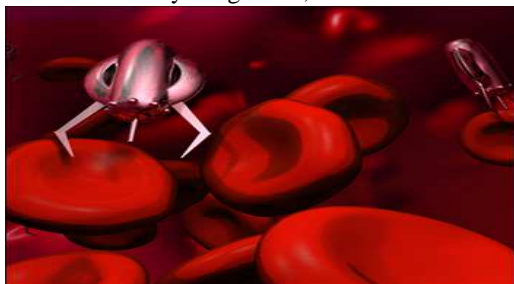
contributions. Some of the opportunities currently envisioned include:

a) BIOMATERIALS:-Nanotechnology-based

materials may provide solutions for repairing damaged tissues as well as for monitoring critical clinical indicators and interfacing for electrical measurement and stimulation. Such materials introduced into the body would not irritate or damage the surrounding tissues, nor would their function be impaired by long-term exposure to tissue fluids. Instead, they would actively communicate with host tissue and would dissolve into harmless components that could be absorbed or excreted when no longer needed. The synthesis and assembly of biologic materials and scaffolds with homologous structure and function to the human body's own tissues and processes are within the realm of possibility, and research pathways are becoming evident.

b) RESPONSIVE DELIVERY OF NEW GENERATION THERAPEUTICS AND DIAGNOSTICS:

While knowledge of cellular pathways related to disease has recently burgeoned, the subtleties of how



these

Nano injectors with red cells

pathways function remain largely unknown. The ability to target pathway interventions to particular cell or tissue types, and to modulate the release or activation of agents in response to cellular signals, would allow specific interventions into disease pathways while minimizing side effects. This capability would make useful a much wider variety of therapeutic agents. Similar concepts can be used to deliver *in vivo* imaging agents for diagnosis, monitoring of disease and therapy, and early disease detection.

c) POINT OF CARE DIGNOSTICS:

Effective detectors of specific molecules can be developed and integrated into compact devices. Such devices can be used to provide rapid information about diseased cells or tissues, and can be used to determine

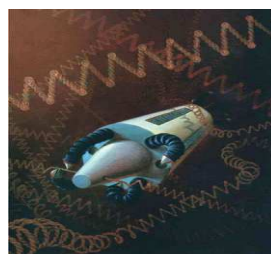
treatment options. Nanodevices could be deployed in physicians' offices or in the field, and related devices would be implanted in patients' bodies to provide real-time records for monitoring disease progression and therapeutic efficacy.

d) IMAGING MICROLOGICAL PROCESSES AND EFFECT OF DISEASE

Current imaging methods can provide excellent information on the structure of molecules *in vitro* (e.g., X-ray diffraction) and high resolution of anatomical information *in vivo* (e.g. computed tomography). However, to understand dynamic living systems, and how they are affected by disease, we need to be able to image biological processes non-destructively *in vivo* in real time. Nanotechnology provides the opportunity for a new generation of imaging tools to probe living processes at the molecular and cellular level, allowing us to study how diseases disrupt normal molecular and cellular signals and pathways.

e) DRUG DELIVERY

One application of nanotechnology in medicine currently being developed involves employing nanoparticles to deliver drugs, heat, light or other substances to specific types of cells (such as cancer



DNA Repair machine

cells). Particles are engineered so that they are attracted to diseased cells, which allows direct treatment of those cells. This technique reduces damage to healthy cells in the body and allows for earlier detection of disease.

For example, nanoparticles that deliver chemotherapy drugs directly to cancer cells are under development. Tests are in progress for targeted delivery of chemotherapy drugs and their final approval for their use with cancer patients is pending.

Many researchers attach ethylene glycol molecules to nanoparticles that deliver therapeutic drugs to cancer tumors. The ethylene glycol molecules stop white blood cells from recognizing the nanoparticles as foreign materials, allowing them to circulate in the blood stream long enough to attach to cancer tumors. However researchers believe that they can increase the time nanoparticles can circulate in the blood stream. They are coating nanoparticles containing therapeutic



drugs with membranes from red blood cells and have shown that these nanoparticles will circulate in a mouse's blood stream for almost two days, instead of the few hours observed for nanoparticles using ethylene glycol molecules.

Researchers are also continuing to look for more effective methods to target nanoparticles carrying therapeutic drugs directly to diseased cells. For example scientists at MIT have demonstrated increased levels of drugs delivery to tumors by using two types of nanoparticles. The first type of nanoparticle locates the cancer tumor and the second type of nanoparticle (carrying the therapeutic drugs) homes in on a signal generated by the first type of nanoparticle.

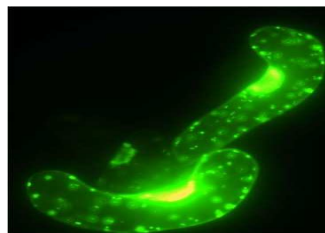
Other researchers have been focused on the best shape of nanoparticle to use for delivering drugs to cancer tumors. They have found that a disk shaped nanoparticle (nanodisk) will stick to the surface of a tumor longer than a spherical shaped nanoparticle, providing more efficient transfer of therapeutic drugs to the tumor.

Researchers are also developing a nanoparticle to defeat viruses. The nanoparticle does not actually destroy viruses molecules, but delivers an enzyme that prevents the reproduction of viruses molecules in the patient's bloodstream.

Researchers are developing a method to increase the immune response generated by vaccines by attaching the vaccine molecules to a DNA nanostructure that delivers the vaccine molecules to specific cells that are key in triggering white blood cells to an immune response.

f) QUANTUM DOTS FOR CLINICAL IMAGING-

A minuscule molecule that will be used to detect cancer is a quantum dot. Quantum dots are tiny crystals that glow when they are stimulated by ultraviolet light. The wavelength, or color, of the light depends on the size of the crystal. Latex beads filled with these crystals can be designed to bind to specific DNA sequences. By combining different sized quantum dots within a single bead, scientists can create probes that release distinct colors and intensities of light. When the crystals are stimulated by UV light, each bead emits light that serves as a sort of spectral bar code, identifying a particular region of DNA.

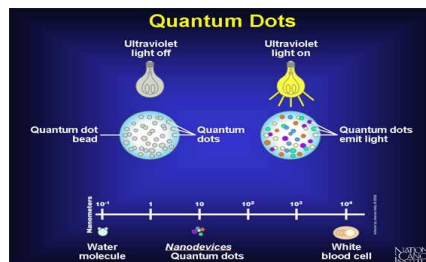


To detect cancer, scientists can design quantum dots that bind to sequences of DNA that are associated with the disease. When the quantum dots are stimulated with light, they emit their unique bar codes, or labels, making the critical, cancer-associated DNA sequences visible.

The diversity of quantum dots will allow scientists to create many unique labels, which can identify numerous regions of DNA simultaneously. This will be important in the detection of cancer, which results from the accumulation of many different changes within a cell. Another advantage of quantum dots is that they can be used in the body, eliminating the need for biopsy.

Nanotechnology may also be useful for developing ways to eradicate cancer cells without harming healthy, neighboring cells. Scientists hope to use nanotechnology to create therapeutic agents that target specific cells and deliver their toxins in a controlled time-released manner.

Because quantum dots are so small, their electrons are compacted, causing them to emit light or to act as a fluorescent tag. Quantum dots can bond chemically to



biological molecules, enabling them to trace specific proteins within

cells. They are called “bioconjugated nanoparticles”—small particles that are chemically linked to biological materials.

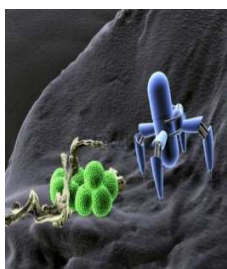
Scientists only have to vary the size of quantum dots slightly and they glow brightly in one of 10 available colors. When different sized dots are embedded in tiny beads made of a polymer material the color of the bead can be finely tuned. Theoretically, beads with tiny permutations of color could tag a million different proteins or genetic sequences in a process called “multiplexing”. A major goal is to catch prostate cancer early enough to treat it successfully before it can spread to other parts of the body. The research is also expected to have applications in tumors of other tissue types, such as breast, colon and lymph. Scientists are also collaborating with cell biologists to study a number of molecules relevant to prostate cancer, including the p53 gene, microtubules, and molecular motors that transport growth-regulating proteins in



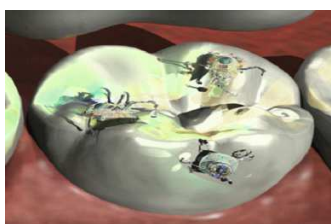
living cells. This research combined with molecular imaging techniques will be used to develop new diagnostic approaches and possible treatment strategies for the disease. Quantum dots have novel properties, including improved brightness, resistance against photo bleaching, and multicolor light emission. The size of the quantum dots also provides enough surface area for linking to other diagnostic and therapeutics agents. There is also some uncertainty about how nano particles are expelled from the body. It may be possible that some take up permanent residence in living tissue.

APPLICATIONS OF NANOROBOTS

□ To cure skin diseases, a cream containing nanorobots may be used. This cream would remove the right amounts of dead skin cells, remove excess oils which may cause oily skin, insert missing oils, apply the specifically right amounts of natural moisturizing compounds. Dermatological problems would thus be avoided or removed.



- A mouthwash full of water and smart nanorobots could identify and destroy pathogenic bacteria, particles of food, plaque, or tartar, while allowing the harmless flora of the mouth to flourish. Being suspended in liquid and able to swim about, devices would be able to reach surfaces beyond reach of toothbrush bristles or the floss fibers. As short-lifetime medical nano-devices, the bots could be built to last only a few minutes in the body before falling apart into materials of the sort found in



Dental nano-robots



Nano robot lung cleaners

foods (such as fibers and other organic compounds). This would not cause any toxic harmful effects in the body, and there would be no need for toothbrushes.

- Medical nanodevices could augment the immune system by finding and disabling unwanted bacteria and viruses. When an invader is identified, it can be punctured, letting its contents spill out and ending its effectiveness. If the contents were known to be hazardous by themselves, then the immune machine

could hold on to it long enough to dismantle it more completely. With even more innovation, pathogens could be broken down into simple substances such as oxygen and extra cellular material which can be used for benefit of the body!

- Devices working in the bloodstream could nibble away at arteriosclerotic deposits, widening the affected blood vessels. Various nano-devices could restore the strength of the arteries and veins. With such applications, many heart attacks would be prevented.

III. DIAGNOSTIC AND IMAGING TECHNIQUES

Carbon nanotubes and gold nanoparticles are being used in a sensor that detects proteins indicative of oral cancer. Tests have shown this sensor to be accurate in detecting oral cancer and provides results in less than an hour.

Silver nanorods in a diagnostic system are being used to separate viruses, bacteria and other microscopic components of blood samples, allowing clearer Raman spectroscopy signals of the components. This method has been demonstrated to allow identification of viruses and bacteria in less than an hour.

Iron oxide nanoparticles can be used to improve MRI images of cancer tumors. The nanoparticle is coated with a peptide that binds to a cancer tumor, once the nanoparticles are attached to the tumor the magnetic property of the iron oxide enhances the images from the Magnetic Resonance Imaging scan.

Nanoparticles can attach to proteins or other molecules, allowing detection of disease indicators in a lab sample at a very early stage. There are several efforts to develop nanoparticle disease detection systems underway. One system being developed by Nanosphere, Inc. uses gold nanoparticles, Nanosphere has clinical study results with their Verigene system involving its ability to detect four different nucleic acids, while another system being developed by T2 Biosystems uses magnetic nanoparticles to identify specimens, including proteins, nucleic acids, and other materials.

Gold nanoparticles that have antibodies attached can provide quick diagnosis of flu virus. When light is directed on a sample containing virus particles and the nanoparticles the amount of light reflected back increases because the nanoparticles cluster around virus particles, allowing a much faster test than those currently used.



Quantum Dots (qdots) may be used in the future for locating cancer tumors in patients and in the near term for performing diagnostic tests in samples. Invitrogen's website provides information about qdots that are available for both uses, although at this time the use "in vivo" (in a living creature) is limited to experiments with lab animals. Concerns about the toxicity of the material that quantum dots are made from is one of the reasons restricting the use of quantum dots in human patients. However, work is being done with quantum dots composed of silicon, which is believed to be less toxic than the cadmium contained in many quantum dots.

IV. ANTI-MICROBIAL TECHNIQUES

One of the earliest nanomedicine applications was the use of nanocrystalline silver which is as an antimicrobial agent for the treatment of wounds.



A nanoparticle cream has been shown to fight staph infections. The nanoparticles contain nitric oxide gas, which is known to kill bacteria. Studies on mice have shown that using the nanoparticle cream to release nitric oxide gas at the site of staph abscesses significantly reduced the infection.

Burn dressing that is coated with nanocapsules containing antibiotics. If a infection starts the harmful bacteria in the wound causes the nanocapsules to break open, releasing the antibiotics. This allows much quicker treatment of an infection and reduces the number of times a dressing has to be changed.

A welcome idea in the early study stages is the elimination of bacterial infections in a patient within minutes, instead of delivering treatment with antibiotics over a period of weeks. You can read about design analysis for the antimicrobial nanorobot used in such treatments in the following article: Microbivores: Artificial Mechanical Phagocytes using Digest and Discharge Protocol.

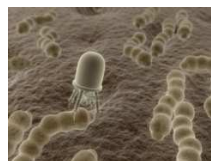
V. POTENTIALS OF NANOMEDICINE

As nanomedical advances, we might soon be able to avoid 99 percent of all medically preventable diseases. Natural death would practically be eradicated. The boost in healthy lifespan could also increase maximum lifespan to around 1,100 years. If we consider this together with our actual lifespan of 80 years, it really seems like a fancy story. Nonetheless, the triumph

against biological death will certainly be achieved within this century.

The rate of suicide is also likely to show an associated decrease. People will have much more hope as human lifespan will ascend to a thousand. Additionally, nano-medical treatment might even be able to treat mental conditions.

There is also a general truth that accidental death will



fall as technological advancement is achieved. Nanotechnology will enhance safety equipment. In other words, crash-safe cars,

Mechanical white blood cell aircrafts and other attacking bacteria vehicles will be developed. There will also be the possibility to incorporate safety devices in households and buildings.

What might happen in the future? Natural death is ceased and accidental death is decreased. It is difficult to accurately predict the potential human lifespan. Nanotechnology will certainly play a significant role in medical science during the decades to come. The drug, known as BIND-014, is the first therapy using microscopic particles which can be targeted at a tumour and programmed to release drug doses at a controlled rate to be trialled in humans.

Researchers hope it will be able to fight cancer by transporting highly concentrated amounts of a chemotherapy drug known as docetaxel or Taxotere to tumours.

Nanoparticles are believed to have potential in cancer care because they could find and kill tumour cells without causing damage to surrounding tissue, meaning the risks of sideeffects would be lower.

This would enable doctors to use higher doses of drugs and potentially magnify their positive effects.

VI. NANOMEDICINE– ECHRONIFICATION: Treating the Disease of Natural Death



Nano-medicine holds promising hopes for human immortality. Progress in nano-medicine can result in so called as



'dechronification' or rather age reversal. With nano-medicine natural death can in the near future be eliminated. The aging process is considered as a disease by most gerontologists and biologists. In clear terms, aging can be cured.

The process of 'dechronification' will go through different phases. The first step is to stop the aging process. The second step is to reverse the aging mechanism. This will involve the rejuvenation of more than 4 trillion tissue cells.

The removal of toxins is the first step. However, toxins will constantly re-accumulate. So to assure that the human body is cleaned. A regular body-cleaning session will have to be conducted maybe once a year.

The second phase would be to perform chromosome replacement therapies to repair genetic damages or mutations. This is a process that might have to be done at an interval of once a year or less. A more complex phase is to induce a mechanism to avoid continuous cellular structural damage to cells. Damages which cannot be repaired by the cells as the mitochondria might have been disabled. This is the most advanced stage of the technology. It involves sending robots to perform maintenance and repair rather than simply cleaning. The human body will be repaired similarly to machines. So we can call our body the human machine.

The speed at which we age will slowly be hampered. Regular cleanouts and checkups could make you one year healthier per annum. The ultimate quest is to restore real youth. Life will certainly be much funnier when you are eternally as healthy as you were in your twenties. Without the presence of natural death, one would only die from accidental causes. This would practically enable an individual to live 700 to 900 years or 10 times longer than today's life expectancy.

VII. BENEFITS OF NANOTECHNOLOGY IN MEDICINE

The use of nanotechnology is ever-expanding in today's technologically advanced world. This form of technology has many advantages over existing ones in many fields and medicine is one of them. There are numerous devices and mechanisms developed with the aid of nanotechnology that can help cure diseases/disorders in a much better and more efficient manner. The usefulness of nanotechnology can especially be seen in the treatment of cancer. Radiation therapy used in cancer treatment requires accurate targeting of affected cells. Today,

nanotechnology is transitioning through the nascent stages of development; however, it is also making rapid progress in the field of medicine.

1. REPAIRING BODY CELLS BECOMES EASY

Nanotechnology is used in the construction of miniscule devices and robots (nanobots) capable of entering the human body and performing a variety of operations; cell repairing one of them. These miniscule devices, developed with the help of nanotechnology, are also referred to as molecular machines. These machines can efficiently carry out repairing of cells, since they can distinguish molecules of one type of body cell from those of another. Earlier, it was not possible to repair body cells individually, however, nanotechnology has made it possible. Damaged heart tissues can be repaired using nanobots. Another heart-related treatment that can be undertaken through nanotechnology is that of unclogging cholesterol-filled arteries. It is seen that healing of bone injuries takes quite a long time. In conventional techniques, scaffolds are tools used for assisting the process of bone healing. However, with the use of polymer scaffolds containing stem cells, speedy recovery of bone injuries becomes possible.

2. EFFICIENT DRUG DELIVERY

The conventional drug delivery systems are such that they need to be controlled manually. Oral intake, injections, and other such modes of manual drug delivery are, however, subject to human error. Medicines have to be consumed in a timely manner. Nanotechnology can be used for timely delivery of medicines; the existing techniques are thereby improved. The drug delivery system meant for a particular patient can be customized and pre-programmed in order to make it effective. Devices used for implementing the delivery of drugs are known as 'nanovehicles'. Some examples of nanovehicles are microchips, layer-by-layer assembled systems, microneedle-based transdermal therapeutic systems, etc. Similar devices (polymer micelles, dendrimers, liposomes, etc.) of a bigger scale were conceptualized way back in the 1960s, however, with recent developments in nanotechnology, it is possible to create their miniature forms.

3. REPLACING ABNORMAL GENES

The small size of devices used in nanotechnology prove to be of great help in the replacement of abnormal or disease-causing cells. A new possibility



of dealing with genetic diseases has emerged with advances taking place in this field. Nanotechnology can be used for replacing abnormal genes (responsible for diseases) with healthier or normal ones. Experiments in the use of nanotechnology for gene therapy were recently made by a team of scientists from the California Institute of Technology, Pasadena. Nanobots made from polymers and covered in a protein called 'transferrin' were used for these experiments. The type of gene therapy tested during these experiments is referred to as 'RNA interference'. The RNA (ribonucleic acid) used in gene therapy does the work of blocking proteins which cause diseases like cancer and blindness.

4. NON-INVASIVE IMAGING TOOLS

Nanotechnology techniques for imaging are also referred to as molecular imaging techniques. These are not used for replacing the existing imaging methods, however, complement them and improve their accuracy. The specialty of imaging techniques - which make use of nanotechnology - is that they depict the actual processes related to diseases at a molecular level.

5. MORPHING THE STEM CELLS

Research in the field of stem cells has uncovered the possibility of treating a variety of diseases. Stem cells are known to possess a unique ability to transform into cells that perform specialized functions. Nanotechnology is used for morphing stem cells into specialized ones. By morphing these cells into specialized ones, the required/desired results can be attained.

The field of nanotechnology has opened many possibilities in the treatment of diseases, cell repair, gene therapy, etc. As technological developments in the field of nanotechnology continue to take place at a rapid pace, the scope of development in nanomedicine seems virtually unlimited.

VIII. CONCLUSION

These applications represent just a few examples of emerging nanotechnology research aimed at medicine and physiology. Developing nanotechnologies are being pursued for general cellular processes such as ubiquitous signaling pathways that may benefit numerous physiological systems, as well as being

targeted toward the particular challenges of specific disorders such as cancer, diabetes mellitus and arteriosclerosis. Ultimately, every patho-physiological process has a molecular origin, and it is from this basic fact that the tremendous potential of nanotechnology applications to medicine arises. With little doubt, nanotechnology will lower the cost of everything, provide nanobots to help us combat diseases, or build spaceships that are cheap and strong enough to satisfy our dream of venturing into space. Nevertheless, we should not get overexcited about nanotechnology and forget to proceed cautiously because we don't know whether this new science might have any negative effect in our health and environment.

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Application of Nano Quantum dots

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1.INTRODUCTION

Nanotechnology is enabling technology that deals with nano-meter sized objects. It is expected that nanotechnology will be developed at several levels: materials, devices and systems. The nanomaterials level is the most advanced at present, both in scientific knowledge and in commercial applications. Researchers have studied quantum dots in transistors, solar cells, LEDs, and diode lasers. They have also investigated quantum dots as agents for medical imaging and hope to use them as qubits in quantum computing. Stated simply, quantum dots are semiconductors whose electronic characteristics are closely related to the size and shape of the individual crystal. Generally, the smaller the size of the crystal, the larger the band gap, the greater the difference in energy between the highest valence band and the lowest conduction band becomes, therefore more energy is needed to excite the dot, and concurrently, more energy is released when the crystal returns to its resting state. In addition to such tuning, a main advantage with quantum dots is that, because of the high level of control possible over the size of the crystals produced, it is possible to have very precise control over the conductive properties of the material. Quantum dots of different sizes can be assembled into a gradient multi-layer nanofilm.

1.1 NANO QUANTUM DOTS

A quantum dot is a nano-scale piece of matter, in this case a semiconductor, whose excitons are confined in all three spatial dimensions so that their electronic characteristics are closely related to the size and shape of the individual quantum dot crystal. Quantum dots can be

tuned to absorb different parts of the solar spectrum by carefully varying their size, and for many years they have been seen as a promising approach to capturing solar power to produce electricity, in part because they can essentially be spray painted onto a substrate. So far however this approach has been hampered by low efficiencies. Quantum dots are particles of semiconductor material with the size so small that, due to quantum mechanics considerations, the electron energies that can exist within them are limited. These energy levels, defined by the size of quantum dots, in turn define the bandgaps. The dots can be grown to any needed size, allowing them to be tuned across a wide variety of bandgaps without changing the underlying material or construction techniques. In typical preparations, the tuning is accomplished by varying the duration or temperature of synthesis. The ability to tune the bandgap which is desirable for solar cell use. In this respect they are similar to the existing expensive GaAs tandem cells, and in theory have efficiencies on the same order. Solar energy reaching the Earth is in the infrared, most of it in the near infrared region. With a quantum dot solar cell, IR-sensitive materials are easy to use as any other, opening the possibility of capturing much more energy cost-effectively. Quantum dot based photovoltaic cells based around dye-sensitized colloidal TiO₂ films were investigated and its efficiency is converting incident light energy to electrical energy, and to be incredibly encouraging due to the low cost of materials used. A single-nanocrystal architecture in which an array of single particles between the electrodes. It is argued that many measurements of the efficiency of the nanocrystal solar



cell are incorrect and that nanocrystal solar cells are not suitable for large scale manufacturing.

2. APPLICATION OF QUANTUM DOTS

2.1 Quantum Computing

Quantum dot technology is one of the most promising candidates for use in solid-state quantum computation. By applying small voltages to the leads, the flow of electrons through the quantum dot can be controlled and thereby precise measurements of the spin and other properties therein can be made. With several entangled quantum dots, or qubits, plus a way of performing operations, quantum calculations and the computers that would perform them might be possible.

2.12 Biology

In modern biological analysis, various kinds of organic dyes are used. Quantum dots have quickly filled in the role, being found to be superior to traditional organic dyes on several counts, one of the most immediately is brightness as well as their stability. It has been estimated that quantum dots are 20 times brighter and 100 times more stable than traditional fluorescent reporters. The usage of quantum dots for highly sensitive cellular imaging has seen major advances over the past decade. The improved photostability of quantum dots, Another application that takes advantage of the extraordinary photostability of quantum dot probes is the real-time tracking of molecules and cells over extended periods of time. Antibodies, streptavidin, peptides, nucleic acid aptamers, or small-molecule ligands can be used to target quantum dots to specific proteins on cells.

The ability to image single-cell migration in real time is expected to be important to several research areas such as embryogenesis, cancer metastasis, stem cell therapeutics, and lymphocyte immunology. There exist two basic targeting schemes: active targeting and passive targeting. In the case of active targeting, quantum dots are functionalized with tumor-specific binding sites to

selectively bind to tumor cells. Passive targeting utilizes the enhanced permeation and retention of tumor cells for the delivery of quantum dot probes.

2.13 Photovoltaic devices

Quantum dots may be able to increase the efficiency and reduce the cost of today's typical silicon photovoltaic cells. The generation of more than one exciton by a single photon is called multiple exciton generation (MEG) or carrier multiplication. Quantum dots of lead selenide can produce as many as seven excitons from one high energy photon of sunlight. This compares favorably to today's photovoltaic cells which can only manage one exciton per high-energy photon, with high kinetic energy carriers losing their energy as heat. Quantum dot photovoltaics would theoretically be cheaper to manufacture, as they can be made "using simple chemical reactions. The generation of more than one exciton by a single photon is called multiple exciton generation (MEG) or carrier multiplication.

2.14 Light emitting devices

There are several inquiries into using quantum dots as light-emitting diodes to make displays and other light sources, such as QD-LED displays, and QD-WLED (White LED). There are several inquiries into using quantum dots as light-emitting diodes to make displays and other light sources, such as QD-LED displays, and QD-WLED (White LED). A proof-of-concept quantum dot display and show a bright emission in the visible and near infra-red region of the spectrum. Quantum dots are valued for displays, because they emit light in very specific gaussian distributions. This can result in a display that more accurately renders the colors that the human eye can perceive. Quantum dots also require very little power since they are not color filtered. Additionally, since the discovery of white-light emitting QD, general solid-state lighting applications appear closer than ever.. A QD-LED integrated at a scanning microscopy tip was used to demonstrate fluorescence near-field scanning optical microscopy (NSOM) imaging.



2.15 Photodetector devices

Quantum dot photodetectors (QDPs) can be fabricated either via solution-processing, or from conventional single-crystalline semiconductors. Conventional single-crystalline semiconductor QDPs are precluded from integration with flexible organic electronics due to the incompatibility of their growth conditions with the process windows required by organic semiconductors. On the other hand, solution-processed QDPs can be readily integrated with an almost infinite variety of substrates, and also postprocessed atop other integrated circuits. Such colloidal QDPs have potential applications in surveillance, machine vision, industrial inspection, spectroscopy, and fluorescent biomedical imaging.

3. CONCLUSION:

The quantum dots play a major role in the field of Nanotechnology. Being zero dimensional structures, thus it has sharper density of states than higher dimensionless structures. The application and the development of research in the quantum dots field, it is further going to expand and the future hope in the multidisciplinary research going to dominate the research world. The usefulness and application of Quantum Dot technology continues to expand and research is striving to bring their benefits to more and more technologically applied fields

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Nanomaterials-graphene & its engineering applications

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Abstract—Physical substances with at least one characteristic dimension between 1-150 nm can be defined as a nanomaterials. Nanomaterials properties can differ from those of the same materials with micron- or mm-scale dimensions. Nanomaterials are the building blocks of practical nanotechnology and can be physically and chemically manipulated for specific applications. Carbon nanomaterials are a family of carbon-based materials with at least one dimension in the nanometer range. Graphene is an allotrope of carbon, whose structure is one-atom-thick planar sheets of sp^2 -bonded carbon atoms that are densely packed in a honeycomb crystal lattice.

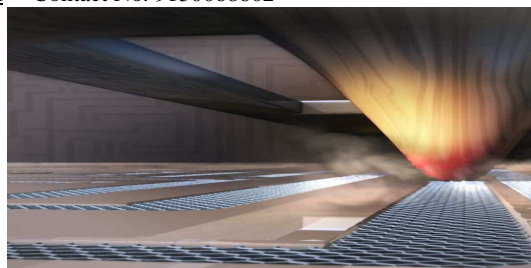
In this Review, firstly I give general introduction about Graphene. Then, I tell about Graphene based anti-corrosion coating, Graphene based Batteries to Power Tomorrow's Electric Cars, Graphene based Technology to Break Speed Limits in Digital Communications and then, Finally conclusion.

Keywords: Graphene, Batteries, Digital Communications

1. Introduction

Graphene is an allotrope of carbon. Its structure is one-atom-thick planar sheets of sp^2 -bonded carbon atoms that are densely packed in a honeycomb crystal lattice. The term graphene was coined as a combination of graphite and the suffix-ene in 1962. Graphene is most easily visualized as an atomic-scale chicken wire made of carbon atoms and their bonds. The crystalline or "flake" form of graphite consists of many graphene sheets stacked together.

The carbon-carbon bond length in graphene is about 0.142 nanometers. Graphene sheets stack to form graphite with an interplanar spacing of 0.335 nm. Graphene is the basic structural element of some carbon allotropes including graphite, charcoal, carbon nanotubes and fullerenes. It can also be considered as an indefinitely large aromatic molecule, the limiting case of the family of flat polycyclic aromatic hydrocarbons.



In a technique known as thermochemical nanolithography, the tip of an atomic force microscope uses heat to turn graphene oxide into reduced graphene oxide, a substance that can be used to produce nanocircuits and nanowires with controllable conductivity.

Graphene replace silicon as the building block of transistors. They have devised a simple and quick one-step process for creating nanowires, tuning the electronic properties of reduced graphene oxide and thereby allowing it to switch from being an insulating material to a conducting material.

2. Miracle material' graphene is thinnest known anti-corrosion coating

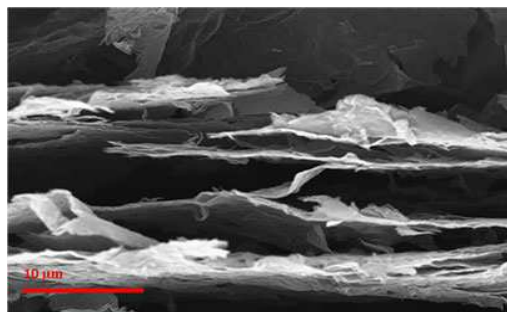
Graphene as the world's thinnest known coating for protecting metals against corrosion. Rusting and other corrosion of metals is a serious global problem, and intense efforts are underway to find new ways to slow or prevent it. Corrosion results from contact of the metal's surface with air, water or other substances. One major approach involves coating metals with materials that shield the metal surface, but currently used materials have limitations. We evaluate graphene as a new coating. Graphene is a single layer of carbon atoms, many layers of which are in lead pencils and charcoal, and is the thinnest, strongest known material. That's why it is called the miracle material. In graphene, the carbon atoms are arranged like a chicken-wire fence in a layer so thin that is transparent, and an ounce would cover 28 football fields.

They found that graphene, whether made directly on copper or nickel or transferred onto another



metal, provides protection against corrosion. Copper coated by growing a single layer of graphene through chemical vapor deposition (CVD) corroded seven times slower than bare copper, and nickel coated by growing multiple layers of graphene corroded 20 times slower than bare nickel. Remarkably, a single layer of graphene provides the same corrosion protection as conventional organic coatings that are more than five times thicker. Graphene coatings could be ideal corrosion-inhibiting coatings in applications where a thin coating is favorable, such as microelectronic components (e.g., interconnects, aircraft components and implantable devices)

Batteries Made From World’s Thinnest Material Could Power Tomorrow’s Electric Cars



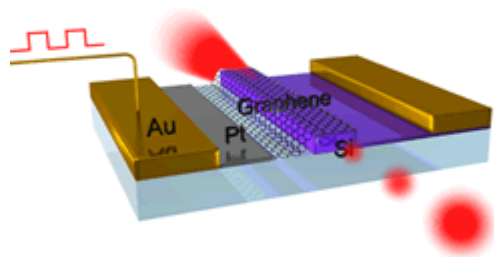
SEM image of the cross section of photo-thermally reduced graphene shows an expanded structure. The graphene sheets are spaced apart with an inter-connected network allowing for greater electrolyte wetting and lithium ion access for efficient high rate performance in lithium ions batteries.

Graphene anode material that can be charged or discharged 10 times faster than conventional graphite anodes used in today’s lithium (Li)-ion batteries.

Rechargeable Li-ion batteries are the industry standard for mobile phones, laptop and tablet computers, electric cars, and a range of other devices. While Li-ion batteries have a high energy density and can store large amounts of energy, they suffer from a low power density and are unable to quickly accept or discharge energy. This low power density is why it takes about an hour to charge your mobile phone or laptop battery, and why electric automobile engines cannot rely on batteries alone and require a supercapacitor for high-power functions such as acceleration and braking. Graphene as a possible replacement for the graphite used as the anode material in today’s Li-ion batteries. Essentially a single layer of the graphite found commonly in our pencils or the charcoal we burn on our barbecues, graphene is an atom-thick sheet of carbon atoms arranged like a nanoscale

chicken-wire fence. In previous studies, Li-ion batteries with graphite anodes exhibited good energy density but low power density, meaning they could not charge or discharge quickly. This slow charging and discharging was because lithium ions could only physically enter or exit the battery’s graphite anode from the edges, and slowly work their way across the length of the individual layers of graphene. Create a large sheet of graphene oxide paper. This paper is about the thickness of a piece of everyday printer paper, and can be made nearly any size or shape. The research team then exposed some of the graphene oxide paper to a laser, and other samples of the paper were exposed to a simple flash from a digital camera. In both instances, the heat from the laser or photoflash literally caused mini-explosions throughout the paper, as the oxygen atoms in graphene oxide were violently expelled from the structure. The aftermath of this oxygen exodus was sheets of graphene pockmarked with countless cracks, pores, voids, and other blemishes. The pressure created by the escaping oxygen also prompted the graphene paper to expand five-fold in thickness, creating large voids between the individual graphene sheets. This damaged graphene paper performed remarkably well as an anode for a Li-ion battery. Whereas before the lithium ions slowly traversed the full length of graphene sheets to charge or discharge, the ions now used the cracks and pores as shortcuts to move quickly into or out of the graphene—greatly increasing the battery’s overall power density. Anode material could charge or discharge 10 times faster than conventional anodes in Li-ion batteries without incurring a significant loss in its energy density. Despite the countless microscale pores, cracks, and voids that are ubiquitous throughout the structure, the graphene paper anode is remarkably robust, and continued to perform successfully even after more than 1,000 charge/discharge cycles. The high electrical conductivity of the graphene sheets also enabled efficient electron transport in the anode, which is another necessary property for high-power applications. The process of making these new graphene paper anodes for Li-ion batteries can easily be scaled up to suit the needs of industry. The graphene paper can be made in essentially any size and shape, and the photo-thermal exposure by laser or camera flashes is an easy and inexpensive process to replicate. The researchers have filed for patent protection for their discovery. The next step for this research project is to pair the graphene anode material with a high-power cathode material to construct a full battery.

Graphene Technology Could Break Speed Limits in Digital Communications



Schematic illustration of the graphene-based optical modulator. A layer of graphene (black fishnet) is placed on top of a silicon waveguide (blue), which is used as an optical fiber to guide light. Electric signals sent in from the side of the graphene through gold (Au) and platinum (Pt) electrodes alter the amount of photons the graphene absorbs.

A tiny optical device that uses graphene, a one-atom-thick layer of crystallized carbon, to switch light on and off. This switching ability is the fundamental characteristic of a network modulator, which controls the speed at which data packets are transmitted. The faster the data pulses are sent out, the greater the volume of information that can be sent. Graphene-based modulators could soon allow consumers to stream full-length, high-definition, 3-D movies onto a smartphone in a matter of seconds, the researchers said.

“This is the world’s smallest optical modulator, and the modulator in data communications is the heart of speed control,” said Zhang, who directs a National Science Foundation (NSF) Nanoscale Science and Engineering Center at UC Berkeley. “Graphene enables us to make modulators that are incredibly compact and that potentially perform at speeds up to ten times faster than current technology allows. This new technology will significantly enhance our capabilities in ultrafast optical communication and computing.”

In addition to high-speed operations, graphene-based modulators could lead to unconventional applications due to graphene’s flexibility and ease in integration with different kinds of materials. Graphene can also be used to modulate new frequency ranges, such as mid-infrared light, that are widely used in molecular sensing.”

Graphene is the thinnest, strongest crystalline material yet known. It can be stretched like rubber, and it has the added benefit of being an excellent conductor of heat and electricity. This last quality of graphene makes it a particularly attractive material for electronics.

When a sufficient negative voltage is applied, electrons are drawn out of the graphene and are no longer available to absorb photons. The light is “switched on” because the graphene becomes totally transparent as the photons pass through.

Graphene is also transparent at certain positive voltages because, in that situation, the electrons become packed so tightly that they cannot absorb the photons.

“If graphene were a hallway, and electrons were people, you could say that, when the hall is empty, there’s no one around to stop the photons,” said Xiaobo Yin, co-lead author of the Nature paper and a research scientist in Zhang’s lab. “In the other extreme, when the hall is too crowded, people can’t move and are ineffective in blocking the photons. It’s in between these two scenarios that the electrons are allowed to interact with and absorb the photons, and the graphene becomes opaque.”

“Electrons can easily make an L-shaped turn because the wavelengths in which they operate are small,”. “Light wavelengths are generally bigger, so they need more space to maneuver. It’s like turning a long, stretch limo instead of a motorcycle around a corner. That’s why optics require bulky mirrors to control their movements. Scaling down the optical device also makes it faster because the single atomic layer of graphene can significantly reduce the capacitance – the ability to hold an electric charge – which often hinders device speed.”

Graphene-based modulators could overcome the space barrier of optical devices, the researchers said. They successfully shrunk a graphene-based optical modulator down to a relatively tiny 25 square microns, a size roughly 400 times smaller than a human hair. The footprint of a typical commercial modulator can be as large as a few square millimeters.

Even at such a small size, graphene packs a punch in bandwidth capability. Graphene can absorb a broad spectrum of light, ranging over thousands of nanometers from ultraviolet to infrared wavelengths. This allows graphene to carry more data than current state-of-the-art modulators, which operate at a bandwidth of up to 10 nanometers, the researchers said.

“Graphene-based modulators not only offer an increase in modulation speed, they can enable greater amounts of data packed into each pulse,” said Zhang. “Instead of broadband, we will have ‘extremeband.’ What we see here and going forward with graphene-based modulators are tremendous improvements, not only in consumer



electronics, but in any field that is now limited by data transmission speeds, including bioinformatics and weather forecasting. We hope to see industrial applications of this new device in the next few years.”

Conclusion

Now a day's nano materials play vital roles in many fields including engineering, medical, electrical etc. About the various application of graphene such as Graphene based anti-corrosion coating, Graphene based Batteries to Power Tomorrow's Electric Cars, Graphene Technology Could Break Speed Limits in Digital Communications

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Nanotechnology and Space Elevator

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Abstract— Nanotechnology deals about nanoparticles and its size and the basic composition of it. nanomaterials has evolved many names which depending upon their sizes and dimensions. We can produce nanomaterials simply by two of the basic process they are top down approach and bottom up approach. They have a desired functionality without regard to how they might be assembled. Study about their property arising from the nanoscale division. Nanotechnologies are used in the both disease preventing and disease producing way.

Space Elevator is ongoing project in NASA and Japan space elevator association it extends from the earth to space by using cables made up of CNT. The basic structure is built on the basic principle of the space elevator. Base station consists of two stations to depart from earth to outer space one is stationary and another one mobile (movable). Cables must be made up of light weight high tensile material like CNT's. Both power and energy are significant issues for climbers. The proposed method used is laser power beaming. Speed must exceed earths gravitational pull so that it can travel much faster than any thing else and reached the desired place. Ribbon is used to counter weight at the end of the space elevator and it is made up of highly rigid material.

If built, the ribbon will represent a modern world wonder, and will be the tallest structure ever built. The space elevator would be 180,720 times taller than the CN Tower. Climbers ascend a ribbon, 100,000 km long, strung between an anchor on Earth and a counterweight in space. Connecting Earth and space in a way never before possible, the space elevator will enable us to inexpensively and completely expand our society into space. Simply we can say this vision is our mission.

I. INTRODUCTION

Nanotechnology, shortened to "nanotech", is the study of the control of matter on an atomic and molecular scale. One nanometer (nm) is one billionth, or 10^{-9} , of a meter. Generally nanotechnology deals with structures of the size 100 nanometers or smaller, and involves developing materials or devices within that size. Nanotechnology has the potential to create many new materials and devices with wide-ranging applications, such as in medicine, electronics, and energy production. By comparison, typical carbon-carbon bond lengths, or the spacing between these atoms in a molecule, are in the range 0.12–0.15 nm. Areas of physics such as nanoelectronics, nanomechanics and nanophotonics have been

evolved during the last decades to provide a basic scientific foundation of nanotechnology.

A. Comparison Of Nanomaterials

As the field of nanostructures has evolved many names and labels have been used.

1) Clusters:

- A collection atoms or reactive molecules up to about 50 units.

2) Colloid:

- A stable liquid phase containing particles in 1 to 1000 nm range. A colloid particle is one such 1 to 1000 nm sized particle.

3) Nano particle:

- A solid particle in the 1 to 1000nm range that could be non crystalline, an aggregate of crystallites or a single crystalline.

4) Nano crystal:

- A solid particle that is a single crystal in the nanometer size.

5) Nanostructures or nanoscale material:

- Any solid material has a nanometer dimension.
- Three dimensions->particles
- Two dimensions-> thin films
- One dimension-> thin wire

B. Synthesis Of Nano Materials

There are two processes for the synthesis of the nanophase materials:

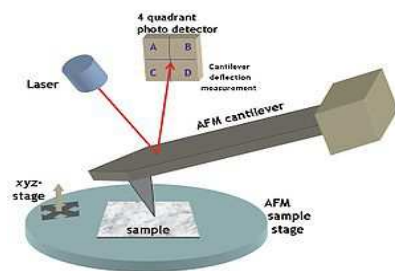
- Top-down processes
- Bottom-up processes
- Top-down approaches:

These seek to create smaller devices by using larger ones to direct their assembly.



Process:

Focused ion beams can directly remove material, or even deposit material when suitable pre-cursor gasses are applied at the same time. For example, this technique is used routinely to create sub-100 nm sections of material for analysis in Transmission electron microscopy



Applications:

Many technologies that descended from conventional solid-state silicon methods for fabricating microprocessors are now capable of creating features smaller than 100 nm, falling under the definition of nanotechnology.

Solid-state techniques can also be used to create devices known as nanoelectromechanical systems or NEMS, which are related to microelectromechanical systems or MEMS.

Atomic force microscope tips can be used as a nanoscale "write head" to deposit a chemical upon a surface in a desired pattern in a process called dip pen nanolithography. This fits into the larger subfield of nanolithography.

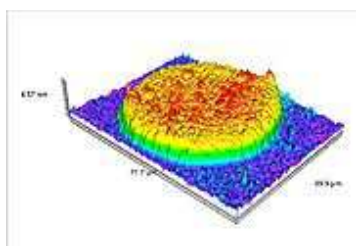
Bottom-up approaches

These seek to arrange smaller components into more complex assemblies.

Applications

DNA nanotechnology utilizes the specificity of Watson-Crick base pairing to construct well-defined structures out of DNA and other nucleic acids.

Until recently, nanotechnology was primarily based in electronics, manufacturing, supercomputers and data storage. Already, nonscientists are manufacturing new kinds of coatings for windows, cars, machines, planes, new materials for making fabric, and new circuits for computers.



Sarfas image of a DNA biochip elaborated by bottom-up approach

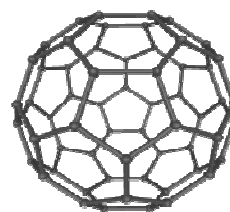
Approaches from the field of "classical" chemical synthesis also aim at designing molecules with well-defined shape (e.g. bis-peptides).

More generally, molecular self-assembly seeks to use concepts of supramolecular chemistry, and molecular recognition in particular, to cause single-molecule components to automatically arrange themselves into some useful conformation

C. Nanomaterials And Its Simple Applications

This includes subfields which develop or study materials having unique properties arising from their nanoscale dimensions.

Interface and Colloid Science has given rise to many materials which may be useful in nanotechnology, such as carbon nanotubes and other fullerenes, and various nanoparticles and nanorods.



Nanoscale materials can also be used for bulk applications; most present commercial applications of nanotechnology are of this flavor.

Progress has been made in using these materials for medical applications; see Nanomedicine.

Nanoscale materials are sometimes used in solar cells which combats the cost of traditional Silicon solar cells.

D. Health And Environmental

Concerns:

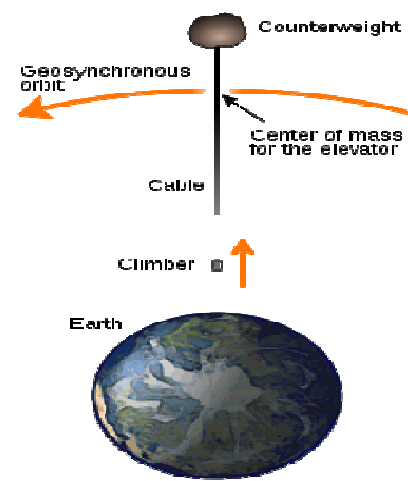
- Researchers have discovered that silver nanoparticles used in socks only to reduce foot odor are being released in the wash with possible negative consequences. Silver nanoparticles, which are bacteriostatic, may then destroy beneficial bacteria which are important for breaking down organic matter in waste treatment plants or farms.
- when rats breathed in nanoparticles, the particles settled in the brain and lungs, which led to significant increases in biomarkers for inflammation and stress response



E. Space Elevator

A space elevator would consist of a cable anchored to the Earth's surface, reaching into space. By attaching a counterweight at the end (or by further extending the cable for the same purpose), inertia ensures that the cable remains stretched taut, countering the gravitational pull on the lower sections, thus allowing the elevator to remain in geostationary orbit. Once beyond the gravitational midpoint, carriages would be accelerated further by the planet's rotation. (Diagram not to scale.)

A space elevator is a proposed structure designed to transport material from a celestial body's surface into space. Many variants have been proposed, all of which involve traveling along a fixed structure instead of using rocket powered space launch. The concept most often refers to a structure that reaches from the surface of the Earth on or near the Equator to geostationary orbit (GSO) and a counter-mass beyond.



The concept of a space elevator dates back to 1895 when Konstantin Tsiolkovsky proposed a free-standing "Tsiolkovsky" tower reaching from the surface of Earth to geostationary orbit. Most recent discussions focus on tensile structures (specifically, tethers) reaching from geostationary orbit to the ground. This structure would be held in tension between Earth and the counterweight in space like a guitar string held taut. Space elevators have also sometimes been referred to as beanstalks, space bridges, space lifts, space ladders, skyhooks, orbital towers, or orbital elevators.

Current technology is not capable of manufacturing practical engineering materials that are sufficiently strong and light to build an Earth-based space elevator. The primary issue is that the total mass of conventional materials needed to construct such a structure would be so great that the cable would break under its own weight. Recent conceptualizations for a space elevator are notable in their plans to use carbon nanotube-based materials as the tensile element in the tether design, since the measured strength of microscopic carbon

nanotubes appears great enough to make this theoretically possible. Current technology could produce elevators for locations in the solar system with weaker gravitational fields, such as the Moon or Mars.

a. Structure

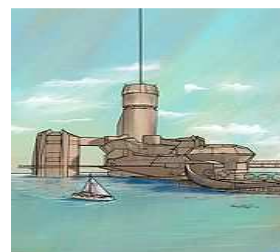
One concept for the space elevator has it tethered to a mobile seagoing platform.

The centrifugal force of earth's rotation is the main principle behind the elevator. As the earth rotates, the centrifugal force tends to align the nanotube in a stretched manner. There are a variety of tether designs. Almost every design includes a base station, a cable, climbers, and a counterweight.



b. Base Station

The base station designs typically fall into two categories—mobile and stationary. Mobile stations are typically large oceangoing vessels. Stationary platforms would generally be located in high-altitude locations, such as on top of mountains, or even potentially on high towers.



Mobile platforms have the advantage of being able to maneuver to avoid high winds, storms, and space debris. While stationary platforms don't have these advantages, they typically would have access to cheaper and more reliable power sources, and require a shorter cable. While the decrease in cable length may seem minimal (typically no more than a few kilometers), the cable thickness could be reduced over its entire length, significantly reducing the total weight.

c. Cable

The cable must be made of a material with a large tensile strength/mass ratio. A space elevator can be made relatively economically feasible if a cable with a density similar to graphite and a tensile strength of ~65–120 GPa can be mass-produced at a reasonable price. Carbon nanotubes would be a highly useful material for creating a space elevator.



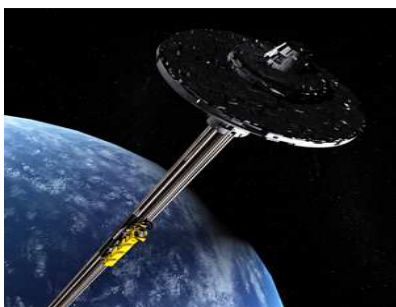
d. Powering Climbers

Both power and energy are significant issues for climbers - the climbers need to gain a large amount of potential energy as quickly as possible to clear the cable for the next payload. Nuclear energy and solar power have been proposed, but generating enough energy to reach the top of the elevator in any reasonable time without weighing too much is not feasible.

The proposed method is laser power beaming, using megawatt powered free electron or solid state lasers in combination with adaptive mirrors approximately 10 m wide and a photovoltaic array on the climber tuned to the laser frequency for efficiency. A major obstacle for any climber design is the dissipation of the substantial amount of waste heat generated due to the less than perfect efficiency of any of the power methods.

F. Launching Into Outer Space

The velocities that might be attained at the end of Pearson's 144,000 km cable can be determined. The tangential velocity is 10.93 kilometers per second, which is more than enough to escape Earth's gravitational field and send probes at least as far out as Jupiter. Once at Jupiter a gravitational assist maneuver permits solar escape velocity to be reached.



RIBBON IN THE SKY

To better understand the concept of a space elevator, think of the game tetherball in which a rope is attached at one end to a pole and at the other to a ball. In this analogy, the rope is the carbon nanotubes composite ribbon, the pole is the Earth and the ball is the counterweight. Now, imagine the ball is placed in perpetual spin around the pole, so fast that it keeps the rope taut. This is the general idea of the space elevator. The counterweight spins around the Earth, keeping the cable straight and allowing the robotic lifters to ride up and down the ribbon.

Under the design proposed by LiftPort, the space elevator would be approximately 62,000 miles (100,000 km) high. Carbon nanotubes have the potential to be 100 times stronger than steel and are as flexible as plastic. The strength of carbon nanotubes comes from their unique structure, which resembles soccer balls. Once scientists are able to make fibers from carbon nanotubes, it will be possible to create threads that will form the ribbon for the space elevator. Previously available

materials were either too weak or inflexible to form the ribbon and would have been easily broken.

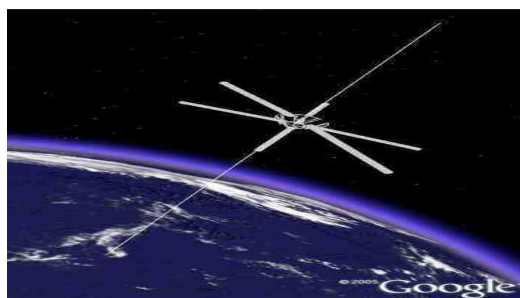
A RIBBON IN TWO WAYS

Long carbon nanotubes -- several meters long or longer -- would be braided into a structure resembling a rope. As of 2005, the longest nanotubes are still only a few centimeters long.

Once a long ribbon of nanotubes is created, it would be wound into a spool that would be launched into orbit. When the spacecraft carrying the spool reaches a certain altitude, perhaps Low Earth Orbit, it would begin unspooling, lowering the ribbon back to Earth. At the same time, the spool would continue moving to a higher altitude. When the ribbon is lowered into Earth's atmosphere, it would be caught and then lowered and anchored to a mobile platform in the ocean.

The ribbon would serve as the tracks of a sort of railroad into space. Mechanical lifters would then be used to climb the ribbon to space.

HOW THE SPACE ELEVATOR MEASURES UP?????



If built, the ribbon will represent a modern world wonder, and will be the tallest structure ever built. Consider that the world's tallest freestanding tower in 2005 is the CN Tower, which rises 1,815 feet 5 inches (553.34 meters) over Toronto, Canada. The space elevator would be 180,720 times taller than the CN Tower!

The 62,000-mile (100,000-km) long space elevator would rise far above the average orbiting height of the space shuttle (115-400 miles/185-643 km). In fact, it would equal nearly a fourth of the distance to the moon, which orbits the Earth at 237,674 miles (382,500 km).

II. CONCLUSION

Climbers ascend a ribbon, 100,000 km long, strung between an anchor on Earth and a counterweight in space. Connecting Earth and space in a way never before possible, the space elevator will enable us to inexpensively and completely expand our society into space.

Beyond Earth, space elevators on the moon and Mars open new economic opportunities and expand humanities reach ever so slightly into the solar system. Here I portray about nanomaterials and space elevator of my knowledge.



Smart Dust Nanosensors and Other Applications of Nanosensors

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Abstract— With the advent of miniaturization of equipments and components, the paradigm has shifted to Nanotechnology and Nanoscience. Nanoparticles have desirable properties of thermal conductivity, strength, magnetic, chemical, optical properties and exhibit interesting phenomena in contrast to their higher solid states of molecules. Hence, Nanotechnology provides the ability to work at miniature levels atom by atom at different molecular structures, lattice arrangements, and fabrication techniques with high sensitivity, low power consumption, durable and light weights. The literature conducted here provides a view of smart dust motes which can sense enormous amount of information by drifting afloat in the atmosphere. Smart dust motes incorporate sensing, MEMS technology, computing, wireless and optical communication and power supply for this purpose. They are suspended in the desired location to detect the movement of enemy tanks or troops, record weather and environmental conditions. They use wireless and optical communication by radio, laser transmission and peer to peer communication between the motes for sensing and relay

Key words: UAV-unmanned aerial vehicle ; CNT- carbon nanotubes; MEMS-microelectro mechanical systems ;BST-base statin transreceiver; SDMA-space division

I. NANO –THE LANDMARK FOR FUTURE REVOLUTION

Nanotechnology is the technology of using nanoparticles of 1nm to 100nm to develop various tools for applications in space science, electronics, biomedicine, national security. These particles exhibit tunable properties and can be integrated at atomic levels in any device. They are manufactured using bottom up assembling and molecular self-assembly and several other techniques. The nanoparticles include carbon, iron, silver, palladium, silicon, gold etc; Recently they are used in purifying water, and removing air contamination from the environment.

Nanosensors are built on atomic scale to receive data and transfer it to a data to be analysed. A sensor consists of two components, a recognition unit which followed by a transducer with high sensitivity that converts the data into their corresponding electrical or optical signals. Nanosensors are used in undersea mine detection, reconnaissance UAVS, undersea surveillance. These sensors maybe chemical, physical, biological or quantum based sensors. These sensors

incorporate nanoparticles at atomic scales and stands apart from the conventional sensors in use. Carbon nanotubes are allotropes of carbon with cylindrical structure. Certain carbon nanotubes are semiconducting while others are metallic and they possess an ability to combine nanoscale geometry suitable for wires and other electronic devices. Single walled carbon nano tubes have increased surface to volume ratio, high resilience and strength (20 to 100 times of steel), chemical vigour, ability to be straightened without damage or extreme bending. The increased surface area thereby increases the potential of the tubes for chemical reactivity, sensitivity, molecular recognition and binding properties. Its conductivity, capacitance, dielectric constants and absorption property and tunable electric properties make them an excellent tool for sensing. Further the surface area can be modified by coating and doping methods to make them responsive to specific materials and to determine them, to increase the conductivity and to control the wavelengths of lights emitted by them.

II. SMART DUST SILICON NANOSENSORS

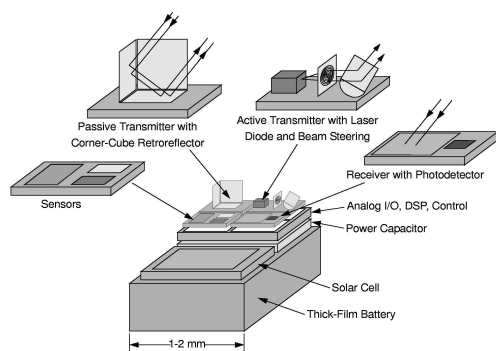
Smart materials are substances that can significantly sense change in mechanical, optical, thermal, electric, electromechanical and thermodynamic properties in predictable manner. Smart dust devices combine sensing, computing, wireless communication with autonomous power supply within limited volume. The particles can be suspended easily in air and have a dimension of less than 5 millimetre cube. They are mainly used to collect and relay information upto certain metres. Smart dust motes are nanostructured silicon sensors that spontaneously gather, orient, sense, report and respond in a local environment which is used in a number of applications. This method was first introduced by Dr. Kris Pister at the University of California.

III. COMPONENTS OF SMART DUST NANOSENSORS

The components of smart dust mote includes power supply analog circuits, optical transreceivers programmed using MEMS, a microcontroller and a memory storage (3kB RAM/SRAM). The sensor integrates computational, sensing, wireless communication and automated power supply in the system. The Primary components include MEMS sensors with integrated circuits and wireless communication systems. The



nanosensor is used as an interface between the system and environment. Signal processing is done using an A/D converter, the microcontroller determines the task and timing of the motes along with power control. In places where human intervention is not possible, due to presence of toxic and harmful gaseous substances, this smart dust approach is implemented where small particles resembling dust are carried by air currents which compose porous silicon etched in crystalline silicon by combining galvanic and anodic currents. These particles are ultrasonicated to form materials for smart dust. Porous Si exhibits photoluminescence. When it comes into contact with explosive chemicals like DNT and TNT, its photoluminescence is quenched due to nitrogendioxide by catalytic oxidation. This signal is monitored at a safe distance and provides information about the nature and quantity of toxic substances in the location and has detection capabilities of ppb. These dust particles can analyse a multitude of parameters ranging from humidity to explosives and can communicate within themselves using 3D concentration profiling. MEMS technology using photolithographic techniques and ultra violet etching of Si wafer is used to make these motes. Wireless sensor nodes are equipped with low power source of less than 0.5-2 ampere per hour and 1.2-3.7 V. They can also renew their energy from solar sources, temperature differences and vibration.



Basic components of the smart dust mote

IV. MECHANISM OF SMART DUST MOTES

Dust motes are oriented and suspended to the particular location for sensing. They are dispersed by UAV and they create a wireless network. Communication is done between the dispersed particles using this wireless sensor networks by radio frequency transmission of around 1000 motes. It can be used in license free communication frequencies of 173,433,868,915MHz and 2.4GHz. They use wireless peer to peer communication to form a self organized network that communicates from the remote to the base station by bidirectional communication. Multi hopping routing algorithms are used for fast, efficient communication and symmetric cryptography is used for secure communication. Nodes can communicate in a secure manner and information is transferred through their respective exchange keys. The nodes in smart dust are known as motes due to their small size.

V. SENSING BY MEMS SENSORS.

The dust mote is an autonomous node incorporating sensing, computing, communication and power source in a cubic mm volume. In order to spontaneously assemble and orient them in an environment they use electromechanical machining process. Initially a porous photonic structure is produced by etching Silicon by electromechanical machining which imparts a highly reflective and specific colour code to the material that acts like an address by identifying the bar code for particles followed by chemical modification of porous silicon photonic structures that locate and stick to the target. Micro-Electro-Mechanical Systems is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology using compatible micro machining processes that selectively etch away parts of the silicon wafer or add new structural layers to create new mechanical and electromechanical devices. The material is an amorphous ribbon of silicon, iron and boron. They create soft magnetic fields which produce flux and acoustic energy and have higher harmonic frequencies on application of external energy. This produces magnetic loops that monitor the field of view and they can respond by adjusting and positioning the devices.

A photodiode controls optical reception. Lasers are used for active optical communication by producing IR beams and focuses it through a lens and optical filter into a narrow beam to the receiver.

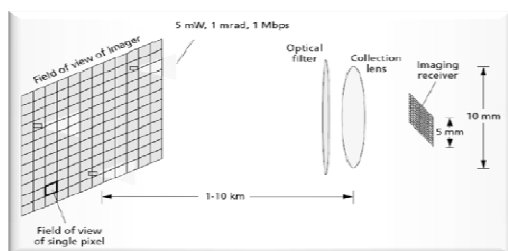
Dust motes use passive optical transmission technique, to transmit modulated optical signals without supplying any optical power is a corner-cube retroreflector (CCR). The CCR comprises of three mutually perpendicular mirrors of gold-coated polysilicon that has the property of reflecting the incident ray of light back to the source. If one of the mirrors is misaligned or changes its orientation, this retro reflection property does not hold good. The microfabricated CCR includes an electrostatic actuator that can deflect one of the mirrors at kilohertz rates. It has been demonstrated that a CCR illuminated by an external light source can transmit back a modulated signal at kilobits per second and the passive transmitter consumes little power. Using a microfabricated CCR, data transmission at a bit rate up to 1 kilobit per second, and over a range up to 150 meters, using a 5-milliwatt illuminating laser has been demonstrated by Kris Pister.

VI. RECOGNITION AT THE RECEIVER.

Sensors are interfaced between the environment and the transducers. They collect information from the environment and transmit it using active communication through diodes and passive communication by reflectors. When they locate the interface for which they were programmed for they line up on the surface of the target. They collectively amplify the



recognition at the surface of the particle and to signal their presence at the interface and they change their colour or exhibit changes in other aspects. The functions of transmitter and receiver are combined in a single device known as transceiver which performs various operations automatically. Most transceivers operate in idle mode when it is not receiving or transmitting. Still, there is a significant consumption of energy while switching from sleep to transmit mode due to transmission of a packet. A base Station Transceiver (BTS) equipped with a compact imaging receiver can decode the simultaneous transmissions from a large number of dust motes from different locations within the receiver field of view by space division multiplexing. Successful decoding of these simultaneous transmissions requires that dust motes not block each other's line of sight to the BTS. Microcontroller collects information periodically about temperature, light, vibration and air pressure. Timers turn on the optical receivers to track communications relayed to it. They also permit the CCR to transmit data accordingly. When the timer is turned off it samples the data received and converts it to digital information and stores it the memory RAM. Another timer receives packets from the base station and the microcontroller interprets the message. The primary constraint is the lack of timing control of the motes by the microcontrollers. Reception of data is done by an imaging receiver (high speed video camera), lens, optical receiver. Each mote will be produced at a different location by the diodes on the image screen. The optical filter prevents the entry of excessive sunlight and the lens system focusses the light from a large field of view by processing the different portions of the image by individual transmissions from different angles. Thus distinguishing individual transmissions from the originating source is done by SDMA. Thus each pixel monitors the signal and decodes the data by sensing using a photosensor and the circuits perform analog to digital conversion followed by amplification. A single mote of minute volume delivers a very little amount of information but an entire collection of motes transmitting information, accurately senses the position and movement of troops and equipments. It is useful for sensors to operate in clusters. Rather than implementing a broad range of sensors in a single integrated circuit, it is possible to simply deploy a mixture of different sensors in a given geographical area and allow them to self-organize into different sensing sections in the same domain. Thus different sensors to detect heat, motion and speed can be used. CDMA is used for such simultaneous transmissions.



Focusing of the individual optical data in optical imaging.

VII. POTENTIAL DRAWBACKS OF NANOPARTICLES

Nanoparticles, which are used in nanosensors, apart from exhibiting many desirable properties are also prone to adhesion, friction, fatigue, contamination and wear. Hence these failure mechanisms are addressed by various other methods to increase the reliability and efficiency of the devices. They may also release toxic nanoparticles and large scale use of nanosensors could have an impact on the environment when these start to degrade and leak to the soil. Since they are considerable density, there is not much chance of being carried by air currents. These nanosensors can pose severe problems to privacy, it can also be used by terrorists for illegal purposes and the cost of implementation is quite high. These smart dust motes must be retrieved after the operation is over, otherwise if they are left without being taken back, they can pose minor damages to the environment. Further, power requirements of these sensors should be efficiently managed.

VIII. OTHER APPLICATIONS OF NANOSENSORS MILITARY.

Nanotechnology is used in military applications as fabrics, armours that incorporate sensing particles and withstand extreme conditions. They are also used in the manufacture of weapons and vehicles for transport. Health diagnosis is also done. A bio nanosensor patch is designed for a soldier on the battlefield. When troops are sent to a battlefield, they are fitted with a biosensor patch on their arms. If injured, the patch would record data about the severity of the trooper's wounds based on their glucose and lactate levels (and any other readily available bio-molecule that can be sampled with the patch). They would be sent to a short-range telemetry, to a medical monitor which would show the location of the injured trooper and the severity of the injury would be notified. If the monitor observed dangerous changes in a soldier's body biochemistry, then the soldier would be assisted first, and then removed from the field for medical care.

Carbon nanotubes coated with bombolitins, protein fragments found in bee venom reacted with nitro aromatic components like TNT at the molecular level. These CNT sensors are capable of detecting a single molecule of an explosive and are more accurate to read shifts in carbon nanotube's fluorescent wavelength. These tubes have a natural glow, when they interact with various substances they will bind at the molecular level and the wavelength emitted makes the tube glow at a different intensity. Researchers have identified various bombolitins which react differently to the various nitro aromatic components allowing them to create a unique identifier for a specific type of explosive.

Blue crab sensor was developed by university of Maryland, has a key component which is a chitosan, a substance found in blue crab and crustaceans. This biological substance is able to bind with negatively charged surfaces and can interact with a wide quantity of substances and hence works well as a nanosensor. They work using multiple mini vibrating cantilevers coated with chitosan and an optical



sensing technique which is used to detect the vibration of cantilevers. Different cantilevers in the sensor can detect difference substances and their concentrations. When the targeted substances passes into the device from air or water, the chitosan that is present on the cantilever interacts with it causes the cantilever to vibrate. The optical sensing senses the vibration and detects the substance. This sensor is used to detect minute quantities of explosives, bioagents and hazardous substances in air and water.

VIII. CONCLUSION

The shrinking size of these sensors and increased sensitivity makes them far more desirable due to their compactness, and is widely being preferred to conventional sensors. This system involves invisible tracking without the notice of others or enemy troops, multidimensional viewing

and image processing is possible and energy is estimated to be conserved upto ten times with recent updated techniques.

Hence, Nanosensor is a unique tool which offers multiple platforms for analogous applications by integration and automation and is expected to accelerate scientific development in medical, space science, national security and communication.

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STUDY OF CARBON NANO STRUCTURES

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Abstract - A **nanosstructure** is an object of intermediate size between molecular and microscopic (micrometer-sized) structures. Nanotubes are the nanosstructure that have two dimensions on the nanoscale, i.e., the diameter of the tube is between 0.1 and 100 nm. **Carbon Nanotubes** (CNTs) which are allotropes of carbon with a cylindrical nanosstructure have been constructed with length-to-diameter ratio of up to 132,000,000:1. These cylindrical carbon molecules which are of two types - Single Walled CNTs and Multi-Walled CNTs, have extraordinary thermal conductivity and mechanical and electrical properties. These strongest and stiffest materials yet discovered in terms of tensile strength and elastic modulus respectively, possess such high strength resulting from the covalent sp^2 bonds formed between the individual carbon atoms. However, under excessive tensile strain, these tubes will undergo plastic deformation, which begins at strains of approximately 5% and can increase the maximum strain the tubes undergo before fracture by releasing strain energy. CNTs are not nearly as strong under compression. Because of their hollow structure and high aspect ratio, they tend to undergo buckling when placed under compressive, torsional, or bending stress. Standard single-walled carbon nanotubes can withstand a pressure up to 24 GPa without deformation. They then undergo a transformation to superhard phase nanotubes. The bulk modulus of superhard phase nanotubes is (462 to 546 GPa) higher than that of diamond.

The Carbon Nanodevices – made of Nano-Structured materials, find their application in many fields including Electronics, Aerospace, Medicine etc. This paper focuses on the applications of CNTs in Aircrafts and Aerospace. The chemical, physical, and mechanical properties of nanotubes can be harnessed in aerospace, defense and security technologies and applications thus making flying in aircrafts safer and faster. Stronger, tougher and

long lasting aerospace components are needed to make flying risk-free. Components made of Nano-structured materials that are perhaps 100 times lighter which can operate at higher temperatures making it suitable to be used in aircrafts. In spacecrafts, elevated-temperature strength of the material is crucial because the components (such as rocket engines, thrusters, and vectoring nozzles) operate at much higher temperatures than aircrafts and higher speeds. Also, embedding *Nanoscale electromechanical system* components into earth-orbiting satellites, planetary probes, and piloted vehicles potentially could reduce the cost of future space programs. Space Elevator – the idea to create a tether from earth to some object in a geosynchronous orbit. Objects can then crawl up the tether into space may be possible due to Nanotechnology. This concept is also applicable to other planets and celestial bodies.

Keywords: Nanostructure, Carbon Nanotube, allotropes, tensile strength, elastic modulus, aspect ratio, torsional, bending stress, plastic deformation, strain energy, space elevator, geosynchronous

Introduction

A **nanosstructure** is an object of intermediate size between molecular and microscopic structures. While describing nanosstructures, it is necessary to differentiate between the number of dimensions on the nanoscale.

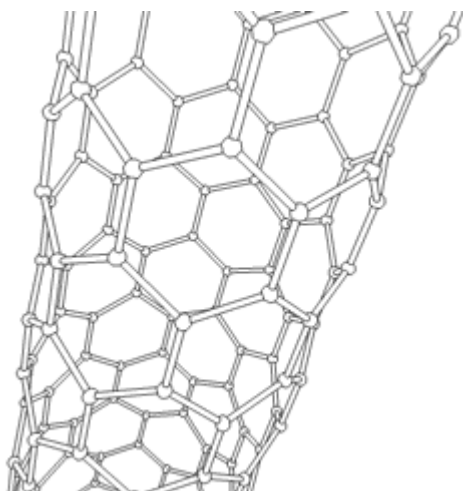
Nanotextured surfaces have **one dimension** on the nanoscale, i.e., only the thickness of the surface of an object is between 0.1 and 100 nm. Nanotubes have **two dimensions** on the nanoscale, i.e., the diameter of the tube is between 0.1 and 100 nm; its length could be much greater. Finally, spherical nanoparticles have **three dimensions** on



the nanoscale, i.e., the particle is between 0.1 and 100 nm in each spatial dimension.

Carbon Nanotubes

The Carbon nanotubes (CNTs) are allotropes of carbon with a cylindrical nanostructure which have been constructed with length-to-diameter ratio of up to 132,000,000:1. These cylindrical carbon molecules have unusual properties, which are valuable for nanotechnology, electronics, optics and other fields of materials science and technology. Nanotubes are basically members of fullerene structural family. They are long, hollow structures and their walls are made of one-atom-thick sheets of Carbon called **Graphene**.



These sheets are rolled at specific and discrete angles called chiral angles. The CNTs are of two types - Single-Walled CNTs and Multi-Walled CNTs. The SWNTs are a unique one-dimensional structure and the MWNTs consist of multiple rolled layers (concentric tubes) of graphene. Due to their extraordinary thermal conductivity and mechanical

Use of Nanotubes in Aerospace Components

Nanotechnology makes flying in aircrafts safer and faster. The chemical, physical, and mechanical properties of nanotubes can be harnessed in aerospace, defense and security technologies and applications.

The two types of (CNTs) - the *SWNT* and the *MWNT* find applications in space and aircraft manufacture.

and electrical properties, carbon nanotubes find applications as additives to various structural materials. For instance, nanotubes form only a tiny portion of the material(s) in (primarily carbon fiber) baseball bats, golf clubs, or car parts.

Properties of CNTs

Carbon nanotubes which are the strongest and stiffest materials yet discovered, in terms of tensile strength and elastic modulus respectively, possess such high strength resulting from the covalent sp^2 bonds formed between the individual carbon atoms. However, under excessive tensile strain the tubes will undergo plastic deformation, which means the deformation is permanent. This deformation begins at strains of approximately 5% and can increase the maximum strain the tubes undergo before fracture by releasing strain energy.

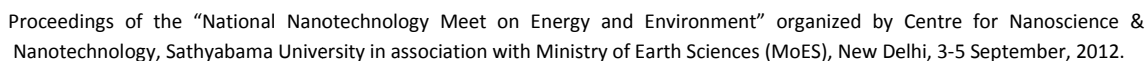
Although the strength of individual CNT shells is extremely high, weak shear interactions between adjacent shells and tubes leads to significant reductions in the effective strength of multi-walled carbon nanotubes and carbon nanotube bundles down to only a few GPa's. This limitation has been recently addressed by applying high-energy electron irradiation, which crosslinks inner shells and tubes, and effectively increases the strength of these materials to ~60 GPa for multi-walled carbon nanotubes and ~17 GPa for double-walled carbon nanotube bundles.

CNTs are not nearly as strong under compression. Because of their hollow structure and high aspect ratio, they tend to undergo buckling when placed under compressive, torsional, or bending stress.

Some of the concerns where aerospace industry needs to exploit new technologies include:

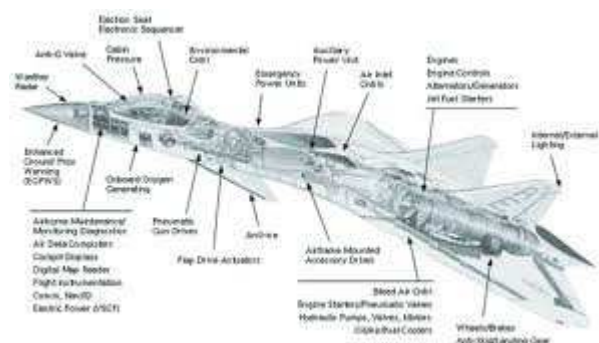
- Increased safety
- Reduced emissions
- Reduced noise
- Increased capacity
- Increased mobility

Stronger, tougher and long lasting aerospace components are needed to make flying risk-free. The major problem faced by air craft manufacturers is the fatigue strength of aircraft components which decreases with the component's age. Fatigue strength can be increased by reducing the grain size of the material which in turn makes the material



aircraft platforms performance, ballistic protection and conductive fibers.

Furthermore, components made of Nano-structured materials that are perhaps 100 times lighter than conventional materials of equivalent strength are possible, so an aircraft can fly faster and more efficiently (for the same amount of aviation fuel).

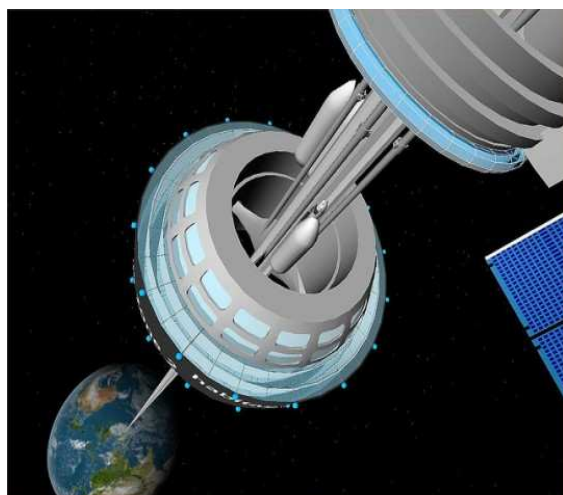


Nanomaterials have a remarkable tensile strength. It is anticipated that nanotube-based materials may become 50–100 times stronger than steel at one-sixth of the weight. Functionalised carbon nanotubes (FCNT) enable new technologies in

Space Elevator

The Discussion of a space elevator dates back to 1895 however the ideas of space elevator is rising again now. A **space elevator** is a proposed type of space transportation system.^[1] Its main component

is a ribbon-like cable called a tether anchored to the surface and extending into space. It is designed to permit vehicle transport along the cable from a planetary surface, such as the Earth's, directly into space or orbit, without the use of large rockets.



Components made of nanomaterials can operate at higher temperatures making it suitable to be used in aircrafts. In spacecrafts, elevated-temperature strength of the material is crucial because the components (such as rocket engines, thrusters, and vectoring nozzles) operate at much higher temperatures than aircrafts and higher speeds. Nanomaterials are perfect candidates for spacecraft applications, as well.

Also, embedding *Nanoscale electromechanical system* components into earth-orbiting satellites, planetary probes, and piloted vehicles potentially could reduce the cost of future space programs. The miniaturized sensing and robotic systems would enhance exploration capabilities at significantly reduced cost.

An Earth-based space elevator would consist of a cable with one end attached to the Earth surface near the equator and the other end in space beyond geosynchronous orbit (35,800 km altitude). The competing forces of gravity, which is stronger at the lower end, and the outward/upward centrifugal force, which is stronger at the upper end, would result in the cable being held up, under tension, and stationary over a single position on Earth. Once deployed, the tether would be ascended repeatedly by mechanical means to orbit, and descended to return to the surface from orbit.

After the development of carbon nanotubes in the 1990s, it was realised that the high strength of these materials might make the concept of an orbital skyhook feasible, and a workshop was held at the Marshall Space Flight Center, inviting many scientists and engineers to discuss concepts and compile plans for an elevator to turn the concept into a reality.

Carbon nanotubes are a good candidate, but lots of technical obstacles will have to be overcome in order to produce long, wide ribbons of carbon nanotubes that are strong enough and resilient enough to do the job.

Whether they're made of carbon or boron nitride or polymer, stronger materials will produce a payoff



long before the elevator gets built — in the form of lighter, more fuel-efficient automobiles, airplanes, boats and, yes, even spacecraft. Cheaper, safer, easier access to space would make a big difference in the financial calculations underpinning the space elevator dream. The world that we'll have with carbon nanotubes will demand that we build a space elevator

Conclusion

The space elevator concept has had its ups and downs — but this year, it looks as if the concept's proponents are definitely trying to push the “up” button again. There is an idea of building a space elevator to Lunar . CNTs are one of the main reasons behind the idea of Space Elevators rising up again.

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Importance of Carbon Nano Structures in Aerospace Technology

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Abstract— The discovery of the Carbon nanostructures, such as graphene and carbon nanotubes, has led to creation of many novel nano-devices. In this paper, more emphasis is given to ideologies for developing the structures of the various nanodevices, on the basis of nano-tubes properties such as hardness, strength, kinetic property, thermal property, electrical property etc. Further discussion was initiated about the various micro-pattern to be followed in-order to maintain better tensile strength and elastic modulus. This paper is based only on the theoretical assumptions, which are required to be implemented with practical experiments. Depending on the continuum – based theories, continuum – elasticity theory, atomistic theory, quantum- mechanics, density functional theory (DFT), few theoretical assumptions are discussed. It is proved that Keeping the current status of technological implements in the field of productions, the better nano structured devices could be achieved.

keywords:-micro-pattern, CNT's, Tensile strength, elastic modulus, computational modelling, DFT

I. INTRODUCTION

Unique among the elements, carbon can bond to itself to form extremely strong two-dimensional sheets. Since we live in a three-dimensional world, these sheets can be rolled and folded into a diverse range of three-dimensional structures, of which the most famous are the ball-shaped fullerenes and the cylindrical nanotubes. Other shapes are also possible, such as carbon nanocones and Swiss cheese-like nanoporous carbon. Aintroduction to the geometry and energetics of carbon nanostructures is also available.

Graphite, the stuff in a pencil, is formed from carbon atoms arranged in a honeycomb pattern.

These honeycomb layers are stacked one above the other. A single sheet of graphite is very stable, strong, and flexible. Since a single sheet is so stable by itself, it binds only weakly to the neighboring sheets. This explains why graphite is used in pencils: as you write, you rub off tiny flakes of graphite.

Although the individual flakes are very strong and flexible, the graphite used in a pencil is weak, since the flakes can easily slide relative to each other. In carbon fibers, the

individual layers of graphite are much larger and form a long, thin winding spiral pattern. These fibers can be stuck together in an epoxy, forming an extremely strong, light (and expensive) composite used in aircraft, tennis rackets, racing bicycles, racecar suspensions, etc. There is another way of arranging the sheets which is even stronger. Imagine wrapping the honeycomb pattern back ontop of itself and joining the edges. You have formed a tube of graphite, a carbon nanotube. These nanotubes are the strongest fibers known. A single perfect nanotube is about 10 to 100 times stronger than steel per unit weight.

II. MANUFACTURE

The carbon nanotubes (CNTs) are produced using four main methods: arc discharge of graphite electrodes in inert atmospheres, pyrolysis of hydrocarbons over catalysts, laser vaporization of graphite targets, and electrolysis of graphite electrodes in the molten salts. Generally speaking, the number of techniques used to produce CNTs is growing day by day, and according to the recent data, even the methane burning in our kitchen produces some quantity of nanotubes and other carbon nanocrystals! This fact raises an important question about the nano-pollution of the environment and the influence of the nanostructures over our health, and this is the question still to be solved.

A. ARC Discharge

Nanotubes were observed in 1991 in the carbon soot of graphite electrodes during an arc discharge, by using a current of 100 amps, that was intended to produce fullerenes. However the first macroscopic production of carbon nanotubes was made in 1992 by two researchers at NEC's Fundamental Research Laborator. The method used was the same as in 1991. During this process, the carbon contained in the negative electrode sublimates because of the high-discharge temperatures. Because nanotubes were initially discovered using this technique, it has been the most widely used method of nanotube synthesis.

The yield for this method is up to 30% by weight and it produces both single- and multi-walled nanotubes with lengths of up to 50 micrometers with few structural defects.



B. Laser Ablation

In the laser ablation process, a pulsed laser vaporizes a graphite target in a high-temperature reactor while an inert gas is bled into the chamber. Nanotubes develop on the cooler surfaces of the reactor as the vaporized carbon condenses. A water-cooled surface may be included in the system to collect the nanotubes.

This process was developed by Dr. Richard Smalley and co-workers at Rice University, who at the time of the discovery of carbon nanotubes, were blasting metals with a laser to produce various metal molecules. When they heard of the existence of nanotubes they replaced the metals with graphite to create multi-walled carbon nanotubes. Later that year the team used a composite of graphite and metal catalyst particles (the best yield was from a cobalt and nickel mixture) to synthesize single-walled carbon nanotubes.

The laser ablation method yields around 70% and produces primarily single-walled carbon nanotubes with a controllable diameter determined by the reaction temperature. However, it is more expensive than either arc discharge or chemical vapor deposition.

C. Chemical Vapour Deposition

The catalytic vapor phase deposition of carbon was reported in 1952 and 1959, but it was not until 1993 that carbon nanotubes were formed by this process. In 2007, researchers at the University of Cincinnati (UC) developed a process to grow aligned carbon nanotube arrays of 18 mm length on a FirstNano ET3000 carbon nanotube growth system.

During CVD, a substrate is prepared with a layer of metal catalyst particles, most commonly nickel, cobalt, iron, or a combination. The metal nanoparticles can also be produced by other ways, including reduction of oxides or oxides solid solutions. The diameters of the nanotubes that are to be grown are related to the size of the metal particles. This can be controlled by patterned (or masked) deposition of the metal, annealing, or by plasma etching of a metal layer. The substrate is heated to approximately 700°C. To initiate the growth of nanotubes, two gases are bled into the reactor: a process gas (such as ammonia, nitrogen or hydrogen) and a carbon-containing gas (such as acetylene, ethylene, ethanol or methane). Nanotubes grow at the sites of the metal catalyst; the carbon-containing gas is broken apart at the surface of the catalyst particle, and the carbon is transported to the edges of the particle, where it forms the nanotubes. This mechanism is still being studied. The catalyst particles can stay at the tips of the growing nanotube during the growth process, or remain at the nanotube base, depending on the adhesion between the catalyst particle and the substrate. Thermal catalytic decomposition of hydrocarbon has become an active area of research and can be a promising route for the bulk production of CNTs. Fluidised bed reactor is the most widely used reactor for CNT preparation. Scale-up of the reactor is the major challenge.

CVD is a common method for the commercial production of carbon nanotubes. For this purpose, the metal nanoparticles are mixed with a catalyst support such as MgO or Al₂O₃ to increase the surface area for higher yield of the catalytic reaction of the carbon feedstock with the metal particles. One issue in this synthesis route is the removal of the catalyst support via an acid treatment, which sometimes could destroy the original structure of the carbon nanotubes. However, alternative catalyst supports that are soluble in water have proven effective for nanotube growth.

III. STRUCTURE-1

The main parameters determining their type are their diameter and chirality. The chirality, or the orientation of six-folds in the nanotube, is an "internal" property, but it determines their stability (their quantity in the experiment) and electronic properties (theoretically shown by Hamada in). The plain graphene, being a semiconducting material, in the form of the nanotubes could have the dielectric, and even the metallic properties. This fact determines the usage of the metallic CNTs as field emitters, even their commercial application – in the flat panel displays (the prototype of flat panel display for TV on the carbon nanotubes was presented by Samsung in 1999), and as emitters in the electronic microscopy. It is interesting to note that recently the similar silicon nanotubes were produced, and they have the common dependence between chirality and metallization. One can speculate, that this fact could be applied also for other two-dimensional systems; but unfortunately the other materials suitable for nanotubes, like boron nitride and molybdenum disulfide, are dielectric.

A. SWNT

Most single-walled nanotubes (SWNT) have a diameter of close to 1 nanometer, with a tube length that can be many millions of times longer. The structure of a SWNT can be conceptualized by wrapping a one-atom-thick layer of graphite called graphene into a seamless cylinder. The way the graphene sheet is wrapped is represented by a pair of indices (n,m). The integers n and m denote the number of unit vectors along two directions in the honeycomb crystal lattice of graphene. If m = 0, the nanotubes are called zigzag nanotubes, and if n = m, the nanotubes are called armchair nanotubes. Otherwise, they are called chiral. The diameter of an ideal nanotube can be calculated from its (n,m) indices as follows, where $a = 0.246$ nm.

Single-walled nanotubes are dropping precipitously in price, from around \$1500 per gram as of 2000 to retail prices of around \$50 per gram of as-produced 40–60% by weight SWNTs as of March 2010, ANALYSIS.

B. MWNT

Multi-walled nanotubes (MWNT) consist of multiple rolled layers (concentric tubes) of graphene. There are two models that can be used to describe the structures of multi-walled nanotubes. In the Russian Doll model, sheets of graphene are arranged in concentric cylinders, e.g., a (0,8) single-walled nanotube (SWNT) within a larger (0,17) single-walled



nanotube. In the Parchment model, a single sheet of graphite is rolled in around itself, resembling a scroll of parchment or a rolled newspaper. The interlayer distance in multi-walled nanotubes is close to the distance between graphene layers in graphite, approximately 3.4 Å. The Russian Doll structure is observed more commonly. Its individual shells can be described as SWNTs, which can be metallic or semiconducting. Because of statistical probability and restrictions on the relative diameters of the individual tubes, one of the shells, and thus the whole MWNT, is usually a zero-gap metal.

Double-walled carbon nanotubes (DWNT) form a special class of nanotubes because their morphology and properties are similar to those of SWNT but their resistance to chemicals is significantly improved. This is especially important when functionalization is required (this means grafting of chemical functions at the surface of the nanotubes) to add new properties to the CNT. In the case of SWNT, covalent functionalization will break some C=C double bonds, leaving "holes" in the structure on the nanotube and, thus, modifying both its mechanical and electrical properties. In the case of DWNT, only the outer wall is modified. DWNT synthesis on the gram-scale was first proposed in 2003 by the CCVD technique, from the selective reduction of oxide solutions in methane and hydrogen.

The telescopic motion ability of inner shells and their unique mechanical properties permit to use multi-walled nanotubes as main movable arms in coming nanomechanical devices. Retraction force that occurs to telescopic motion caused by the Lennard-Jones interaction between shells and its value is about 1.5 nN.

C. Nanobuds

Carbon nanobuds are a newly created material combining two previously discovered allotropes of carbon: carbon nanotubes and fullerenes. In this new material, fullerene-like "buds" are covalently bonded to the outer sidewalls of the underlying carbon nanotube. This hybrid material has useful properties of both fullerenes and carbon nanotubes. In particular, they have been found to be exceptionally good field emitters. In composite materials, the attached fullerene molecules may function as molecular anchors preventing slipping of the nanotubes, thus improving the composite's mechanical properties.

D. PEAPOD

Carbon peapod is a novel hybrid carbon material which traps fullerene inside a carbon nanotube. It can possess interesting magnetic properties with heating and irradiating. It can also be applied as an oscillator during theoretical investigations and predictions.

IV. PROPERTIES

The properties of CNT are very much important as well as they are need to be modify on the basis of their strength ,

hardness , micro- pattern arrangement, and magnetic properties. As well as we must concentrate on their tensile strength, modulus of elasticity.

A. Strength

Carbon nanotubes are the strongest and stiffest materials yet discovered in terms of tensile strength and elastic modulus respectively. This strength results from the covalent sp² bonds formed between the individual carbon atoms. In 2000, a multi-walled carbon nanotube was tested to have a tensile strength of 63 gigapascals (GPa). (For illustration, this translates into the ability to endure tension of a weight equivalent to 6422 kg on a cable with cross-section of 1 mm².) Further studies, conducted in 2008, revealed that individual CNT shells have strengths of up to ~100 GPa, which is in good agreement with quantum/atomistic models. Since carbon nanotubes have a low density for a solid of 1.3 to 1.4 g/cm³, its specific strength of up to 48,000 kN•m•kg⁻¹ is the best of known materials, compared to high-carbon steel's 154 kN•m•kg⁻¹.

Under excessive tensile strain, the tubes will undergo plastic deformation, which means the deformation is permanent. This deformation begins at strains of approximately 5% and can increase the maximum strain the tubes undergo before fracture by releasing strain energy.

Although the strength of individual CNT shells is extremely high, weak shear interactions between adjacent shells and tubes leads to significant reductions in the effective strength of multi-walled carbon nanotubes and carbon nanotube bundles down to only a few GPa's. This limitation has been recently addressed by applying high-energy electron irradiation, which crosslinks inner shells and tubes, and effectively increases the strength of these materials to ~60 GPa for multi-walled carbon nanotubes and ~17 GPa for double-walled carbon nanotube bundles.

CNTs are not nearly as strong under compression. Because of their hollow structure and high aspect ratio, they tend to undergo buckling when placed under compressive, torsional, or bending stress.

B. Hardness

Standard single-walled carbon nanotubes can withstand a pressure up to 24GPa without deformation. They then undergo a transformation to superhard phase nanotubes. Maximum pressures measured using current experimental techniques are around 55GPa. However, these new superhard phase nanotubes collapse at an even higher, albeit unknown, pressure.

The bulk modulus of superhard phase nanotubes is 462 to 546 GPa, even higher than that of diamond(420 GPa for single diamond crystal).

C. Kinetic Properties

Multi-walled nanotubes are multiple concentric nanotubes precisely nested within one another. These exhibit a striking telescoping property whereby an inner nanotube core may slide, almost without friction, within its outer nanotube shell, thus creating an atomically perfect linear or rotational bearing.



This is one of the first true examples of molecular nanotechnology, the precise positioning of atoms to create useful machines. Already, this property has been utilized to create the world's smallest rotational motor. Future applications such as a gigahertz mechanical oscillator are also envisaged.

D. Thermal Properties

All nanotubes are expected to be very good thermal conductors along the tube, exhibiting a property known as "ballistic conduction", but good insulators laterally to the tube axis. Measurements show that a SWNT has a room-temperature thermal conductivity along its axis of about $3500 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$; compare this to copper, a metal well known for its good thermal conductivity, which transmits $385 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$. A SWNT has a room-temperature thermal conductivity across its axis (in the radial direction) of about $1.52 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$, which is about as thermally conductive as soil. The temperature stability of carbon nanotubes is estimated to be up to 2800°C in vacuum and about 750°C in air.

E. Molecular Mechanics

Molecular mechanics consists of simulating the behavior of an object (e.g. a nanotube) by calculating the interaction of every atom with its neighbors. For example, this powerful technique enables us to calculate how tubes of different diameter are distorted when placed on a substrate.

It costs the tubes energy to bend or deform, but in turn they can gain energy from the van der Waals interaction with other tubes or with the substrate they are deposited upon. The radial deformation of adsorbed single-wall carbon nanotubes calculated using molecular mechanics. The extent of radial deformation increases as the tube diameter is increased. The system can lower its energy by increasing the area of contact between the tube and the substrate.

V. DEFECTS

As with any material, the existence of a crystallographic defect affects the material properties. Defects can occur in the form of atomic vacancies. High levels of such defects can lower the tensile strength by up to 85%. An important example is the Stone Wales defect, which creates a pentagon and heptagon pair by rearrangement of the bonds. Because of the very small structure of CNTs, the tensile strength of the tube is dependent on its weakest segment in a similar manner to a chain, where the strength of the weakest link becomes the maximum strength of the chain.

Crystallographic defects also affect the tube's electrical properties. A common result is lowered conductivity through the defective region of the tube. A defect in armchair-type tubes (which can conduct electricity) can cause the surrounding region to become semiconducting, and single monoatomic vacancies induce magnetic properties.

Crystallographic defects strongly affect the tube's thermal properties. Such defects lead to phonon scattering, which in turn increases the relaxation rate of the phonons. This reduces

the mean free path and reduces the thermal conductivity of nanotube structures. Phonon transport simulations indicate that substitutional defects such as nitrogen or boron will primarily lead to scattering of high-frequency optical phonons. However, larger-scale defects such as Stone Wales defects cause phonon scattering over a wide range of frequencies, leading to a greater reduction in thermal conductivity.

VI. TOXICITY

The toxicity of carbon nanotubes has been an important question in nanotechnology. Such research has just begun. The data are still fragmentary and subject to criticism. Preliminary results highlight the difficulties in evaluating the toxicity of this heterogeneous material. Parameters such as structure, size distribution, surface area, surface chemistry, surface charge, and agglomeration state as well as purity of the samples, have considerable impact on the reactivity of carbon nanotubes. However, available data clearly show that, under some conditions, nanotubes can cross membrane barriers, which suggests that, if raw materials reach the organs, they can induce harmful effects such as inflammatory and fibrotic reactions.

A study led by Alexandra Porter from the University of Cambridge shows that CNTs can enter human cells and accumulate in the cytoplasm, causing cell death.

Results of rodent studies collectively show that regardless of the process by which CNTs were synthesized and the types and amounts of metals they contained, CNTs were capable of producing inflammation, epithelioid granulomas (microscopic nodules), fibrosis, and biochemical/toxicological changes in the lungs. Comparative toxicity studies in which mice were given equal weights of test materials showed that SWCNTs were more toxic than quartz, which is considered a serious occupational health hazard when chronically inhaled. As a control, ultrafine carbon black was shown to produce minimal lung responses.[62]

The needle-like fiber shape of CNTs is similar to asbestos fibers. This raises the idea that widespread use of carbon nanotubes may lead to pleural mesothelioma, a cancer of the lining of the lungs or peritoneal mesothelioma, a cancer of the lining of the abdomen (both caused by exposure to asbestos). A recently published pilot study supports this prediction. Scientists exposed the mesothelial lining of the body cavity of mice to long multiwalled carbon nanotubes and observed asbestos-like, length-dependent, pathogenic behavior that included inflammation and formation of lesions known as granulomas. Authors of the study conclude:

This is of considerable importance, because research and business communities continue to invest heavily in carbon nanotubes for a wide range of products under the assumption that they are no more hazardous than graphite. Our results suggest the need for further research and great caution before introducing such products into the market if long-term harm is to be avoided.

According to co-author Dr. Andrew Maynard:



This study is exactly the kind of strategic, highly focused research needed to ensure the safe and responsible development of nanotechnology. It looks at a specific nanoscale material expected to have widespread commercial applications and asks specific questions about a specific health hazard. Even though scientists have been raising concerns about the safety of long, thin carbon nanotubes for over a decade, none of the research needs in the current U.S. federal nanotechnology environment, health and safety risk research strategy address this question.

Although further research is required, the available data suggests that under certain conditions, especially those involving chronic exposure, carbon nanotubes can pose a serious risk to human health.

VII. POTENTIAL APPLICATIONS

The strength and flexibility of carbon nanotubes makes them of potential use in controlling other nanoscale structures, which suggests they will have an important role in nanotechnology engineering. The highest tensile strength of an individual multi-walled carbon nanotube has been tested to be 63 GPa. Carbon nanotubes were found in Damascus steel from the 17th century, possibly helping to account for the legendary strength of the swords made of it.

A. Structural

Because of the carbon nanotube's superior mechanical properties, many structures have been proposed ranging from everyday items like clothes and sports gear to combat jackets and space elevators. However, the space elevator will require further efforts in refining carbon nanotube technology, as the practical tensile strength of carbon nanotubes can still be greatly improved.

For perspective, outstanding breakthroughs have already been made. Pioneering work led by Ray H. Baughman at the NanoTech Institute has shown that single and multi-walled nanotubes can produce materials with toughness unmatched in the man-made and natural worlds.

Carbon nanotubes are also a promising material as building blocks in bio-mimetic hierarchical composite materials given their exceptional mechanical properties (~1TPa in modulus, and ~100 GPa in strength). Initial attempts to incorporate CNTs into hierarchical structures led to mechanical properties that were significantly lower than these achievable limits. Windle et al. have used an in situ chemical vapor deposition (CVD) spinning method to produce continuous CNT yarns from CVD grown CNT aerogels. With this technology, they fabricated CNT yarns with strengths as high as ~9 GPa at small gage lengths of ~1 mm, however, defects resulted in a reduction of specific strength to ~1 GPa at 20 mm gage length.[121][122] Espinosa et al. developed high performance DWNT-polymer composite yarns by twisting and stretching ribbons of randomly oriented bundles of DWNTs thinly coated with polymeric organic compounds. These DWNT-polymer yarns exhibited unusually high energy to failure of ~100 J·g⁻¹ (comparable to one of the toughest natural materials – spider

silk), and strength as high as ~1.4 GPa. Effort is ongoing to produce CNT composites that incorporate tougher matrix materials, such as Kevlar, to further improve on the mechanical properties toward those of individual CNTs.

Because of the high mechanical strength of carbon nanotubes, research is being made into weaving them into clothes to create stab-proof and bulletproof clothing. The nanotubes would effectively stop the bullet from penetrating the body, although the bullet's kinetic energy would likely cause broken bones and internal bleeding.

B. Electrical Circuits

Nanotube-based transistors, also known as carbon nanotube field-effect transistors (CNTFETs), have been made that operate at room temperature and that are capable of digital switching using a single electron. However, one major obstacle to realization of nanotubes has been the lack of technology for mass production. In 2001 IBM researchers demonstrated how metallic nanotubes can be destroyed, leaving semiconducting ones behind for use as transistors. Their process is called "constructive destruction," which includes the automatic destruction of defective nanotubes on the wafer. This process, however, only gives control over the electrical properties on a statistical scale.

The potential of carbon nanotubes was demonstrated in 2003 when room-temperature ballistic transistors with ohmic metal contacts and high-k gate dielectric were reported, showing 20–30x higher ON current than state-of-the-art Si MOSFETs. This presented an important advance in the field as CNT was shown to potentially outperform Si. At the time, a major challenge was ohmic metal contact formation. In this regard, palladium, which is a high-work function metal was shown to exhibit Schottky barrier-free contacts to semiconducting nanotubes with diameters >1.7 nm.

The first nanotube integrated memory circuit was made in 2004. One of the main challenges has been regulating the conductivity of nanotubes. Depending on subtle surface features a nanotube may act as a plain conductor or as a semiconductor. A fully automated method has however been developed to remove non-semiconductor tubes.

Another way to make carbon nanotube transistors has been to use random networks of them. By doing so one averages all of their electrical differences and one can produce devices in large scale at the wafer level. This approach was first patented by Nanomix Inc. (date of original application June 2002). It was first published in the academic literature by the United States Naval Research Laboratory in 2003 through independent research work. This approach also enabled Nanomix to make the first transistor on a flexible and transparent substrate.

Large structures of carbon nanotubes can be used for thermal management of electronic circuits. An approximately 1 mm-thick carbon nanotube layer was used as a special material to fabricate coolers, this materials has very low density, ~20 times lower weight than a similar copper structure, while the cooling properties are similar for the two materials.



Overall, incorporating carbon nanotubes as transistors into logic-gate circuits with densities comparable to modern CMOS technology has not yet been demonstrated.

C. Solar Cells Additional research has been conducted on creating SWNT hybrid solar panels to increase the efficiency further. These hybrids are created by combining SWNT's with photexcitable electron donors to increase the number of electrons generated. It has been found that the interaction between the photoexcited porphyrin and SWNT generates electro-hole pairs at the SWNT surfaces. This phenomenon has been observed experimentally, and contributes practically to an increase in efficiency up to 8.5%.

VIII. CONCLUSION

The above paper is totally deals with the structural , mechanical and arrangements of the carbon tubes in the in various patterns. Theoretical assumptions are explained here, which as to experience practically, and the MICRO PATTERN ARRANGEMENT can leads to many changes of the carbon-tubes in its properties which has proved by theoretically.

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Carbon Nanotubes Sensors for Gas Detection

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Abstract:- Nanotechnology based chemical sensors can provide high sensitivity, low power and low cost portable tools for in-situ chemical analysis in space and terrestrial applications. Nano chemical sensors will greatly increase science measurement capability for earth science, space science, life support systems in long duration missions, and planetary exploration. For example, the carbon nanotubes sensor demonstrates higher sensitivity and lower power consumption than the state-of-the-art systems. Combined with MEMS technology, light weight and compact size sensors can be made in wafer scale with low cost. This nanosensor technology can extend its application in civilian areas such as explosives detection, monitoring filter bed breakthroughs, personnel badge detectors, embedded suit hermeticity sensors, and other applications. Additionally, a wireless capability with the sensor chip can be used for networked mobile and fixed-site detection and warning systems for military bases, facilities and battlefield areas.

Keywords: - nanosensor, SWNTs, silicon-based microfabrication, MEMS, nanostructures, nanowires, interdigitated electrodes (IDE)

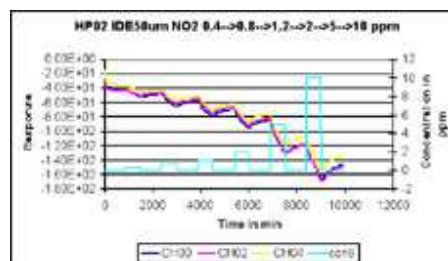
I. INTRODUCTION

Carbon nanotubes (CNTs) are allotropes of carbon with a cylindrical nanostructure. Nanotubes have been constructed with length-to-diameter ratio of up to 132,000,000:1, significantly larger than for any other material. These cylindrical carbon molecules have unusual properties, which are valuable for nanotechnology, electronics, optics and other fields of materials science and technology. In particular, owing to their extraordinary thermal conductivity and mechanical and electrical properties, carbon nanotubes find applications as additives to various structural materials. For instance, nanotubes form only a tiny portion of the material(s) in (primarily carbon fiber) baseball bats, golf clubs, or car parts.

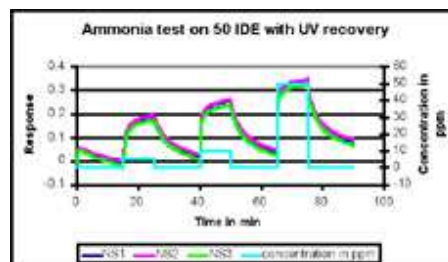
II. The SWNT nanosensor technology

A nanosensor technology has been developed in NASA Ames using nanostructures, such as single walled carbon nanotubes (SWNTs) and metal oxides nanobelts or nanowires, on a pair of interdigitated electrodes (IDE) processed with a silicon-based microfabrication and micromachining technique. The IDE fingers were fabricated using photolithography and thin film metallization techniques. Both in-situ growth of nanostructure materials and

casting of the nanostructure dispersions were used to make chemical sensing devices. These sensors have been exposed to nitrogen dioxide, acetone, benzene, nitrotoluene, chlorine, and ammonia in the concentration range of ppm to ppb at room temperature.



SWNT sensor response to NO₂ at 0.4, 0.8, 1.2, 2, 5, and 10 ppm.



SWNT sensor response to NH₃ at 5, 10, and 50 ppm.

• Mechanism

Carbon nanotubes in the sensor platform can be understood by electron modulation of the nanostructure devices and analytes in terms of charge transfer mechanisms. As a result of the charge transfer, the conductance of nanostructures will change. The metal oxide nanobelts sensors operate at much lower temperature around 150 degrees Celsius compared with 500 degree Celsius for conventional metal oxides sensors with same sensing behavior. Due to the large surface area, low surface energy barrier and high thermal and mechanical stability, nanostructured chemical sensors potentially can offer higher sensitivity, lower power consumption and better robustness than the state-of-the-art systems, which make them more attractive for defense and space applications, and for other commercial applications. Combined with MEMS technology, light weight and compact size sensors can be made in wafer scale with high yield and low cost. Additionally, a wireless capability of such a sensor chip can be used for networked mobile and fixed-site detection and warning systems for military bases, facilities and battlefield areas.



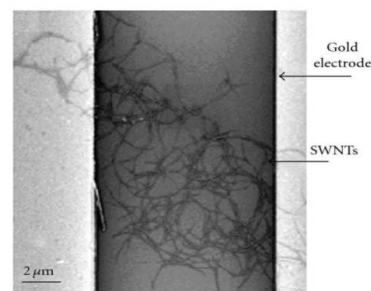
Nanostructured materials such as carbon nanotubes and metal oxide nanowires promise superior performance over conventional approaches due to the ability to direct the selective uptake of gaseous species based on their controlled pore size and chemical properties, increased adsorptive capacity due to their increased surface area, and the effectiveness of carbon nanotubes as matrix materials for gas and vapor detection. In addition, CNTs can be functionalized, doped with catalysts and mixed with polymers accordingly to achieve the selectivity.

The research effort on this technology has been funded by NASA and with interagency agreement in past several years.

The development of recommended nanosensor and nano devices has gained NASA's attention for funding in future years to raise the technical readiness level (TRL) for space mission. Currently, NASA is putting \$500-\$600K in this project to develop a sensor module that has a sensor chip contains 32 sensing channels using different nanostructured materials, a complete electronic system for sensing signal acquisition, and a pneumatic pathway for gas sample delivery. This sensor module will be plugged in a satellite secondary payload in an orbit around 500km for a flight demonstration of trace chemical detection using nanosensors. A prototype can be easily derived from this flight module.

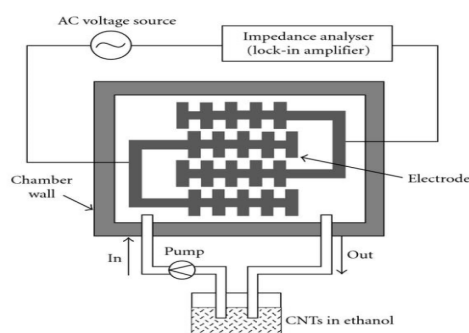
III. Fabrication of CNTs Gas Sensors

There are several methods to integrate CNTs to different gas sensor structures. Li et al. developed a resistive gas sensor by simply casting SWCNTs on interdigitated electrodes (IDEs). The electrodes were fabricated by photolithography and evaporation of Ti and Au (60nm in thickness together) on silicon oxide. As-grown SWCNTs were purified with acid first and then by air oxidation before being integrated with the IDEs. As a result, the final SWCNTs had a relatively high purity up to 99.6%, and the impact of impurities on the sensor's characteristic was minimized. The purified nanotubes were then dispersed in dimethylformamide (DMF) and drop-deposited onto the electrode area. A network of nanotubes subsequently formed after the evaporation of DMF, as shown in Figure. Another simply method is screen-printing of CNTs onto patterned electrodes. Lee et al. [15] screen-printed CNTs paste mixed with MWNTs, terpineol, ethylcellulose, and glass frits onto electrode-coated glass as the gas sensing element for NO₂ detection. The organic binder can be removed by annealing in N₂ ambient.



SEM image of SWCNTs across two gold electrodes

Fabrication of CNTs sensors can also be achieved by dielectrophoresis (DEP) method. DEP is the electro kinetic motion of dielectrically polarized materials in nonuniform electric fields and has been used to manipulate CNTs for separation, orientation, and positioning of CNTs. Suehiro et al. demonstrated that the DEP fabrication could establish a good electrical connection between CNTs and the electrodes. During fabrication, the CNTs with high purity were suspended in ethanol and ultrasonicated for 60 minutes. The system to fabricate the CNTs-based gas sensor is schematically depicted in Figure. An interdigitated microelectrode was patterned on a glass substrate. The electrode had a castle-wall pattern in order to form high and low electric field regions periodically. The castle-wall electrode was surrounded by a silicon rubber spacer to form a sealed chamber in which CNTs suspension was continuously fed from a reservoir by a peristaltic pump. The DEP trapping of MWCNTs on the microelectrode was performed with an ac voltage. After a desired period of time, the DEP process was stopped and the ethanol was evaporated at room temperature. The DEP-fabricated CNTs gas sensors successfully detected various vapours such as NH₃, NO₂, SO₂, and HF. With this technique, the amount of trapped CNTs can be controlled by monitoring electrical impedance of the sensor and various metal materials can be employed as the electrodes.

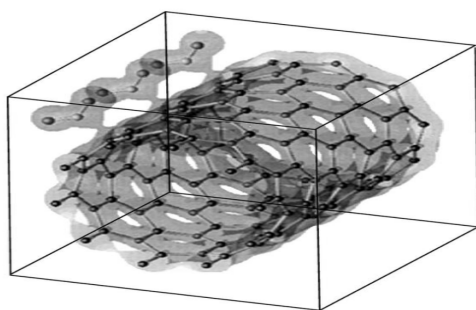


Schematic diagram of the experimental setup for MWCNT gas sensor fabrication on a microelectrode using DEP

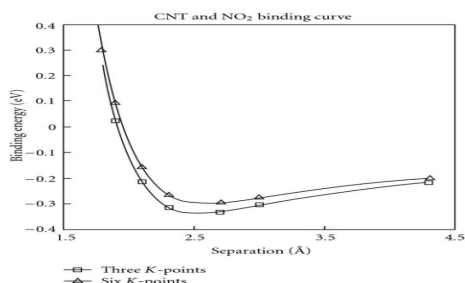


IV. Gas Adsorption on CNTs

The adsorption of various gas molecules on SWNTs is usually studied by first-principles calculations using density functional theory (DFT). The binding energy, tube-molecule distance, and charge transfers are generally investigated. Peng and Cho [31] studied the adsorption of NO₂ on to SWNTs by this method. Figure 5 shows one binding configuration for NO₂ gas molecule on the SWNT with three units. NO₂ gas molecule of this configuration is found to bind with SWNT with adsorption energy of 0.3 eV, and it is also found that the molecule has high diffusion kinetics on nanotubes surfaces. Electron density analysis shows that charge transfer is induced from C atom to the NO₂ gas molecule leading to hole (or p-type) doping of semiconducting nanotubes.



(a)



(b)

Total valence electron charge density plot. The value of charge contour is 0.0015 (e/Å³) showing the binding charge between the SWNT and the NO₂ molecule. Three units are shown in this figure. (b) Binding energy curve for NO₂ interacting SWNT as a function of distance from NO₂ to the nanotube. The solid line curve is a fitting with universal binding curve.

- Ammonia Absorption

The results obtained indicate that the carbon nanotubes samples were sensitive to ammonia. Upon exposure to ammonia, the resistance of carbon nanotubes increased significantly. The absorbed ammonia gas had interacts with carbon nanotube

molecules and does not desorbed immediately. carbon nanotubes have a high affinity for ammonia due to ammonia being a polar molecule with a dipole moment of 1.5 debye. When the samples are exposed to NH₃ gas, electrons are transferred from NH₃ to carbon nanotubes. NH₃ molecules donate electrons to the valence band of the carbon nanotubes, decreasing the number of holes, thereby increasing the separation between the conduction band and the valence band. This forms a space charge region at the surface of the semiconducting carbon nanotubes, increasing the electrical resistance. The increase in resistance proves that the carbon nanotubes are a p-type semiconductor. The sensor is sensitive to NH₃ gas and the conductance of MWNTs decreases when exposed to NH₃ gas at room temperature of 25°C. This suggests that the MWNTs could be a good candidate material for NH₃ detection at room temperature. Researchers noted that NH₃ absorbed into carbon nanotubes by replacing pre-adsorbed oxygen within the carbon atoms. Oxygen, an oxidizing gas, increases the conductivity of p-type carbon nanotubes as it increases the holes concentration; hence the replacement of oxygen by ammonia should reduce the conductivity.

- Carbon Dioxide Absorption

The results of carbon dioxide absorption into carbon nanotubes samples indicate that injection of carbon dioxide gas had similar effect as in ammonia absorption. Carbon dioxide is a reducing gas and its absorption results in injection of electrons to the carbon nanotubes and reduced number of holes in the material. Holes are the main charge carrier for p-type semiconductor, holes depletion will result in increase resistivity or decrease conductivity of the sample.

Hydrogen Absorption

Hydrogen is the lightest and most abundant element in universe. At standard pressure and temperature, it occurs as diatomic gas. Hydrogen absorption into carbon nanotubes samples at room temperature has no significant change in the resistance of carbon nanotubes. This is in a mutual agreement with results reported by other researchers. The carbon nanotubes need to be doped with other atoms or operated at higher temperature for them to be a good gas sensor for hydrogen. Gas sensor utilizing carbon nanotubes in a thin layer Pd/CNTs/n+-Si structure has a high sensitivity to hydrogen over a wide temperature range. Raw and palladium doped carbon nanotubes sensors do not detect hydrogen at room temperature. The sensing activity of raw carbon nanotubes started at temperatures higher than 200°C.

V. Effects of Molecule Adsorption on Electronic Properties of CNTs

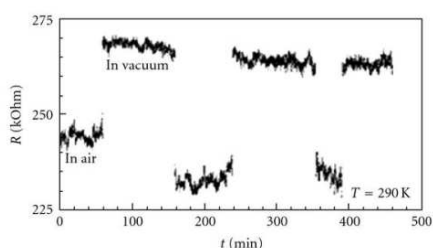
Generally, the electronic property of an SWNT is determined by the tube chirality and diameter. However, it has been demonstrated experimentally that the electronic properties of SWNTs are very sensitive to their chemical environment, especially on oxygen



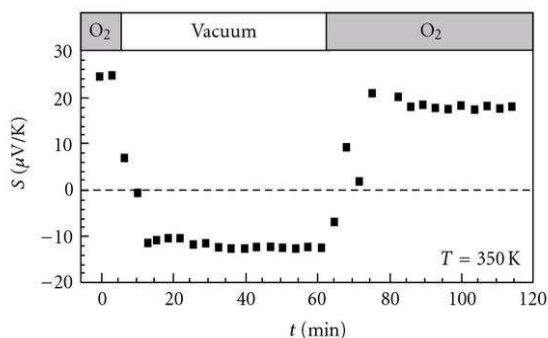
exposure. Collins et al. measured the electrical resistance, thermoelectric power (TEP), and local density of states of SWNTs by transport measurement and scanning tunneling spectroscopy. The results showed that these parameters can be reversibly “tuned” by exposure to very small concentrations of oxygen, as shown in Figure. Isolated semiconducting nanotubes can be converted into apparent metals through room-temperature exposure to oxygen. Sumanasekera et al. also demonstrated experimentally that, by degassing the SWNTs mat in vacuum from air at 500 K, the TEP

(a)

CNTs application as sensitive gas sensors. However, they also indicate that many reported electronic properties measured on as-



prepared nanotubes should be assigned to oxygen-doped CNTs instead of intrinsic CNTs.



VI. Applications of CNT sensors

• Leading Aerospace Applications

There are two leading aerospace applications. One is to greatly increase the science measurement capability with compact size, less mass and power requirements for electronics shape, size) of products, olfactory inspection assesses (a) the chemical integrity (consistency, presence of contaminants). The technology can significantly reduce the amount of time and money spent analyzing those materials in a lab, as well as reducing the amount of materials handling.

• Environment:

Increasing awareness and new regulations for safety and emission control make environmental monitoring one of the most desired amongst the numerous industrial and civil applications for which the development of reliable solid-state gas sensors is demanded. Current methods for air quality

value decreased slowly from an initial value of $+54\mu\text{V/K}$, changed sign, and then eventually approached a constant value of $-44\mu\text{V/K}$, as shown in Figure. Nuclear magnetic resonance (NMR) study of SWNTs also proved that the spin-lattice relaxation rates of all nanotubes increased dramatically upon exposure to oxygen. Jhi et al. studied the electronic and magnetic properties of oxidized CNTs theoretically using the ab initio pseudo potential total energy method [40]. The calculations showed consistent results with the experimental ones. These results demonstrated the potential for

and sensors; to provide a portable device for composition measurements of Earth's atmosphere; to make highly miniaturized gas detectors enabling Earth Science Enterprise Plans for in situ measurements to validate satellite observations. Another application is to deploy the nanosensors which ensure the proper operation in the microgravity or reduced gravity environment, especially those which must operate in multiphase media, or are strongly impacted by the lack of natural buoyancy, such as combustion and precombustion monitors. The unique microgravity considerations make this deliverable particularly NASA-specific. Microgravity transport modeling capability will be employed to enable interpretation of sensor data, such as localization of hazards. Sample acquisition for accurate monitoring must account for the complexities of multiphase (gas, liquid, solid) behavior in micro or reduced gravity, and must also require little or no crew time and expendables. Sample handling may be necessary to achieve the necessary sensitivity and selectivity. The recommended nanosensors can be used for External Environment Monitoring to monitor hazardous conditions in the extra-vehicular environment. Hazards in these regions include but are not limited to reactive chemicals, erosive dust, and radiation.

• Potential Non-Aerospace Applications

The proposed technology has a specific application in space mission. Meanwhile it has a wide spectrum of application in terrestrial area, such as defense, industry, environmental, and medical and biological applications.

• Industry:

Nanostructure based chemical sensors possess high sensitivity, small size and low power consumption, which can be used to quickly verify incoming raw materials at the delivery point; to monitor the changing composition of the vapor phase surrounding or contained within the process. Much like vision inspection is used to assess the visual integrity (color,

control approved by the standards consist of analytical techniques, which need the use of very costly and bulky equipment. For applications in this arena, sensors that are able to selectively detect various gases at a concentration level of a few ppb and in the form of low-cost portable handheld devices for continuous in-situ monitoring are needed. With unique advantages of high sensitivity, small size and low power consumption, and strong mechanical and thermal stability, carbon nanotubes based chemical sensors are best fit for this type of application.



State-of-the-art Flue Gas Analyzer - testo 350.

With the testo 350, up to 6 gases can be analyzed at the same time – the user can choose between the following sensors: O₂, CO, CO₂, NO, NO₂, SO₂, HC, H₂S. The sensors are easily replaceable by the user in the field, within minutes, with not even using any tools.

- Defense:

Chemical sensors are very focused for security and defense applications due to their portability and low power consumption. Carbon nanotubes sensors potentially can offer higher sensitivity and lower power consumption than the state-of-the-art systems, which make them more attractive for defense applications. Some examples include monitoring filter breakthrough, personnel badge detectors, embedded suit hermiticity sensors and other applications. Additionally, a wireless capability with the sensor chip can be used for networked mobile and fixed-site detection and warning systems for military bases, facilities and battlefield areas.

- Medical/Bio:

It is believed that chemical sensors would provide physicians with a quicker and more accurate diagnostic tool. Applications could include obtaining objective information on the identity of certain chemical compounds in exhaled air and excreted urine or body fluids related to specific metabolic conditions, certain skin diseases or bacterial infections, such as those common to leg or burn wounds. Additionally, the chemical sensors may provide more accurate, real-time patient monitoring during anesthesia administration. It is note worthy that the sensing platform developed in this project can also be used in liquid phase for heavy metals and pH detection, as well as for bio species detection, such as pathogen, bacteria, and enzymes.

VII. CONCLUSIONS

With less than twenty years history, the progress and application in CNTs-related technology has been developed impressively fast due to their unique inherent morphologies and properties. CNTs-based sensors have demonstrated huge potential and found their application in various areas. Gas sensors based on both SWNTs and MWNTs have been developed. The nanotubes can be integrated with different sensor architectures by direct-growing, drop-deposition, printing, or DEP method. It has been proved both theoretically and experimentally that, the electrical resistance, thermoelectric power, and local density of states of SWNTs can be reversibly

changed by exposure to certain vapours. This can be attributed to the charge transfer between the molecules and the nanotubes, or the change of the charge carries lifetime in CNTs. Therefore, gas sensing FET or resistors that measure the resistance change of CNTs as the transducer is the most commonly used sensor structures. However, this limits the range of the gases that CNTs sensors can detect, especially for the sensing of inert agents. Compared with the resistance sensors, CNTs enhanced ionization chambers allow the detection of gas molecules with low adsorption energy, hence a wide range of vapours. With CNTs integrated, the breakdown voltage can be lowered significantly. Other promising methods to improve the sensing characteristics include the functionalization of CNTs and nanocomposites of CNTs with various polymers, which can broaden the sensing range or enhance the sensitivity. CNTs can also be integrated into resonators sensors. By measuring the change of the resonate frequency, wireless gas sensing can be achieved. Although CNTs have demonstrated their great potential for gas sensing experimentally, there are still several challenges remained before the real-world application. Synthesise of pure and ideal CNTs is still challenging and costly. It is very difficult to grow defect-free nanotubes continuously to macroscopic length. The precise control over the growth or dispersion of CNTs on surfaces is another problem. Depending on the preparation technique and process, the property and behaviour of the sensors can vary significantly, which is very crucial to the stability of the CNTs-based devices. Therefore, the ability to synthesize of identical and reproducible CNTs with consistent properties is very important for the application of CNTs in all areas. Degradation of the devices has to be investigated more deeply before real-world application. Slow response and recovery is another challenge to be addressed for CNTs-based gas sensors, which is caused by the nature of gas adsorption and desorption process to the nanotubes. However, it was demonstrated that by integrating a microheater under the MWCNTs sensing layer or shortly exposure to UV light, the response time of the sensor can be improved [93, 94]. It is believed that, with the increase interests and development of related technologies, CNTs gas sensors have a promising future and will bring a huge change to the current industries and our everyday life.

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Nanoparticles and their Applications

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ABSTRACT—This brief paper presentation on the topic ‘NANOPARTICLES AND THEIR APPLICATIONS’ will give us a bird’s eye view of understanding nanoparticles, how nanoparticles are different, the manufacturing of nanoparticles and most importantly their applications. Nanoparticles has been widely applied in the field of textiles ,bio-medical, health care, food agriculture, industrial, electronics, environment and renewable energy. This `would create a great revolution in the field of technology.

Key Words— nanoparticles, bio-medicine, agriculture, environment, renewable energy.

I. INTRODUCTION

Nanoparticles and their applications, are essentially very small pieces of material that measure no more than an atom or two across. They are small enough that they can interact easily on the same level with microscopic pathogens such as bacteria or viruses. Since they can literally be particles from any substance, they are also versatile enough that they can be used in many types of technological applications, from delicate electronics to revolutionary medical procedures. Most of all, you should be interested in the nanoparticle for one very important reason—it’s going to change your life.

II. NANOPARTICLES

Nanoparticles are particles that have one dimension that is 100 nanometers or less in size. The properties of many conventional materials change when formed from nanoparticles^[1]. This is typically because nanoparticles have a greater surface area per weight than larger particles; this causes them to be more reactive to certain other molecules.

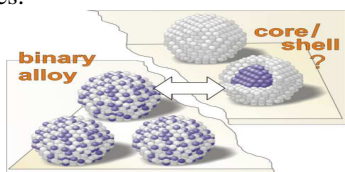


Figure 1.Nanoparticles

A. What is different about a nanoparticle

There is no strict dividing line between nanoparticles and non-nanoparticles. The size at which materials display different properties to the bulk material is material dependant and can certainly be claimed for many materials much larger in size than 100nm. Definitions certainly become more difficult for materials that are a very long way from being a sphere, such as carbon nanotubes for example. One of the aims for these materials is to grow them into long tubes, certainly not ‘nano’ in length, but as they have a diameter in the order of 3nm for a single walled tube, they have properties that distinguish them from other allotropes of carbon, and hence can be described as nanomaterials^[2]. This sort of nanomaterial has led to the extension of the idea of nanomaterials being considered as such if any one of their structural features are on a scale of less than 100nm, that cause their properties to be different from that of the bulk material.

B. Manufacturing methods for nanoparticles

Many of these nanomaterials are made directly as dry powders, and it is a common myth that these powders will stay in the same state when stored. In fact, they will rapidly aggregate through a solid bridging mechanism in as little as a few seconds. Whether these aggregates are detrimental will depend entirely on the application of the nanomaterial. If the nanoparticles need to be kept separate, then they must be prepared and stored in a liquid medium designed to facilitate sufficient interparticle repulsion forces to prevent aggregation.

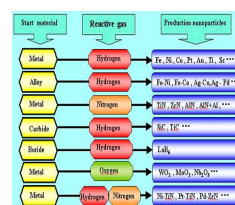


Figure 2.Nanoparticles Production

1. How do nanoparticles form in the liquid phase

Defined bottom-up production of nanoparticles in the liquid phase with respect to particle size, chemical composition, surface and charge properties occurs mainly through controlled chemical reactions (Frens 1973), and self limiting self assembly processes have evolved by controlling growth conditions. In view of the ecological cycling of nanomaterials, some emphasis has to be given to the corrosion and disintegration of bulk materials, where little knowledge is currently available (Oberdorster G et al 2005]. Naturally occurring processes generating nanosized structures in the liquid phase include erosion and chemical disintegration of organic (plant or microorganism debris) or geological (e.g. clays) parent materials. In all these types of disintegration process, the surface properties and their change through chemical reaction are critical in determining whether individual nanoparticles will be formed in the respective medium (Boyle et al 2005).

2. How do nanoparticles form in the gas phase

The main route of bottom-up formation of nanoparticles in the gas-phase is by a chemical reaction leading to a non-volatile product, which undergoes homogeneous nucleation followed by condensation and growth. Recently, this has become an important pathway for the industrial production of nanoparticle powders, which may be of metals, oxides, semiconductors, polymers and various forms of carbon, and which may be in the form of spheres, wires, needles, tubes, platelets or other shapes_[3]. This is also the unintentional pathway by which nanoparticles are formed following the oxidation of gas-phase precursors in the atmosphere, in volcanic plumes, in natural and man-made combustion processes, or in fumes associated with any man-made process involving volatilisable material at elevated temperature, such as welding or smelting, polymer fabrication, or even cooking. As with the liquid phase case, disintegration processes of parent materials provide a pathway which only leads to nanoparticles suspended in the gas phase under special conditions. While in the liquid phase the presence of emulsifying agents accompanying an erosion or chemical disintegration process could support the suspension process, the dispersion of nanoparticles into a gas from liquid emulsions or dry powders is severely limited by the strong adhesive forces between individual nanoparticles. Therefore, any

mechanically induced stress on the parent material mostly leads to particles in the micrometer range and above. Only under accidental conditions, e.g. in the case of uncontrolled release of a powder or an emulsion from a highly pressurized vessel could strong shear forces overcome these adhesive forces (Reeks and Hall 2001). In contrast, the spraying of liquids containing nanoparticles or soluble material at very low concentrations, followed by drying of the solvent, can lead to the resuspension of nanoparticles or to the formation of new nanoparticles from the solutes. This can lead to redistribution of nanoparticles, biological material or toxic substances into nanoparticulate airborne form.

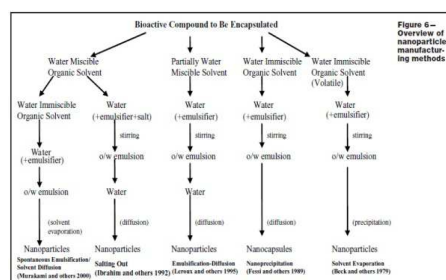


Figure 3. Overview of nanoparticle manufacturing methods

3. What are the sources of airborne nanoparticles

The amount of nanoparticles in the air can be surprisingly similar in urban and rural areas, with as much as 106 to 108 nanoparticles per litre of air depending on conditions. In rural areas, nanoparticles mostly originate from the oxidation of volatile compounds of biogenic or anthropogenic origin, including secondary organic aerosols_[4]. In urban areas, the primary sources of these particles are diesel engines (Schneider et al 2005) or cars with defective or cold catalytic converters (Zhiqiang et al 2000). Photo-oxidation processes also lead to significant numbers of nanoparticles in urban areas. Real-time measurements show that exhaust aerosol concentrations range between 104 to 106 particles.cm⁻³, with the majority of the particles by number being less than 50 nm in diameter. The highest particle number concentrations and smallest particle size are associated with high-speed road traffic, presumably due to the subtle conditions during concomitant cooling and dilution of the exhaust gases_[5]. Emission factors for gasoline vehicles ranged from 1.9 to 9.9x10¹⁴ particles.km⁻¹ and 2.2x10¹⁵ to 1.1x10¹⁶ particles.kg⁻¹ fuel (Kittelson et al 2003 a,b). The awareness that combustion processes significantly contribute to the nanoparticle load by number has been rising recently and



has provided a new motivation for airborne particle research (Donaldson et al 2001a).

III. APPLICATIONS OF NANO PARTICLES

A. Optical

Nanoparticles could be engineered and used for anti-reflection product coatings, producing a refractive index for various surfaces, and also providing light based sensors for use in diagnosing cancer^[7].

B. Magnetic

Nanoparticles have the potential to increase the density of various storage media, and also when magnetized they can improve the detail and contrast of MRI images as previously alluded to.

C. Thermal

Specifically engineered particles could improve the transfer of heat from collectors of solar energy to their storage tanks^[8]. They could also enhance the coolant system currently used by transformers in these types of processes.

D. Mechanical:

Nanoparticles could provide improved wear and tear resistance for almost any mechanical device^[6]. They could also give these devices previously unseen anti-corrosion abilities, as well as creating entirely new composites and structural materials that are both lighter and stronger than those we use today.

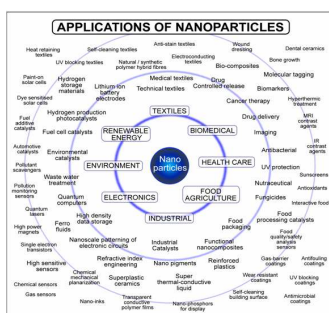


Figure 4. Production techniques of nanoparticles

E. Electronic

Because of their tiny size, nanoparticles are inherently poised to aid in the production of high performance delicate electronics; they may provide not only materials with a high rate of conductivity, but also sleeker parts for small consumer electronics like cell phones^[9]. And when it

comes to advertising, nanoparticle electronics can create digital displays that are more electricity-efficient, less expensive to produce, brighter in colour, and also bigger.

F. Energy

Nanoparticle batteries would be longer-lasting and have a higher energy density than those we use today^[10]. Metal nanoparticle clusters could also have revolutionary applications for hydrogen storage; they could also produce extremely efficient fuel cells by acting as electro catalyst for these devices^[11]. Nanoparticles may also pave the way for practical and renewable energy; they have already demonstrated an ability to improve solar panel efficiency many times over^[8]. Not only that, but when nanoparticles are used as catalysts in combustion engines, they have shown properties that render the engine more efficient and therefore more economic.

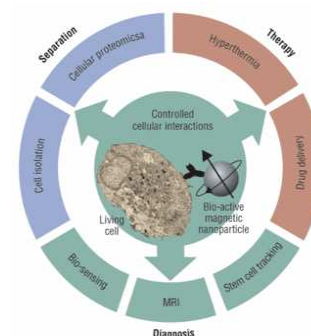


Figure 5. Biomedical application

G. Biomedical:

You may soon find that your wounds are dressed with antibacterial coatings of silver nanoparticles^[12]. Nanoparticles have also been used to produce "quantum dots," which can detect diseases, as well as interactive foods and drinks that change flavour and colour based on your tastes, or in some cases may even alter their nutrient content based on your state of health.

IV. CONCLUSION

The above given outline emphatically gives us a brief idea of what is nanoparticles and their applications in various fields. Their usages will



bring a radical transformation in the fields of nanotechnology .

V. REFFERENCES

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Carbon Nanotubes Enhancing Aerospace Composite Materials

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graphites epoxy composites in portions of the airframes. Carbon fiber composites tends to be less dense as compare to

Abstract— It is known that the documented increase in the use of high performance composites as structural materials in aerospace components is continuously raising the demands in terms of dynamic performance, structural integrity, reliable life monitoring systems and adaptive actuating abilities practices in material property tailoring and custom design aim to the enhancement of dynamic and damage tolerance characteristics, whereas life monitoring and actuation are performed with embedded sensors that may be detrimental to the structural integrity of the component. This paper explores the unique properties of carbon nanotubes (CNT) as an additive in the matrix of fibre Reinforced plastics (FRP) for producing structural composites with improved mechanical performance as well as sensing /actuating capabilities. Its main application in the F-35 will feature a different kind of CNT material as wingtip fairings. Eventually, CNT could applied in flight control structures and safety-critical systems. Also the nanotube composites are with the aim of reducing spacecraft weight. This paper also deals with the matter that how nanotechnology can be used to reduce the mass, volume, and power of a wide range of spacecraft systems including sensors, communications, navigation, and propulsion system. Further nanotechnology enables the dream true of space agency by making the space elevator reality.. Such factor is also exclusively deal in depth at this presentation.

Key words: CFRP, Sensors, CNT, wingtip fairing, EMI , nanotechnology.

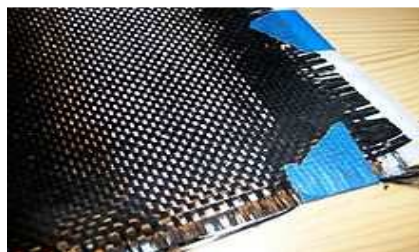
I. INTRODUCTION

Aircraft design favors materials with high specific strength, which reduce aircraft mass while maintain airframe structure integrity. many present days aircraft structure take advantages of the specific strength benefits of aluminum alloy such as, 2024-T3 for the fuselage and graphite epoxy composites for the empennage and control surfaces. The nanoscience fibers known as carbon nanotube are new form of carbon elemental with intriguing properties. Utilizing the carbon nanotubes as a molecular “fibers” in the carbon nanotubes reinforced polymers provides a potentially favourable materials for aircraft applications. Many present days commercial aircrafts including the Boeing 747-400 employ

the metals, and often provide improved strength and corrosion protection. This paper discusses the carbon nanotube molecules, its use in composite material (CNRP), and the potential impacts of CNRP on the current commercial airframes the Boeing 747-400. It is followed by a brief discussion on carbon nanotubes and their applications in aircraft industry. And also one analytical case study is presented on impact of mass reduction on the aircraft performance, fuel consumption, and wake vortex formation.

II. COMPOSITE MATERIALS

A combination of two or more materials (reinforcing elements, fillers, and composite matrix binder), differing in form or composition on a macroscale. Normally, the components can be physically identified and exhibit an interface between one another. Examples are cermets and metal-matrix composites.



III. CARBON NANOTUBES

Carbon nanotubes are large molecules of pure carbon that are long and thin and shaped like tubes, about 1-3 nanometers (1 nm = 1 billionth of a meter) in diameter, and hundreds to thousands of nanometers long. As individual molecules, nanotubes are 100 times stronger than steel and one-sixth its weight. Some carbon nanotubes can be extremely efficient conductors of electricity and heat; depending on their configuration, some act as semiconductors.



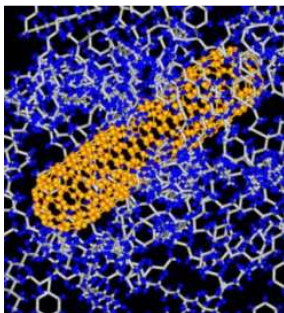
IV. CNT'S SYNTHESIS

Carbon nanotubes are large molecules of pure carbon that are long and thin and shaped like tubes, about 1-3 nanometers

(1 nm = 1 billionth of a meter) in diameter, and hundreds to thousands of nanometers long. As individual molecules, nanotubes are 100 times stronger-than-steel and one-sixth its weight. Some carbon nanotubes can be extremely efficient conductors of electricity and heat; depending on their configuration, some act as semiconductors.

V. NANO TUBES AND ITS APPLICATIONS

The properties of nanotubes have caused researchers and companies to consider using them in several fields. For example, because carbon nanotubes have the highest strength to weight ratio of any known material, researchers at NASA are combining carbon nanotubes with other materials into composites as shown in the photo below that can be used to build light weight spacecraft.



Another property of nanotubes is that they can easily penetrate membranes such as cell walls. In fact, nanotubes long, narrow shape make them look like miniature needles, so it makes sense that they can function like a needle at the cellular level. Medical researchers are using this property by attaching molecules that are attracted to cancer cells to nanotubes to deliver drugs directly to diseased cells.

VI. APPLICATIONS

Carbon nanotubes are finding new applications in improving conventional polymer-based fibers.

Another interesting property of carbon nanotubes is that their electrical resistance changes significantly when other molecules attach themselves to the carbon atoms. Companies are using this property to develop sensors that can detect chemical vapors such as carbon monoxide or biological molecules.

These are just a few of the potential uses of carbon nanotubes. The following survey of carbon nanotube applications introduces these and many other uses.

For example, composite fibers made from single-walled carbon nanotubes (SWNTs) and polyacrylonitrile – a carbon fiber precursor – are stronger, stiffer and shrink less than

standard fibers. Nanotube-reinforced composites could ultimately provide the foundation for a new class of strong and lightweight fibers with properties such as electrical and thermal conductivity unavailable in current textile fibers. Inc., single-walled nanotubes exist in bundles 30 nanometers in

diameter containing more than 100 tubes. Addition of carbon nanotubes to traditional fibers can double their stiffness, reduce shrinkage by 50 percent, raise the temperature at which the material softens by 40 degrees Celsius and improve solvent resistance. These properties will make the composite fibers valuable to the aerospace industry, where the improved strength could reduce the amount of fiber needed for composite structures, cutting weight. But the greatest impact of carbon nanotubes will be realized only if researchers can learn how to break up the bundles to produce individual nanotubes, a process called exfoliation. If that can be done, the quantity of tubes required to improve the properties of fibers could be reduced from 10 percent to as little as 0.1 percent by weight. That could help make use of the tubes – which now cost hundreds of dollars per gram – feasible for commercial products. Including individual nanotubes in composite fibers could help improve the orientation of the polymer chains they contain, reducing the amount of fiber entanglement and increasing the crystallization rate.

A. Types of carbon nanotubes

Single walled nanotubes, multi walled nanotubes, OH functionalized nanotubes –OH-CNT's, COOH functionalized –COOH-CNT's, short nanotubes 0.5-2.0um long –short CNT's, industrial grade nanotubes –IGCNT'S, graphitized nanotubes GMWNT'S, carbon nanotubes arrays-CNT arrays, C60 and other fullerenes.

B. Electrical Properties of CNT's

The electrical properties of CNTs are extremely sensitive to defects which can be introduced during the growth, by mechanical strain, or by irradiation with energetic particles such as electrons, heavy ions, alpha-particles, and protons. When highly energetic particles collide, a latchup, electrical interference, charging, sputtering, erosion, and puncture of the target device can occur. Therefore the information on the effects of various types of high energetic irradiation on CNTs and other nanomaterials will be important in developing radiation-robust devices and circuits of nanomaterials under aerospace environment. The most important outcome of this work is that no significant change in the electrical properties of CNT-based FET was observed, even after high-energy proton beam irradiated directly on the device. This result shows that CNT-based devices can be a promising substitute for classical silicon-based devices, which are known to be very fragile against proton radiations. It has been reported previously that electronic devices became more radiation tolerant when their dimensions are reduced. For example, multi-quantum well or quantum dot devices can be tens or hundreds of times more radiation tolerant than conventional bulk devices. It even was shown that quantum dot/CNT-based



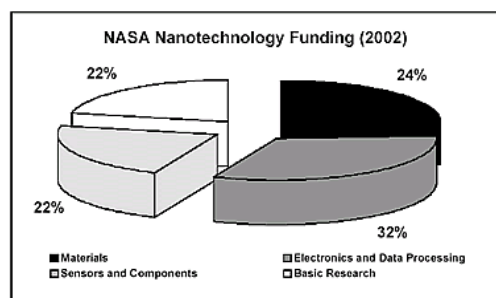
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photovoltaic devices were five orders of magnitude more resistant than conventional bulk solar cells.

C. Advanced Composites Materials

Aerospace industry basically wants is that it must be lighter, stronger, more Durable, Resistant to Extreme

Conditions. Also interested in materials that have unique properties. Aerospace Nanotechnology. There are basically four areas where the aircraft industry focus is Materials, Electronics and Data Processing, Sensors and Component's Basic Research.



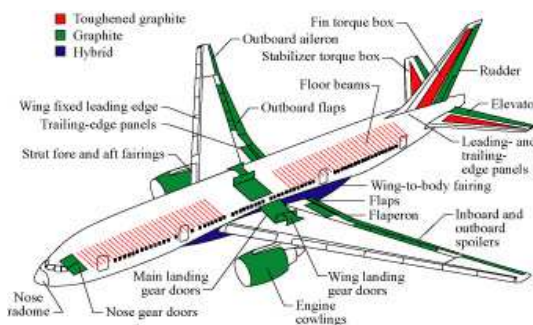
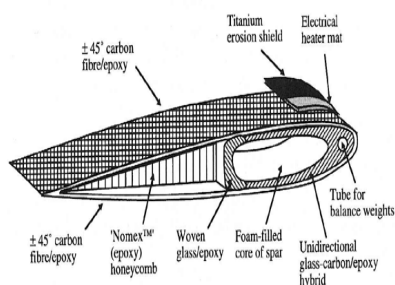
Composites materials are combinations of two or more organic or inorganic components. Consist of high strength nano fibers embedded in a matrix.

Materials are:

1. Matrix material: material that holds everything together. e.g. epoxy, bismaleimide, or polyimide.
2. Fibers: serve as a reinforcement, embedded in the matrix. e.g. glass fiber, boron fiber, carbon fiber.
3. Traditionally using material is Aluminum metal. Aluminum made planes heavier, consume more fuel. Fiberglass was first used in the Boeing 707 passenger jet in the 1950s, only 2% of the structure. Now, about one-third of the structure of the commercial planes uses composites. Composites are stronger. Composites makes aircrafts 20% lighter. They are Fuel efficient.

D. Aerospace Paint and Sealant

Sealants to seal the structures like fuel tanks, aerodynamic sealing, and windshield installation. Based on nanotechnology e.g. PRC® and Pro-Seal™ PPG. Aerospace chromate-free de-paint/repaint process includes an epoxy primer. Based on nanotechnology they are Environment friendly, Better adhesion, Corrosion resistant e.g. DeSoto® Aerospace Coatings



F. Deicing

When a plane is in the air, icing can occur plane's performance suffers and disasters can occur. Currently used techniques: use bleed air: heating the surface with engine bleed air. mechanical boot: breaking the bond between surface and ice. Issues occurred are, they are Too complex, too heavy, draws too much power to be effective. The applications of nanotechnology in aerospace were very interesting. Some of the applications appear to be so far in the future that they are not worth mentioning, such as the space elevator. Would have liked to see an analysis for the time estimate to implement the carbon nano-tubes in the replacing copper wires. Since there are other advancing aerospace programs, we would have liked to know about any other applications that these programs are exploring. We would like to know if these programs are progressing in this research more rapidly than NASA. A survey of carbon nanotube applications are under



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development. Researchers and companies are working to use carbon nanotubes in various fields. Carbon nanotubes are being developed to clean up oil spills. Researchers have found that adding boron atoms during the growth of carbon nanotubes causes the nanotubes to grow in a sponge like material that can absorb many times its weight in oil.

They have also made the nanotube sponges magnetic, which should make retrieval of the sponges easier once they are filled with oil.

Researchers are developing materials, such as a carbon nanotube based composite developed by NASA that bends with when a voltage is applied, that will need only an electrical voltage to change the shape (morphing) of aircraft wings and other structures. Longer lasting concrete, researchers have found that carbon nanotubes can fill the voids that occur in conventional concrete. Because it's these voids that allow water to penetrate into concrete, resulting in the formation of cracks; including nanotubes in the mix stops the cracks from forming. Lightweight windmill blades made with an epoxy containing carbon nanotubes. The strength and low weight provided by the use of nanotube filled epoxy allows longer windmill blades to be used. This increases the amount of electricity generated by each windmill.

Aircraft using carbon nanotubes to increase strength and flexibility in highly stressed components. A lightweight, low power anti-icing system using carbon nanotubes in a layer coated onto aircraft wing surfaces. Strong, lightweight composites of carbon nanotubes and other materials that can be used to build lightweight spacecraft. Cables made from carbon nanotubes strong enough to be used for the Space Elevator to drastically reduce the cost of lifting people and materials into orbit. Carbon nanotubes used to direct electrons to illuminate pixels, resulting in a lightweight, millimeter thick "nanoemissive" display panel.

G. New Material for Aircraft Wings Could Save Billions

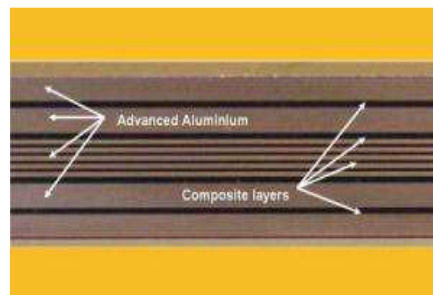
The unusual qualities of this special material (called CentrAl, an abbreviation of Central Reinforced Aluminium) can make a significant contribution to the development of truly energy-efficient, 'green' aircraft. Lower fuel consumption and reduction of maintenance costs could lead to worldwide savings as high as \$100 billion.

Fatigue is a phenomenon that affects materials after long-term exposure to cyclic loading. As a result of varying loads, fractures eventually occur. The new, high-quality CentrAl aluminium constructions are stronger than the carbon fibre reinforced plastic (CFRP) constructions that have recently been used in aircraft wings such as the Boeing 787. By using CentrAl wing constructions, the weight can be reduced by another 20 per cent compared to CFRP constructions. Furthermore, using CentrAl results in considerably lower manufacturing and maintenance costs.

The CentrAl concept comprises a central layer of fibre metal laminate (FML), sandwiched between one or more thick layers of high-quality aluminium. This creates a robust construction material which is not only exceptionally strong, but also insensitive to fatigue. The CentrAl technique allows for simple repairs to be carried out immediately, as is the case in aluminium constructions, -- but not the case when using CFRP constructions.

During a conference in Delft (Conference on Damage Tolerance of Aircraft Structures: 2528 September 2007), GTM and Alcoa have presented the new concept to international experts in the field of metal fatigue and damage sensitivity of aircraft constructions. The US Air Force, Alcoa and GTM will also shed new light on the fact that the new CentrAl materials create possibilities for so-called 'Carefree structures'.

These are aircraft constructions that are less sensitive to damage caused, for example, by fatigue, hail storms, other weather phenomena, trucks that collide with the aircraft and corrosion. Carefree aircraft constructions will be characterized by significantly reduced maintenance costs.



Detail of CentrAl sandwich. The unusual qualities of this special material can make a significant contribution to the development of truly energy-efficient, 'green' aircraft.

H. Carbon nanotubes in finding and fixing aircraft wing defects

Finding cracks

A carbon nanotube-laced epoxy surface treatment was applied over an embedded wire matrix that forms an x-y grid over the entire surface. By scanning through the grid with a signal probe, tiny cracks can be detected. Cracks were sensed as a higher resistance when a probe signal had to travel a longer distance around a crack to complete a circuit.

Once a cracked region is identified, self-healing was initiated by passing a higher-current pulse through the nanotubes laced into the cracked region. The embedded nanotubes provided the electrical conductivity required to heat that region with a short, but high-current, pulse. Heat-activated healing agents mixed into the epoxy then flowed into the crack to stop its growth and recover 70 percent of the structure's original strength.

Healing cracks



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RPI's method solves the problem by allowing every square inch of a wing to be scanned for defects before each take off. If cracks are detected, they can be repaired immediately by merely increasing the level of the electrical signal to that region, thereby melting the embedded healing agents. The technique can also detect and repair less common forms of structural damage such as delamination of polymer composite layers.

VII. CONCLUSION

The analysis presented considered notional 747-400 with carbon nanotubes as a primary structures replacing the entire volume of the structural volume, and aircraft frame which help to reduce the mass at take off for each airframe in each aircraft structure.

Consequential benefits exit due to mass reduction found in the notional CNRP airframe structured airframe analysis, including in aircraft flight range and cruise altitude and most important factor is reduce in fuel consumption which is co relate to more economical flight. these benefits translate to

saving for the air carrier maintain fleets of these aircraft, especially fuel expenditures. Though the probability of CNRP structured contemporary airframe is unlikely, this type of

analysis provides insight into a small group of benefits seen by a nanostructured material applied on the macro scale.

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The effect of nano particles and its applications in nano technology

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Abstract— Nanotechnology has become the order of the day. The study includes the particles in nano size of the order of 10^{-9} m. Nano particles have various enhanced properties due to their reduced size. These particles are finding applications in almost any field from delicate electronics to life-changing medical procedures. They can be made of any material, but industrially, nano particles are generic description for either spherical metal or semi conductor particles with nano-sized diameters.

They have a greater surface area per unit weight than larger particles which cause them to be more reactive and effective than other molecules; hence they are highly versatile. The paper highlights the application of nano concepts to magnetic properties and how they behave under magnetic fields. Magnetic nano particles are being researched for applying in the fields of medicine, optics and data storage.

Key words: nano particles, applications, magnetic properties, reactive, nano concept.

I. INTRODUCTION

In nanotechnology, Particles are further classified according to size: in terms of diameter, coarse particles cover a range between 10,000 and 2,500 nanometers. Nanoparticles have a greater surface area per weight than larger particles which causes them to be more reactive and effective than other molecules with at least one dimension less than 100 nm. It is a generic description for either spherical metal or semi conductor particles with nano sized diameters. In nano technology, particles are further classified according to size : in terms of diameter, they cover a range between 10,000 and 2,500 nanometers. Nanoparticles and their applications, are essentially very small pieces of material that measure no more than an atom or two across. They are small enough that they can interact easily on the same level with microscopic pathogens such as bacteria or viruses.

II. TYPES OF NANO PARTICLES

A . NanoClusters

First, there are nanoclusters which are defined as semi crystalline nanostructures with at least one dimension between 1-10 nm and narrow size distribution. Nano clusters are nothing but the group of nano particles with same dimensions put together.

B. Nanopowders

Nanopowders are defined as powdered materials with individual particles having sizes under 100 nanometers.

The particles in nanopowders are smaller than the wavelength of visible light and therefore are rendered invisible. This means they can be used in applications like sunscreens that are clear. The tiny size of nanopowders gives them an extremely high surface area to volume ratio that results in extraordinary properties like extreme strength.

C. NanoCrystals

A nanocrystal is a crystalline particle with at least one dimension measuring less than 1000 nanometers (nm), where 1 nm is defined as 1 thousand-millionth of a meter (10^{-9} m). Nanocrystals have a wide variety of proven and potential applications. Nanocrystals are single crystalline. Those are just the most basic subdivision of nanoparticles.

D.Nanorods

Nanorods are one morphology of nanoscale objects. Each of their dimensions range from 1–100 [nm](#). They may be synthesized from metals or semiconducting materials. Standard [aspect ratios](#) (length divided by width) are 3-5.,

There are even nanocups, nanospheres, nanodiamonds and nanostars Not to mention one of the most promising types of nanoparticles, the quantum dot .Nanoparticles may or may not exhibit size-related properties that differ



significantly from the Nanotechnology has expanded its wings in various spheres of life.

III. NANOPARTICLES

Nanotechnology has given rise to house cleaning chemicals that appear to have miraculous effects; the nanoparticles inside these cleaning fluids have been engineered on the molecular level so that when they encounter unwanted dirt or grime, they "eat" it..

But perhaps the timeliest use for nanoparticles lies in their medical applications. Their pathogen-sized proportions naturally make them prime candidates for the fight against various unwanted invaders of the human body; they can be injected into your bloodstream to fight viruses and bacteria.

IV. MAGNETIC NANOPARTICLES

These are a class of [nanoparticle](#) which can be manipulated using [magnetic field](#). The physical and chemical properties of magnetic nanoparticles largely depend on the synthesis method and chemical structure. In most cases, the particles range from 1 to 100 nm in size and may display [superparamagnetism](#).

A. Properties:

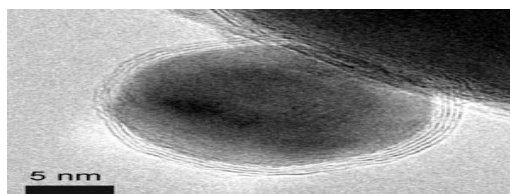
The physical and chemical properties of magnetic nanoparticles largely depend on the synthesis method and chemical structure. In most cases, the particles range from 1 to 100 nm in size and may display [superparamagnetism](#).

Cobalt nanoparticle with graphene shell.

B. Ferrites

[Ferrite](#) nanoparticles are the most explored magnetic nanoparticles up to date. Once the ferrite nanoparticles become smaller than 128 nm they become [superparamagnetic](#) which prevents self agglomeration since they exhibit their magnetic behavior only when an external magnetic field is applied. Just like non-magnetic oxide nanoparticles, the surface of ferrite nanoparticles is often modified by [surfactants](#), [silicones](#) or [phosphoric acid](#) derivatives to increase their stability in solution

C. Metallic with a shell

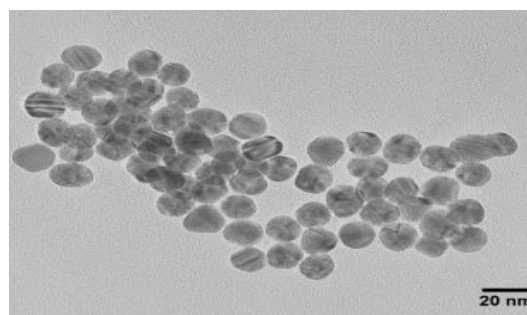


The metallic core of magnetic nanoparticles may be passivated by gentle oxidation, surfactants, polymers and precious metals. In an oxygen environment, Co nanoparticles form an anti-ferromagnetic CoO layer on the surface of the Co nanoparticle. Recently, work has explored the synthesis and exchange bias effect in these Co core CoO shell nanoparticles with a gold outer shell Nanoparticles with a magnetic core consisting either of elementary [Iron](#) or [Cobalt](#) with a nonreactive shell made of [graphene](#) have been synthesized recently. The advantages compared to ferrite or elemental nanoparticles are:

1. Higher [magnetization](#)
2. Higher stability in [acidic](#) and [basic](#) solution as well as [organic solvents](#)

IV. GOLD NANOPARTICLES

As a result of extensive research and continuous development, it has been discovered that gold can be used successfully for scientific purposes as well. One of these special uses of gold refers to what is called 'nanogold' or 'gold nanoparticles', i.e. sub-micrometer-sized particles of gold dispersed in a fluid, usually water.



Gold Nanoparticles are mainly known for their extraordinary optical, electronic and molecular-recognition properties. These properties allow the gold nanoparticles to have applications in various fields, including electron microscopy, electronics, nanotechnology and materials science.

Biological electronic microscopy is one of the areas where gold nanoparticles have been extensively used as contrast agents. They can be associated with many traditional biological probes such as antibodies, lectins, superantigens, glycans, nucleic acids and receptors. Because gold particles having various sizes can be easily spotted in electron micrographs, it is possible for multiple experiments to be conducted simultaneously.

Gold nanoparticles have been successfully used as part of the treatment for some diseases such as Rheumatoid arthritis. The most important medical purpose for which



gold nanoparticles can be used is the localization and treatment of cancer.

V. PROPERTIES OF NANOPARTICLES

Nanoparticles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecular structures.

A bulk material should have constant physical properties regardless of its size, but at the nano-scale size-dependent properties are often observed.

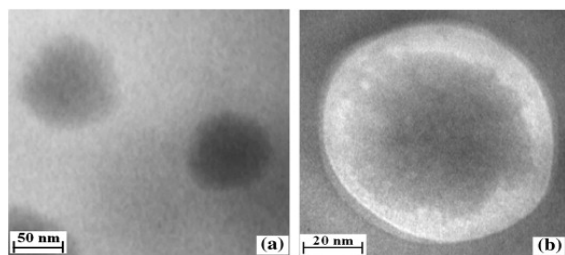
Thus, the properties of materials change as their size approaches the nanoscale and as the percentage of atoms at the surface of a material becomes significant.

For example, nanoparticles of usually yellow gold and gray silicon are red in color; gold nanoparticles melt at much lower temperatures (~300 °C for 2.5 nm size) than the gold slabs (1064 °C); and absorption of solar radiation in photovoltaic cells is much higher in materials composed of nanoparticles than it is in thin films of continuous sheets of material – the smaller the particles, the greater the solar absorption.

Other size-dependent property changes include quantum confinement in semiconductor particles, surface plasmon resonance in some metal particles and superparamagnetism in magnetic materials. Ironically, the changes in physical properties are not always desirable.

Ferroelectric materials smaller than 10 nm can switch their magnetisation direction using room temperature thermal energy, thus making them unsuitable for memory storage.

Suspensions of nanoparticles are possible since the interaction of the particle surface with the solvent is strong enough to overcome density differences, which otherwise usually result in a material either sinking or floating in a liquid.



Nanoparticles also often possess unexpected optical properties as they are small enough to confine their

electrons and produce quantum effects. For example gold nanoparticles appear deep red to black in solution.

The high surface area to volume ratio of nanoparticles provides a tremendous driving force for diffusion, especially at elevated temperatures.

Sintering can take place at lower temperatures, over shorter time scales than for larger particles. This theoretically does not affect the density of the final product, though flow difficulties and the tendency of nanoparticles to agglomerate complicates matters. Moreover, nanoparticles have been found to impart some extra properties to various day to day products.

for example the presence of titanium dioxide nanoparticles imparts what we call the self-cleaning effect, and the size being nano range, the particles can not be observed. Zinc oxide particles have been found to have superior UV blocking properties compared to its bulk substitute. This is one of the reasons why it is often used in the preparation of sunscreen lotions., and is completely photostable.

Clay nanoparticles when incorporated into polymer matrices increase reinforcement, leading to stronger plastics, verifiable by a higher glass transition temperature and other mechanical property tests. These nanoparticles are hard, and impart their properties to the polymer (plastic). Nanoparticles have also been attached to textile fibers in order to create smart and functional clothing.

Metal, dielectric, and semiconductor nanoparticles have been formed, as well as hybrid structures (e.g., core-shell nanoparticles). Nanoparticles made of semiconducting material may also be labeled quantum dots if they are small enough (typically sub 10 nm) that quantization of electronic energy levels occurs. Such nanoscale particles are used in biomedical applications as drug carriers or imaging agents.

Semi-solid and soft nanoparticles have been manufactured. A prototype nanoparticle of semi-solid nature is the liposome. Various types of liposome nanoparticles are currently used clinically as delivery systems for anticancer drugs and vaccines.

V.Current Applications of Nanoparticles

This can either give you a much-needed boost, or in the case of AIDS sufferers it may make the difference between life and death. For those with severe auto-immune diseases like HIV and AIDS, nanoparticles could essentially serve as a synthetic immune system.

A. Applications of Nanopowders



The applications for materials that incorporate nanopowders increase everyday. Current applications include: Catalysts, solid rocket fuel, targeted drug delivery, metallic paint.

B. Applications of Nanocrystals

They have been used in the manufacture of filters that refine crude oil into diesel fuel. Nanocrystals can also be layered and applied to flexible substrates to produce solar panels. Titania nanocrystals can be suspended in liquid form and applied to surfaces, making it possible to literally paint a solar panel onto an exterior wall or roof.

Possible future uses of nanocrystals include: Production of hydrogen, Removal of pollutants and toxins, Medical imaging, Bio-tags for gene identification, Drug manufacture, Protein analysis, Flat-panel displays, Illumination, Optical and infrared [lasers](#), Magneto-optical memory chips, Self-organized smart materials.

C. Applications The properties and the applications related to particular property are discussed:

Some other universal applications of the nanoparticle include:

i. Medical

It seems likely that nanoparticles will also be key players in the fight against cancer. current cancer treatments tend to be traumatic and painful for the patient while at the same time providing unpredictable levels of success, especially when it comes to chemotherapy. Chemotherapy uses the bloodstream, and—as the name “circulatory system” suggests—this method of transportation distributes the lethal chemical throughout several parts of the body in its quest to find the cancer’s location.

ii. Optical.

Nanoparticles could be engineered and used for anti-reflection product coatings, producing a refractive index for various surfaces, and also providing light based sensors for use in diagnosing cancer. this shows

iii. Magnetic

Nanoparticles have the potential to increase the density of various storage media, and also when magnetized they can improve the detail and contrast of MRI images as previously alluded to.

iv. Thermal.

Specifically engineered particles could improve the transfer of heat from collectors of solar energy to their storage

tanks. They could also enhance the coolant system currently used by transformers in these types of processes.

v. Mechanical

Nanoparticles could provide improved wear and tear resistance for almost any mechanical device. They could also give these devices previously unseen anti-corrosion abilities, as well as creating entirely new composites and structural materials that are both lighter and stronger than those we use today.

Vi. Electronic

Because of their tiny size, nanoparticles are inherently poised to aid in the production of high performance delicate electronics; they may provide not only materials with a high rate of conductivity, but also sleeker parts for small consumer electronics like cell phones. And when it comes to advertising, nanoparticle electronics can create digital displays that are more electricity-efficient, less expensive to produce, brighter in color, and also bigger.

vii. Energy.

Nanoparticle batteries would be longer-lasting and have a higher energy density than those we use today. Metal nanoparticle clusters could also have revolutionary applications for hydrogen storage; they could also produce extremely efficient fuel cells by acting as electrocatalysts for these devices. Nanoparticles may also pave the way for practical and renewable energy; they have already demonstrated an ability to improve solar panel efficiency many times over. Not only that, but when nanoparticles are used as catalysts in combustion engines, they have shown properties that render the engine more efficient and therefore more economic.

viii. Biomedical

Our wounds are dressed with antibacterial coatings of silver nanoparticles. Nanoparticles have also been used to produce “quantum dots,” which can detect diseases, as well as interactive foods and drinks that change flavor and color based on your tastes, or in some cases may even alter their nutrient content based on your state of health

VI. CONCLUSION

Here by, we conclude that the nano particles are one of the most important part of our day to day life. This is because of their small size and extraordinary properties of different types of nano particles. Nano particles are very usefull to human in each and every field to a great extent. Hence they could be even more modified and used for better purposes. These particles are just the particles with the nano size of particular type of particles.



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Nanomaterials for Aviation Industry

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I. INTRODUCTION

Abstract— Nanotechnology is recognized as a very strong innovation driver and is therefore seen as a strategic technology for the world's future economy. Nano materials with their exceptional multifunctional properties are transforming the functioning of aviation industry dramatically. The success of the Aviation Industry depends on various factors ranging from reduction of weight, availability of materials with multifunctional properties, eco-friendly fuels, less fuel consumption, faster and highly responsive communication systems, less or no repairs, extended and safe life, reduced time frame of development cycle from concept to implementation and many more. Nanomaterials can be primarily used in three areas of Aviation Industry which are Airframe Structure, Aero-Engine Parts and Aircraft Electro-Communication System. The modern aviation design requirements like faster, miniature, highly manoeuvrable, self-healing, intelligence guided, smart, eco-friendly, light weight and stealth systems can be satisfied by the use of nanomaterials in airframe structure such as Carbon Nanotube (CNT) based Polymer Composites, Nanoclays reinforced Polymer Composites and Metal Nanoparticles incorporated Composites. Nanocoatings for Aero-Engine Parts are generally used for protecting the structures and surfaces of the aircraft from harsh environments. Materials like SiC Nanoparticles in SiC-particle-reinforced alumina and Yttria stabilized nanozirconia can facilitate crack healing, resulting in improved high-temperature, strength and creep resistance as compared to monolithic ceramics. TiN nanocrystallites embedded in amorphous Si₃N₄ are used for wear-resistant coatings. CNTs have unique set of properties, including ballistic electron transport and a huge current carrying capacity, which make them suitable for Aircraft Electro-Communication Components. Magnetic Nanoparticles (Iron oxide Nanoparticles i.e. Fe₂O₃ & Fe₃O₄) incorporated polymer films and composites can be used in various Data Storage Media. Ceramic Nanoparticles like Barium Titanate, Barium Strontium Titanate are used for making Super Capacitors. MEMS (Micro Electro Mechanical Systems) and NEMS (Nano Electro Mechanical Systems) offer the possibility of developing a standard fuel management unit which controls the fuel control in aero-engines. CNTs can release hydrogen in a control way to generate power. CNTs with their High Ballistic Resistance Capacity, High Energy Absorption Capacity and Multi Hit Resistance are proved to be the best candidates for making Ballistic Armours.

Keywords:— CNT, Nanoclay, metal nanoparticles, MEMS and NEMS

The stupendous growth of aviation industry is inconceivable without the advancements in material science and engineering. The stringent performance requirements such as reduced mass, volume and enhanced functionality are the design drivers for modern aviation industry. As a result, a broad spectrum of materials like high performance metals, alloys, ceramics, high performance polymers, conducting polymers, rubbers, elastomers and composites have been developed. With the invention and discovery of these macroscopic materials, aircraft industry has grown tremendously within the last few decades. Despite vast growth of aircraft industry and the availability of various macroscopic materials, aircraft designers still face lot of problems in the form of non availability of materials to meet various safety requirements such as the protection against bird, ballistic and lightning strike and containment of events like fire and fan blade off. In the constant quest to identify suitable advanced materials to meet stringent requirements of aerospace industry, many innovative and exotic technological areas have been explored.

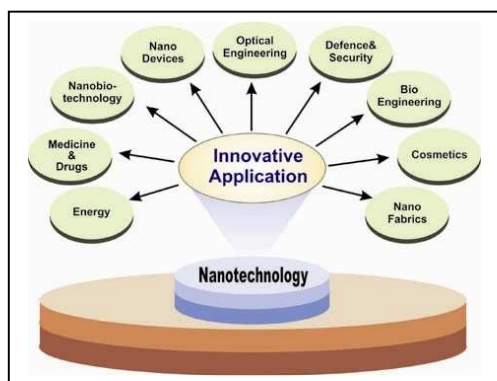
Nanotechnology has become cynosure of scientific community in the last decade due to their promising potential applications in both civil and defence sectors. With the fascinating mechanical, optical and electronic properties nanotechnology is believed to revolutionize every industry including aviation and defence in years to come and will have a significant impact on global economy. The term “nanotechnology” was first coined by Eric Drexler in his famous book “Engines of Creation” (1986) to describe the manipulation of individual atoms and molecules to build structures to complex, atomic specifications. It commonly refers to the branch of science and engineering which deals with designing, manufacturing of structures, devices and systems by manipulating atoms and molecules at the nanoscale, i.e., those having one or more dimension in the order of 100 nanometres.

The physical and chemical properties of nanostructures are distinctly different from those of a single atom (molecule) and bulk matter with the same chemical composition. The size and shape dependent properties of nanomaterials and their



promising applications have given the impetus for the growth of nanomaterial research. .

The present paper provides a brief synopsis about the application of various nanomaterials such as carbon nanotubes, nanoparticles, nanoclay-composites and CNT/polymer composites in the aviation industry. The mechanical, electrical, thermal, flammability properties, challenges and opportunities of nanomaterials are also discussed. Finally, in this paper, an attempt has been made to summarise potential applications of nanomaterials in aviation industry particularly for airframe structures, engine coatings, armour and electro-communication applications.

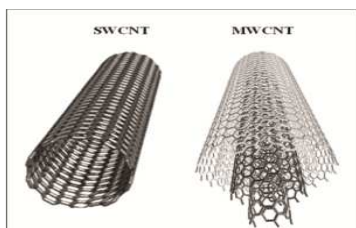


II. NANOMATERIALS IN AIRFRAME STRUCTURES

The design requirements of the materials to be used in airframe structures are light weight, high strength, high toughness, corrosion resistance, easy repairability, reusability, less maintenance, durability etc. Metals like aluminium, titanium, duralumin, magnesium and their alloys, composites

both metal matrix and polymer reinforced composites have been used tremendously and successfully through the ages for making various structures. The modern aviation design requirements like faster, miniature, highly manoeuvrable, self healing, intelligence guided, smart, eco-friendly, light weight and stealth systems warrant for materials with extraordinary mechanical and multifunctional properties.

Classically, composites consist of a high-modulus fiber in a low-modulus matrix, where the fiber toughens and strengthens the binding material, or matrix. Due to their exceptional mechanical properties, Single Walled Carbon Nanotubes (SWNT) are commonly used as the reinforcing fiber in carbon nanotube composite, and will be used for the Carbon Nanotube (CNT) based polymer composites.



The CNT based polymer composites with their wide range of properties like high young's modulus, high specific strength, crash resistance and thermal performance provides an edge over conventional composites and light weight metals. Many CNT based composites like CNT/Epoxy, CNT/polyimide; CNT/PP etc. have been studied in detail to exploit the properties of CNTs for use in aero structures. Nano fibres of Kevlar, glass and carbon and other polymer materials show exciting properties and can be directly used as replacement for conventional fibres in composites thereby enhancing various mechanical and electrical properties. These materials may satiate the designer's appetite for new high strength materials which can withstand bird strike. With the help of Carbon Nanotube Reinforced Polymer (CNRP) based airframe structure there is a notable reduction in mass at take-off (MAT) of the aircraft. Consequential benefits exist due to the mass reduction found in the notional CNRP-structured airframe analysis, including increases in aircraft flight range and cruise altitude, and a decrease in fuel consumption, which directly correlate to more economical flights.

Looking beyond current advanced aircraft materials such as those used in the B-2 Stealth Bomber...

Material	Density (g/cc)	Modulus (Gpa)	Strength (Mpa)
High Carbon Steel	7.6	207	676
Titanium (Ti-55A)	4.5	83	241
Aluminum 2024	2.8	70	468
Carbon Fiber RP	2.7	140	2505
Carbon Nanotube RP	1.2	147	15220

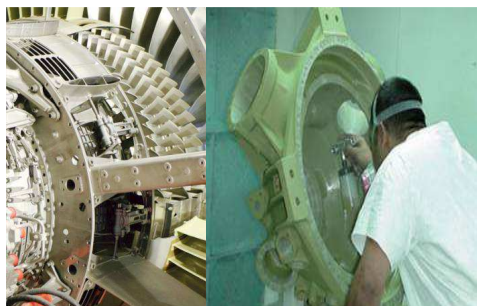
Nanoclays and their polymer composites are the fastest growing fields of nanomaterials due to their excellent mechanical, barrier, flame retardant properties, easy processability and low cost. In general, the organically modified silicate nanolayers are referred as 'nanoclays' or 'organosilicates'. Clay minerals have a layered structure with unit layers about 1 nm thick and sizes ranging from several nanometres to several micrometers. Each layer is formed of tetrahedral coordinated Si atoms fused into an edge-sharing octahedral plane of either alumina or magnesia. Many types of clay such as montmorillonite, Hectorite, saponite, and vermiculite are used for making polymer - nanoclay composites. Polymer/nanoclay composites are generally prepared by intercalative polymerization, melt intercalation and exfoliation/adsorption techniques by using injection moulding, twin screw extrusion moulding and various blenders.

The extraordinary electrostatic discharge and electromagnetic interference (EMI) shielding properties of CNT incorporated plastics and metal nanoparticles incorporated composites make them the probable futuristic solution for making the structure which are resistant to lightning strikes. Many research organizations world over are working on smart skins for aircrafts made up of nanotubes and nanobased composites.



III. NANOCOATINGS FOR AERO-ENGINE PARTS

Coatings have many potential applications in the aerospace industry. Coatings are generally used for protecting the structures and surfaces of the aircrafts from harsh environments. The stringent requirements like resistance to extreme temperatures, extreme climates, corrosion, abrasion and wear of engine parts have sparked an increased demand for more reliable high performance coatings. Many coatings have been developed and used on aircrafts and in aeroengines depending on the requirements. Hitherto, aluminide, chromide and MCrAlY based metallic coatings and mullite coatings are used for protection of superalloys and ceramic parts respectively. Zirconia based coatings were used as thermal barrier coatings to protect the surfaces from high temperature. Incremental improvements to current coating technologies are unlikely to meet the goals of future-generation, higher performance turbine engines, therefore innovative concepts and metals are required.



Promising research of nanocrystalline substrates and coating materials, with improved high-temperature properties may allow higher engine-operating temperatures and therefore improved performance in the future. For example, the SiC nanoparticles in SiC-particle-reinforced alumina, yttria stabilized nanozirconia, appear to facilitate crack healing, resulting in improved high-temperature, strength and creep resistance as compared to monolithic ceramics. Nanocrystalline coatings consisting of TiN nanocrystallites embedded in amorphous Si₃N₄ are being studied for use as wear-resistant coatings. Apart from these high temperature coatings, many other coatings were developed to improve the tribological properties of moving parts in aeroengines and aircraft. The nanocomposite coatings made of crystalline carbide, diamond like carbide and metal dichalcogenide, TiN, Ti_xB_xC_y, CrAlN, Zr-Y-N are used for low friction and wear resistant applications of aircraft. Nanotube and nanoparticles (nanographite, nanoaluminium etc) containing polymer coatings are used for electrostatic discharge, EMI shielding and low friction applications of aircraft surfaces.

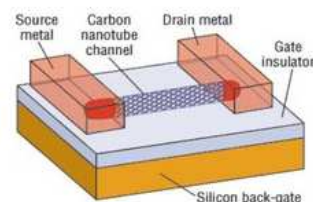
IV. NANOMATERIALS FOR AIRCRAFT ELECTRO-COMMUNICATION COMPONENTS

Nano-electronics will lead to lower power consumption per process on microchips, to an improved signal to noise ratio, to higher processing speeds and shorter transit times and to a higher function density. Nanoelectronics and enabled

products will revolutionize aviation systems and subsystem designs by allowing miniaturization of electronic, optical, mechanical and sensing components.

Improvements such as reducing power consumption while decreasing the weight and thickness of display screens on electronics devices are obtained with the help of CNT's. Since CNT has excellent field emission characteristics like low turn-on field and high current density, they are applied as the electron source of field emission display (FED). Advantages of CNT-FED are thin profile, high luminance, high contrast, high light efficiency, wide view angle, fast response, low driving voltage, lower power consumption, wide operating temperature and flexible dimensions.

CNTs have unique set of properties, including ballistic electron transport and a huge current carrying capacity, which make them of great interest for future nanoelectronics. There are two main areas where CNTs are being considered in integrated circuits as interconnects between the transistors, and as the channel material in FETs. The CNTFET is a promising alternative to the silicon transistor for low-power and high-performance design due to its ballistic transport and low OFF-current properties. CNTFETs is among the most promising nanodevices in line to succeed the MOS transistor. CNTFET replaces the MOSFET, existing logic functions directly to a new technology. It is proved that a significant performance gain can be achieved justifying a shift in fabrication technologies to CNTFET based logic circuits. Specific properties of the CNTFET allowing the creation of completely new logic functions, inaccessible to MOSFET based circuits.



A schematic of a typical carbon nanotube FET.

Other possibilities in electronics are microelectromechanical systems (MEMS)- type memory devices, vacuum microelectronics for displays, transistors, integrated circuits, flexible electronics, sensors etc., Magnetic nanoparticles (Iron oxide nanoparticles) incorporated polymer films and composites can be used in various data storage media. Ceramic nanoparticles like barium titanate, barium strontium titanate are used for making super capacitors. MEMS and Nano electromechanical systems (NEM) offer the possibility of developing a standard fuel management unit which controls the fuel control in aeroengines.

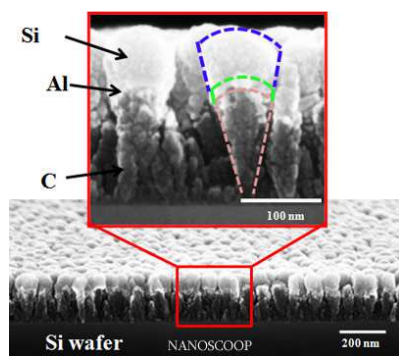
V. NANOMATERIALS FOR ENERGY STORAGE DEVICES

Energy plays a vital role in the development of aviation industry. The energy requirements of aviation industry mainly depend upon various hydrocarbon fuels and electricity developed by various natural sources like coal and water. In



future, the ever increasing energy requirements of aviation industry will not be met by these natural resources due to their constant depletion. This will hamper the growth of aviation industry drastically. Keeping this situation in view, many research activities are being concentrated on various renewable sources for energy generation and storage. This area includes materials for improved batteries and capacitors, fuel cells, solar cells, hydrogen storage devices, and some chemical energy storage in the form of fuels.

Nanotubes have been long heralded as potential candidate for hydrogen storage devices. The high surface area, porosity, and the ability to enclose hydrogen atoms inside their pores and channels between the tubes make nanotubes a suitable candidate for storing hydrogen for alternative fuel applications. Hydrogen can be stored into the CNTs through chemisorption and physisorption under particular conditions. CNTs release hydrogen in a control way to generate power. A relatively recent work has demonstrated the use of multi-walled carbon nanotube films as opaque organic solar cell anodes, and more recently the use of SWNT films as transparent anodes has been demonstrated. Until now Li-ion based and Ni-Cd based batteries are being used in aviation industry. The arrival of nanomaterials gave lithium-ion batteries a new lease of life and provided benefits in terms of capacity, power, cost and materials sustainability. A new type of nanomaterial developed at Rensselaer Polytechnic Institute in Troy, New York could sharply reduce the time needed to recharge lithium (Li)-ion batteries. The new material, says its developers, withstands extremely high rates of charge and discharge that would cause conventional electrodes used in most of today's Li-ion batteries to deteriorate and fail. It has a shape resembling a cone with a scoop of ice cream on top, and is thus called a "nanoscoop". The nanoscoop's success lies in its unique material composition, structure, and size.



The storage devices like high capacity batteries, hydrogen storage devices, fuel cells, solar cells are soon going to replace the existing energy resources leading to a tremendous saving in hydrocarbon fuel besides weight reduction without affecting aerodynamic performance.

VI. NANOMATERIALS FOR BALLISTIC ARMOURS

Ballistic armours provide protection to the personnel and aircraft from various projectiles. Generally cockpit areas and

belly of the aircrafts are being protected by armour panels. The field of ballistic armours has reached a mature level since the early days of using metal plate. There are various types of armour panels available depending on the threat and protection level. These armour panels require trade-offs among many factors such as penetration resistance, weight, deflection, multi-hit resistance capability, flexibility, comfort and field durability. Advanced armour panels typically in multi-layers consisting of ceramics, fibre-reinforced polymers, metallic screens, and possibly rubber materials are already under development.

Carbon nanotubes with their high ballistic resistance capacity, high energy absorption capacity and multi-hit resistance are proved to be the best candidates for making ballistic armours. Multi layers of Kevlar nanofibres, dyneema nanofibres also offers excellent impact resistance and elastic storage energy for making futuristic armours. Ceramic nanoparticles, inorganic SiC nanoparticles incorporated in some polymer matrices may also serve another option for producing high performance ballistic armour.

VII. OTHER APPLICATIONS

Nanoparticles like nanographite, nanosilica etc., are extensively used in the rubber compounds to prepare gaskets and sealants, which may find potential applications in aeroengines. Nanopowders of copper, aluminium, iron are being used in the preparation of making conductive plastics which will be used in various components of aircrafts where electrostatic discharge and EMI shielding applications are required. Some nanoparticles and nanofillers are being used in the preparation of retread tyres of aircraft. Nanochromium based corrosion inhibitors are being developed for protection of aluminium metals of aero structures. Aluminium nanoparticles incorporated textiles, coatings and plastics are used in aircraft interiors to protect aircraft parts from fungus, bacteria and foul smell. Many nano fibres and textiles are being used in parachutes and aircraft arresters. Aluminium, boron and WS₂ nanoparticles mixed in fuels have resulted in enhancement of combustion properties of fuels. High performance nano fibres of nylon and Kevlar may find applications in the belts of ejection system. Insulating cables can be made using nanoclay incorporated PVC which will exhibit good thermal, insulation and flame retardant properties.

VIII. CHALLENGES

Despite the vast growth, still there exist many challenges to be overcome by the diversified scientists and engineers. The speed and efficiency at which the scientific community addresses the challenges, decides the success of nanotechnology. Scientists and engineers should evolve some novel methodologies and synthesis procedures to overcome the following challenges.

The first and foremost challenge is to produce highly pure nanomaterials in large quantities cost effectively. There is an urgent requirement to develop more reliable and repeatable processes for producing nanomaterials with high purity levels



and with controlled size, shape and distribution. More efforts are to be concentrated on developing processes or methods by which the carbon nanotube diameter, length, chirality and purity could be controlled.

Proper methods have to be worked out to convert the physical, chemical properties of nanomaterials into applications effectively. Ensuring the adhesion of nanotubes and nanomaterials to different matrix both qualitatively and quantitatively is more important to predict the strength and long term durability of composites and coatings. Large scale arrays of CNTs self assembly are to be fabricated to realize the full potential of nanotubes in electronic field. Novel, efficient, fast and reliable characterization methods for mechanical and electrical properties of nanomaterials and nano based devices are to be developed for using them in various fields. Faster growth of nanotechnology is only possible with the radical development of breakthrough next-generation instrumentation.

All the industrial sectors in general and aviation industry, in particular should work on the feasibility of using their existing production lines for fabricating components based on nanomaterials, nanocomposites and nanodevices. Viable models, reliable simulations, and quantitative experimental guidelines will have to be developed to understand the implications of nanomaterials on various critical performance requirements of aerial vehicles such as aerodynamics, fuel consumption, safety and life of the systems and sub systems. The focus of the aviation industry should be on the development of novel processing methods and new tools for fabrication of nano material based components in large quantities.

IX. CONCLUSION

The tremendous research on nanomaterials has resulted in many novel materials such as carbon nanotubes, nanoparticles, high strength nanofibers, polymer nanocomposites with exciting properties which may find potential applications in every industry. The essential advantages offered by these nanomaterials to the aviation industry is in the form of high strength-to-weight materials, fire-resistant composites, smart

materials which can sense and actuate, energy-efficient fuels and propellants, active camouflage and protective coatings for multifunctional structures and miniaturized and high speed electronic devices. These nanomaterials with their unique strength properties seem to be the probable candidates for fabricating airframe structures which can survive lightening strike and bird attack. Full fledged utilization of nanotechnology is possible only with the constant efforts of diversified researchers in understanding the structure property relationships of nanomaterials to create novel systems and devices with multifunctional properties. To enjoy the fruits of nanotechnology, it is very essential to bring down the cost of materials which is feasible through the creative thinking and effective completion of programmes without cost and time overruns. In future nanotechnology, nanomaterials and their products like composites, coatings and electronic devices will definitely catapult the aviation industry into greater heights. Finally, with all the major funding around the globe and

radical developments in characterization techniques and instrumentation, nanotechnology will grow with dynamic speeds and will influence every walk of the society.

ACKNOWLEDGEMENTS

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Thrust force studies in drilling of wood composite panels

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Abstract— Medium density fiberboard (MDF) is a wood composite extensively used in construction and industrial applications because of their strength and aesthetic appearance. Drilling is the most frequently used machining process in joining of components in the assembly of the final product. The cutting forces developed during drilling affects the quality of surface drilled. Delamination and tool wear are due to the cutting forces developed and it is mainly depends upon the drilling parameters, tool geometry, tool and work material, drill type, etc. To improve the surface quality and to minimize the drilling damages the control of cutting force is very much essential. The aim of this study is to investigate the influence of input parameters on the cutting forces developed in drilling of wood composite panels. The drilling experiments are planned based on the Taguchi design of experiments. RSM mathematical model is developed to predict the influence of feed rate, spindle speed and point angle on the thrust force. Analysis of variance (ANOVA) is used to check the adequacy of the developed mathematical model. Based on the experimental results and RSM plots it is observed that the increase in feed rate increases and increase in spindle speed decreases the thrust force. It is revealed that high spindle speed with low feed rate combination minimizes the thrust force developed in drilling of wood composite panels.

Keywords: Thrust force, Drilling, Medium density fiberboard (MDF), Taguchi method, Response surface methodology (RSM)

1. Introduction

Medium density fiberboard (MDF) wood composite commonly manufactured using softwood powder, wax and resin in sheet form. Wood veneer or plastic laminates are normally coated on the boards to gain the appearance of a natural solid wood product [1] and also available as uncoated panels. The high dimensional stability, superior machinability, good strength and excellent surface characteristics increase the use of MDF in the structural and other industrial applications [1, 2, and 3]. The thrust force and torque

developed during drilling process affects the quality of surface and also causes the delamination damage as a result reduces the performance of the final product [4]. In drilling point angle, feed rate [5], work material hardness and drill diameter [6] are the most significant factors in developing thrust force and torque. In drilling process the control of thrust force is a major concern [7]. The thrust force and torque increased with larger drill diameters [8, 9].

Many research works were carried out by the researchers to study the influence of machining parameters in drilling of composite materials. Gaitonde et al [1] conducted drilling tests and based on the developed mathematical models using RSM they revealed that the proper combination of cutting speed and feed rate can minimize the delamination tendency. Dippon et al [4] performed drilling experiments and developed a mathematical model to predict the cutting forces in machining of MDF with tools having complex geometry such as router bits. Davim et al [10] investigated the relationships and parametric interaction between the cutting speeds and feed rate on the delamination factor using response surface methodology (RSM). They found that higher cutting speed reduces the delamination tendency in drilling of MDF panels. Palanikumar et al [11] conducted drilling experiments to investigate the influence of drilling process parameters and found that the delamination can be reduced at low feed rates. Prakash and Palanikumar [12] performed drilling experiments using Taguchi technique and RSM. They concluded that feed rate and diameter were the most dominant factors in affecting the surface qualities. Prakash et al [13] conducted drilling experiments and found that cutting parameters

affect the quality of surface in drilling of MDF. Valarmathi and Palanikumar [14] conducted drilling experiments and revealed that low feed rate and high spindle speed combinations can minimize the thrust force developed in drilling of laminated MDF panels. In this study the carbide twist drills with different point angles are used to evaluate the cutting forces at different spindle speeds and feed rates in drilling of plain MDF.

2. Method of Analysis

Taguchi Technique

Taguchi method is a combined technique of statistical and engineering methods. The cost and time of conducting the experiments is reduced using the design of experiments with "Orthogonal Array (OA)". The effects of noises are eliminated using three S/N ratios suggested by Taguchi to measure the quality characteristics. The significant process parameters are identified through analysis of variance (ANOVA). In this investigation the quadratic loss function relation the smaller - the - better (1) is used to determine the optimal machining process parameters.

$$\frac{S}{N} = -10 \log_{10} \left[\frac{1}{n} \sum_{i=1}^n y_i^2 \right] \quad (1)$$

Response Surface Methodology

Response surface methodology (RSM) is a technique used to develop mathematical models to analyze the problems in which one or more responses are influenced by several factors, to establish the quantitative relationship between the input control

Table 1
of Plain

Tensile strength (N/mm ²)	Modulus of Rupture (N/mm ²)	Moisture Content (%)	Density (Kg/mm ³)
0.7 – 0.8	28	5 – 15	500 – 900

Properties
Mdf

Composites Tested

variables and the response variables. The relationship between the control parameters and the responses is given in (2) as:

$$Y_u = \phi(X_{1u}, X_{2u}, \dots, X_{ku}) + \varepsilon_u \quad (2)$$

Where $u = 1, 2, 3, k$ and k represents the number in the factorial experiment.

The terms $x_{i,u}$ represent the level of the i^{th} factor in the u^{th} experiment. The function ϕ is called the response surface. The residual ε_u measures the experimental error in the u^{th} observation [15]. In this study the RSM technique is used to develop a mathematical model to find out the influence of various control parameters on the thrust force.

3. Experimental Details

The drilling experiments were performed based on Taguchi design of experiments on plain MDF panels which are conforming to ISI 12406/2003 of 12mm thickness with carbide twist drills of diameter 10 mm and point angles of 100°, 118° and 135° using CNC vertical machining center with a maximum spindle speed of 5,000 rpm and a maximum feed rate of 4,000 mm/min at dry condition. The thrust force signals were measured using Kistler dynamometer and stored for further analysis. Properties of plain MDF composites tested are given in Table 1. The control factors and their levels are shown in Table 2. The vertical machining centre is shown in Fig. 1.

Table 2 Control factors and their levels

Parameters	Levels		
	1	2	3
Spindle speed (N) rpm	1000	3000	5000
Feed rate (f) mm/min	75	150	225
Point angle (Φ) degrees	100	118	135



Fig 1. Vertical Machining Center

4. Results and Discussion

The MDF panels are widely used in wooden industries. Drilling is the most important operation performed in machining of MDF panels. The cutting parameters significantly influence the surface quality and also cause the drilling damages. The delamination and surface roughness increases with the increase of thrust force. In this study the mathematical model is developed using RSM technique to assess and predict the influence of various machining conditions in drilling of plain MDF panels to reduce the thrust force.

The Analysis of variance (ANOVA) is used to analyze the quantitative data to justify the accuracy of the fit for the developed mathematical model at 95% confidence level. To check the goodness of fit of the thrust force

model, the coefficient of determination (R^2) was determined. Figure 2 depicts the effects

plot for the thrust force ($F_{z \max}$) for means. From Figure 2 it is evident that the thrust force developed is decreased when the spindle speed

is increased and increased with the increase of feed rate. Figure 3 shows the surface plots for the thrust force developed in drilling. Figure 4 shows the contour plots for thrust force developed in drilling. The hold values taken for all the surface and contour plots are low values. From Figure 3, 4 it is observed that the thrust force is increased when the spindle speed is decreased and it is decreased when the feed rate is decreased.

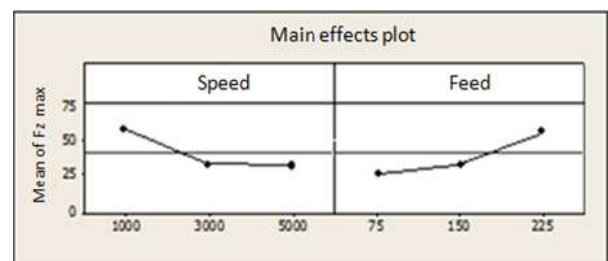


Fig 2. Effects plot for means

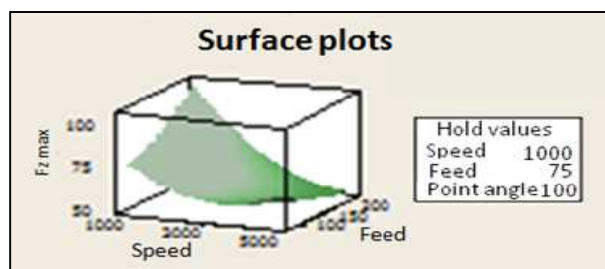


Fig 3. Surface plots

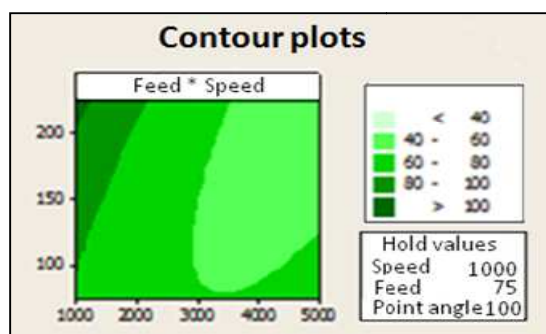


Fig 4. Contour plots

5. Conclusion

The drilling experiments were planned using Taguchi design of experiments to study the influence of cutting parameters on thrust force in drilling of wood composite panels. Taguchi's quality loss function approach is applied to determine the effects of process parameters. The RSM technique is used to develop the mathematical model. The adequacy of the model is checked with ANOVA. Based on the experimental results the following conclusions are obtained:

From the main effects plot it is observed that the increase in spindle speed decreases the thrust force and the increase in feed rate increases the thrust force.

From the surface and contour plots it is revealed that the thrust force developed can be minimized with low feed rate and high spindle speed combination.

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Polymer Nanotechnology

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Abstract - In the large field of nanotechnology[1], polymer matrix based nano-composites have become a prominent area of current research and development. Exfoliated clay-based nano-composites have dominated the polymer literature but there are a large number of other significant areas of current and emerging interest. Phase separated polymer blends often achieve nano-scale phase dimensions; block copolymer domain morphology is usually at the nano-scale[2] level; asymmetric membranes often have nano-scale void structure, miniemulsion particles are below 100 nm; and interfacial phenomena in blends and composites involve nano-scale dimensions. Even with nano-composites, carbon black reinforcement of elastomers, colloidal silica modification and even naturally occurring fiber (e.g., asbestos-nano-scale fiber diameter) reinforcement are subjects that have been investigated for decades.

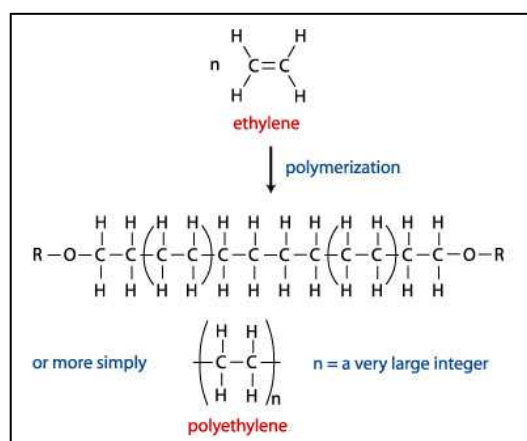
I. INTRODUCTION

In essence, the nano-scale of dimensions is the transition zone between the macrolevel and the molecular level. Recent interest in polymer matrix based nano-composites has emerged initially with interesting observations involving exfoliated clay and more recent studies with carbon nano-tubes, carbon nano-fibers, exfoliated graphite (graphene), nano-crystalline metals and a host of additional nano-scale inorganic filler or fiber modifications. While the reinforcement aspects of nano-composites are the primary area of interest, a number of other properties and potential applications are important including barrier properties, flammability resistance, electrical/electronic properties, membrane properties, polymer blend compatibilization. The synergistic advantage of nano-scale dimensions ("nanoeffect") relative to larger scale modification is an important consideration. Understanding the property changes as the particle (or fiber) dimensions decrease to the nano-scale level is important to optimize the resultant nano-composite. Nanoscale is considered where the dimensions of the particle, platelet or fiber modification are in the range of 1–100 nm. With the platelet or fiber, the smallest dimension is considered for that range (platelet thickness or fiber-diameter).

II. POLYMERS

A polymer is a large molecule (macromolecule) composed of repeating structural units. These sub-units are typically connected by covalent chemical bonds. Although the term polymer[3] is sometimes taken to refer to plastics, it actually encompasses a large class of compounds comprising both natural and synthetic materials with a wide variety of properties. Their role ranges from familiar synthetic plastics and elastomers to natural biopolymers such as nucleic acids

and proteins that are essential for life. Natural polymers : cellulose, which is the main constituent of wood and paper. Synthetic polymers: synthetic rubber, Bakelite, neoprene, nylon, PVC, polystyrene, polyethylene, polypropylene, polyacrylonitrile, PVB, silicone, and many more. Tensile strength[5]: The tensile strength of a material quantifies how much stress it can withstand before suffering permanent deformation. This is very important in applications that rely upon a polymer's physical strength or durability. For example, a rubber band with a higher tensile strength will hold a greater weight before snapping. In general, tensile strength increases with polymer chain length and crosslinking of polymer chains. Young's Modulus of elasticity[6]: Young's modulus quantifies the elasticity of the polymer. It is defined, for small strains, as the ratio of rate of change of stress to strain. Like tensile strength, this is highly relevant in polymer applications involving the physical properties of polymers, such as rubber bands. The modulus is strongly dependent on temperature.



III. POLYMERS AND NANOMATERIALS

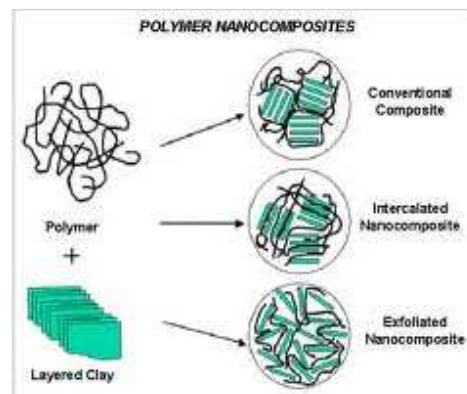
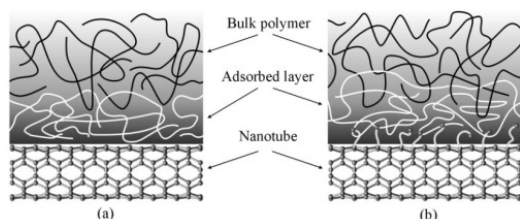
Polymer nanocomposites consist of a polymer or copolymer having nanoparticles or nanofillers dispersed in the polymer matrix. These may be of different shape (e.g., platelets, fibers, spheroids), but at least one dimension must be in the range of 1 to 50 nm. These polymer nanocomposites[6] belong to the category of multi-phase systems (blends, composites, and foams) that consume nearly 95% of plastics production. These systems require controlled mixing/compounding, stabilization of the achieved dispersion, orientation of the dispersed phase and the compounding strategies for all multi phase systems, including polymer nanocomposites are similar.

Investigating the smallest possible particles had provided the opportunity of exploring new performance standards for materials. New dimensions are appearing in material processing and applications in most disciplines of science and technology and the field of textile has no exception. From the production of synthetic fibers from polymer melt to the special finishing effects of fabric substrates, nanoparticles are occupying the positions in producing the composite structure for desired effects. Nanoparticles are atomic assembly that exhibits outstandingly different behavior than the bulk of material. An example may be seen in ceramics which are known as brittle and rigid materials. A ceramic material can be made deformable when their constituent grain size is reduced to low nanometer range. Also, a small amount of nanoparticles of a substance when included in a polymer matrix having similar size range the resulting system exhibits an exceptional performance level. This is the result of relatively significant increased surface area-to-mass ratio. The same material becomes more chemically reactive and exhibits different physical properties. Moreover, below the particle size of 50 nm, the laws of classical physics follow quantum effects that result in different optical, electrical and magnetic performance relative to the large size structure of same material.

In automobiles, perhaps the Toyota and General Motor have the leading positions in using nanocomposites. Toyota introduced first polymer/ clay auto parts in 1980s. General Motor stepped up to bring nanocomposite on road by launching first commercial auto exterior use of a nanocomposite in 2002 GMC Safari and Chevrolet Astro Van. The nanocomposite part was also on 2003, 2004 models. General Motors highest volume car, the 2004- Chevrolet Impala has body side molding composed of PP/nanoclay composite. The latest example was seen on 2005 GM Hummer H2 SUT; its cargo bed used around seven pounds of molded-in- color nanocomposite parts.

The transition from micro- to nano-particles lead to change in its physical as well as chemical properties. Two of the major factors in this are the increase in the ratio of the surface area to volume, and the size of the particle. The increase in surface area-to-volume ratio, which increases as the particles get smaller, leads to an increasing dominance of the behavior of atoms on the surface area of particle over that of those interior of the particle. This affects the properties of the particles when they are reacting with other particles. Because of the higher surface area of the nano-particles, the interaction with the other particles within the mixture is more

and this increases the strength, heat resistance, etc. and many factors do change for the mixture.



Nanostructured polymers

- Synthesis and properties
- Applications
- Beads/Gels/Biomaterials
- Processing

Solvent casting is one of the easiest and less time consuming methods for the synthesis of polymer nanocomposites. Systems in which the inorganic particles are the individual layers of a lamellar compound – most typically a smectite clay or nanocomposites of a polymer (such as nylon) embedded among layers of silicates – exhibit dramatically altered physical properties relative to the pristine polymer. For instance, the layer orientation, polymer-silicate nanocomposites exhibit stiffness, strength and dimensional stability in two dimensions (rather than one). Due to nanometer length scale which minimizes scattering of light, nanocomposites are usually transparent. Polymer nanocomposites represent a new alternative to conventionally filled polymers. Because of their nanometer sizes, filler dispersion nanocomposites exhibit markedly improved properties when compared to the pure polymers or their traditional composites. These include increased modulus and strength, outstanding barrier properties, improved solvent and heat resistance and decreased flammability. Polymers that contain transition metal complexes either attached to or directly in a π -conjugated backbone are an exciting and a promising class of modern materials. These macromolecules are hybrid of π -conjugated organic and transition metal-containing polymers. π -conjugated organic polymers,

such as polyacetylene, polythiophene, and polypyrrole, as well as oligomers and derivatives of these materials have been extensively explored. These materials are endowed with many important properties such as nonlinear optical properties, electronic conductivity and luminescence, and have been proposed for their use in various applications including chemical sensors, electroluminescent devices, electrocatalysis, batteries, smart windows and memory devices. Layered silicate/polymer nanocomposites exhibit superior mechanical



characteristics (e.g. 40% increase of room temperature tensile strength), heat resistance (e.g. 100% increase in the heat distortion temperature) and chemical resistance (e.g. ~10 fold decrease in O₂ and H₂O permeability) compared to the neat or traditionally filled resins. These property improvements result from only a 0.1-10 vol. % addition of the dispersed nanophase. Polyimide-clay hybrids represent another example of polymer nanocomposites. These nanocomposites have been prepared by intercalation of the organoclay with a polyamic acid. The claypolyimide hybrid composite films exhibit greatly improved CO₂ barrier properties at low clay content; less than 8.0 vol. % clay results in almost a ten-fold decrease in permeability. Adding nanoscale ceramic powders to commercial products can produce another class of polymer nanocomposites. The addition of reinforcing agents is widely used in the production of commodities (packaging films and tyres). It is expected that the reduction of the added particle size down to nanometric scale could enhance the performance of these materials, even though not to the extent as layer addition. These new materials are aimed at being a substitute for more expensive technical parts (gear systems in wood drilling machines, wear resistance materials) and in the production of barrier plastic film for food industry. The coatings of magnetic particles are of special interest because of their important applications viz. technological energy transformation, magnetic recording, magnetic fluids and magnetic refrigeration system. Polymer materials have been filled with several inorganic compounds in order to increase properties like heat resistance, mechanical strength and impact resistance and to decrease other properties like electrical conductivity, dielectric constant thereby increasing the permeability for gases like oxygen and water vapor. Polymer composites containing ferrites are increasingly replacing conventional ceramic magnetic materials because of their mouldability and reduction in cost. They are also potential materials for microwave absorbers, sensors and other aerospace applications. These flexible magnets or rubber ferrite composites are possible by the incorporation of magnetic powders in various elastomer matrices. This modifies the physical properties of the polymer matrix considerably. Solvent casting method is one of the easiest methods for the preparation of polymer nanocomposites. It needs simple equipment and is less time consuming.

While extensive research has been carried out in the field of structural polymer-based nanocomposites, much less investigations have been concerned with polymer nanocomposites for functional applications. Among the functional nanomaterials, nanocomposites consisting of metal nanoparticles dispersed in a dielectric matrix are of particular interest due to their novel functional properties offering hosts of new applications. Here, polymers are attractive as matrix, and several approaches have been reported to incorporate metal nanoparticles into polymers.

The present talk is concerned with the preparation of polymer-based nanocomposites by vapor phase co- and tandem deposition and the resulting functional properties. The techniques involve evaporation and sputtering, respectively, of metallic and organic components and inter alia allow the

preparation of composites which contain alloy clusters of well defined composition. Emphasis will be placed on soft-magnetic high frequency materials with cut-off frequencies well above 1 GHz and high quality factors and on optical composites with tuned plasmon resonances suitable for ultra thin color filters, Bragg reflectors, and other devices. In addition, antibacterial coatings and selective sensors for organic vapors based on nanocomposites with filling factors close to the percolation threshold will be addressed. Moreover, a novel approach to produce magnetic nanorods for potential applications in high-density data storage and other fields will be presented.

There are numerous examples where animals or plants synthesize extracellular high-performance skeletal biocomposites consisting of a matrix reinforced by nanosize crystalline domains. Cellulose and chitin are classical examples of these reinforcing elements, which occur as whisker-like microfibrils that are biosynthesized and deposited in a continuous fashion. In many cases, this mode of biogenesis leads to crystalline microfibrils that are almost defect-free, with the consequence of axial physical properties approaching those of perfect crystals.

During the last decade we have attempted to mimic biocomposite by blending cellulose or chitin whiskers from different sources with polymer matrices. Aqueous suspensions of such nanocrystals can be prepared by acid hydrolysis of the substrate. The object of this treatment is to dissolve away regions of low lateral order so that the water-insoluble, highly crystalline residue may be converted into a stable suspensoid by subsequent vigorous mechanical shearing action. The resulting nanocrystals occur as rod-like particles or whiskers, which dimensions depend on the nature of the substrate. Starch can also be used as a source for the production of nanocrystals. The constitutive nanocrystals appear as platelet-like nanoparticles with a length ranging between 20 and 40 nm, a width ranging between 15 and 30 nm and a thickness ranging between 5 and 7 nm. Since the first announcement of using cellulose whiskers as a reinforcing phase, they were extensively used as model fillers in several kinds of polymeric matrices, including synthetic and natural ones.

Casting mixtures of polysaccharide nanocrystals and lattices led to composites with drastically enhanced mechanical properties, especially at $T > T_g$ of the matrix, by virtue of the formation of a whiskers network, even when the whisker volume fraction was only a few percent. The formation of this rigid network, resulting from strong interactions between whiskers was assumed to be governed by

a percolation mechanism. This hydrogen-bonded network induced a thermal stabilization of the composite up to 500 K, the temperature at which polysaccharides start to decompose.

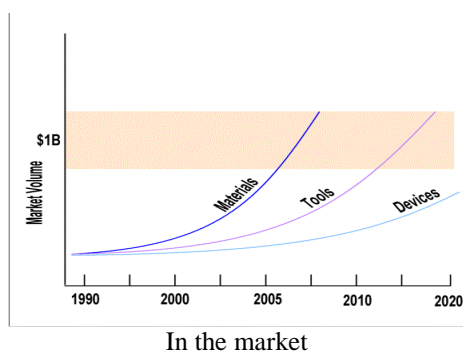
In addition to some practical applications, the study of these nanocomposite materials can help to understand some physical properties as geometric and mechanical percolation effect. α -Hematite nanorods were used as filler for the epoxy resin. Electrical and dielectrical properties of the obtained nanocomposite were investigated. DC-conductivity



measurements showed a significant influence of Fe_2O_3 -nanorods on the DC-electrical properties of the epoxy matrix. However, the observed effects of the filler below and above the glass transition are different. Because of their high specific surfaces, nanorods affected segmental mobility of epoxy molecules to a large extent, which resulted in an increase in the glass transition temperature (T_g) and a decrease in the real part of dielectric permittivity in high frequency/low temperature region.

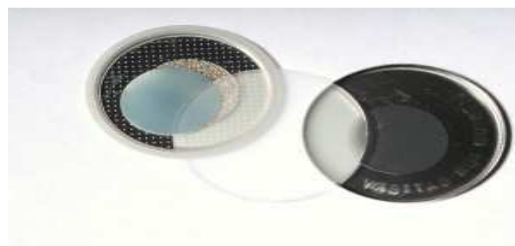
A number of exotic materials having a wide range of properties are required for accomplishing various space missions. These requirements are met to a large extent by the use of high performance polymers. The most important polymeric system used in satellite launch vehicle is the polymeric fuel binder for composite solid propellants. The present day binders have a polybutadiene backbone. Hydroxyl terminated polybutadiene (HTPB) is the state of the art binder which has been developed and produced inhouse. Polymer based insulations and inhibitors are used to protect the rocket motor case and to give the desired burning pattern to the propellant grain.

Natural fibers are increasingly used as reinforcement in commercial thermoplastics due to their low cost, high specific properties and their renewable nature, as well as the environmental concerns and a shortage of petroleum resources. In this study, the mechanical behavior of biocomposites based on biodegradable polymer matrix (PLA) was investigated. Two different kind of natural fibers using pineapple leaf and rice stem fiber as reinforcements were prepared, respectively. The natural fiber and PLA pellet were mixed and biocomposites were fabricated using a compression molding method. Regarding the chemical treatment, maleic anhydride (MA) was used as a compatibilizer between fiber and matrix. Alkali treatment can remove the lignin, oil and other impurity on the surface of the fiber. The mechanical behavior of present biocomposite is estimated to be better than that of pure PLA.



IV. RECENTLY IN NANO-FIELD

A novel self-charging power cell that has the ability to convert and store energy has been developed by researchers at the Georgia Institute of Technology. The hybrid generator-storage cell directly converts mechanical energy to chemical energy. When compared to other systems that use separate batteries and generators, the new cell makes better utilization of mechanical energy.



Components of a new self-charging piezoelectric power cell are shown in this photo. The clear disc in the center is the piezoelectric film that serves as a charge pump for lithium ions. Normally, generation of electricity and its storage are considered as separate activities and are performed in separate units. The new power cell contains both charge conversion and storage. Titanium dioxide nanotubes that have been grown upon a titanium film are used as the anode, while lithium-cobalt oxide is used as the cathode in the power cell. A polyvinylidene fluoride (PVDF) film membrane is used to separate the electrodes.

A piezoelectric potential is generated by the PVDF film when the power cell undergoes mechanical compression. This potential functions as a charge pump and drives lithium ions to the anode side where it is stored as lithium-titanium oxide. Charging takes place in cycles and gets completed when lithium-cobalt oxide gets oxidized to $\text{Li}_{1-x}\text{CoO}_2$ at the cathode and titanium dioxide gets oxidized to Li_xTiO_2 at the anode. The cycle repeats when the power cell is compressed again. The compression required may be generated even when a person walks.

On connecting an experimental electrical load, the researchers found that the power cell demonstrated a storage capacity of 0.036 mAh. Lithium ions flowed back to the cathode while electrons flowed to the load. The researcher's stated that improved packaging materials will increase the power stored by the cell.

V. CONCLUSION

Novel polymer/clay nanocomposites can be prepared by varying two parameters; first by optimizing polymer to clay ratio and second by varying the processing techniques. An exploration in making the polymer/clay nanocomposites with different clays, surfactants and polymers is a continuing subject of research and interest to both academia and industry.

REFERENCES

- [1] nanotechnology
- [2] nano-scale
- [3] polymer
- [4] tensile strength
- [5] young's modulus of elasticity
- [6] polymer nanocomposites



The Importance of Composite Interfaces in Nanotechnology

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Abstract— composite materials proved to be a boon for the aircrafts in recent few decades, still 100% composite materials made aircrafts are not yet used. This paper deals with the reason behind this fact and the use of composite materials in stealth technology. Composite materials play a great role in Stealth technology due to its exceptional properties. Interface on the other hand is the most important phenomena of composite materials especially to ensure that the load is distributed between the two constituents namely matrix and reinforcement. The types of composites and their uses are described in this paper and also materials which can be used for aircrafts are logically discussed in this paper.

Keywords-composite, types of composites, application, interfaces, stealth technology,

1. I.INTRODUCTION

What are composite materials? ^[5]To define in gist they are materials that are combinations of two or more organic and inorganic components while interfaces in composites are zones of compositional, structural, and property gradients. The versatile nature of these materials attracted the designer to use these materials for several critical aircraft structural applications. As a result, large number of materials are developed for use. Added to this, a large number of fabrication processes are also developed. To realize a cost effective civil aircraft structure, what material and process need to be used is not an easy matter to decide.

2. COMPOSITE MATERIALS.

The main reason for the slower than anticipated take up for composite material is the high cost of aircraft components as compared to similar structures made from metals and alloys. Other factors include high cost of certification for new components and their relatively low resistance to mechanical damage, low through-thickness strength, and (as compared with titanium alloys) temperature limitations. The most important polymer-matrix fibre material for aircraft structures is carbon fibre-reinforced epoxy.

Wood is a natural composite of cellulose fibres, in a matrix of lignin.^[7] The earliest man-made composite materials were straw and mud combined to form bricks for building construction. This ancient brick-making process was documented by Egyptian tomb paintings.



Composites are made up of individual materials referred to as constituent materials. There are two categories of constituent materials: matrix and reinforcement. At least one portion of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combination.

Engineered composite materials must be formed to shape. The matrix material can be introduced to the reinforcement before or after the reinforcement material is placed into the mould cavity or onto the mould surface. The matrix material experiences a melding event, after which the part shape is essentially set. Depending upon the nature of the matrix material, this melding event can occur in various ways such as chemical polymerization or solidification from the melted state.

A variety of moulding methods can be used according to the end-item design requirements. The principal factors impacting the methodology are the natures of the chosen matrix and reinforcement materials. Another important factor is the gross quantity of material to be produced. Large quantities can be used to justify high capital expenditures for rapid and automated manufacturing technology. Small production quantities are accommodated with



lower capital expenditures but higher labour and tooling costs at a correspondingly slower rate.

Many commercially produced composites use a polymer matrix material often called a resin solution. There are many different polymers available depending upon the starting raw ingredients. There are several broad categories, each with numerous variations. The most common are known as polyester, vinyl ester, epoxy, phenolic, polyimide, polypropylene, peek, and others. The reinforcement materials are often fibres but also commonly ground minerals. The various methods described below have been developed to reduce the resin content of the final product, or the fibre content is increased. As a rule of thumb, lay up results in a product containing 60% resin and 40% fibre, whereas vacuum infusion gives a final product with 40% resin and 60% fibre content. The strength of the product is greatly dependent on this ratio.

A. Properties of Composites

Composites offer many advantages over other materials. Within aerospace and marine markets, where exceptional performance is required but weight is critical, composites continue to grow in importance.^[3] The most distinct properties of composites may be summarized as: 1) Stronger and stiffer than metals on a density basis for the same strength, lighter than steel by 80% and aluminum by 60%. 2) Superior stiffness-to-weight ratios. 3) Capable of high continuous operating temperatures Up to 250°. 4) Highly corrosion resistant. 5) High energy absorption or high energy conductivity. 6) Exceptional formability. 7) Outstanding durability. Well-designed composites have exhibited apparent infinite life characteristics, even in extremely harsh environments.

B. Types of Composites

1) Reinforcements: The primary function of fibers or reinforcements is to carry load along the length of the fiber to provide strength and stiffness in one direction. The largest volume reinforcement is glass fiber.

2) Fillers:^[2] Fillers are used to improve performance and reduce the cost of a composite by lowering compound cost of the significantly more expensive

resin and imparting benefits as shrinkage control, surface smoothness, and crack resistance.

3) Additives: Additives and modifier ingredients expand the usefulness of polymers, enhance their process ability or extend product durability

Each of these constituent materials play an important role in the processing and final performance of the end product.

C. Applications and advantages

Each year, composites find their way into hundreds of new applications, from golf clubs and tennis rackets to jet skis, aircraft, missiles and spacecraft.^[1] Composite materials offer designers an increasing array of a material and system solution.

Advantages: 1) Defense applications 2) Enhanced field effectiveness 3) Improved handling 4) High impact tolerance 5) Insensitive to climate and temperatures 6) Reduced maintenance costs.

3. IMPACT OF COMPOSITES ON AIRCRAFT INDUSTRY

As is known, the development of high-performance aerospace vehicles gives rise to an increasing demand for advanced structures made of laminated composite materials and smart materials. Since the early 1990's, composites are mainly used on many different exterior panels, fairings, and structures for use on commercial and business aircraft. Composite aircraft structures provide improved strength and stiffness to weight performance, versus conventional fabricated aluminum structures. They offer improved fatigue life. They can be primed and painted like the rest of the airplane, and then corrosion eliminated in those areas of the airplane. Fiberglass is the most common composite material, and consists of glass fibers embedded in a resin matrix. Fiberglass was first used in the Boeing 707 passenger jet in the 1950s, where it comprised about two percent of the structure. By the 1960s, other composite materials became available, in particular boron fiber and graphite, embedded in epoxy resin

A. Commonly used composites in aircrafts: Fiber Reinforced Plastic (FRP), Carbon fiber reinforced plastic (CFRP):

1) Carbon Fiber



is a material consisting of extremely thin fibers about 0.0002–0.0004 inches (0.005–0.010 mm) in diameter and composed mostly of carbon atoms. Carbon fiber can be combined with a plastic resin and wound or molded to form composite materials such as carbon fiber reinforced plastic (also referenced as carbon fiber) to provide a high strength-to-weight ratio material.

CFRP is widely used in automotive and aerospace industries.

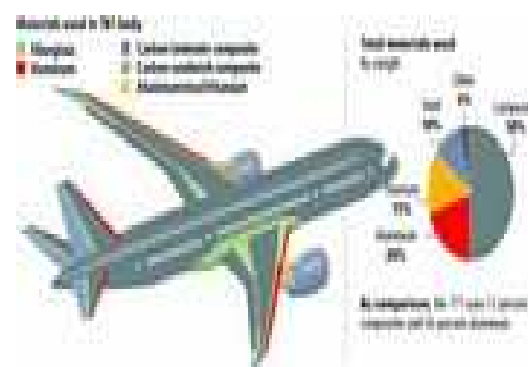
Much of the fuselage of the new Boeing 787 Dream liner and AirbusA350 XWB will be composed of CFRP, making the aircraft lighter than comparable aluminum fuselage, with the added benefit of less maintenance thanks to CFRP's superior fatigue resistance. Due to its high ratio of strength to weight, CFRP is widely used in micro air vehicles

2) Some of the other FRPs used are GFR (glass fiber), AFRP (Aramid fiber), Nano Composites KFRP (Kevlar fiber) etc.

4. STEALTH TECHNOLOGY AND USES OF COMPOSITE MATERIALS IN IT.

Stealth technology also termed LO technology (low observable technology) is a sub-discipline of military tactics and passive electronic countermeasures, which cover a range of techniques used with personnel, aircrafts, ships, submarines, and missiles to make them less visible (ideally invisible) to radar, infrared, sonar and other detection methods. Development in the United States occurred in 1958 where earlier attempts in preventing radar tracking of its U-S spy planes during the Cold war by the Soviet had been unsuccessful. Designers turned to develop a particular shape for planes that tended to reduce detection, by redirecting Electromagnetic waves from radars. Radar absorbent materials were also tested and made to reduce or block radar signals that reflect off from the surface of planes. Such changes to shape and surface composition form stealth technology as currently used on the Northrop Grumman B-2 Spirit "Stealth Bomber". The concept of stealth is to operate or hide without giving enemy forces any indications as to the presence of friendly forces. This concept was first explored through camouflage by blending into the background visual clutter. As the potency of detection and interception technologies (radar, IRST, surface-to-air missiles etc.) have increased over time, so too has the extent to which the design and operation of military

personnel and vehicles have been affected in response. Some military uniforms are treated with chemicals to reduce their infrared signature. A modern "stealth" vehicle will generally have been designed from the outset to have reduced or controlled signature. Varying degrees of stealth can be achieved. The exact level and nature of stealth embodied in a particular design is determined by the prediction of likely threat capabilities. Dielectric composites are more transparent to radar, whereas electrically conductive materials such as carbon as metals and fibers reflect electromagnetic energy incident on the material's surface. Composites may also contain ferrites to optimize the dielectric and magnetic properties of a material for its application. Radar signals pass right through composites, a property that makes composites ideal materials for use anywhere radar equipment is operating, whether on the ground or in the air. Composites play a key role in stealth aircraft, such as the U.S. Air Force's B-2 stealth bomber, which is nearly invisible to radar. Stealth technologies work by reducing or eliminating these telltale signals. Panels on planes are angled so that radar is scattered and no signal returns. Planes are also covered in a layer of absorbent materials that reduce any other signature the plane might leave. They are also made of composite materials for this purpose. Shape also has a lot to do with the 'invisibility' of stealth planes. Extreme aerodynamics keep air turbulence to a minimum and cut down on flying noise. The B-2 stealth bomber has a "bat-wing" shape to reduce its RADAR cross-section, as well as visual recognition, especially on the horizon. Special low-noise engines are contained inside the body of the plane. Hot fumes are then capable of being mixed with cool air before leaving the plane. This fools





Prepregs	Resin infusion	Autoclave Moulding	Floor beams
a) All control surfaces	Bottom skin with integral ribs and spars of the wing	All leading edges(wing, fin, horizontal stabilizer	Floors Honey comb panels (glass + nemex core)
b)empennage	Radome (glass or Kevlar fibers with low loss polyester resin)		
c)wing top skin	Wing tip – glass fiber epoxy		
d)front fuselage	Horizontal stabilizer tip- glass fiber epoxy	Glass fiber epoxy	
e)machined bulk-heads of fuselage	Fin tip- glass fiber epoxy	Glass fiber epoxy	Rtm Window frames (carbon epoxy)
d)doors			Wing-fuselage fairing fin fuselage fairing
Fuselage skin panels with integral stiffeners			

5. AGEING AIRCRAFTS, A MAJOR CONCERN:

According to a study by the India Strategic defense magazine ,IAF needs to replace and augment nearly 100 percent of its fighter, transport and helicopter fleet for the simple reason that all of them are around 20 years old or more. The rising number of air crashes

in our Indian Armed forces, both because there were no advanced jet trainers (AJTs) and also assume of the aircraft were getting old.

The air force now needs to replace as well as augment its aircraft and systems in line with modern technology. The IAF is embarking on a massive overhaul of its fleet of combat aircraft, including its Jaguars (background) and some MiG-21 fighters (foreground). Conservative estimate puts the total cost of upgrading some 300 of the service's existing aircraft at more than \$3.5 billion over the next five to seven years. IAF has some of the following aircrafts for specific roles apart from transport and helicopter fleets. Role Aircraft: 1) Air superiority and Multi-role combat 2) Su-30 MKI (48nos) MIRAGE-2000 (46nos) 3) MiG- 21 (+/- 400nos) 4) MiG-29 (54nos) 5) Strike, attack and offensive support 6) JAGUAR (84nos) MiG-27 (109nos) 7) Reconnaissance and AWACS 8) MiG-23 (18nos) IL-76 (24nos) The majority of fighter jets forming frontline air defense are the Russian made MiG-21s. The Indian Air Force's affair with the MiG-21 spans nearly forty years. The first MiG-21s, arrived in October 1963. The MiG-21 airframe has a 3,500-hour life. Frequent replacement of airframe is not practically possible due to the cost factors involved and also due to the non-availability of spare parts. The Mig-21 airframe is mainly made of aluminium and other metals which are comparatively heavier and weaker than the composite materials. With IAF's fighter squadrons depleting fast, the need to maintain the operational readiness level is very much in need. So what is the solution?

6. COMPOSITES – THE ULTIMATE SOLUTION

Composites are the most important materials to be adapted for aviation since the use of aluminum in the 1920s. One useful feature of composites is that they can be layered, with the fibers in each layer running in a different direction. This allows materials engineers to design structures that behave in certain ways. For instance, they can design a structure that will bend in one direction, but not another. The indigenous HANSA, by HAL is India's first all composite aircraft. Currently seven are flying in Indian sky. Also about 40% of the LCA- Tejas is made of composites. The designers of the Grumman X-29 (below) experimental plane used this attribute of composite materials to design forward-swept wings that did not bend up at the tips like metal wings of the same shape would have bent in flight. The greatest value of composite materials is that they can be both



lightweight and strong. The heavier an aircraft weighs, the more fuel it burns, so reducing weight is important to aeronautical engineers. Modern military aircraft, such as the F-22, use composites for at least a third of their structures, and some experts have predicted that future military aircraft will be more than two-thirds composite materials. EADS' Euro fighter Typhoon is made of almost 80% of Carbon fiber composites which gives them an airframe life span of 6000 hours which is almost double the lifetime of an MiG21 airframe. Hence by Upgrading the MiG21's airframe composite structures, we can improve fatigue.

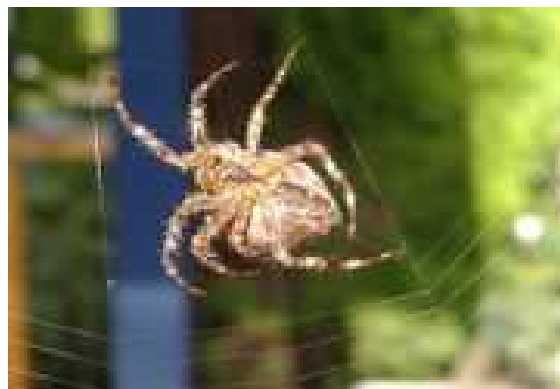
7. INTERFACES IN COMPOSITES.

Interfaces are among the most important yet least understood components of a composite material. In particular, there is a lack of understanding of processes occurring at the atomic level of interfaces, and how those processes influence the global material behavior. There is a close relationship between the processes that occur on the atomic, microscopic, and macroscopic levels. In fact, knowledge of the sequences of events occurring on these different levels is extremely important in understanding the nature of interfacial phenomena. Interfaces in composites, often considered as surfaces, are in fact zones of compositional, structural, and property gradients, typically varying in width from a single atom layer to micrometers. Characterization of the mechanical properties of interfacial zones is necessary for understanding mechanical behavior. In fact, the mechanical characteristics of a fiber/resin composite depend primarily on the mechanical properties of the combined material, the surface of the fiber, and the nature of the fiber/resin bonding as well as the mode of stress transfer at the interface. Among the many factors that govern the characteristics of composites involving a fibrous material, such as carbon, glass, or ceramic, and a macromolecular matrix, it is certain that the adhesion between fiber and matrix plays a predominant part. The stress transfer at the interface requires an efficient coupling between fiber and matrix. It is important to optimize the interfacial bonding since a direct linkage between fiber and matrix gives rise to a rigid, low impact resistance material.

8. FUTURE COMPOSITES

A. Ceramic Matrix Composites

Major efforts are underway to develop light-weight, high-temperature composite materials. NASA Aeronautics and Space Administration (NASA) for use in aircraft parts. Temperatures as high as 1650°C are anticipated for the turbine inlets of a conceptual engine based on preliminary calculations^[2]. In order for materials to withstand such temperatures, the use of Ceramic Matrix Composites (CMCs) is required. The use of CMCs in advanced engines will also allow an increase in the temperature at which the engine can be operated, leading to increased yield. Although CMCs are promising structural materials, their applications are limited due to lack of suitable reinforcement materials, processing difficulties, lifetime and cost.



Scientists have as of yet been unable to perfectly re-synthesize spider silk.

B. Spider Silk fibers.

Spider silk is another promising material for composite material usage. Spider silk exhibits high ductility, allowing stretching of a fibre up to 140% of its normal length.^[12] Spider silk also holds its strength at temperatures as low as -40°C.^[12] These properties make spider silk ideal for use as a fibre material in the production of ductile composite materials that will retain their strength even at abnormal temperatures. Ductile composite materials will be beneficial to an aircraft in parts that will be subject to variable stresses, such as the joining of a wing with the main fuselage. The increased strength, toughness and ductility of such a composite will allow greater stresses to be applied to the part or joining before catastrophic failure occurs. Synthetic spider silk based composites will also have the advantage that their fibres will be biodegradable.



Many unsuccessful attempts have been made at reproducing spider silk in a laboratory, but perfect re-synthesis has not yet been achieved.^[13]

C. Hybrid Composite Steel Sheets

promising material can be stainless steel constructed with inspiration from composites and nanotech-fibres and plywood. The sheets of steel is made of same material and is able to handle and tool exactly the same way as conventional steel. But is some percent lighter for the same strengths. This is especially valuable for vehicle manufacturing. Patent pending, swedish company Lamera is a spinoff from research within Volvo Industries.^[3]

9. GLOBAL FAILURE

Interface failure is a common failure mode which is observed in reinforced composite materials. However, the macroscopic failure of reinforced composites is a complex process, which usually is investigated experimentally on a macroscopic scale, providing overall properties of the material. The global failure of composites is due to the accumulation of elementary processes, like fiber breakage, matrix cracking and interface failure.

Commonly, the failure process begins with a fiber break, developing at a surface defect. After total fiber break occurs, interfacial de bonding starts, causing a very large portion of strain energy to be released. It is worth the effort to analyze these elementary failure processes on a microscopic scale. Essential parameters to be considered are the energy release rate of the interface as well as the interface friction after de Aboning. It becomes clear, then, that adhesion of the fiber and the matrix at the composite interface is fundamental to the failure of the composite. As such, approaches to measure the adhesion are necessary. Also, ways to control and increase the adhesion are desired. There are several commonly used techniques which have been developed to determine the interfacial adhesion in composite materials. Among these is the single fiber pullout test or a so-called micro bond technique^[1]. In this test, a very small amount of resin in the form of a micro droplet is deposited on a single filament. The force required to displace the micro droplet is recorded and used to compute the interfacial shear strength. Another common technique is the single fiber fragmentation test^[2]. In this test, a test specimen consists of one fiber encapsulated in the polymer matrix in a dog bone shape. Elongating the specimen in a tensile tester results in fiber breakage.

The fiber breaks into incrementally smaller fragments at locations where the fiber's axial stress reaches its tensile strength. The fragment length at which no more breaks occur when applying further strain to the specimen is measured and from this calculation of the interfacial shear stress is done. An issue with these and other tests, including single fiber compression testing, is that different tests are unable to provide similar answers for the level of adhesion of a given composite system. In fact, even for the same test, round robin testing has shown that different results are obtained in different laboratories. However, although these tests up to now do not result in quantitative measures for the adhesion between fiber and matrix, a given test procedure at a given laboratory can be used to characterize and compare different composite systems. These issues with existing characterization techniques for the adhesion in composites have been one of the factors prompting continued development of new characterization methods. One of the recent advances in this area has been the establishment of in-situ monitoring methods. These techniques allow for the measurement of the composite properties during the fabrication process as well as during the use of the composite material. As such, they provide real-time feedback on the composite performance. Among approaches which are being developed in this regard are the use of ultrasonic and fiber optic sensors which monitor the events which are occurring at the interface under load conditions^[3]. This is in comparison to past approaches in which it was necessary to remove the load from the structure, place a transducer on the structure and, then, inspect the unloaded structure. This approach is often time-consuming and the most effective use of time and resources. This in-situ monitoring technology is becoming increasingly important as the concept of seal-healing composites continues to develop. These materials work through a mechanism that involves the release of a healing agent which is initiated by the formation of micro cracks in the composite^[4]. The healing agent flows down through the crack and comes into contact with a polymerization catalyst, which begins the polymerization process. This process eventually bonds the crack closed.

10. CONCLUSION

Due to their reduced weight, composite materials have an advantage over conventional metallic materials; although, currently it is expensive to fabricate composites. Until techniques are introduced to reduce initial implementation costs and address the issue of non-biodegradability of current composites,



this relatively new material will not be able to completely replace traditional metallic alloys.

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ROLE OF BIOTECHNOLOGY

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Abstract— Nano biotechnology is the term that refers to the intersection of nanotechnology and biology. The subject is one that has only emerged very recently, it serves as a blanket terms for various related technologies. This discipline helps to indicate the merging of biological research with various fields of nanotechnology. Nano biotechnology is more widespread, in that it simply provides more tools for the study of biology & promises to recreate biological mechanisms and pathways in a form that is useful in many ways. Most of the devices designed for Nano biotechnological use are directly based on other existing nanotechnologies. Nano biotechnology helps modern medicine progress from treating symptoms to generating cures and regenerating biological tissues. DNA nanotechnology is one important example of bio nanotechnology. DNA nanotechnology is the design and manufacture of artificial nucleic acid structures for technological uses. In this field, nucleic acids are used as non-biological engineering materials for nanotechnology rather than as the carriers of genetic information in living cells. This use is enabled by the strict base pairing rules of nucleic acids, which cause only portions of strands with complementary base sequences to bind together to form strong, rigid double helix structures.

1. Introduction

In this presentation we are going to enumerate about the Nano biotechnology and its applications. Also about the DNA Nano biotechnology which is one of the most important applications of Nano biotechnology

2. Nanotechnology

Nanotechnology (sometimes shortened to "nanotech") is the manipulation of matter on an atomic and molecular scale. Generally, nanotechnology works with materials, devices, and other structures with at least one dimension sized

from 1 to 100 nanometers. Quantum mechanical effects are important at this quantum-realm scale Nanotechnology is very diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly from developing new materials with dimensions on the Nano scale to direct control of matter on the atomic scale Nanotechnology entails the application of fields of science in surfacescience, organic, chemistry, molecular biology, semiconductor, physics, micro fabrication etc.



3. Nano biotechnology

A decade ago Nano particles were studied because of their size-dependent physical and chemical properties. Now they have entered a mericial exploration period. Living organisms are built of sizes that are typically 10 μ m. however the cell parts are much smaller are in the sub-micron size domain. Even smaller are the proteins with a type size are just 5nm ,which is comparable with a dimension of smallest man-made Nano particles .This simple size comparison gives an idea of using Nano particles as a very small probes that would allow as to spy as a cellular machinery without introducing to much interference. Understanding of biological processes



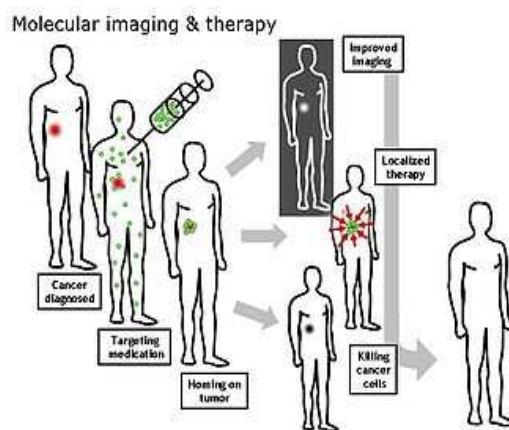
on Nano level is a strong driving force behind the development of nanotechnology to the Nano biotechnology. Nano biotechnology (sometimes referred to as Nano biology) is best described as helping modern medicine progress from treating symptoms to generating cures and regenerating biological tissues. Three American patients have received whole cultured bladders with the help of doctors who use Nano biology techniques in their practice. Also, it has been demonstrated in animal studies that an uterus can be grown outside the body and then placed in the body in order to produce a baby. Stem cell treatments have been used to fix diseases that are found in the human heart and are in clinical trials in the United States. There is also funding for research into allowing people to have new limbs without having to resort to prosthesis. Artificial proteins might also become available to manufacture without the need for harsh chemicals and expensive machines. It has even been surmised that by the year 2055, computers may be made out of biochemical and organic salts. The utilization of the inherent properties of nucleic acids like DNA to create useful materials is a promising area of modern research. Another important area of research involves taking advantage of membrane properties to generate synthetic membranes. Protein folding studies provide a third important avenue of research, but one that has been largely inhibited by our inability to predict protein folding with a sufficiently high degree of accuracy. Given the myriad uses that biological systems have for proteins, though, research into understanding protein folding is of high importance and could prove fruitful for bio nanotechnology in the future. Nano- systems in biology, the most complex and highly functional Nano-scale materials and machines have been invented by nature. Proteins and nucleic acids, and other naturally occurring molecules (polymers) regulate and control biological systems with incredible precision. Many nanotechnologists are in fact drawing inspiration from biology to device new materials and devices

4. Some of the innovative challenges in the field of biology are:

1. New molecular imaging techniques
2. Quantitative analytical tools
3. Physical model of the cell as a machine

4. Better ex-vivo tests and improvement in current laboratory techniques and
5. Better drug delivery systems

i) New molecular imaging techniques are important to probe Nano-scale physiological processes in human organs. Such a system would help to diagnose the disease at the early stages, and to understand the effects of therapies given to the patient.



ii) Quantitative analytical tools help us to understand how cell functions are regulated at the molecular level. Such an understanding would help for advancement of cell biology and help to invent better medicines.

iii) Physical model of cell as a machine is essential to understand how the components of cell work together to accomplish a task. Genomics, proteomics, and metabolomics combined with the power of Nano biotechnology, will thus help in understanding the disease in a way that was previously not possible. Eventually, it is expected that the disease will be targeted more effectively and precisely.

iv) Ex-vivo tests and improvement in current laboratory techniques would allow for measurement with greater sensitivities and specificities. Apart from helping to achieve the above nanotechnology would play an important role in sustainability of agriculture, water, energy, materials, and clean environment. Nanotechnology will lead to dramatic changes in the use of natural resources, energy, and water. Waste and pollution is expected to be minimized.



Moreover, new technologies will allow recovery and reuse of materials, energy, and water.

v) Technology is turning around to help the humans by providing easier methods to keep up a healthy living. As the population in the modern times ages, scientists are finding it difficult to manage the right combination of drugs to make them effective. The existing means of intake of drugs orally or through injections are becoming moderately effective and can be extremely painful due to the non-availability of accurate diagnosis. One of the newer methods to deliver drugs at the right place, time, and amounts is being addressed through Nanobiotechnology. Scientists and engineers have come out with new systems where the human-body parameters are monitored using a semiconductor chips that is placed inside a human body. The information recorded/acquired is then transmitted to another wrist-watch like equipment using telemetry, which, in turn, instructs the semiconductor chip to deliver the right amounts of drug to the right place. Nanotechnology has been a boon for the medical field by delivering drugs to specific cells using nanoparticles. The overall drug consumption and side-effects can be lowered significantly by depositing the active agent in the morbid region only and in no higher dose than needed. This highly selective approach reduces costs and human suffering. An example can be found in dendrimers and Nano porous materials. Another example is to use block co-polymers, which form micelles for drug encapsulation. They could hold small drug molecules transporting them to the desired location. Another vision is based on small electromechanical systems; nanoelectromechanical systems are being investigated for the active release of drugs. Some potentially important applications include cancer treatment with iron nanoparticles or gold shells. A targeted or personalized medicine reduces the drug consumption and treatment expenses resulting in an overall societal benefit by reducing the costs to the public health system. Nanotechnology is also opening up new opportunities in implantable delivery systems, which are often preferable to the use of injectable drugs, because the latter frequently display first-order kinetics (the blood concentration goes up rapidly, but drops exponentially over time). This rapid rise may cause difficulties with toxicity, and

drug efficacy can diminish as the drug concentration falls below the targeted range.



For example: When a patient is being treated for diabetes, the semiconductor chip monitors the blood-sugar levels and passes on the information to the device outside of the body. The external device, in turn, instructs the semiconductor chip that acts as the drug delivery system, to release the right amounts of insulin into the blood, thus causing less or no side effects to the patient.

5. Recent developments in Nano biotechnology

i) Tissue engineering

Natural bone surface is quite often contains features that are about 100 nm across. If the surface of an artificial bone implant were left smooth, the body would try to reject it. Because of that smooth surface is likely to cause production of a fibrous tissue covering the surface of the implant. This layer reduces the bone-implant contact, which may result in loosening of the implant and further inflammation. It was demonstrated that by creating Nano-sized features on the surface of the hip or knee prosthesis one could reduce the chances of rejection as well as to stimulate the production of osteoblasts. The osteoblasts are the cells responsible for the growth of the bone matrix and are found on the advancing surface of the developing bone.

The effect was demonstrated with polymeric, ceramic and, more recently, metal materials. More than 90% of the human bone cells from suspension adhered to the nanostructures metal surface but only 50% in the control sample. In the end this findings would allow to design a more durable and longer lasting hip or knee replacements and to reduce the chances of the implant getting loose.



Titanium is a well-known bone repairing material widely used in orthopedics and dentistry. It has a high fracture resistance, ductility and weight to strength ratio. Unfortunately, it suffers from the lack of bioactivity, as it does not support cell adhesion and growth well. Apatite coatings are known to be bioactive and to bond to the bone. Hence, several techniques were used in the past to produce an appetite coating on titanium. Those coatings suffer from thickness non-uniformity, poor adhesion and low mechanical strength. In addition, a stable porous structure is required to support the nutrients transport through the cell growth.

It was shown that using a biomimetic approach – a slow growth of nanostructures apatite film from the simulated body fluid – resulted in the formation of a strongly adherent, uniform Nano porous layer the layer was found to be built of 60 nm crystallites, and possess a stable Nano porous structure and bioactivity.

A real bone is a Nano composite material, composed of hydroxyapatite crystallites in the organic matrix, which is mainly composed of collagen. Thanks to that, the bone is mechanically tough and, at the same time, plastic, so it can recover from a mechanical damage. The actual Nano scale mechanism leading to this useful combination of properties is still debated.

An artificial hybrid material was prepared from 15–18 nm ceramic nanoparticles and poly (methyl methacrylate) copolymer Using tribology approach, a viscoelastic behavior (healing) of the human teeth was demonstrated. An investigated hybrid material, deposited as a coating on the tooth surface, improved scratch resistance as well as possessed a healing behavior similar to that of the tooth.

ii) Cancer therapy

Photodynamic cancer therapy is based on the destruction of the cancer cells by laser generated atomic oxygen, which is cytotoxic. A greater quantity of a special dye that is used to generate the atomic oxygen is taken in by the cancer cells when compared with a healthy tissue. Hence, only the cancer cells are destroyed then exposed to a laser radiation.

Unfortunately, the remaining dye molecules migrate to the skin and the eyes and make the patient very sensitive to the daylight exposure. This effect can last for up to six weeks.

To avoid this side effect, the hydrophobic version of the dye molecule was enclosed inside porous nanoparticles the dye stayed trapped inside the Ormosil nanoparticles and did not spread to the other parts of the body. At the same time, its oxygen generating ability has not been affected and the pore size of about 1 nm freely allowed for the oxygen to diffuse out.

iii) Protein detection

For dye signature detection with a standard Proteins are the important part of the cell's language, machinery and structure, and understanding their functionalities is extremely important for further progress in human wellbeing. Gold nanoparticles are widely used in immunohistochemistry to identify protein-protein interaction. However, the multiple simultaneous detection capabilities of this technique are fairly limited. Surface-enhanced Raman scattering spectroscopy is a well-established technique for detection and identification of single dye molecules. By combining both methods in a single nanoparticles probe one can drastically improve the multiplexing capabilities of protein probes. The group of Prof. Mirkin has designed a sophisticated multifunctional probe that is built around a 13 nm gold nanoparticles. The nanoparticles are coated with hydrophilic oligonucleotides containing a Raman dye at one end and terminally capped with a small molecule recognition element (e.g. biotin). Moreover, this molecule is catalytically active and will be coated with silver in the solution of Ag(I) and hydroquinone. After the probe is attached to a small molecule or an antigen it is designed to detect, the substrate is exposed to silver and hydroquinone solution. A silver-plating is happening close to the Raman dye, which allows Raman microscope. Apart from being able to recognize small molecules this probe can be modified to contain antibodies on the surface to recognize proteins. When tested in the protein array format against both small molecules and proteins, the probe has shown no cross-reactivity.

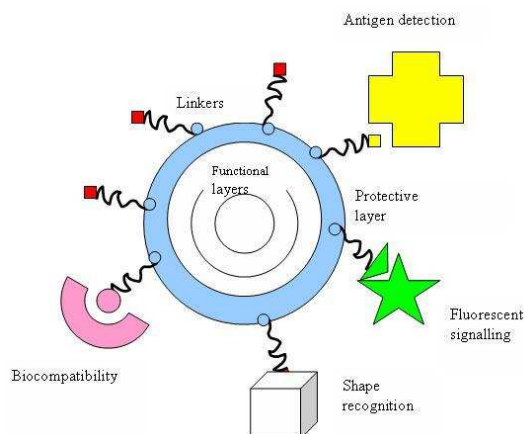


6. Applications

A list of some of the applications of nanomaterial's to biology or medicine is given below:

- DNA Nanotechnology
- Fluorescent biological labels
- Drug and gene delivery
- Bio detection of pathogens
- Detection of proteins
- Probing of DNA structure
- Tissue engineering
- Tumor destruction via heating (hyperthermia)
- Separation and purification of biological molecules and cells
- MRI contrast enhancement
- Phagokinetic studies

As mentioned above, the fact that nanoparticles exist in the same size domain as proteins makes nanomaterial's suitable for bio tagging or labeling. However, size is just one of many characteristics of nanoparticles that it is rarely sufficient if one is to use nanoparticles as biological tags. In order to interact with biological target, a biological or molecular coating or layer acting as a bioinorganic interface should be attached to the nanoparticles. Examples of biological coatings may include antibodies, biopolymers like collagen or monolayers of small molecules that make the nanoparticles biocompatible. In addition, as optical detection techniques are wide spread in biological research, nanoparticles should either fluoresce or change their optical properties. The approaches used in constructing Nano-biomaterials are schematically presented below.



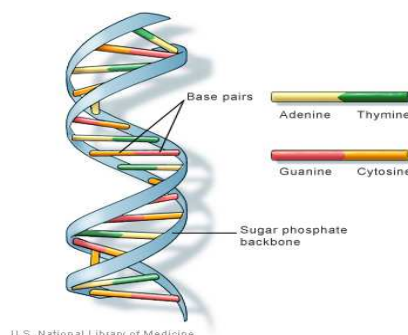
Here we are going to explain briefly about the most important applications of Nano biotechnology which is DNA Nanotechnology.

7. DNA Nanotechnology

What is DNA?

DNA, or deoxyribonucleic acid, is the hereditary material in humans and almost all other organisms. Nearly every cell in a person's body has the same DNA. Most DNA is located in the cell nucleus (where it is called nuclear DNA), but a small amount of DNA can also be found in the mitochondria (where it is called mitochondrial DNA or mtDNA).

DNA bases pair up with each other, A with T and C with G, to form units called base pairs. Each base is also attached to a sugar molecule and a phosphate molecule. Together, a base, sugar, and phosphate are called a nucleotide. Nucleotides are arranged in two long strands that form a spiral called a double helix. The structure of the double helix is somewhat like a ladder, with the base pairs forming the ladder's rungs and the sugar and phosphate molecules forming the vertical sidepieces of the ladder. An important property of DNA is that it can replicate, or make copies of itself. Each strand of DNA in the double helix can serve as a pattern for duplicating the sequence of bases. This is critical when cells divide because each new cell needs to have an exact copy of the DNA present in the old cell.





What is DNA Nanotechnology?

DNA Nano technology is the field in Nano technology that uses the unique structure of DNA to create different structures

DNA nanotechnology is the design and manufacture of artificial nucleic acid structures for technological uses. In this field, nucleic acids are used as non-biological engineering materials for nanotechnology rather than as the carriers of genetic information in living cells. This use is enabled by the strict base pairing rules of nucleic acids, which cause only portions of strands with complementary base sequences to bind together to form strong, rigid double structures. This allows for the rational design that will selectively assemble to form complex target structures with precisely controlled Nano scale features.

8. Nucleic acid

Nucleic acids are biological molecules essential for known forms of life on Earth. They include DNA (deoxyribonucleic acid) and RNA (ribonucleic acid). Together with proteins, nucleic acids are the most important biological macromolecules; each is found in abundance in all living things, where they function in encoding, transmitting and expressing genetic information.

9. DNA is an excellent Nano construction material because of its inherent merits:

- The rigorous Watson-Crick base pairing makes the hybridization between DNA strands highly predictable.
- The structure of the B-form DNA double helix is well-understood.
- DNA possesses combined structural stiffness and flexibility. The rigid DNA double helices can be linked by relatively flexible single-stranded DNA (ss-DNA) to build stable motifs with desired geometry.
- Modern organic chemistry and molecular biology have created a rich toolbox for readily synthesizing,
- Modifying, and replicating DNA molecules.
- DNA is a biocompatible material, making it suitable for the construction of multi

component nanostructures made from hetero biomaterials.

DNA nanotechnology is sometimes divided into two overlapping subfields:

- i) Structural DNA nanotechnology
- ii) Dynamic DNA nanotechnology

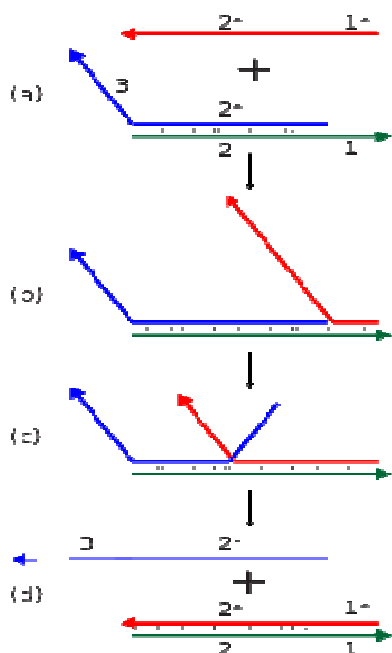
10. Structural DNA nanotechnology

Structural DNA nanotechnology, sometimes abbreviated as SDN, focuses on synthesizing and characterizing nucleic acid complexes and materials where the assembly has a static, equilibrium endpoint. The nucleic acid double helix has a robust, defined three-dimensional geometry that makes it possible to predict and design the structures of more complicated nucleic acid complexes. Many such structures have been created, including two- and three-dimensional structures, and periodic, aperiodic, and discrete structures

11. Dynamic DNA nanotechnology

Dynamic DNA nanotechnology often makes use of toehold-mediated strand displacement reactions. In this example, the red strand binds to the single stranded toehold region on the green strand (region 1) And then in a branch migration process across region 2) the blue strand is displaced and freed from the complex. Reactions like these are used to dynamically reconfigure or assemble nucleic acid nanostructures. In addition, the red and blue strands can be used as signals in a molecular logic gate

Dynamic DNA nanotechnology focuses on creating nucleic acid systems with designed dynamic functionalities related to their overall structures, such as computation and mechanical motion. There is some overlap between structural and dynamic DNA nanotechnology, as structures can be formed through annealing and then reconfigured dynamically, or can be made to form dynamically in the first place



12. Advantages of using DNA Nano biotechnology

- Easy to program and predict intermolecular inter molecular interactions with DNA sticky ends
- Local structure of DNA is known, making it easy to manipulate DNA for constructing
- DNA can hold components in place for molecular electronic devices
- DNA's solid support synthesis can be used for DNA based computing
- DNA can also be manipulated using different enzymes
- DNA is the best Nano wire in existence because
- It can self-assemble
- It can self-replicate
- It can adopt various states and conformations
- Different DNA can be insulating, semiconducting, or metallic

13. Applications of DNA Nanotechnology

DNA nanotechnology is moving towards potential real-world applications. The ability of nucleic acid arrays to arrange other molecules indicates its potential applications in molecular scale electronics. The assembly of a nucleic acid structure could be used to template the assembly of molecular electronic elements such as molecular wires, providing a method for nanometer-scale control of the placement and overall architecture of the device analogous to a molecular breadboard. DNA nanotechnology has been compared to the concept of programmable matter because of the coupling of computation to its material properties.

There are potential applications for DNA nanotechnology in Nanomedicine, making use of its ability to perform computation in a biocompatible format to make "smart drugs" for targeted drug delivery. One such system being investigated uses a hollow DNA box containing proteins that induce apoptosis, or cell death, that will only open when in proximity to a cancer cell. There has additionally been interest in expressing these artificial structures in engineered living bacterial cells, most likely using the transcribed RNA for the assembly, although it is unknown whether these complex structures are able to efficiently fold or assemble in the cell's cytoplasm. If successful, this could enable directed evolution of nucleic acid nanostructures.

14. Conclusion

- DNA Nano Biotechnology has the potential to greatly affect the future
- The very specific bonding properties make DNA a widely useable structural material
- In the future more and more uses of DNA Nano technology will be continued to be found



Proceedings of the “National Nanotechnology Meet on Energy and Environment” organized by Centre for Nanoscience & Nanotechnology, Sathyabama University in association with Ministry of Earth Sciences (MoES), New Delhi, 3-5 September, 2012.

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Ethyl Amine Induced Tall Mutants in Jute

(*Corchorus olitorius* L.)

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ABSTRACT

Presoaked seeds of jute (*Corchorus olitorius* L. Variety JRO-632) were treated with 1% Ethyl amine for 6 hours. Tall mutants were screened in M3 in contrast to the normal plants. Tall mutants otherwise looked normal excepting the nature of palmate leaf habit. A number of yield component growth parameters were recorded like plant height, basal diameter, plant spread, root length, pod per plant, seeds per pod, pod length/ breadth ratio, number of primary branches per plant, number of secondary branches per plant, leaf angle, branching angle, first flowering date, 100% flowering date, total duration, % of pollen sterility and weight of 100 seeds which were found to vary from the control plant. Chromosome analysis revealed a number of aberrations like stickiness, fragmentation, clumping, polyploidy, and laggard and bridge formation etc. at very low frequency. This tall mutant plant gives more fiber yield than the control plants with superior quality.

Key words: Ethyl amine, *Corchorus olitorius* L., Tall mutant, 6 hours, chromosome, concentration 1%

I. Introduction

Jute (*Corchorus olitorius* L. Variety JRO-632) is one of the very important fiber yielding cash crops with great demand in International market. A number of mutants in jute were reported through genetic manipulation by application of ionizing radiations (Kundu, 1944, Ghosh, 1969, Hossain, 1970 and Basu, 1967). However, Chemical mutagenesis in jute is still lacking although considerable work has been done on this line in other commercial crops, the present work was therefore, undertaken to investigate the potentiality of host chemical substances to induce mutation in jute.

II. Material and Method

Jute seeds (*Corchorus olitorius* L. Variety JRO-632) obtained from Jute Agriculture Research Institute, ICAR, Barrackpore, W.B. were presoaked in distilled water for 24 hours and then treated with 1%

Ethyl amine for 6 hours. The seeds were thoroughly washed with distilled water and then sown in the field directly with equal spacing for raising M1 generation. The individual M1 plants were harvested separately for growing M2 generation in progeny rows. The tall mutants were screened and again harvested for raising M3 generation. The mutants were screened in M3 generation. A number of essential yield components were recorded. Cytological anomalies and pollen sterility were recorded as per schedule techniques.

III. Results and Discussion

The present investigation indicates that some tall mutants were screened after M3 generations. The tall mutants otherwise looked normal plants like. Variation of yield component growth parameters was recorded. The segregation behavior in M2 generations was fitted to a ratio 3:1. In M2 almost all the plants were tall mutants excepting one or two cases of normal plants. No much noticeable variation in chromosome anomalies was recorded. Segregation behavior indicates that this is due to a single gene of recessive nature and pollen sterility was also recorded.

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Ethylmethane Sulphonate Induced Bushy Head Mutants in JUTE

(*Corchorus Olitorius* L. Variety JRO-632)

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ABSTRACT—Presoaked seeds of jute (*Corchorus olitorius* L. Variety JRO-632) were treated with 0.5% Ethylmethane Sulphonate (EMS) for 24 hours. Bushy head mutants were screened in M3 in contrast to the normal plants. Bushy head mutants otherwise looked normal excepting the nature of early flowering habit. A number of yield component growth parameters were recorded like plant height, basal diameter, plant spread, root length, pod per plant, seeds per pod, pod length/ breadth ratio, number of primary branches per plant, number of secondary branches per plant, leaf angle, branching angle, first flowering date, 100% flowering date, total duration, % of pollen sterility and weight of 100 seeds which were found to vary from the control plant. Chromosome analysis revealed a number of aberrations like stickiness, fragmentation, clumping, polyploidy, and laggard and bridge formation etc. at very low frequency. These early flowering mutant plants gives more fiber yield than the control plants with superior quality. Multiple cropping has been possible with the availability of irrigation water and a number of early maturing varieties have introduced in case of various other crops. There should be a suitable early maturing variety of jute also to be best fitted in the multiple cropping patterns. With this objective in view the work on induction of mutation with chemical mutagen Ethylmethane sulphonate (EMS) was initiated.

Key words: Ethylmethane Sulphonate (EMS), *Corchorus olitorius* L., Bushy head Mutant, 24 hours, chromosome, concentration 0.5%.

I. INTRODUCTION

Jute (*Corchorus olitorius* L. Variety JRO-632) is one of the very important fiber yielding cash crops with great demand in International market. A number of mutants in jute were reported through genetic manipulation by application of ionizing radiations (Kundu, 1944, Ghosh, 1969, Hossain, 1970 and Basu, 1967, Bandhyopadhyay, 1974 and Monti, 1968). However, Chemical mutagenesis in jute is still lacking although considerable work has been done on this line in other commercial crops, the present work was therefore, undertaken to investigate the potentiality of host chemical substances to induce mutation in jute.

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Jute seeds (*Corchorus olitorius* L. Variety JRO-632) obtained from Jute Agriculture Research Institute, ICAR, Barrackpore, W.B. were presoaked in distilled water for 24 hours and then treated with 0.5% Ethylmethane sulphonate for 24 hours. The seeds were thoroughly washed with distilled water and then sown in the field directly with equal spacing for raising M1 generation. The individual M1 plants were harvested separately for growing M2 generation in progeny rows. The bushy head mutants were screened and again harvested for raising M3 generation. The mutants were screened in M3 generation. A number of essential yield components were recorded. Cytological anomalies and pollen sterility were recorded as per schedule techniques.

III. RESULTS AND DISCUSSIONS

The present investigation indicates that some bushy head mutants were screened after M3 generations. These bushy head mutants otherwise looked normal plants like. Variation of yield component growth parameters was recorded. The segregation behavior in M2 generations was fitted to a ratio 3:1. In M2 almost all the plants were 8-locular fruit mutants excepting one or two cases of normal plants. No much noticeable variation in chromosome anomalies was recorded. Segregation behavior indicates that this is due to a single gene of recessive nature and pollen sterility was also recorded. Multiple cropping has been possible with the availability of irrigation water and a number of bushy head varieties have introduced in case of various other crops. There should be a suitable early maturing variety of jute also to be best fitted in the multiple cropping patterns. With this objective in view the work on induction of mutation with chemical mutagen Ethylmethane sulphonate (EMS) was initiated.

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Induced Crumple Leaf Mutant in Jute (*Corchorus Olitorius* L.Variety-Jro-632)

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ABSTRACT-Presoaked seeds of jute (*Corchorus olitorius* L.Variety JRO-632) were treated with 2% Ethylamine (EA) for 24 hours. Crumple leaf mutants were screened in M3 in contrast to the normal looking fruit plants. A number of yield component parameters were recorded including plant height, basal diameter, plant spread, root length, pod per plant, seeds per pod, pod length/breadth ratio, number of primary branches, number of secondary branches, leaf angle, branching angle, first flowering date, 100% flowering date, total duration, percentage of pollen sterility, and weight of 100 seeds which were found to vary from the control plant. Chromosome analysis revealed aberrations like stickiness, fragmentation, polyploidy, clumping, laggard and bridge formation etc. Multiple cropping has been possible with the availability of irrigation water and a number of early maturing varieties have introduced in case of various other crops. There should be a suitable crumple leaf mutants of jute also to be best fitted in the multiple cropping patterns. With this objective in view the work on induction of mutation with chemical mutagen Ethylamine (EA) was initiated.

Key words: *Corchorus olitorius* L., chromosome, crumple leaf mutants, Ethylamine, 24 hours, concentration 2%.

I. INTRODUCTION

Jute (*Corchorus olitorius* L. Variety JRO-632) is one of the very important fiber yielding cash crops with great demand in International market. A number of mutants in jute was reported through genetic manipulation by application of ionizing radiations (Kundu, 1944, Ghosh, 1969, Hossain, 1970 and Basu, 1967, Chatterjee and Jana, 1974, Nayar, 1979). However, Chemical mutagenesis in jute is still lacking although considerable work has been done on this line in other commercial crops, the present work was therefore, undertaken to investigate the potentiality of host chemical substances to induce mutation in jute.

II. MATERIAL AND METHOD

Jute seeds (*Corchorus olitorius* L. Variety JRO-632) obtained from Jute Agriculture Research Institute, ICAR, Barrackpore, W.B. were presoaked in distilled water for 24 hours and then treated with 2% Ethylamine for 24 hours. The seeds were thoroughly washed with distilled water and then

sown in the field directly with equal spacing for raising M1 generation. The individual M1 plants were harvested separately for growing M2 generation in progeny rows. The crumple leaf mutants were screened and again harvested for raising M3 generation. The mutants were screened in M3 generation. A number of essential yield components were recorded. Cytological anomalies and pollen sterility were recorded as per schedule techniques.

III. RESULTS AND DISCUSSIONS

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Importance of Nano Materials In Nano Technology

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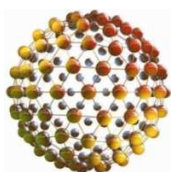
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Abstract: This presentation shows about Nanomaterials. Nanomaterials are at the leading edge of the rapidly developing field of nanotechnology. Their unique size-dependent properties make these materials superior and indispensable in many areas of human activity. This brief review tries to summarise the most recent developments in the field of applied nanomaterials, in particular their application in biology and medicine, and discusses their commercialisation prospects.

Keywords: nanotechnology; nanomaterials; nanoparticles; quantum dots; nanotubes; medicine; biology; applications

I. INTRODUCTION



Nanotechnology is enabling technology that deals with nano-meter sized objects. It is expected that nanotechnology will be developed at several levels: materials, devices and systems^[1]. The nanomaterials level is the most advanced at present, both in scientific knowledge and in commercial applications. A decade ago, nanoparticles were studied because of their size-dependent physical and chemical properties. Now they have entered a commercial exploration period. Living organisms are built of cells that are typically 10 μm across. However, the cell parts are much smaller and are in the sub-micron size domain. Even smaller are the proteins with a typical size of just 5 nm, which is comparable with the dimensions of smallest manmade nanoparticles. This simple size comparison gives an idea of using nanoparticles as very small probes that would allow us to spy at the cellular machinery without

introducing too much interference. Understanding of biological processes on the nanoscale level is a strong driving force behind development of nanotechnology. Out of plethora of size-dependant physical properties available to someone who is interested in the practical side of nanomaterials, optical and magnetic effects are the most used for biological applications. The aim of this

review is firstly to give reader a historic prospective of nanomaterial application to biology and medicine, secondly to try to overview the most recent developments in this field, and finally to discuss the hard road to commercialisation. Hybrid bionanomaterials can also be applied to build novel electronic, optoelectronics and memory devices (see for example^[7]). Nevertheless, this will not be discussed here and will be a subject of a separate article.

II. APPLICATIONS

Some of the applications of nanomaterials to biology or medicine are^[2]:

- a) Fluorescent biological labels
- b) Drug and gene delivery
- c) Bio detection of pathogens
- d) Detection of proteins
- e) Probing of DNA structure
- f) Tissue engineering
- g) Tumour destruction via heating (hyperthermia)
- h) Separation and purification of biological molecules and cells
- i) MRI contrast enhancement - Phagokinetic studies

As mentioned above, the fact that nanoparticles exist in the same size domain as proteins makes nanomaterials suitable for bio tagging or labelling. However, size is just one of many characteristics of nanoparticles that itself is rarely sufficient if one is to use nanoparticles as biological tags. In order to interact with biological target, a biological or molecular coating or layer acting as a bioinorganic interface should be attached to the nanoparticle. Examples of biological coatings may include antibodies, biopolymers like collagen, or monolayers of small molecules that make the nanoparticles biocompatible. In addition, as optical detection techniques are wide spread in biological



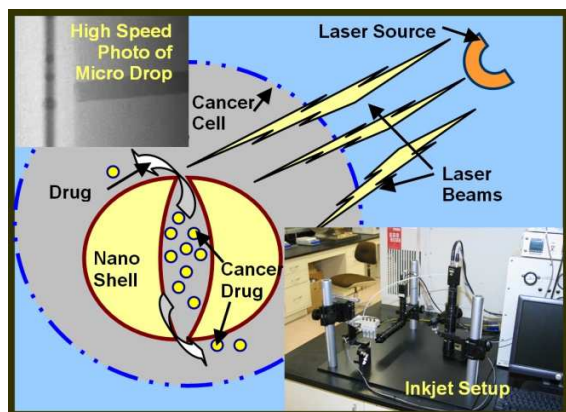
research, nanoparticles should either fluoresce or change their optical properties. The approaches used in constructing nano-biomaterials are schematically presented below. Typical configurations utilised in nano-bio materials applied to medical or biological problems. Nano-particle usually forms the core of nano-biomaterial. It can be used as a convenient surface for molecular assembly, and may be composed of inorganic or polymeric materials. It can also be in the form of nano-vesicle surrounded by a membrane or a layer. The shape is more often spherical but cylindrical, plate-like and other shapes are possible. The size and size distribution might be important in some cases, for example if penetration through a pore structure of a cellular membrane is required. The size and size distribution are becoming extremely critical when quantum-sized effects are used to control material properties. A tight control of the average particle size and a narrow distribution of sizes allow creating very efficient fluorescent probes that emit narrow light in a very wide range of wavelengths. This helps with creating biomarkers with many and well distinguished colours. The core itself might have several layers and be multifunctional. For example, combining magnetic and luminescent layers one can both detect and manipulate the particles. The core particle is often protected by several monolayers of inert material, for example silica. Organic molecules that are adsorbed or chemisorbed on the surface of the particle are also used for this purpose. The same layer might act as a biocompatible material. However, more often an additional layer of linker molecules is required to proceed with further functionalisation. This linear linker molecule has reactive groups at both ends. One group is aimed at attaching the linker to the nanoparticle surface and the other is used to bind various moieties like biocompatibles (dextran), antibodies, fluorophores etc., depending on the function required by the application.

III. RECENT DEVELOPMENTS

Tissue engineering: Natural bone surface is quite often contains features that are about 100 nm across. If the surface of an artificial bone implant were left smooth, the body would try to reject it. Because of that smooth surface is likely to cause production of a fibrous tissue covering the surface of the implant^[3]. This layer reduces the bone-implant contact, which may result in loosening of the implant and further inflammation. It was demonstrated that by creating nano-sized features on the surface of the hip or knee prosthesis one could reduce the chances of rejection as well as to stimulate the production of osteoblasts. The osteoblasts are the cells

responsible for the growth of the bone matrix and are found on the advancing surface of the developing bone. The effect was demonstrated with polymeric, ceramic and, more recently, metal materials. More than 90% of the human bone cells from suspension adhered to the nanostructured metal surface, but only 50% in the control sample. In the end this findings would allow to design a more durable and longer lasting hip or knee replacements and to reduce the chances of the implant getting loose. Titanium is a well-known bone repairing material widely used in orthopaedics and dentistry. It has a high fracture resistance, ductility and weight to strength ratio. Unfortunately, it suffers from the lack of bioactivity, as it does not support cell adhesion and growth well. Apatite coatings are known to be bioactive and to bond to the bone. Hence, several techniques were used in the past to produce an apatite coating on titanium. Those coatings suffer from thickness non-uniformity, poor adhesion and low mechanical strength. In addition, a stable porous structure is required to support the nutrients transport through the cell growth. It was shown that using a biomimetic approach – a slow growth of nanostructured apatite film from the simulated body fluid – resulted in the formation of a strongly adherent, uniform nanoporous layer. The layer was found to be built of 60 nm crystallites, and possess a stable nanoporous structure and bioactivity. A real bone is a nanocomposite material, composed of hydroxyapatite crystallites in the organic matrix, which is mainly composed of collagen. Thanks to that, the bone is mechanically tough and, at the same time, plastic, so it can recover from a mechanical damage. The actual nanoscale mechanism leading to this useful combination of properties is still debated. An artificial hybrid material was prepared from 15–18 nm ceramic nanoparticles and poly (methyl methacrylate) copolymer. Using tribology approach, a viscoelastic behaviour (healing) of the human teeth was demonstrated. An investigated hybrid material, deposited as a coating on the tooth surface, improved scratch resistance as well as possessed a healing behaviour similar to that of the tooth.

IV. CANCER THERAPY



Photodynamic cancer therapy is based on the destruction of the cancer cells by laser generated atomic oxygen, which is cytotoxic^[4]. A greater quantity of a special dye that is used to generate the atomic oxygen is taken in by the cancer cells when compared with a healthy tissue. Hence, only the cancer cells are destroyed then exposed to a laser radiation. Unfortunately, the remaining dye molecules migrate to the skin and the eyes and make the patient very sensitive to the daylight exposure. This effect can last for up to six weeks. To avoid this side effect, the hydrophobic version of the dye molecule was enclosed inside a porous nanoparticle. The dye stayed trapped inside the Ormosil nanoparticle and did not spread to the other parts of the body. At the same time, its oxygen generating ability has not been affected and the pore size of about 1 nm freely allowed for the oxygen to diffuse out.

V. MULTI COLOUR OPTICAL CODING FOR BIOLOGICAL ASSAYS

The ever increasing research in proteomics and genomic generates escalating number of sequence data and requires development of high throughput screening technologies. Realistically, various array technologies that are currently used in parallel analysis are likely to reach saturation when a number of array elements exceed several millions. A three-dimensional approach, based on optical "bar coding" of polymer particles in solution, is limited only by the number of unique tags one can reliably produce and detect. Single quantum dots of compound semiconductors were successfully used as a replacement of organic dyes in various bio-tagging applications. This idea has been taken one step further by combining differently sized and hence having different fluorescent colours quantum dots, and combining them in polymeric microbeads. A precise control of quantum dot ratios has been achieved. The selection of nanoparticles used in those experiments had

6 different colours as well as 10 intensities. It is enough to encode over 1 million combinations. The uniformity and reproducibility of beads was high letting for the bead identification accuracies of 99.99%.

VI. MANIPULATION OF CELLS AND BIOMOLECULES

Functionalised magnetic nanoparticles have found many applications including cell separation and probing; these and other applications are discussed in a recent review. Most of the magnetic particles studied so far are spherical, which somewhat limits the possibilities to make these nanoparticles multifunctional. Alternative cylindrically shaped nanoparticles can be created by employing metal electrodeposition into nanoporous alumina template. Depending on the properties of the template, nanocylinder radius can be selected in the range of 5 to 500 nm while their length can be as big as 60 μm . By sequentially depositing various thicknesses of different metals, the structure and the magnetic properties of individual cylinders can be tuned widely. As surface chemistry for functionalisation of metal surfaces is well developed, different ligands can be selectively attached to different segments. For example, porphyrins with thiol or carboxyl linkers were simultaneously attached to the gold or nickel segments respectively. Thus, it is possible to produce magnetic nanowires with spatially segregated fluorescent parts. In addition, because of the large aspect ratios, the residual magnetisation of these nanowires can be high. Hence, weaker magnetic field can be used to drive them. It has been shown that a self-assembly of magnetic nanowires in suspension can be controlled by weak external magnetic fields. This would potentially allow controlling cell assembly in different shapes and forms. Moreover, an external magnetic field can be combined with a lithographically defined magnetic pattern ("magnetic trapping").

VII. PROTEIN DETECTION

Proteins are the important part of the cell's language, machinery and structure, and understanding their functionalities is extremely important for further progress in human well being. Gold nanoparticles are widely used in immunohistochemistry to identify protein-protein interaction^[5]. However, the multiple simultaneous detection capabilities of this technique are fairly limited. Surface-enhanced Raman scattering spectroscopy is a well-established technique for detection and identification of single dye molecules. By combining both methods in a single nanoparticle probe one can drastically improve the multiplexing capabilities of protein probes. The group of Prof. Mirkin has



designed a sophisticated multifunctional probe that is built around a 13 nm gold nanoparticle. The nanoparticles are coated with hydrophilic oligonucleotides containing a Raman dye at one end and terminally capped with a small molecule recognition element (e.g. biotin). Moreover, this molecule is catalytically active and will be coated with silver in the solution of Ag(I) and hydroquinone. After the probe is attached to a small molecule or an antigen it is designed to detect, the substrate is exposed to silver and hydroquinone solution. A silver-plating is happening close to the Raman dye, which allows for dye signature detection with a standard Raman microscope. Apart from being able to recognise small molecules this probe can be modified to contain antibodies on the surface to recognise proteins. When tested in the protein array format against both small molecules and proteins, the probe has shown no cross-reactivity.

VIII. COMMERCIAL EXPLORATION

The majority of the companies are small recent spinouts of various research institutions. Although not exhausting, this is a representative selection reflecting current industrial trends^[6]. Most of the companies are developing pharmaceutical applications, mainly for drug delivery. Several companies exploit quantum size effects in semiconductor nanocrystals for tagging biomolecules, or use bio-conjugated gold nanoparticles for labelling various cellular parts. A number of companies are applying nano-ceramic materials to tissue engineering and orthopaedics..

IX. CONCLUSION

Most major and established pharmaceutical companies have internal research programs on drug delivery that are on formulations or dispersions containing components down to nano sizes. Colloidal silver is widely used in anti-microbial formulations and dressings^[7]. The high reactivity of titania nanoparticles, either on their own or then illuminated with UV light, is also used for bactericidal purposes in filters. Enhanced catalytic properties of surfaces of nano-ceramics or those of noble metals like platinum are used to destruct dangerous toxins and other hazardous organic materials. It is seen that government bodies, companies, and university researchers are joining forces or competing to synthesize, investigate, produce, and apply these amazing nanomaterials.

X. SCOPE FOR FURTHER DEVELOPMENT

As it stands now, the majority of commercial nanoparticle applications in medicine are geared towards drug delivery. In biosciences, nanoparticles are replacing organic dyes in the applications that require high photostability as well as high multiplexing capabilities. There are some developments in directing and remotely controlling the functions of nano-probes, for example driving magnetic nanoparticles to the tumour and then making them either to release the drug load or just heating them in order to destroy the surrounding tissue. The major trend in further development of nanomaterials is to make them multifunctional and controllable by external signals or by local environment thus essentially turning them into nano-devices.

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Synthesis, Characterization and Antimicrobial activity of Zinc Oxide Nanoparticles

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Abstract— Nanostructured materials have received much attention because of their novel properties, which differ from those of bulk materials. This work focuses on synthesis and characterization of Zinc Oxide nanoparticles (ZnO Nps) and to evaluate their antimicrobial potency against bacteria causing food borne illness. We have prepared ZnO Nps by wet chemical method using Zinc Nitrate ($\text{Zn}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$) and Sodium Hydroxide (NaOH) as the starting materials. ZnO Nps were characterized by X-ray diffraction (XRD), UV-VIS absorption, and Scanning Electron Microscope (SEM). Particle size variations were achieved by varying the pH in the reaction mixture. At pH 8, we obtained hexagonal shaped nanoparticles with large surface area. The effects of particle size and concentration on the antibacterial activity of ZnO nanoparticles were studied using bacteriological tests such as disc diffusion agar methods, growth curve kinetics. We have analyzed the antimicrobial activity of ZnO Nps against *Bacillus cereus*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Aeromonas hydrophilia* and *Escherichia coli*. Our findings reveal that gram-negative bacteria seemed to be more resistant to ZnO nanoparticles than gram-positive bacteria. Hence, ZnO Nps garners interest to be applied as one of the effective antimicrobial agents.

Keywords: ZnO nanoparticles (Nps), antimicrobial activity, Characterization.

I. INTRODUCTION

Nanostructured ZnO materials have drawn broad attention due to its wide range of applications in ultraviolet (UV) lasers, power generators, solar cells, gas sensors, field emission devices, capacitors, varistors, transparent UV resistance coating, photoprinting, electrophotography, electrochemical and electromechanical nanodevices, sun screen lotion (cream), cosmetic and medicated creams etc. The antimicrobial properties of nanoparticles are well established, and a mechanism of inhibition has been proposed by several researchers. ZnO Nps are synthesized and widely used due to their remarkable physical and chemical properties stemming from their large surface area and high reactivity (4, 5, 6, 7, 8, 9, 11, 18, and 19). This study describes the synthesis of ZnO nanoparticles and their antibacterial activity against selected human pathogens like *Bacillus cereus*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Aeromonas hydrophilia*, *E.coli* (both Gram-positive and Gram negative).

II. MATERIALS AND METHODS

All the chemicals used such as Zinc nitrate, Sodium hydroxide, Muller Hinton agar, were obtained from HI media Mumbai and used as received. UV – double beam (Mapada UV-1800) in identical compartments each for reference and test solutions fitted with 1-cm path length quartz cuvettes. The morphology of the ZnO Nps were analysed using Tescon Scanning Electron Microscope. *Bacillus cereus* - 6840, 1305, *Staphylococcus aureus* – 9542 *Pseudomonas aeruginosa* - 2488, 2295 *Aeromonas hydrophilia* - 1739 *E.coli*- 40 are provided by Microbial type culture collection (MTCC).

A. Preparation of ZnO Nps

ZnO NPs were prepared by Wet chemical method and optimized the concentration of Zinc Nitrate solution at 1.57 M $\text{Zn}(\text{NO}_3)_2$ and 1M NaOH. We have added slowly Zinc Nitrate solution into the NaOH solution at 50-55°C at pH8. Then conical flask was scaled at this condition for 2 hours to forms the white precipitations of ZnO Nps. ZnO Nps was collected by Whatman filter paper and were cleaned with deionized water and ethanol. The cleaned ZnO NPs were dried at 60°C and grind using mortar and pestle. ZnO Nps were characterized by X-ray diffraction (XRD), UV-VIS absorption, and Scanning Electron Microscope (SEM) (10, 13, 14, and 19).

B. Antimicrobial Activity of Zinc Oxide Nano Particles

Antimicrobial test was carried out to evaluate the efficacy of zinc oxide against five major pathogenic bacteria namely *E.coli*, *Bacillus* sp., *Staphylococcus* sp., *Pseudomonas* sp. and *Aeromonas* sp. (12,13,17)

a. Growth Curve Studies

The bactericidal activity of the ZnO nanoparticles was tested by growth inhibition studies. Sterile Erlenmeyer flasks containing 100 ml nutrient broth and the desired amount of ZnO were inoculated with 1 ml of the freshly prepared bacterial suspension. The flasks were then incubated in a rotary shaker at 150 rpm at 37°C. Bacterial growth was monitored on an hourly basis for 24 h by measuring the absorbance at 600 nm using a

UV-visible spectrophotometer. A control flask containing nutrient broth and bacteria but devoid of ZnO was also monitored (fig 1).



Fig1: Growth curve turbidity

b. Zone of Inhibition Studies – Disc Diffusion Method

A disc diffusion method was used to evaluate the antibacterial activity of ZnO nanoparticles against selected human pathogens. Various concentrations of ZnO (0, 2, 5 and 7 ng/ μ l) suspended in DMSO were loaded on a 6 mm diameter disc. The discs were placed on the agar plates and incubated at 37°C for 18 h. The zone of inhibition (ZOI) was measured by standard methods. This assay was performed in triplicate and average results were tabulated.

c. Minimum Inhibitory Concentration

The minimum inhibitory concentration (MIC) of ZnO was determined for each of the test organisms. The test organisms were inoculated in 5 ml of nutrient broth and incubated at 37°C for 3–4 h. Various concentrations of ZnO Nps (0, 2, 5, 7 and 10 ng/ μ l) were added to the tubes at the initial log phase of the organism to arrest the growth. Optical density at 620 nm was read for each of the test organisms inoculated with the nanoparticles.

III. RESULT AND DISCUSSION

A. Characterization of ZnO Nps

a. UV-Visible spectrophotometer

We have dispersed ZnO Nps in Milli-Q water and recorded the optical density using UV-Vis spectrophotometer. Fig 2(a) shows the excitonic absorption very sharp peak is observed due to the ZnO Nps at 362 nm.

b. SEM analysis for ZnO Nps

Morphology of the ZnO sample was investigated using SEM. Fig 2(c) shows the typical SEM images of the sample. These images demonstrate that hexagonal shaped nanoparticles with large surface area were observed. The observed size of nanoparticles ranged from 50–100 nm.

c. Powder X-Ray Diffraction analysis for ZnO Nps

Fig 2(b) shows X-ray diffraction spectrum of our powder. The Lattice constants ($a = b = 0.32$ nm and $c = 0.52$ nm) peaks corresponding to these planes 100, 002 and 101 were comparable to JC-PDF (Joint committee for powder x-ray diffraction File) data of ZnO, thus confirming the presence of ZnO in our powdered sample.

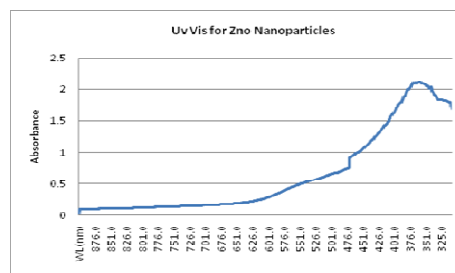


Fig 2(a): Characterization of ZnO Nps using UV-Vis spectrum

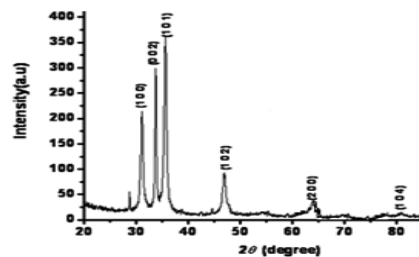


Fig 2(b): XRD patterns of ZnO Nps



Fig 2(c): SEM analysis for ZnO

B. Anti Microbial Activity Of ZnO Nps

All metal oxides have potential antibacterial action. The antibacterial action is mediated by reaction of superoxide ions on carbonyl group in the peptide linkages of cell wall of bacteria leading to degradation of the protein with ZnO Nps, the increase in surface area leads to an increase in oxygen concentration resulting in effective destruction of cell wall bacteria. Experimental evidence suggests that DNA loses its replication ability once the bacteria have been treated with Zinc oxide. Hence we have carried out antimicrobial experiment against ZnO Nps on the selected microorganism (1, 2, 3, 11, and 14).

a. The growth kinetics

The growth kinetics of the bacteria is shown in Fig 3. Growth was inhibited in the initial stages, and in media containing ZnO Nps, there was no obvious visible growth after the fourth hour. In the control experiment, we observed typical lag, log and death phases at the 4th, 13th and 26th hour, respectively. All organisms showed a typical inhibitory point after the addition of ZnO nanoparticles. The growth curves of *E. coli*, *Bacillus* sp., *Staphylococcus* sp., *Pseudomonas* sp. and *Aeromonas* sp. showed similar results. There was an increase in growth from the lag to log phase and a constant pattern of growth in the succeeding stationary phase.

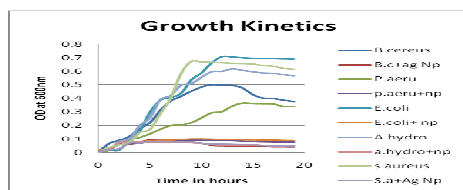


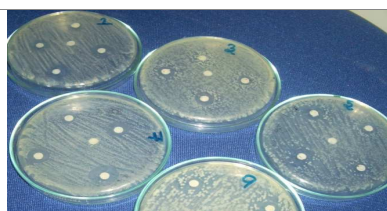
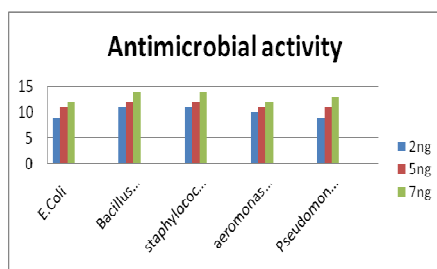
Fig 3: Growth kinetics of different microorganisms in the presence and absence of ZnO nanoparticles

b. Disc diffusion method

The antibacterial activity of the synthesised ZnO nanoparticles was studied by a qualitative disc diffusion assay on both Gram-positive and Gram-negative bacteria. Table 1 shows the diameter of the ZOI for each organism. After 18 h of incubation at 37°C, the nutrient agar plates containing various concentrations of nanoparticles exhibited a ZOI of around 9-14 mm diameter Fig 4. Control plates devoid of nanoparticles did not exhibit any inhibition zones. *B. cereus*, *S. aureus* showed a ZOI of 14 mm when 7.0 ng of ZnO nanoparticles were loaded onto the disc. *E.coli* and *A. hydrophila* showed a ZOI of 12 mm, *P. aeruginosa* showed a ZOI of 13mm Fig 4. In this study, the average particle size was about 50 nm-100 nm thus, the effective inhibition observed in our studies.

Organism	2ng	5ng	7ng
<i>E.coli</i>	9±0.2582	11±0.7	12±0.2160
<i>Bacillus cereus</i>	11±0.282	12±0.2	14±0.8406
<i>Staphylococcus aureus</i>	2	483	14±0.7393
<i>Aeromonas hydrophila</i>	2	160	12±0.941
<i>Pseudomonas aeruginosa</i>	9±0.2582	943	13±0.9273

Table 1: ZOI (mm) against different bacterial strains and at different concentrations of ZnO nanoparticles.



c. Minimum inhibitory concentration

The MIC of nanoparticles was evaluated to determine the toxicity of ZnO. This concentration is reached when there is a crease in bacterial growth but no accompanying toxicity is served. For all organisms, 10µl aqueous ZnO Nps having g ZnO Nps gave a significant decrease shown in Fig 5. The timum MIC was determined to be 7ng observed in our studies.

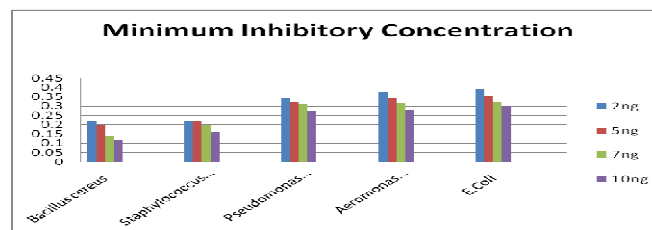


Fig 5(a): Antibacterial tests: MIC seen around different concentrations of ZnO nanoparticles

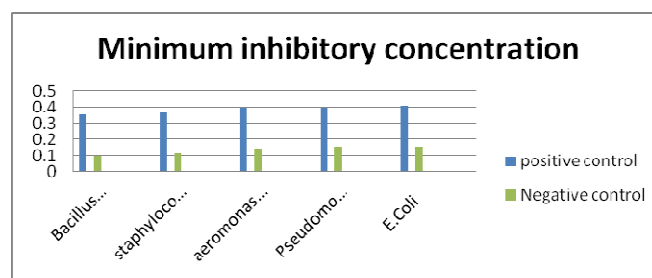


Fig 5 (b): Minimum inhibitory concentration of positive and negative control

IV. CONCLUSION

ZnO Nps were prepared by wet chemical method is an easy and very fast Compared to other methods. The ZnO Nps obtained were characterized using UV-Vis Spectroscopy, XRD and SEM. X ray diffraction studies confirms the presence of ZnO Nps in the powdered sample. SEM is used to measure the size of nanoparticles. UV-Vis Spectroscopy confirmed the presence of ZnO Nps with sharp excitonic absorption peak, corresponding to ZnO. Antimicrobial studies revealed that ZnO possess moderate antimicrobial activity, the disc diffusion studies, MIC and Growth curve studies concluded that the Gram negative bacteria was found to be more resistant to ZnO nanoparticles than Gram positive bacteria. Thus ZnO nanoparticles can be used as an efficient and safer compound to be used in food and beverage industries as a packaging material. The future prospective of this study may involve an increased use of such harmless compound in day today life and may be used in detergents, soaps, cosmetics and medicine.

ACKNOWLEDGEMENTS



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Investigation on Enhanced Photocatalytic Activity of Nanoparticle for the Degradation of Azo Dye in Textile effluent

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Abstract— Hazardous pollutants, especially dyes and aromatic hydrocarbons constitute the effluents generated from textile Industries. Among the various technologies developed for the treatment of dyes, the heterogeneous photocatalysis is regarded as a promising technology to decompose the recalcitrant dyes into final non-toxic products. Nano TiO₂ has been proved to be a very effective photocatalyst for the degradation of dyes in textile effluent because of its high stability, non-toxicity and low cost. Nano structured titanium dioxide (TiO₂) has been synthesized by modified sol-gel method. The material was characterized by X-ray diffraction (XRD) and SEM micrograph. The results showed that pure nano TiO₂ was composed of uniform distribution nanoparticles of ~ 15 nm and with spherical morphology. The present study aims in the photocatalytic degradation of dye reactive red 198 on the surface of nanoTiO₂ in a batch reactor. Optimisation of parameters such as catalyst weight, concentration of the dye has been studied. All the experiments were performed in a photochemical batch reactor equipped with 8-W UV lamp emitting a peak wavelength around 254 nm. Under optimum conditions complete degradation of the organic dye was achieved and the photodegradation follows pseudo first order kinetics.

Keywords—Textile Wastewater; Degradation; Organic contaminants; Nano TiO₂; Photo catalyst

which will add more cost to the process [3]. Hence there is a need to develop treatments methods that are more effective in eliminating dyes from the wastewater by conventional chemical treatment systems [4].

The superiority of photocatalytic degradation by semiconductors in wastewater treatment is due to its advantages over the traditional techniques, such as quick oxidation of pollutants. It is an effective and rapid technique for the removal of pollutants from wastewater.

Recently there has been considerable interest in the utilization of advanced oxidation processes (AOPs) for the complete destruction of dyes. AOPs are based on generation of reactive species such as hydroxyl radicals that oxidizes a broad range of organic pollutants quickly and nonselectively [5]. AOPs include photocatalysis systems such as combination of semiconductors and light, and semiconductor and oxidants. Heterogeneous photocatalysis has emerged as an important destructive technology leading to the total mineralization of most of the organic pollutants including organic reactive dyes.

I. INTRODUCTION

Textile industries produce large volume of colored dye effluents. Among the different types of dyes used in textile industries, 60-70% is azo compounds. These dyes create severe environmental pollution problems by releasing toxic and potential carcinogenic substances into the aqueous phase [1]. Various chemical and physical processes such as precipitation, adsorption, air stripping, flocculation, reverse osmosis and ultra filtration can be used for color removal from textile effluents [2]. However these techniques are non-destructive, since they only transfer the nonbiodegradable matter into sludge, giving rise to new type of pollution, which needs further treatment of solid-wastes and regeneration of the adsorbent

Till now many kinds of semiconductors have been studied as photocatalysts including titanium dioxide (TiO₂), zinc oxide (ZnO), cadmium sulphide (CdS), zinc sulphide (ZnS), stannic oxide (SnO₂) and so on [6]. Titanium dioxide photocatalyst is chemically and biologically inert, photocatalytically stable, relatively easy to produce and to use, able to efficiently catalyze reactions and without risk to the environment or humans. It has become the most promising photocatalysts due to its chemical-physical stability, thermal and electrical properties, low cost and excellent degradation of organic pollutants [7]. It has much interest in recent years for its highly active photocatalytic functions, such as the ability to decompose chemical compounds, as well as super

hydrophilic and antimicrobial properties. The UV photon is able to activate the photocatalyst, which results in the excitation of an electron from the valence band (VB) to the conductance band (CB). When titania is irradiated by ultraviolet light, electron hole pairs are generated and then produce a powerful reactive oxygen species (ROS), which can decompose most organic compounds.

The aim of the current work is to prepare the TiO_2 nanoparticle photocatalyst by modified sol-gel method and to characterize the material by XRD, SEM studies. The photocatalytic activity of the nanoparticle is investigated by taking RR198 an azo dye as model compound.. Optimisation of parameters such as catalyst weight and concentration of the dye solution in the photocatalytic degradation studies has been studied.

II. MATERIALS AND METHODS

Titanium (IV) isopropoxide, glacial acetic acid and all the organic reagents were analytical grade procured from Merck, India. Dye sample for experimental studies have been obtained from dyestuff suppliers and used without further purification. Solutions have been prepared using double distilled water.

A. Synthesis of TiO_2 nanoparticles

Synthesis of TiO_2 nanoparticle using modified sol-gel method is summarized below. Titanium (IV) isopropoxide, glacial acetic acid and double distilled water were used in a molar ratio of 1:10:350. First titanium (IV) isopropoxide was hydrolyzed by glacial acetic acid at 0°C and double distilled water was added drop wise under vigorous stirring followed by ultra sonication for 4h to get a clear solution. The solution was kept under dark for 12 h for nucleation and dried at 70°C for 12h. The dried sample was crushed into fine powder and calcined at 500°C for 5h.

B. Catalyst characterization

The XRD analysis was done to analyze the crystallite size of nano TiO_2 . Sample for powder X-ray Diffraction (XRD) were prepared by making a thin film of the powder with ethanol on a glass plate and the measurement was performed with a Rigaku Geigerflex X-ray diffractometer with Ni-filtered $\text{CuK}\alpha$ radiation ($\lambda=1.5406 \text{ \AA}$, 30kV, 15mA). The XRD patterns were recorded in the range of $20-70^\circ$, with a scan speed of $2^\circ/\text{min}$. The Cary-50 ultraviolet spectrophotometer (Varian), and Scanning Electron microscopy analysis using FESEM- SUPRA55, CARL ZEISS, Germany coupled with dispersive spectroscopy were used in the experiments.

C. Experimental set up

The photodegradation studies have been carried out in a batch reactor system. The slurry is stirred magnetically and low-pressure mercury vapour lamp has been used as an irradiation source. The lamp emits 8W of UV radiation with a peak wavelength of 254 nm. The reactor configuration and operating conditions for the photocatalytic degradation have been optimised by preliminary trial experiments with respect to (i) the total batch volume of reactant solution, (ii) the stirring speed and (iii) the time for adsorption equilibrium prior to exposure to UV light. The optimum conditions consists of a batch volume of 250 ml, stirring speed of 70 rpm and 30 minutes for adsorption equilibrium

The experimental procedure consists of irradiation of the organic dye solution of known concentration mixed with a known weight of catalyst powder at a constant volume of 250 ml. The slurry has been stirred well using a magnetic stirrer throughout the period of experiment. In all the studies the suspensions have been stirred well for about 30 minutes to allow equilibration of adsorption process before exposure to UV light. Samples of 3 ml have been withdrawn at regular intervals of time, centrifuged, absorbance measured at 532 nm, respectively and returned to the reactor. All studies have been carried out at 30°C . The pH of the solution has been adjusted to the desired values between 4.0 and 10.0 by using dilute solutions of HCl or NaOH.

III. RESULTS AND DISCUSSION

A. Particle size and structural properties TiO_2 nanoparticle

The patterns of calcined (500°C) nano TiO_2 correspond to anatase phase as shown in Figure.1. The XRD patterns of anatase phase have a main peak at $2\theta = 25.2^\circ$ corresponding to the 101 plane (JCPDS 21-1272). The average particle size was estimated from the scherrer equation on the anatase using the angle ($2\theta=25.3, 48.1$ and 37.8), width (0.5767, 0.6217 and 0.7810) and the corresponding crystal sizes are 14.4nm, 14.3nm and 10.9 nm from the 3 different diffraction peaks.

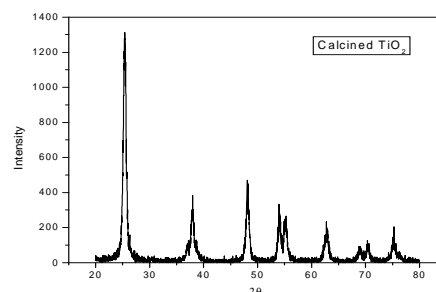


Figure.1.XRD pattern of TiO_2 nanoparticle

Average crystal sizes of nano TiO_2 was calculated to be around 13-14 nm, respectively. During the synthetic process, a relatively large amount of water was used to enhance the nucleophilic attack of water on titanium (IV) isopropoxide and to suppress fast condensation of titanium (IV) isopropoxide species yielding TiO_2 nanoparticles. Shape and morphology is clearly observed in the SEM micrograph of the sample calcined at that temperature. Figure.2 shows the SEM micrographs of TiO_2 nanoparticles prepared by modified sol-gel method at the calcination temperature of 500°C consists of spherical in shape and uniform in nature.

B. Photodegradability of reactive red 198

The photodegradability of the dye has been investigated by exposing the dye solution to UV light in the absence and in the presence of nano TiO_2 photocatalyst in a batch reactor. It is seen from the Figure.3 that in the presence of both UV light and TiO_2 about 90% of the dye was degraded at an irradiation time of 1 h. But in the absence of UV light and in the presence nano TiO_2 the dye solution is stable though adsorption has been found to be responsible for the decrease in dye concentration.

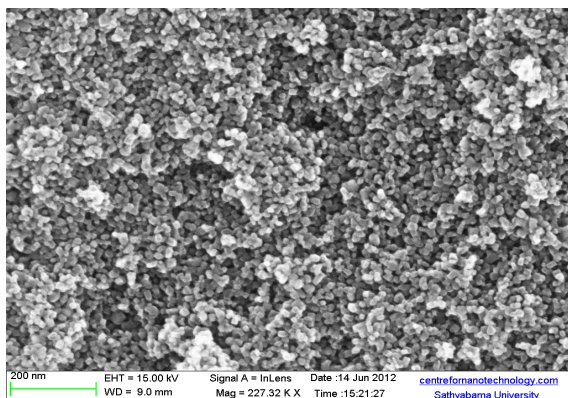


Figure.2. SEM image of TiO_2 nanoparticle

For the same experiment performed in the absence of nano TiO_2 , only 0.5% of dye undergoes degradation when the UV lamp had been switched off and the reaction was allowed to occur in the darkness. These experiments demonstrated that both UV light and a photocatalyst were needed for the effective destruction of reactive red 198. Because it has been established that the photocatalysed degradation of organic matter in solution is initiated by photo excitation of the semiconductor, followed by the formation of an electron-hole pair on the surface of catalyst. The high oxidative potential of the hole ($h^+\text{VB}$) in the catalyst permits the direct oxidation of organic matter (dye) to reactive intermediates. Very reactive hydroxyl radicals can also be formed either by the decomposition of water or by the reaction of the hole with OH^- . The

hydroxyl radical is an extremely strong, non-selective oxidant ($E^0 = +3.06 \text{ V}$) which leads to the partial or complete mineralization of several organic chemicals.

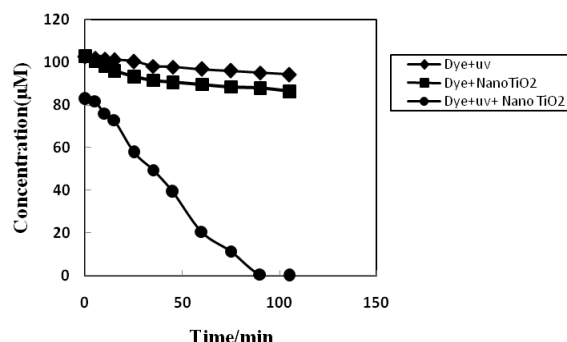


Figure.3 Photodegradability of RR198. pH = 7.0; Concentration= $100\mu\text{M}$; Weight of nano TiO_2 catalyst = 1 g/L Temperature = $30\pm 0.1^\circ\text{C}$

C. Effect of catalyst weight

Experiments performed with effect of three different catalyst weights showed that the photo degradation efficiency increased with an increase in weight of nano photo catalyst. The total active surface area increases with increasing catalyst dosage. The catalyst concentration above which conversion levels off depends on several factors (e.g. reactor geometry, operating conditions, wavelength and intensity of light source) and corresponds to the point where all catalyst particles are fully illuminated [8].

The effect of catalyst loading on the degradation of RR198 at pH=7 was studied in the range of 0.5-1g/L of dye solution. It can be seen that the rate of decolorization increases slowly with increase in catalyst loading from 0.5-1g/L is shown in the Figure.4. The observation can be explained in terms of availability of active sites on the catalyst surface and the penetration of visible light in to the suspension. The total active surface area increases with increasing catalyst dosage. And it is important to keep the treatment expenses low for industrial use. So an optimum loading of 1g/L was used for further investigation.

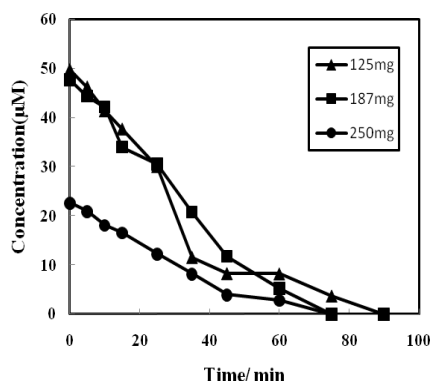


Figure.4. Effect of catalyst weight on the photo catalytic degradation of the dye; pH = 7.0; Concentration = 100(µM); Temperature = 30±0.1°C

D. Effect of dye concentration

The effect of initial concentration of RR198 on photocatalytic decolorization was carried out at fixed amount of the catalyst (1g/L) and varying concentration of the dye from 50µM-120µM. Figure.5 shows that the photodegradation efficiency of RR198 decreases with an increase on the concentration of dye. The degradation rate is directly proportional to the probability of formation of hydroxyl radicals (OH^\bullet) on the catalyst surface and the probability of hydroxyl radicals reacting with the dye molecules [9]. As the concentration of the dye increase, there should be more interaction with OH^\bullet radicals. At high dye concentration the generation of OH^\bullet radicals on the surface of catalyst is reduced since the active sites are covered with the dye ions. Also, with increase in dye concentration, less photons reach the photocatalyst surface (UV screening effect), resulting in slower production of hydroxyl radicals [10].

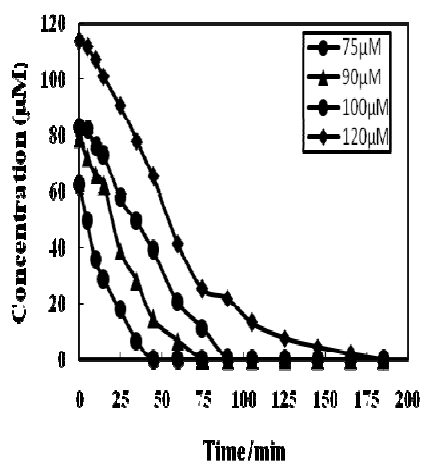


Figure.5. Effect of concentration on the photo catalytic degradation of the dye; pH = 7.0; Weight of nano TiO_2 catalyst =1 g/L; Temperature = 30±0.1°C.

E. Kinetics studies on photocatalytic degradation of RR198

Under constant conditions of pH, catalyst weight and photon flux the effect of concentration of the dye on its photodegradability has been studied. The results show that the photocatalytic decolorization of RR198 dye in aqueous TiO_2 follows first order kinetics.

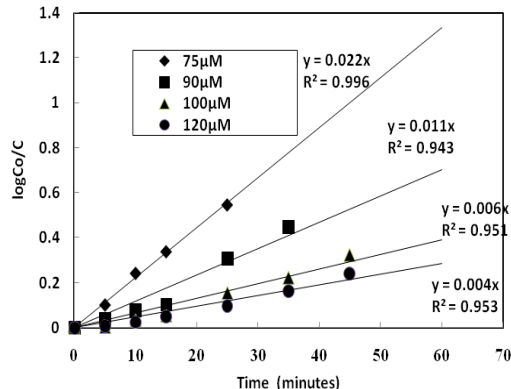


Figure.6. Linear transform $\text{Ln}(C_0/C)$ of the disappearance of reactive red 198.

$\text{Ln}(C_0/C) = kt$, where C_0 is the initial concentration and C is the concentration at any time, t . Table.1 shows the $\text{Ln}(C_0/C)$ value for the concentration of dye varying from 75 µM -120 µM. The plot of $\text{Ln}(C_0/C)$ vs t gave a straight line as shown in the Figure.6. The correlation constant R^2 for the best fit line was calculated to be 0.996, 0.953, 0.951, 0.943 respectively. The rate constants were calculated to be 0.022 min^{-1} , 0.004 min^{-1} , 0.006 min^{-1} , 0.011 min^{-1} respectively. The rate constant values were found to decrease with increase in concentration.

S.No	Time in mts	$\text{Ln}(C_0/C)$			
		75µM	90 µM	100 µM	120 µM
1	0	-	-	-	-
2	5	0.1021	0.0399	0.0047	0.0082
3	10	0.2423	0.0787	0.0366	0.0256
4	15	0.3383	0.1028	0.0545	0.0518
5	25	0.5456	0.3066	0.1562	0.0980
6	35	0.9702	0.4471	0.2236	0.1175
7	45	1.0293	0.7333	0.3245	0.2410

Table.1. $\text{Ln}(C_0/C)$ value for the concentration of dye varying from 75 µM -120 µM

F. Reuse of catalyst



The catalyst lifetime is an important parameter of the photocatalytic process because its use for longer period of time leads to a significant cost reduction of the treatment. For this reason, the catalyst was recycled which showed a drop in efficiency from 100% in 5h to 90%.

IV. CONCLUSIONS

Nano TiO₂ had been prepared successfully by the sol-gel method and studied by XRD and SEM micrograph. In conclusion, one of the industrial textile dyes, namely reactive red 198 was studied effectively for its photocatalytic decolorization in UV light using titanium dioxide nanoparticle as photocatalyst. The XRD data showed nano TiO₂ had anatase phase and SEM micrograph showed the uniform and spherical shape of the particle. Introduced at comparatively lower dose, nano TiO₂ was found to be highly efficient in decolorizing and degrading the water pollutant. The photocatalytic degradation rate was improved with increasing amount of nano TiO₂. All these results indicate that TiO₂ nanoparticle can be a better candidate to handle the waste textile water issue gently, to harmonize water system to its natural state. The photocatalytic degradation of RR198 can be described with pseudo-first order reaction kinetics.

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Synthesis and Characterization of Trisodium Citrate Capped Silver Nanoparticles

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Abstract—Silver has been used since time immemorial in different chemical form to treat burns, wounds and several infections caused by pathogenic bacteria. Trisodium citrate capped silver nanoparticles were synthesized by chemical reduction method. The influence of pH on properties of silver nanoparticles was studied. Structural, size, optical properties of the silver nanoparticles were studied using X-ray diffraction (XRD), transmission electron microscopy (TEM) and Fourier transform infrared (FT-IR). Broadened XRD peaks confirmed the formation of nanosized silver nanoparticles with face centered cubic (FCC) structure and is consistent with TEM studies. Particle size decreases with increasing pH value which is confirmed by both XRD and TEM studies. Optical absorption spectra revealed the blue shift of surface plasmon resonance (SPR) band. FTIR measurements conclude the intact of trisodium citrate with silver nanoparticles. The obtained nanoparticles were well dispersed in water, ethanol and polar solvents and thus more suitable for biocompatible.

Key words: Silver nanoparticles, XRD, EDAX.

I INTRODUCTION

Nanotechnology is one of the most vigorous areas of research in present material science. Nanotechnology deals with the tailoring of materials at atomic level to accomplish distinctive properties, which can be properly influence for the preferred applications [1]. A convergence of nanotechnology and biology can address several biomedical problems, and can modernize the field of health and medicine because the majority of the natural processes also take place in the nanometre scale regime [2]. The fabrication of metal nanoparticles offers advantages at the quantum-level, such as surface-enhanced Raman spectroscopy and metal-enhanced fluorescence. Nanoparticles are increasingly receiving attention as important starting points for the generation of micro and nanostructures [3] due to their interesting physical properties such as small sizes and high surface/volume ratio [4] which differs significantly from that of the bulk phase. Silver nanoparticles (Ag NPs) have been a subject of great interest among scientists due to their remarkable properties such as good conductivity, catalytic and antibacterial effect [5–8]. Metallic silver colloids were first prepared more than a century ago. Ag nanoparticles can be synthesized using various methods: chemical, electrochemical [9], γ -radiation [10] photochemical [11], laser ablation [12] etc.

The most popular preparation of Ag colloids is chemical reduction of silver salts by sodium borohydride or sodium citrate. This preparation is simple, but the great care must be exercised to make stable and reproducible nanoparticles. The

purity of water and reagents, cleanliness of the glassware are critical parameters. Solution temperature, pH of solution, concentrations of the metal salt and reducing agent, reaction time influences particle size. Controlling size and shape of metal nanoparticles remains a challenge [13]. The size-induced properties of nanoparticles enable the development of new applications or the addition of flexibility to existing systems in many areas, such as catalysis, optics, microelectronics and so on. Silver nanoparticles exhibit new optical properties, which are not observed neither in molecules nor in bulk metals. One example is presence of absorption band in visible light region. This band appears due to the surface Plasmon oscillation modes of conduction electrons which are coupled through the surface to external electromagnetic fields. In addition, Ag nanoparticles have recently been shown to be a promising antimicrobial material [14].

II EXPERIMENTAL

Silver nanoparticles were prepared by simple polyol method. In a typical synthesis procedure, 1.679g of silver nitrate (AgNO_3) is taken into a 50ml of pure distilled water, results in the molarity of 0.2M aqueous solution. 2g of trisodium citrate solution having 0.1M molarity is added as reducing agent to the above aqueous solution. Then after, NaOH is added drop wise in order to maintain pH of the reaction system constant and the above solution was sealed and kept under continuous stirring on a magnetic stirrer (i.e. about 4hours) maintaining constant temperature of 70°C. Trisodium citrate in the solution phase reduces the silver ions, as it is a strong reducing agent it promotes a fast reaction rate and favours the formation of smaller silver nanoparticles. By simply varying pH of the reaction system, we can tune the size of the nanoparticles. Then the above solution is cooled to room temperature and kept idle in order to settle the silver nanoparticles at the bottom of the solution for 6 hours. The solution thus obtained was filtered and the precipitate is dried up. This precipitate is grinded in a clean motor and silver nanoparticles are collected. The above procedure is reiterated by varying the pH 8 and 10.

The as-synthesized silver nanoparticles were subjected to various characterization studies. Characterization is performed using a variety of different techniques such as X-ray diffractometry (XRD), Transmission electron microscopy (TEM), Energy Dispersive Analysis of X-Rays (EDAX), UV-vis spectroscopy and FTIR (Fourier Transform Infra Red Spectroscopy). The X-ray /Max 2550 diffractometer with the Cu



K α radiation ($\lambda = 1.5406 \text{ \AA}$) powder diffraction (XRD) pattern was recorded using a Rigaku D 54056A^o) in 2θ ranging from 30° to 90° . The TEM micrograph was obtained using a JEOL JEM-100CX II electron microscope operating at 100 kV. The sample for TEM was prepared by placing a drop of silver colloid onto the standard carbon coated copper grids. UV-visible adsorption spectra were collected with a SHIMADZU UV-2450 UV-visible spectrophotometer.

III RESULTS AND DISCUSSION

a) X-RAY DIFFRACTION STUDIES:

The XRD analysis has been done for the as-synthesized silver nanoparticles. The XRD spectrum is shown in the fig.1 which shows XRD pattern of silver nanoparticles which are indexed as (111), (200), (220), (311), (222) are observed. The (111), (220), (311) and (222) Bragg's reflections are weak and broadened relative to the intense (111) reflections. This feature indicates that the nanocrystals are oriented as confirmed by high resolution TEM measurements [15]. The broadening of Bragg's peaks indicated the formation of nanoparticles. The mean size of silver nanoparticles was calculated using Debye Scherrer's Equation by determining the width of the (111) Bragg's reflection. The size of the nanoparticles was such determined to be about $95 \pm 5 \text{ nm}$.

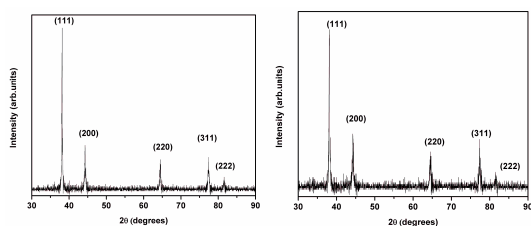


Fig.1 XRD patterns of silver nanoparticles prepared at pH 8 and 10

b) TRANSMISSION ELECTRON MICROSCOPE:

The size and morphology of the silver nanoparticles prepared under different pH values were observed by TEM measurements. The TEM images were shown in fig. 2(a). The prepared silver nanoparticles were found to be homogeneous and the particles are almost always isolated with no confirmation of any substantial aggregation. The average sizes of the particles prepared at pH of 8.0 and 10.0 were of 100nm and 90nm respectively. The average size decreased with increase in high pH which was consistent with XRD results and blue shift of the absorption peaks in the UV-vis spectra.

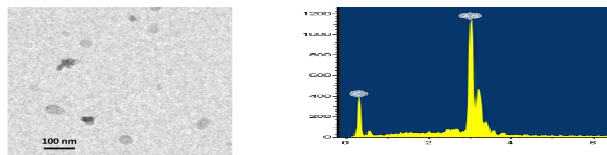


Fig.2 (a) Representative TEM image (b) representative EDAX Spectrum of pH 8.

c) Energy Dispersive Analysis of X-Rays (EDAX)

The spectrum obtained from EDAX analysis is shown in Fig.3, which shows the *presence of elemental silver formed*. This indicates the reduction of silver ions to elemental silver. It was also observed from the EDAX spectra (Fig. 2(b)) that the elemental carbon peak arises, which could be due to adhesion of carbon tape on to the stud and it also comes due to the addition of trisodium citrate as a capping agent. No other elemental peaks were observed. EDAX spectra confirmed the presence of elemental signal of the silver nanoparticles. Identification lines for the major emission energies for silver (Ag) were displayed and these correspond with peaks in the spectrum, thus giving confidence that silver has been correctly identified. Hence, it confirms formation of pure silver nanoparticles.

d) UV VISIBLE ABSORPTION:

UV-vis absorption spectroscopy is a valuable tool for structural characterization of silver nanoparticles [16]. UV-vis spectroscopy is an important technique to ascertain the formation and stability of metal nanoparticles in aqueous solution. Fig 5 shows the UV- visible spectra of silver nanoparticles at different pH values. From the figure it was observed that the resonance absorption peak is at 390-421 nm indicates the formation of silver nanoparticles of smaller size with narrow size distribution. The decreased particle size with increasing pH values is a well known phenomenon. It is normally attributed to the increased reaction rates. As the reaction rate increases the silver ions are consumed faster and hence smaller particles and narrower size distributions are obtained for higher pH values.

The number of nucleus increased with elevated pH due to the promoted reactivity of the reducing agent, thus absorption peaks of the products underwent blue-shift with increased pH as shown in Fig.3 attributed due to the decreased size and anisotropy degree of the silver particles [17-20]. It is well known that the optical absorption spectra of metal nanoparticles with longer wave lengths correspond to increase in particle [21]. In all cases silver particles display a very distinct yellowish-brown color and an absorbance in the region 400–420 nm attributed to the collective oscillations of free conduction electrons and termed as Surface Plasmon Resonance (SPR) [22, 23]. It is obvious from UV-Vis spectra that the wider absorption (SPR) peak becomes sharper upon increasing pH which further confirms decreasing in particle size upon increasing pH values.

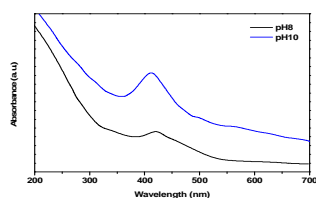


Fig.3 UV-visible absorption Spectra

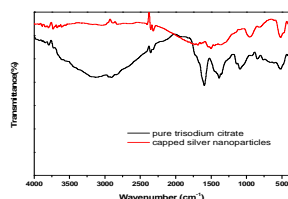


Fig.4 FTIR Spectra of Trisodium citrate and trisodium citrate capped silver nanoparticles.

e) FTIR STUDIES

FTIR measurements were carried out to identify the possible trisodium citrate responsible for capping, leading to efficient stabilization of the silver nanoparticles. The relative shift in position and intensity distribution of the IR bands in the spectra show that the trisodium citrate for capping and stabilization in silver nanoparticles. Fig.4. shows the FTIR Spectra of pure trisodium citrate as well as trisodium citrate capped silver nanoparticles. For trisodium citrate the characteristic bands correspond to the symmetric stretching of -COO , at 1394 cm^{-1} and for the anti symmetric stretching of -COO , at 1590 cm^{-1} . The stretching vibration frequency of -OH is at 3455 cm^{-1} are clearly shown in Fig.6.a. When the citrate ligand bound to NPs surface, the antisymmetric stretching of -COO at 1590 cm^{-1} almost remain same but the symmetric -COO stretching mode of citrate becomes red shifted and appears sharply at 1398 cm^{-1} [24,25]. The red-shifted symmetric -COO stretching mode evidently confirms the bi-dentate binding of two carboxylate oxygen's with the surface of Ag NPs [26].

IV CONCLUSION

Uniform silver nanoparticles have been successfully synthesized by chemical reduction method in the presence of trisodium citrate as reduction agent and surfactant. The influence of pH on silver nanoparticles was studied. Size of the silver nanoparticles was tunable by simply changing pH, of the reactions. The formation of silver nanoparticles was monitored via UV visible spectral analysis. From the UV- vis spectrum it is observed that, with the increase of pH the particle size decrease. The obtained silver nanoparticles were bio and eco compatible.

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Preparation and Characterization of Rutile TiO₂ Nanoparticles using Sol-Gel Method

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Abstract— Titanium dioxide (TiO₂) nanoparticles were synthesized by using sol-gel method using titanium tetraisopropoxide (TTIP) as precursor material. By calcining the obtained TiO₂ at varying temperatures (300oC, 500oC and 700oC) Rutile-phase TiO₂ (r-TiO₂) was obtained. The obtained r-TiO₂ was characterized using FESEM, EDAX and XRD. FESEM results confirmed the formation of nano structures of r-TiO₂ with size varying from 20nm to 200nm.

Keywords- Titanium dioxide, Sol-Gel, Nanoparticles, Rutile.

I. INTRODUCTION

Titanium dioxide (TiO₂), is one of the popular, promising and most investigated metal oxides because of its multifunctional properties. Applications in the field of electronic devices, decomposition of polluting compound, protection of artwork from oxidation, medical bioengineering, photoreactions for specific syntheses, solar energy conversion with optimal quantum yields, and production of molecular hydrogen from water were generating along the years, a substantial scientific literature [1]. The list of TiO₂ applications is still growing due to peculiar properties of this promising material emerging at the nanoscale [2, 3].

The TiO₂ crystal exists in two major forms: rutile and anatase [4, 5]. Anatase is thermodynamically metastable and can be transformed irreversibly to rutile phase at high temperatures [4, 6]. Most of the chemistry researchers have paid greater attention to anatase TiO₂ than rutile TiO₂ (r-TiO₂) in both photocatalytic reactions and photoelectrochemical cell, because anatase phase of TiO₂ had been considered to be more active than rutile. Several excellent properties of r-TiO₂, such as chemical inertness, superior light scattering characteristics, and lower cost [4, 7], however, make it a potentially important phase in photocatalytic and photovoltaic applications. Wang et al. reported the high photocatalytic activity of r-TiO₂ for decomposition of rhodamine-B in water under artificial solar light irradiation [8]. Bacsá and Kiwi found that the presence of r-TiO₂ showed enhanced catalytic activity compared to pure anatase TiO₂ during the degradation of p-coumaric acid [9]. Rutile phase has also been shown to be more active than anatase in photodecomposition of H₂S [10], and photooxidation of H₂O with Fe³⁺ [11]. Park et al. showed that the photovoltaic

characteristics of rutile TiO₂-based DSSCs are comparable to those of anatase TiO₂-based solar cells [12, 13].

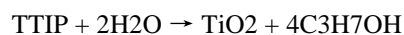
In the present work, TiO₂ nanoparticles were synthesized employing sol-gel method. The effect of post annealing deposition temperature on structural morphology of TiO₂ has been studied.

II. EXPERIMENTAL

Nano-sized TiO₂ powder was synthesized via a Sol-Gel method using titanium tetraisopropoxide (TTIP), isopropanol, ammonia (NH₃), nitric acid (HNO₃) and deionized water as starting materials. All chemicals were purchased from Aldrich in the highest quality commercially available.

A. Synthesis

A fixed amount of a mixture of isopropanol and deionized water (MIsopropanol : MTTIP : MH₂O = 1:2:12) was added in drops into TTIP solution while magnetic stirring was applied at the same time. When the titration process finished, HNO₃ was added into the aqueous solution and pH was maintained at 2.0. The acid was used to restrain the hydrolysis process and consequently, to control the grain growth [14]. The solution was stirred at high speed for another 1 h and peptized overnight. After peptization, a two-layer solution was seen to be formed: the upper layer being, the organic by-product of the hydrolysis, and the lower layer a titanic acid gel. The gel was then collected by filtration and dried at 110oC for several hours, until yellow block crystals appeared. These crystals were crushed and ground into fine powder using a mortar and pestle to obtain nanostructures of TiO₂. The hydrolysis reaction leading to the formation of TiO₂ can be represented by the following reaction:



A process flow chart depicting the synthesis of nanocrystalline TiO₂ is shown in Figure 1

B. Annealing

The TiO₂ nanopowder obtained was calcined at different temperatures (300oC, 500oC, 700oC) for 3 h in atmosphere, to obtain rutile phase of TiO₂.

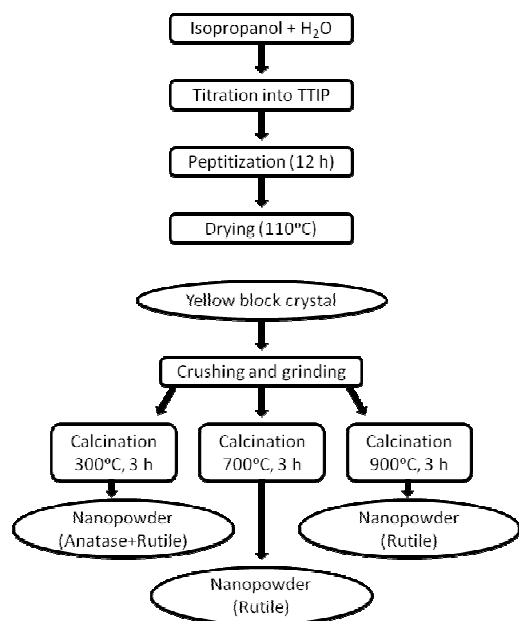


Figure 1. Flow chart showing preparation of nano-TiO₂ powders through a Sol-Gel process.

III. CHARACTERIZATION

TiO₂ nanopowders calcined at different temperatures were characterized using Field Emission Scanning Electron Microscope (FESEM) – Carl ZEISS, Energy-dispersive X-ray spectroscopy (EDX) – Carl ZEISS and X-ray diffractometer (XRD) – Rigaku SmartLab. FESEM was used to study the morphology of the synthesized nanoparticles. The composition of the nanoparticles was confirmed using EDAX and XRD was used to analyze the crystallographic structure of the nanoparticles.

A. FESEM Analysis

FESEM images of the TiO₂ nanoparticles annealed at different temperatures are shown in Figure 2. The size of the nanoparticles was found to increase with increase in annealing temperatures. TiO₂ nanoparticles before annealing have approximate size of 10 nm. The particles annealed at 300°C, 700°C and 900°C showed average size of 20 nm, 50 nm and 200 nm respectively.

B. EDX Analysis The EDX spectrum revealed the clear identification of the elemental composition profile of the synthesized nanoparticles, which suggests the presence of TiO₂ as the ingredient element.

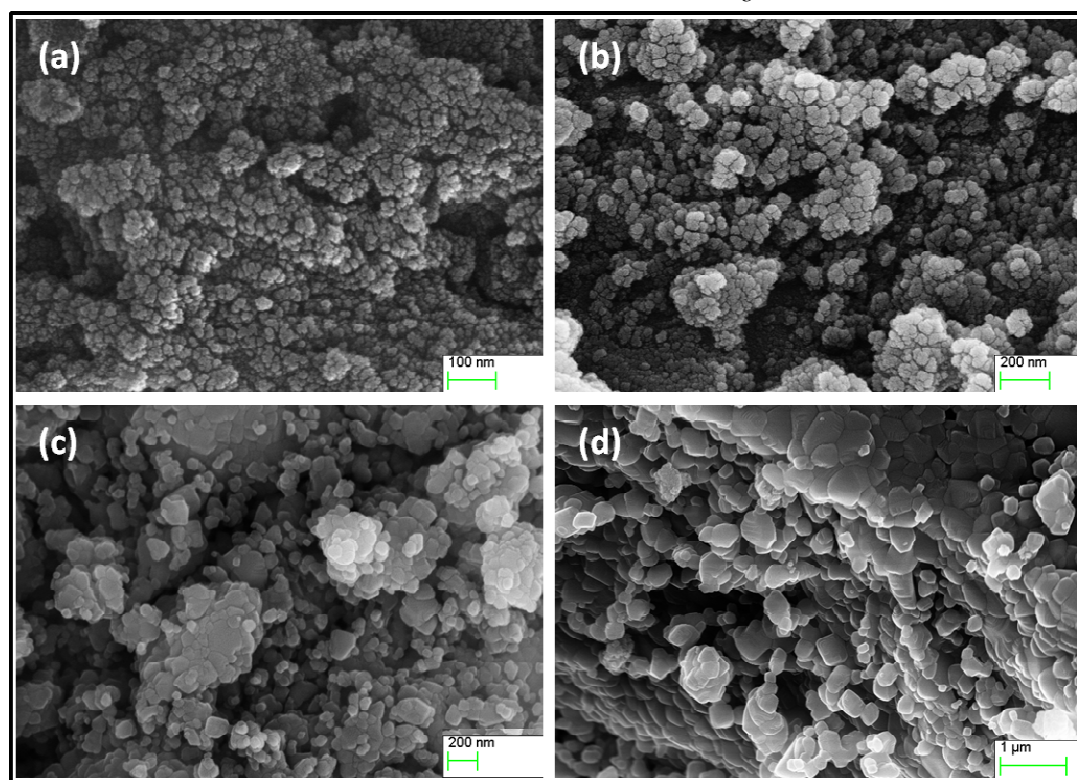


Figure 2. FESEM images of TiO₂ nanoparticles (a) Before annealing, (b) 300°C, (c) 500°C (d) 700°C.

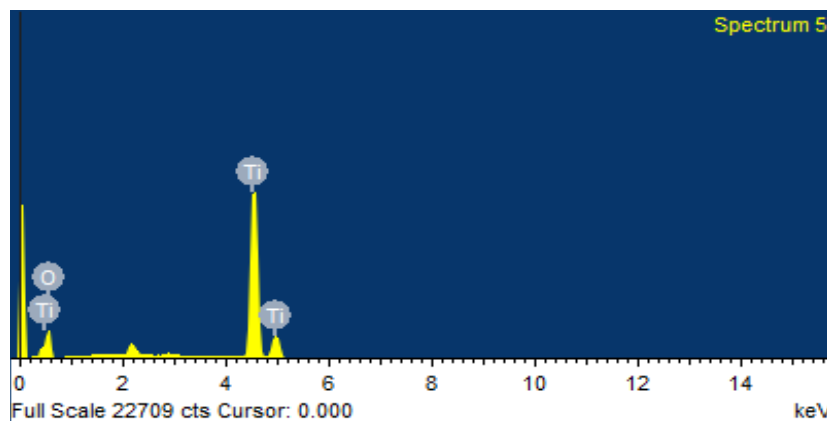
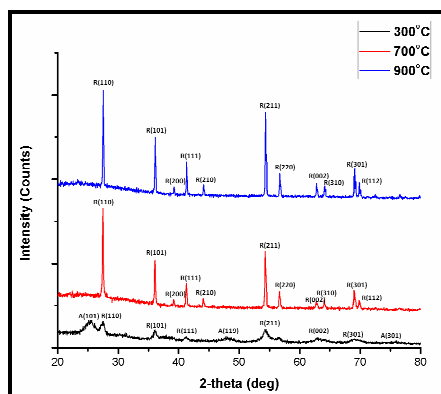


Figure 3. EDX spectrum showing the elemental of Ti and O.

C. XRD Analysis

Crystallographic study of TiO₂ nanoparticles annealed at different temperatures have been performed using powder X-ray rotating anode diffractometer (XRD; Rigaku SmartLab) using monochromatic Cu-K α X-rays ($\lambda = 1.5406 \text{ \AA}$) of power 40 kV, 100 mA, scan speed- 3.00 deg/min, step width- 0.02 deg. Because very accurate data were needed, only the step-scan technique was used. The scanning range was from 20 to 80° 2 θ .

As an aid, a simulation of the theoretical X-ray powder pattern of a possible TiO₂ sample was carried out on the basis of the ICDD-PDF according to the files 89-4920, 89-4921, for rutile and anatase, respectively. Each allotropic phase was selected in order to attain a well-resolved pattern. The XRD patterns in Figure 4 shows the phase evolution of the synthesized powder when calcined at different temperatures, where the phase transition into rutile phase is seen at 700°C and 900°C. The pattern of the sample annealed at 300°C included in this figure shows the mixture of anatase and rutile phase.





Synthesis and characterization of noble metal nanoparticles by soft chemical route

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Abstract— Growth of gold nanoparticles (AuNPs) and silver nanoparticles (AgNPs) has been achieved by chemical reduction method using various reducing agents. In this work, the morphology control on the nanoparticles, by tuning the experimental parameters such as, varying the precursor (AuNPs) and tailoring the concentration of hydrochloric acid using ethylene glycol (Ag nanocubes) has been demonstrated. AuNPs are synthesized using two different reducing agents, glucose and trisodium citrate, which acts as both reducing agent and capping agent. In this chemical route of synthesis, different concentrations of aurochloric acid (HAuCl₄) are used to study its effect on the size of the nanoparticles. Color ranges of pale pink-pink-dark pink are seen, indicating the formation of Au NPs of different size range, confirmed by FESEM. Growth of nearly cube shaped Ag nanoparticles, by varying the concentration of HCl has been studied. The reaction of silver nitrate is carried out with ethylene glycol at 180°C, which serves as both reductant and solvent. The primary stages of the reaction are observed by their distinctive colors. The solution turns milky white after the injection of the solutions of AgNO₃ and polyvinylpyrrolidone (PVP), indicating the formation of AgNPs. The changes in the shape of AgNPs from spherical to nearly cube were confirmed using FESEM.

Keywords: AuNPs, AgNPs, polyvinylpyrrolidone

1. Introduction

Design and synthesis of novel nanomaterials of varying size and shape is one of the emerging areas of materials science. The properties of the nanomaterials depend on the particle morphology and hence demands for the tailoring of size and shape of the nanostructures. The nanostructures with variable size and shape, decide the optical and magnetic properties which play an important role in many different areas. They are used to experimentally probe the effects of quantum confinement on electronic, magnetic, and other related properties [1–3]. They have also been widely exploited for use in photography [4], catalysis [5], biological labeling [6], photonics [7], optoelectronics [8], information storage [9], surface-enhanced Raman scattering (SERS) [10–12], and formulation of magnetic

ferrofluids [13–15]. Metal nanoparticles have received considerable attention because of their extraordinary electrical and optical properties. In particular, metal nanoparticles of noble elements such as silver and gold are well studied because of their applications in surface-enhanced Raman scattering (SERS) [16], plasmonics [17], etc. Monodisperse nanomaterials of controllable composition and structure can be processed [18]. Capping reagents have been used to kinetically stabilize synthetic systems with less stable facets [19, 20].

Sun and Xia [21] synthesized monodisperse silver nanocubes in large quantities by reducing silver nitrate with ethylene glycol in the presence of PVP. The cubes were found to be single crystals and were characterized by a slightly truncated shape bounded by {100}, {110}, and {111} facets. Their study showed that the concentration of PVP is vital in determining the morphology and size of the end product. Im *et al* [22] showed that by introduction of a small amount of hydrochloric acid during silver nanoparticles synthesis can result in monodispersed single crystal nanocubes. Addition of HCl resulted in better yield and perfection of the cube than the conventional polyol process. They also investigated the dependence of morphology on the concentration of HCl. Their studies showed that it is possible to control the size and hence the optical properties of Ag nanocubes simply by varying the reaction time.

2. Experimental

Materials and Methods

Silver nitrate (SISCO Research Lab Pvt. Ltd. (SRL)), poly(vinylpyrrolidone) (PVP) (ALDRICH), ethylene glycol (Central Drug House Pvt. Ltd.), ethanol (Hayman Ltd.), chloroauric acid (HiMEDIA Laboratories Pvt. Ltd.), D-glucose (SRL), trisodium citrate (Lab Rasayan - Sd - Fine Chem. Ltd.). AR grade chemicals were used for the synthesis. Dust free Milli-Q water has been used throughout the synthesis.

Synthesis of AgNPs



Silver nanoparticles were synthesized by chemical reduction method. We have used AgNO_3 as the precursor for silver, PVP as the capping agent to prevent agglomeration of the nanoparticles and ethylene glycol as the reducing agent as well as the solvent. The experimental parameters varied for morphology control is shown in Table. 1. In all the synthesis we have maintained the same concentration of AgNO_3 and PVP and dissolved them in 3ml ethylene glycol. The synthesis methodology for sample AgNC-1 is briefed. Exactly 5ml of ethylene

glycol was heated at 180°C for 1 hour, to this hot solution dissolved solution of AgNO_3 and PVP in 3ml ethylene glycol was added drop wise at a drop rate of $750\mu\text{l}$ per minute with stirring. Coloration changes were observed from colorless to pale yellow and then to yellowish brown. The reaction was carried out for 30 minutes, after which the solution was cooled to room temperature. The resultant nanoparticles were purified by centrifugation at 15,000 RPM and then re-dispersed in ethanol.

Table. 1: Reactant concentrations for achieving shape control for silver nanoparticles

S. No	Sample Label	AgNO_3 (M)	PVP (M)	Ethylene Glycol (M)	HCl (M)	Color Change
1	AgNC-1	0.250	0.375	0.496	0.000	Colourless to yellowish brown
2	AgNC-2	0.250	0.375	0.496	0.036	Milky white-pale yellow-yellowish orange
3	AgNC-2	0.250	0.375	0.496	0.182	Milky white-pale yellow-ocher

In order to synthesize samples AgNC-2 and AgNC-3, 1 ml of 3 mM HCl and 5 ml of 3 mM HCl was added respectively to 5mL of ethylene glycol maintained at 180°C . After 10 minutes the desired concentration of AgNO_3 and PVP (see Table. 1) dissolved in 3ml of ethylene glycol was added drop wise for the same drop rate as carried out for AgNC-1. The color change observed for AgNC-2 and Ag NC-3 are milky

white-pale yellow-yellowish orange and milky white-pale yellow-ocher respectively. The purification of the nanoparticles suspension was repeated as mentioned above.

Synthesis of AuNPs

Gold nanoparticles have been synthesized using two different reducing agents: glucose and trisodium citrate. The concentration of the reactants used for synthesis is given in Table. 2.

S. No	Sample Label	HAuCl_4 (M)	Reducing Agent (M)	Color Change
1	GNP-1	0.0180	0.1 Glucose	Colorless to pink
2	GNP-2	0.0072	0.1 Glucose	Light yellow to dark pink
3	GNP-3	0.0045	0.1 Glucose	Light yellow to pinkish red
4	GNP-4	0.0001	0.0001 trisodium citrate	Colourless to deep purple to deep red

power 40 kV, 100 mA, Scan speed- 3.00 deg/min, Step width- 0.02 deg.

3. Characterizations

Morphological studies were performed using field-emission scanning electron microscope (FESEM; Zeiss-SUPRA 55), Crystallographic and electronic structural studies have been performed using powder X-ray diffractometer (XRD; Rigaku SmartLab) using monochromatic $\text{Cu-K}\alpha$ X-rays ($\lambda = 1.5406 \text{ \AA}$) of

4. Results and Discussion

The silver and gold nanoparticles that were prepared using various reducing agents were characterized using Field Emission Scanning Electron Microscope and X-ray Diffraction.



Figure 1A shows the size and shape of the gold nanoparticles prepared using glucose as the reducing agent with 1 ml of HAuCl_4 . The FESEM image confirms that the particles are 12-13 nm in size and spherical in shape. Figure 1B shows the particles with a size of 28-37 nm with spherical shape on addition of 2.5 ml of HAuCl_4 . On further increasing the gold concentration to 4 ml, the size increased to 54 nm as depicted in Figure 1C. Figure 1D shows the XRD analysis of the so formed gold nanoparticles confirming the cubic phase.

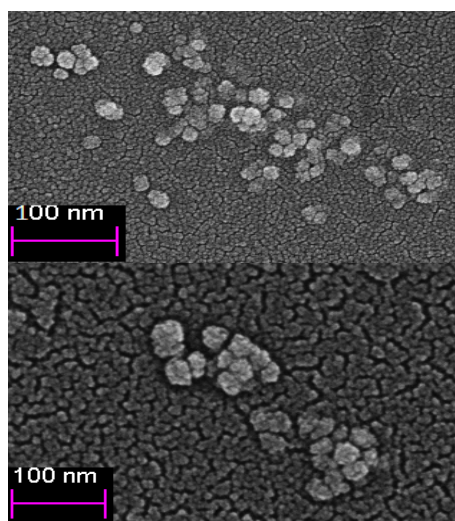


Fig.1A. FESEM OF AuNP (1ml HAuCl_4)

Fig.1B. FESEM OF AuNP (2.5ml HAuCl_4)

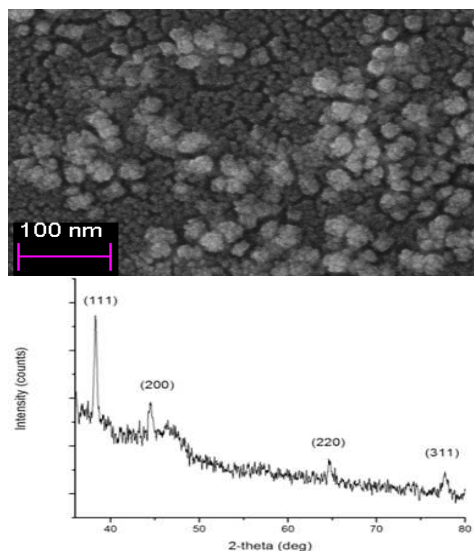


Fig.1C. FESEM OF AuNP (4ml HAuCl_4)

Fig.1D. XRD OF AuNP

Thus, the study shows the effect of HAuCl_4 on the size of the nanoparticles as it increases with higher concentrations of the precursor.

Figure 2A shows the size and shape of the gold nanoparticles prepared using Trisodium citrate (TSC) as the reducing agent. The FESEM image confirms that the particles are 40-50 nm in size and spherical in shape with a uniform distribution. Figure 2B shows the XRD analysis of the so formed gold nanoparticles confirming the cubic phase.

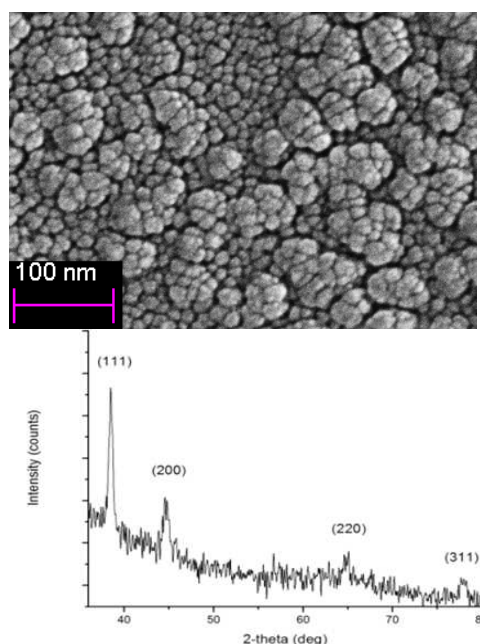


Fig.2A. FESEM OF AuNP reduced with TSC

Fig.2B. XRD OF AuNP with TSC

Figure 3A shows a uniform distribution of silver nanoparticles, prepared using ethylene glycol as a reducing agent without HCl with a size range of 35-37 nm at 200 nm scale. The picture also shows the individual particles combined to form a cauliflower shaped structure. Figure 3B shows the XRD analysis of the so formed silver nanoparticles confirming the cubic phase

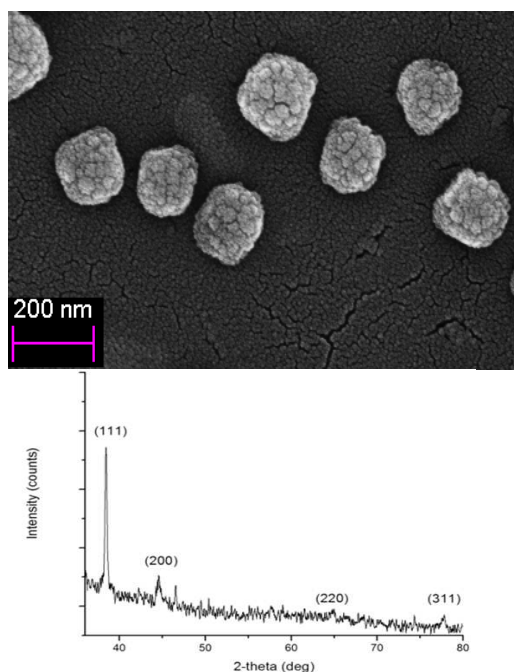


Fig.3A. FESEM OF AgNP
Fig.3B. XRD OF AgNP

Figure 4A shows a uniform distribution of silver nanoparticles prepared using ethylene glycol as reducing agent and 1 ml of HCl. The particles are cubic in shape and 47-55 nm in size. Figure 4B shows the XRD analysis of the so formed silver nanoparticles confirming the cubic phase.

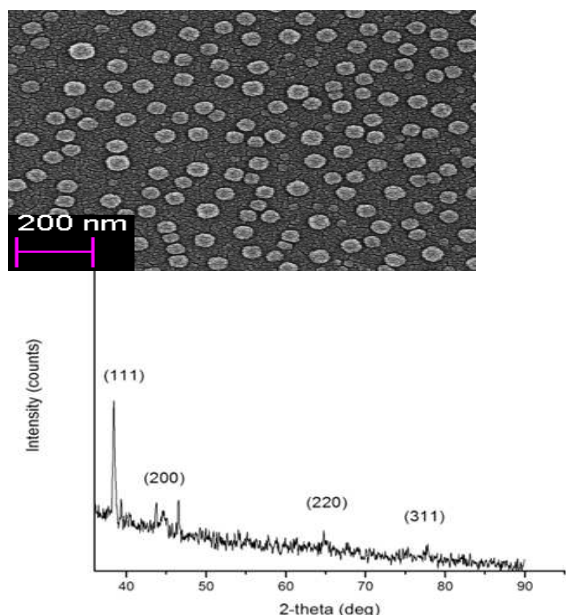


Fig.4A. FESEM OF AgNP with 1ml HCl
Fig.4B. XRD OF AgNP with 1ml HCl

Figure 5A shows the silver nanoparticles prepared using ethylene glycol as reducing agent and 5ml HCl. The nanoparticles are clustered to form a cubic structure of size 150 nm with increased concentration of HCl. Figure 5B shows the XRD analysis of the so formed silver nanoparticles confirming the cubic crystalline phase.

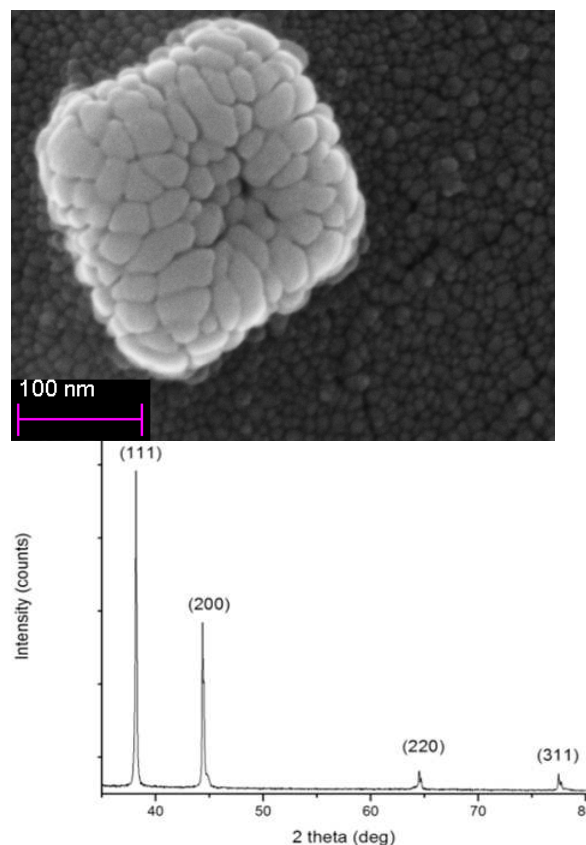


Fig.5A. FESEM OF AgNP with 5ml HCl
Fig.5B. XRD OF AgNP with 5ml HCl

Conclusions

In summary, silver nanocubes were synthesized using a small amount of hydrochloric acid to the conventional polyol synthesis. FESEM results and observed colour changes confirms that hydrochloric acid plays an important role in selective etching. Further, in the second set, on increasing the amount of the hydrochloric acid, it was observed that the nearly cube shape of the particles was more prominent than the earlier set.



5. Acknowledgements

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Study of Nano Materials

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Abstract- For centuries during the middle ages, alchemists worked wistfully to achieve the ultimate goal of creating gold or silver from other elements, but to no avail. Recently, however, scientists and engineers are becoming “*new-age alchemists*” by diving into a new scientific realm known as nanotechnology to create materials that will change the way we will live. Existing materials will be stronger, lighter, and more durable when coupled with *nano-technology*. Isolated nano-particles exhibit amazing properties, and when mixed with other materials the new compound becomes improved in a variety of ways. There are already many nano-material-enhanced products on the market, and efforts are being made that would turn polymers into efficient solar energy converters simply by mixing them with nano-crystals. The infinite possibilities that nanotechnology has on the production of nano-materials is going to significantly alter the material world. Over the past decade, nano-materials have been the subject of enormous interest. These materials, notable for their extremely small feature size, have the potential for wide-ranging industrial, biomedical, and electronic applications. As a result of recent improvement in technologies to see and manipulate these materials, the nano-materials field has seen a huge increase in funding from private enterprises and government, and academic researchers within the field have formed many partnerships.

Keywords- *Nano-technology, classification of nano-materials, Sectors influenced by Nano-materials, Special applications, Advanced nano-materials, safety.*

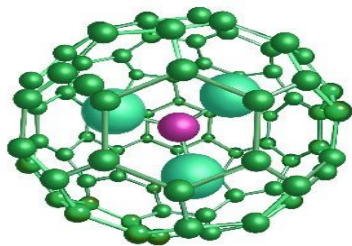


Figure 1 Fullerene

I.INTRODUCTION

What is Nano-technology?

Nanotechnology is the engineering of functional systems at the molecular scale. This covers both current work and concepts that are more advanced.. K. Eric Drexler popularized the word 'nanotechnology' in the 1980's. Much of the work being done today that carries the name 'nanotechnology' is not nanotechnology in the original meaning of the word. Nanotechnology, in its traditional sense, means building things from the bottom up, with atomic precision. This theoretical capability was envisioned as early as 1959 by the renowned physicist Richard Feynman. I want to build a billion tiny factories, models of each other, which are manufacturing simultaneously. . .

The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom. It is not an attempt to violate any laws; it is something, in principle, that can be done; but in practice, it has not been done because we are too big. — Richard Feynman, Nobel Prize winner in physics.

II. Nano Materials

Nano-materials is a field that takes a materials science-based approach to nanotechnology. It studies materials with morphological features on the nanoscale, and especially those that have special properties stemming from their nanoscale dimensions. Nanoscale is usually defined as smaller than a one tenth of a micrometer in at least one dimension, though this term is sometimes used for even smaller materials. A natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50% or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm – 100 nm. In specific cases and where warranted by concerns for the environment, health, safety or competitiveness the number size distribution



threshold of 50% may be replaced by a threshold between 1 and 50%. An important aspect of nanotechnology is the vastly increased ratio of surface area to volume present in many nanoscale materials, which makes possible new quantum mechanical effects. One example is the "quantum size effect" where the electronic properties of solids are altered with great reductions in particle size. This effect does not come into play by going from macro to micro dimensions. However, it becomes pronounced when the nanometer size range is reached. A certain number of physical properties also alter with the change from macroscopic systems. Novel mechanical properties of nano-materials is a subject of nano-mechanics research. Catalytic activities also reveal new behavior in the interaction with biomaterials.

Although a broad definition, we categorize nano-materials as those which have structured components with at least one dimension less than 100nm. Materials that have one dimension in the nanoscale (and are extended in the other two dimensions) are layers, such as a thin films or surface coatings. Some of the features on computer chips come in this category. Materials that are nanoscale in two dimensions (and extended in one dimension) include nanowires and nanotubes. Materials that are nanoscale in three dimensions are particles, for example precipitates, colloids and quantum dots (tiny particles of semiconductor materials). Nano-crystalline materials, made up of nano-metre-sized grains, also fall into this category. Some of these materials have been available for some time; others are genuinely new

Two principal factors cause the properties of nano-materials to differ significantly from other materials: increased relative surface area, and quantum effects. These factors can change or enhance properties such as reactivity, strength and electrical characteristics. As a particle decreases in size, a greater proportion of atoms are found at the surface compared to those inside. For example, a particle of size 30 nm has 5% of its atoms on its surface, at 10 nm 20% of its atoms, and at 3 nm 50% of its atoms. Thus nano-particles have a much greater surface area per unit mass compared with larger particles. As growth and catalytic chemical reactions occur at surfaces, this means that a given mass of material in nano-particulate form will be

much more reactive than the same mass of material made up of larger particles



Figure 2 U.S. Dollar

To understand the effect of particle size on surface area, consider an American Silver Eagle coin. This silver dollar contains 31 grams of coin silver and has a total surface area of approximately 3000 square millimeters. If the same amount of coin silver were divided into tiny particles – say 10 nanometer in diameter – the total surface area of those particles would be 7000 square meters (which is equal to the size of a soccer field – or larger than the floor space of the White House, which is 5100 square meters). In other words: when the amount of coin silver contained in a silver dollar is rendered into 10 nm particles, the surface area of those particles is over 2 million times greater than the surface area of the silver dollar!

III. Classification of nano-materials

Materials referred to as "nano-materials" generally fall into two categories: fullerenes, and inorganic nanoparticles.

Fullerenes

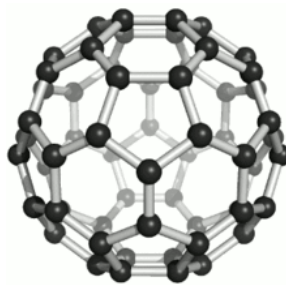


Figure 3 Rotating view of Buckminsterfullerene

The fullerenes are a class of allotropes of carbon which conceptually are graphene sheets rolled into tubes or spheres. These include the carbon nanotubes (or silicon nanotubes) which are of



interest both because of their mechanical strength and also because of their electrical properties.

For the past decade, the chemical and physical properties of fullerenes have been a hot topic in the field of research and development, and are likely to continue to be for a long time. In April 2003, fullerenes were under study for potential medicinal use: binding specific antibiotics to the structure of resistant bacteria and even target certain types of cancer cells such as melanoma. The October 2005 issue of Chemistry and Biology contains an article describing the use of fullerenes as light-activated antimicrobial agents. In the field of nanotechnology, heat resistance and superconductivity are among the properties attracting intense research.

A common method used to produce fullerenes is to send a large current between two nearby graphite electrodes in an inert atmosphere. The resulting carbon plasma arc between the electrodes cools into sooty residue from which many fullerenes can be isolated. There are many calculations that have been done using ab-initio Quantum Methods applied to fullerenes. By DFT and TDDFT methods one can obtain IR, Raman and UV spectra. Results of such calculations can be compared with experimental results.

Nanoparticles

Nano-particles or nano-crystals made of metals, semiconductors, or oxides are of particular interest for their mechanical, electrical, magnetic, optical, chemical and other properties. Nano-particles have been used as quantum dots and as chemical catalysts such as nano-material-based catalysts.

Nano-particles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecular structures. A bulk material should have constant physical properties regardless of its size, but at the nano-scale this is often not the case. Size-dependent properties are observed such as quantum confinement in semiconductor particles, surface Plasmon resonance in some metal particles and superparamagnetism in magnetic materials.

Nano-particles exhibit a number of special properties relative to bulk material. For example, the bending of bulk copper (wire, ribbon, etc.) occurs with movement of copper atoms/clusters at about the 50 nm scale. Copper nano-particles smaller than 50 nm are considered super hard materials that do not exhibit the same malleability and ductility as bulk copper. The change in

properties is not always desirable. Ferroelectric materials smaller than 10 nm can switch their magnetization direction using room temperature thermal energy, thus making them useless for memory storage. Suspensions of nano-particles are possible because the interaction of the particle surface with the solvent is strong enough to overcome differences in density, which usually result in a material either sinking or floating in a liquid. Nano-particles often have unexpected visual properties because they are small enough to confine their electrons and produce quantum effects. For example gold nanoparticles appear deep red to black in solution.

The often very high surface area to volume ratio of nanoparticles provides a tremendous driving force for diffusion, especially at elevated temperatures. Sintering is possible at lower temperatures and over shorter durations than for larger particles. This theoretically does not affect the density of the final product, though flow difficulties and the tendency of nanoparticles to agglomerate do complicate matters. The surface effects of nanoparticles also reduces the incipient melting temperature.

Most current nano-materials could be organized into four types:

- ☐ Carbon Based Materials
- ☐ Metal Based Materials
- ☐ Dendrimers
- ☐ Composites

- *Carbon Based Materials*- These nanomaterials are composed mostly of carbon, most commonly taking the form of a hollow spheres, ellipsoids, or tubes. Spherical and ellipsoidal carbon nanomaterials are referred to as fullerenes, while cylindrical ones are called nanotubes. These particles have many potential applications, including improved films and coatings, stronger and lighter materials, and applications in electronics.
- *Metal Based Materials* -These nanomaterials include quantum dots, nanogold, nanosilver and metal oxides, such as titanium dioxide. A quantum dot is a closely packed semiconductor crystal comprised of hundreds or thousands of

atoms, and whose size is on the order of a few nanometers to a few hundred nanometers. Changing the size of quantum dots changes their optical properties.

- *Dendrimers*- These nano-materials are nano sized polymers built from branched units. The surface of a dendrimer has numerous chain ends, which can be tailored to perform specific chemical functions. This property could also be useful for catalysis. Also, because three-dimensional dendrimers contain interior cavities into which other molecules could be placed, they may be useful for drug delivery.
- *Composites*- Composites combine nanoparticles with other nanoparticles or with larger, bulk-type materials. Nanoparticles, such as nanosized clays, are already being added to products ranging from auto parts to packaging materials, to enhance mechanical, thermal, barrier, and flame-retardant properties.

IV. Properties of Nano-materials

- *Mechanical properties*-The large amount of grain boundaries in bulk materials made of nano-particles allows extended grain boundary sliding leading to high plasticity.
- *Catalytic Properties*-Due to their large surface, nano-particles made of transition element oxides exhibit interesting catalytic properties. In special cases, catalysis may be enhanced and more specific by decorating these particles with gold or platinum clusters.
- *Magnetic Properties*-In magnetic nano-particles, the energy of magnetic anisotropy may be that small that the vector of magnetization fluctuates thermally; this is called superparamagnetism. Such a material is free of remanence, and coercivity. Touching superparamagnetic particles are loosing this special property by interaction, except the particles are kept at distance. Combining particles with high energy of anisotropy with superparamagnetic ones leads to a new class of permanent magnetic materials.

- *Optical Properties*-Distributions of non-agglomerated nanoparticles in a polymer are used to tune the index of refraction. Additionally, such a process may produce materials with non-linear optical properties. Gold or CdSe nanoparticles in glass lead to red or orange coloration. Semi-conducting nanoparticles and some oxide-polymer nanocomposites exhibit fluorescence showing blue shift with decreasing particle size.V. Nano-materials in medicine

The nanoparticles for instances are used to find diseases in human body.

Another use for the nanoparticles are the reactivation of some of the cells in the brain and help the doctors to health diseases like Parkinson.

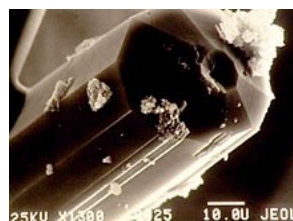


Figure 4 Fullerene Nano-crystals

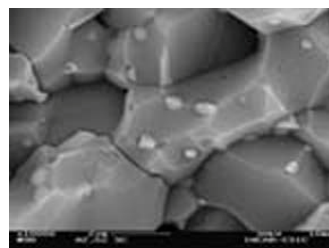


Figure 5 Aluminium Nanooxide

Here are some names of the nanoparticles that exist in the market already: Doped Zinc Oxides, Mixed Rare Earth Metal oxides, NanoArc™ Bismuth Oxide, NanoArc™ Cerium oxide SGH, NanoArc™ Copper oxide, NanoDur™ Aluminum oxide, NanoGard, LL Zinc oxide, USP, NanoGard Zinc oxide, USP, Nanophase Zinc oxide NanoTek Aluminum oxide.

VI. Nanomaterials for Aviation Industry

Nanotechnology is recognized as a very strong innovation



Driver and is therefore seen as a strategic technology for the world’s future economy.

Nanomaterials with their exceptional multifunctional

Properties may transform the functioning of aviation industry dramatically.



The success of the Aviation Industry depends on various factors ranging from reduction of weight, availability of materials with multifunctional properties, eco- friendly fuels , less fuel consumption, faster and highly responsive communication systems, less or no repairs, extended and safelife, reduced timeframe of development cycle from concept to implementation and many more. Nanomaterial scan be primarily used in three areas of Aviation Industry. These are:

1. AirframeStructure

2. Aero-EngineParts

3. AircraftElectro-CommunicationSystem
Properties of Materials required for Airframe Structure: The design requirements of the materials to be used in Airframe Structure are

- Light Weight
- High Strength
- High Toughness
- Corrosion Resistanc
- Easy Reparability & Reusability
- Less Maintenance & Durability

Nanomaterials which can fulfill the requirements:

The modern aviation design requirements like faster, miniature, highly maneuverable, selfhealing, intelligence guided, smart, eco-friendly, light

Weight and stealth systems warrant for materials with extraordinary mechanical and multifunctional properties.

VII. Nanomaterials and Their Applications

1.

- Next-Generation Computer Chips
- Kinetic Energy (KE) Penetrators with Enhanced Lethality
- Better Insulation Materials
- Phosphors for High-Definition TV
- Low-Cost Flat-Panel Displays
- Tougher and Harder Cutting Tools
- Elimination of Pollutants
- High Energy Density Batteries
- High-Power Magnets
- High-Sensitivity Sensors
- Automobiles with Greater Fuel Efficiency
- Aerospace Components with Enhanced Performance Characteristics
- Better and Future Weapons Platforms
- Longer-Lasting Satellites
- Longer-Lasting Medical Implants
- Ductile, Machinable Ceramics
- Large Electrochromic Display Devices

Next-Generation Computer Chips

The microelectronics industry has been emphasising miniaturisation, whereby the circuits, such as transistors, resistors, and capacitors, are reduced in size. By achieving a significant reduction in their size, the microprocessors, which contain these components, can run much faster, thereby enabling computations at far greater speeds. However, there are several technological impediments to these advancements, including lack of the ultrafine precursors to manufacture these components; poor dissipation of tremendous amount of heat generated by these microprocessors due to faster speeds; short mean time to failures (poor reliability), etc. Nanomaterials help the



industry break these barriers down by providing the manufacturers with nanocrystalline starting materials, ultra-high purity materials, materials with better thermal conductivity, and longer-lasting, durable interconnections (connections between various components in the microprocessors).

Kinetic Energy (KE) Penetrators with Enhanced Lethality

The Department of Defense (DoD) is currently using depleted-uranium (DU) projectiles (penetrators) for its lethality against hardened targets and enemy armoured vehicles. However, DU has residual radioactivity, and hence, it is toxic (carcinogenic), explosive, and lethal to the personnel who use them. However, some of the important reasons for the continued use of DU penetrators are that they possess a unique self-sharpening mechanism on impact with a target, and the lack of suitable non-explosive, non-hazardous replacement for DU. Nanocrystalline tungsten heavy alloys lend themselves to such a self-sharpening mechanisms because of their unique deformation characteristics, such as grain-boundary sliding. Hence, nanocrystalline tungsten heavy alloys and composites are being evaluated as potential candidates to replace DU penetrators.

Better Insulation Materials

Nanocrystalline materials synthesised by the sol-gel technique result in foam like structures called "aerogels." These aerogels are porous and extremely lightweight; yet, they can loads equivalent to 100 times their weight. Aerogels are composed of three-dimensional, continuous networks of particles with air (or any other fluid, such as a gas) trapped at their interstices. Since they are porous and air is trapped at the interstices, aerogels are currently being used for insulation in offices, homes, etc. By using aerogels for insulation, heating and cooling bills are drastically reduced, thereby saving power and reducing the attendant environmental pollution. They are also being used as materials for "smart " windows, which darken when the sun is too bright (just as in changeable lenses in prescription spectacles and sunglasses) and they lighten themselves, when the sun is not shining too brightly.

Phosphors for High-Definition TV

The resolution of a television, or a monitor, depends greatly on the size of the pixel. These pixels are essentially made of materials called "phosphors," which glow when struck by a stream

of electrons inside the cathode ray tube (CRT). The resolution improves with a reduction in the size of the pixel, or the phosphors. Nanocrystalline zinc selenide, zinc sulfide, cadmium sulfide, and lead telluride synthesised by the sol-gel techniques are candidates for improving the resolution of monitors. The use of nanophosphors is envisioned to reduce the cost of these displays so as to render high-definition televisions (HDTVs) and personal computers affordable to be purchased by an average household in the U. S.

Low-Cost Flat-Panel Displays

Flat-panel displays represent a huge market in the laptop (portable) computers industry. However, Japan is leading this market, primarily because of its research and development efforts on the materials for such displays. By synthesising nanocrystalline phosphors, the resolution of these display devices can be greatly enhanced, and the manufacturing costs can be significantly reduced. Also, the flat-panel displays constructed out of nanomaterials possess much higher brightness and contrast than the conventional ones owing to their enhanced electrical and magnetic properties.

Tougher and Harder Cutting Tools

Cutting tools made of nanocrystalline materials, such as tungsten carbide, tantalum carbide, and titanium carbide, are much harder, much more wear-resistant, erosion-resistant, and last longer than their conventional (large-grained) counterparts. They also enable the manufacturer to machine various materials much faster, thereby increasing productivity and significantly reducing manufacturing costs. Also, for the miniaturisation of microelectronic circuits, the industry needs microdrills (drill bits with diameter less than the thickness of an average human hair or 100 μm) with enhanced edge retention and far better wear resistance. Since nanocrystalline carbides are much stronger, harder, and wear-resistant, they are currently being used in these microdrills.

Elimination of Pollutants

Nanocrystalline materials possess extremely large grain boundaries relative to their grain size. Hence, nanomaterials are very active in terms of their chemical, physical, and mechanical properties. Due to their enhanced chemical activity, nanomaterials can be used as catalysts to react with such noxious and toxic gases as carbon monoxide and nitrogen oxide in automobile catalytic converters and power generation equipment to prevent environmental pollution arising from burning gasoline and coal.



High Energy Density Batteries

Conventional and rechargeable batteries are used in almost all applications that require electric power. These applications include automobiles, laptop computers, electric vehicles, next-generation electric vehicles (NGEV) to reduce environmental pollution, personal stereos, cellular phones, cordless phones, toys, and watches. The energy density (storage capacity) of these batteries is quite low requiring frequent recharging. The life of conventional and rechargeable batteries is also low. Nanocrystalline materials synthesised by sol-gel techniques are candidates for separator plates in batteries because of their foam-like (aerogel) structure, which can hold considerably more energy than their conventional counterparts. Furthermore, nickel-metal hydride (Ni-MH) batteries made of nanocrystalline nickel and metal hydrides are envisioned to require far less frequent recharging and to last much longer because of their large grain boundary (surface) area and enhanced physical, chemical, and mechanical properties.

High-Power Magnets

The strength of a magnet is measured in terms of coercivity and saturation magnetisation values. These values increase with a decrease in the grain size and an increase in the specific surface area (surface area per unit volume of the grains) of the grains. It has been shown that magnets made of nanocrystalline yttrium-samarium-cobalt grains possess very unusual magnetic properties due to their extremely large surface area. Typical applications for these high-power rare-earth magnets include quieter submarines, automobile alternators, land-based power generators, motors for ships, ultra-sensitive analytical instruments, and magnetic resonance imaging (MRI) in medical diagnostics.

VIII. Engineered nanomaterials and occupational health and safety

The significance of engineered nanomaterials (ENM) and nanotechnologies grows rapidly. Nanotechnology applications may have a positive marked impact on many aspects of on human every day life, for example by providing means for the production of clean energy and pure drinking water. Hundreds of consumer nano-based products are already on the market. However, very little is known of the risks of ENM to occupational safety and health (OSH), even though workers are likely to be at extra risk, as compared with other potentially exposed groups of people, because the levels of exposure are usually higher at workplaces

than in other environments. However, knowledge of the exposure to, or effects of, ENM on human health and safety in occupational environments is limited and does not allow reliable assessment of risks of ENM on workers' health. Several issues related to ENM in the workplaces require marked attention. The most topical issues include:

- (1) improved understanding of ENM metrics associated with ENM toxicity;
- (2) development of monitoring devices for ENM exposure assessment;
- (3) understanding the changes of ENM structure and state of agglomeration at different concentrations in aerosols;
- (4) understanding translocation of ENM in the human body;
- (5) identifying the key health effects of ENM including pulmonary toxicity, genotoxicity, carcinogenic effects, and effects on circulation;
- (6) development of tiered approaches for testing of safety of ENM;
- (7) Utilizing these data for health risk assessment, with a special emphasis on occupational environment. Available data on several ENM – ability to enter the body and reach almost any organ, to cause pulmonary inflammation and fibrosis, and even to cause increased risk of mesotheliomas in animal models, call for immediate action. It is crucial to identify those ENM that may cause occupational health and safety risks from those ENM which are innocent, hence allowing prioritization of regulatory and preventive actions at workplaces at national, regional and global levels.

IX. Conclusion

Nano-material is a study which has infinite possibilities, it gives a lot of avenues for research and betterment of mankind. It plays an integral part in the near future as humans are a developing species, we will always strive to make the next generation a little brighter and a little more prosperous and nano-material science gives us the right tools for such an endeavour. Nano-material science allows to create things at the very base and go from there, hence the freedom to create better existence than the current ones.

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Study of Composites and Interfaces

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Abstract— Necessity is the mother of invention. Our needs are increasing day by day. Hence it is necessary to develop needs to develop more and more new things. This includes invention of new modern materials for comfort. Also, a traditional material needs to be replaced for satisfying our requirements in some specific applications like aerospace, automobile, construction etc. In this paper we are going to present the usage of composite materials in aircraft industry i.e., Composite materials are widely used in the Aircraft industry and have allowed engineers to overcome obstacles have been met when using the materials individually. In regards to this the constitute materials retain their identities in the composites and do not dissolve or otherwise merge completely into each other. In addition to this the development of light weight, high- temperature resistant composite materials will allow the next generation of high performance, economical aircraft designs to materialize. In future, usage of such materials will reduce fuel consumption, improve efficiency and reduce direct operating costs of aircrafts.

Keywords: *Composite material, Temperature resistant, Fuel saving with reduced weight, Aviation, Environmental Impact*

I. INTRODUCTION

The proper blending of two or more materials is called a composite material or “smart materials” having more superior properties than base material. Composite interfaces provides a forum for interdisciplinary scientific and engineering research on composite interfaces and their related phenomena. It presents new concepts and approaches for composite interface study. Presenting new concepts for composite interface study, we baglances interest in, physical & mechanical properties, characterization techniques and theiories.

Composite materials can be formed into various shapes and, if desired, the fibres can be wound tightly to increase strength. A useful feature of composites is that they can be layered, with the fibres in each layer running in a different direction. This allows an engineer to design structures with unique properties. For example, a structure can be designed so that it will bend in one direction, but not another.

II. AVIATION AND COMPOSITES

Composite materials are important to the Aviation Industry because they provide structural strength comparable to

metallic alloys, but at a lighter weight. This leads to improved fuel efficiency and performance from an aircraft.[2][3] .

Making composite structures is more complex than manufacturing most metal structures. To make a composite structure, the composite material, in tape or fabric form, is laid out and put in a mold under heat and pressure. The resin matrix material flows and when the heat is removed, it solidifies. It can be formed into various shapes. In some cases, the fibers are wound tightly to increase strength. One useful feature of composites is that they can be layered, with the fibers in each layer running in a different direction. This allows materials engineers to design structures that behave in certain ways. For instance, they can design a structure that will bend in one direction, but not another. The designers of the Grumman X-29 experimental plane used this attribute of composite materials to design forward-swept wings that did not bend up at the tips like metal wings of the same shape would have bent in flight.

The greatest value of composite materials is that they can be both lightweight and strong. The heavier an aircraft weighs, the more fuel it burns, so reducing weight is important to aeronautical engineers.

A. The Role of Composites in the Aviation Industry

High-speed forward-swept-wing airplanes like Grumman's experimental X-29 or the Russian Sukhoi S-27 Berkut would not have been possible without the development of composite materials to keep their wings from bending out of shape. Fibreglass is the most common composite material, and consists of glass fibres embedded in a resin matrix. Fibreglass was first used widely in the 1950s for boats and automobiles. Fibreglass was first used in the Boeing 707 passenger jet in the 1950s, where it comprised about two percent of the structure. Each generation of new aircraft built by Boeing had an increased percentage of composite material usage; the highest being 50% composite usage in the yet-to-be-released 787 Dream liner.

Usage of various materials in the Boeing 787 Dream liner. Boeing's 787 Dreamliner will be the first commercial aircraft in which major structural elements are made of composite materials rather than aluminum alloys.[4] There will be a shift away from archaic fibreglass composites to more advanced carbon laminate and carbon sandwich composites in this



aircraft. Problems have been encountered with the Dreamliner's wing box, which have been attributed to insufficient stiffness in the composite materials used to build the part.[4] This has lead to delays in the initial delivery dates of the aircraft. In order to resolve these problems, Boeing is stiffening the wing boxes by adding new brackets to wing boxes already built, while modifying wing boxes that are yet to be built.[4]



Figure 1. Graphite composite air frame

III. TESTING OF COMPOSITE MATERIALS

It has been found difficult to accurately model the performance of a composite-made part by computer simulation due to the complex nature of the material. Composites are often layered on top of each other for added strength, but this complicates the pre-manufacture testing phase, as the layers are oriented in different directions, making it difficult to predict how they will behave when tested.[4]



Figure 2. Boeing 787 Dream liner

IV. FACTORS OF COMPOSITE MATERIAL USAGE

Weight reduction is the greatest advantage of composite material usage and is one of the key factors in decisions regarding its selection. Other advantages include its high corrosion resistance and its resistance to damage from fatigue. These factors play a role in reducing operating costs of the aircraft in the long run, further improving its efficiency. Composites have the advantage that they can be formed into almost any shape using the moulding process, but this compounds the already difficult modeling problem.

A major disadvantage about use of composites is that they are a relatively new material, and as such have a high cost. The high cost is also attributed to the labour intensive and often complex fabrication process. Composites are hard to inspect for flaws, while some of them absorb moisture.[5]

Even though it is heavier, aluminum, by contrast, is easy to manufacture and repair. It can be dented or punctured and still hold together. Composites are not like this; if they are damaged, they require immediate repair, which is difficult and expensive.[5]

V. FUEL SAVINGS WITH REDUCED WEIGHT

Fuel consumption depends on several variables, including: dry aircraft weight, payload weight, age of aircraft, quality of fuel, air speed, weather, among other things. The weight of aircraft components made of composite materials are reduced by approximately 20%, such as in the case of the 787 Dream liner.[3]

A sample calculation of total fuel savings with a 20% empty weight reduction will be done below for an Airbus A340-300 aircraft.

Initial sample values for this case study were obtained from an external source.[6]

Given:

- Operating Empty Weight (OEW): 129,300kg
- Maximum Zero Fuel Weight (MZFW): 178,000kg
- Maximum Take-Off Weight (MTOW): 275,000kg
- Max. Range @ Max. Weight: 10,458km

Other quantities can be calculated from the above given figures:

$$\text{Maximum Cargo Weight} = \text{MZFW} - \text{OEW} = 48,700\text{kg}$$

$$\text{Maximum Fuel Weight} = \text{MTOW} - \text{MZFW} = 97,000\text{kg}$$

So, we can further calculate the fuel consumption in kg/km based on maximum fuel weight and maximum range = $97,000\text{kg}/10,458\text{km} = 9.275\text{kg/km}$

Following is the calculation for anticipated fuel savings with a 20% weight reduction, which will only reduce the OEW value by 20%:

$\text{OEW}(\text{new}) = 129,300\text{kg} * 0.8 = 103,440\text{kg}$, which equates to a 25,860kg weight saving.

Assuming that cargo and fuel weight remain constant:

$$\text{MZFW}(\text{new}) = \text{MZFW} - 25,680\text{kg} = 152,320\text{kg}$$

$$\text{MTOW}(\text{new}) = \text{MTOW} - 25,680\text{kg} = 249,320\text{kg}$$

The 97,000kg mass of fuel has a reduced MTOW to deal with, and thus will have increased range because maximum weight and maximum range are inversely proportional quantities.



Using simple ratios to calculate the new range:

Solving for X gives a new range of:

$$X = 11,535.18\text{km}$$

This gives a new value for fuel consumption with reduced weight = $97,000\text{kg}/11,535.18\text{km} = 8.409\text{kg/km}$

To put this in perspective, over a 10,000km journey, there will be an approximate fuel saving of 8,660kg with a 20% reduction of empty weight.

VI. ENVIRONMENTAL IMPACT

There is a shift developing more prominently towards Green Engineering. Our environment is given increased thought and attention by today's society. This is true for composite material manufacture as well.



Figure 3. Recycling of parts from decommissioned aircrafts is possible.[7]

As mentioned previously, composites have a lighter weight and similar strength values as heavier materials. When the lighter composite is transported, or is used in a transport application, there is a lower environmental load compared to the heavier alternatives. Composites are also more corrosion-resistant than metallic based materials, which means that parts will last longer.[8] These factors combine to make composites good alternate materials from an environmental perspective.



Figure 4. Fiber composites- enormous fuel savings

Conventionally produced composite materials are made from petroleum based fibers and resins, and are non-biodegradable by nature.[9] This presents a significant problem as most composites end up in a landfill once the life

cycle of a composite comes to an end.[9] There is significant research being conducted in biodegradable composites which are made from natural fibers.[10] The discovery of biodegradable composite materials that can be easily manufactured on large-scale and have properties similar to conventional composites will revolutionize several industries, including the aviation industry.

An alternative option to aid environmental efforts would be to recycle used parts from decommissioned aircraft. The 'unengineering' of an aircraft is a complex and expensive process, but may save companies money due to the high cost of purchasing first-hand parts.[7]

VII. FUTURE COMPOSITE MATERIALS.

Composites are the most important materials to be adapted for aviation since the use of aluminum in the 1920s. Composites are materials that are combinations of two or more organic or inorganic components. One material serves as a "matrix," which is the material that holds everything together, while the other material serves as reinforcement, in the form of fibers embedded in the matrix. Until recently, the most common matrix materials were "thermosetting" materials such as epoxy, or polyimide. The reinforcing materials can be glass fiber, boron fiber, carbon fiber, or other more exotic mixtures.

A. Ceramic Matrix Composites

Major efforts are underway to develop light-weight, high-temperature composite materials at National Aeronautics and Space Administration (NASA) for use in aircraft parts. Temperatures as high as 1650°C are anticipated for the turbine inlets of a conceptual engine based on preliminary calculations.[2] In order for materials to withstand such temperatures, the use of Ceramic Matrix Composites (CMCs) is required. The use of CMCs in advanced engines will also allow an increase in the temperature at which the engine can be operated, leading to increased yield.[11] Although CMCs are promising structural materials, their applications are limited due to lack of suitable reinforcement materials, processing difficulties, lifetime and cost.

B. Hybrid composite steel sheets

Another promising material can be stainless steel constructed with inspiration from composites and nanotechnology-fibers and plywood. The sheets of steel are made of same material and are able to handle and tool exactly the same way as conventional steel. But is some percent lighter for the same strengths. This is especially valuable for vehicle manufacturing. Patent pending, Swedish company Lamara is a spinoff from research within Volvo Industries.[3]

VIII. CONCLUSION

Due to their reduced weight, composite materials have an advantage over conventional metallic materials; although, currently it is expensive to fabricate composites. Until techniques are introduced to reduce initial implementation costs and address the issue of non-biodegradability of current



composites, this relatively new material will not be able to completely replace traditional metallic alloys.

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The influence of using different substrates on structural properties of nanostructured ZnO thin films grown by RF magnetron sputtering

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Abstract— ZnO thin films were deposited on glass, quartz and silicon substrates under the same growth condition by r.f. magnetron sputtering technique using a high purity (99.99%) ZnO target of 2-in. diameter and 3 mm thickness in an Argon atmosphere with sputtering power of 50W and sputtering pressure of 2×10^{-2} Torr. A systematic study has been made of the influence of substrate on the film structural properties. Crystalline properties of ZnO films as a function of deposited substrate were investigated using X-ray diffraction. XRD analysis revealed that the deposited films were polycrystalline in nature with strong preferential orientation of grains along the c-axis. The micro structural parameters, such as the lattice constant, crystallite size, stress and strain are calculated. The effect of substrate on the deposited films was discussed.

Keywords- ZnO, RF magnetron sputtering, substrates, structural properties.

1.INTRODUCTION

Recently, ZnO film has gained much more interest due to its potential use in many applications, ranging from UV light emitters [1], varistors [2], transparent high-power electronics [3], surface acoustic wave devices [4], piezoelectric transducers, and chemical and gas sensing [5], which attributed to its wide and direct band gap (about 3.37 eV), excellent chemical and thermal stability, and a larger exciton binding energy (60 meV). Moreover, ZnO has novel and very important optical properties. The elements doped ZnO films have emerged as excellent candidates for potential applications as transparent electrodes in optoelectronic devices [6]. So far, various preparation methods have been used to deposit the ZnO films, such as: RF magnetron sputtering [7], spray pyrolysis, chemical vapor deposition (CVD) [8], pulsed laser deposition [9], and sol-gel process [10]. Among these means, RF Magnetron sputtering is preferred due its reproducibility and for getting highly oriented films. This physical vapor deposition is used to produce films with the desired optoelectronic and nanostructure properties by precisely controlling the

parameters like Ar-O₂ flux deposition pressure, target-substrate distance, RF power and substrate temperature. In the present study, we have made an attempt to produce highly textured ZnO nanocrystalline films in the absence of oxygen environment on glass, quartz and silicon substrates using RF magnetron sputtering and studied the effect of substrates on the structural properties.

2. EXPERIMENTAL DETAILS

2.1. Substrate cleaning

The substrate cleaning is very important in the deposition of thin films. Commercially available glass slides with a size of 75 mm x 25 mm x 1.5 mm were cleaned by a mild soap solution. The glass slides were degreased with acetone, etched with 5% of HCl for 30 min., ultrasonically cleaned by de-ionized water and finally dried in the air.

2.2. ZnO thin film deposition

ZnO thin films were grown on ultrasonically cleaned glass, quartz and silicon substrates by using RF magnetron sputtering. The sputtering system is capable of creating an ultimate vacuum of 5×10^{-5} Torr. A power supply operated at a crystal-controlled frequency of 13.56 MHz. The sputtering chamber was pumped with turbo molecular pump and rotary pump combination. The pressure in the sputter chamber was measured using digital Pirani and Penning gauge combination. The magnetron target assembly was mounted on top of the sputter chamber such that the sputtering could be done by sputter down configuration. A high purity (99.99%) ZnO target of 2-in. diameter and 3 mm thickness was used for the sputtering. Pure argon was used as sputtering gas. The flow rate of argon gas was controlled by Tylan mass flow controller. The sputtering chamber was pumped down to the vacuum of 5×10^{-5} Torr before the introduction of Argon gas. The target was pre-sputtered for 15 min to remove any impurity on the surface of the target. A shutter was placed between the target and substrate to control period of coating. The target was water-cooled and the substrate was kept at room

temperature initially. During the film deposition, the substrate temperature was increased due to the bombardments

of the sputtering ions and the final substrate temperature was nearly 40–60 °C. To measure the deposition rate and film thickness, a vibrating quartz crystal was used. The sputtering conditions maintained during the growth of ZnO films are given in Table 1.

The crystalline structure of the films was studied by x-ray diffraction measurements obtained with a Philips X'Pert X-Ray Diffractometer (XRD) in the 2θ range of 20°– 80° using CuK α radiation of wavelength $\lambda=1.5406$ Å at room temperature. X-ray tube was operated at 40 kV (Voltage) and 30 mA (current) with scanning speed of 0.5°/min. The thickness of the films was measured using Quartz crystal monitor thickness measurement system.

3. RESULTS AND DISCUSSION

3.1. Structural properties

XRD patterns of ZnO films grown on glass, quartz and silicon substrates at RT are shown in Fig. 1. It is found that XRD patterns of ZnO thin films show the same form, that is only a (002) diffraction peak is detected in the films. This indicates that ZnO films prepared by sputtering deposition show a good c-axis orientation perpendicular to the substrate. The diffraction peak angle of the films grown on glass, quartz and silicon substrates at RT appears at 34.01° , 34.17° and 34.31° , respectively. Compared with the (002) peak position of ZnO powder ($2\theta = 34.42^\circ$), the diffraction angle of the films decreases, which results in the increase of c-axis value. This indicates that ZnO films suffer compressive stress along the interfaces. The full-width at half-maximum (FWHM), determined from the XRD spectra of ZnO films prepared on glass, quartz and silicon substrates, are 0.1952, 0.1968 and 0.144, respectively. The smaller FWHM value indicates that the ZnO films are more textured along the c-axis. The peak intensity of ZnO films deposited on Si substrates is higher than that of those prepared on glass and quartz substrates. However, a slight increase of crystalline size is observed for the sample deposited on Si substrate.

The average crystallite sizes of the films grown on glass, quartz and silicon substrates have been calculated using the Scherrer's formula:

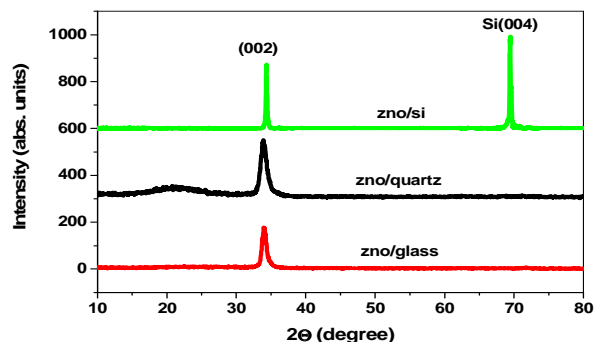
$$D = 0.94\lambda/(\beta \cos \theta) \quad (1)$$

Where λ , θ and β are X-ray wavelength, the Bragg's diffraction angle and the full width at half maxima (FWHM) of the peak corresponding to the " θ " value.

Table 1

Deposition parameters maintained during the deposition of ZnO films by RF magnetron sputtering .

Sputtering target	ZnO (99.99%)
	(2-in. diameter and 3 mm thickness)
Target to substrate distance	40 mm
Substrates	glass, quartz and silicon
Ar gas flow rate	80 SCCM
Ultimate pressure	5×10^{-5} Torr
Sputtering pressure	1.2×10^{-2} Torr
Substrate temperature	room temperature



Sputtering power	50 W
Thickness	100 nm

Fig.1 XRD patterns of ZnO films deposited on different substrates

Dislocation density (δ) and Number of crystallites per unit area (N) have been calculated using the crystallite size and thickness of the film [11-13].

The average uniform strain (e_{zz}) in the lattice along the c-axis in the randomly oriented ZnO films grown on glass, quartz and silicon substrates have been estimated from the lattice parameters using the following expression [14],

$$e_{zz} = (d - d_0)/d_0 \quad (2)$$

Where "d" is the lattice parameter of the ZnO film calculated from (0 0 2) peak of XRD pattern and the " d_0 " is the lattice parameter for the ZnO bulk.

For hexagonal crystals, the stress (σ) in the plane of the film can be calculated using the biaxial strain model [15]:

$$\sigma = (2C_{13} - (C_{11} + C_{12}) C_{33}/C_{13}) \cdot e_{zz} \quad (3)$$

here C_{ij} are elastic stiffness constants ($C_{11} = 2.1 \times 10^{11}$ N/m², $C_{33} = 2.1 \times 10^{11}$ N/m², $C_{12} = 1.2 \times 10^{11}$ N/m², and $C_{13} = 1.05 \times 10^{11}$ N/m²).

This yields the following numerical relation for the stress derived from the change in the 'd' lattice parameter:

$$\sigma \text{ (N m}^{-2}\text{)} = -4.5 \times 10^{11} \cdot e_{zz} \quad (4)$$

The various structural parameters for ZnO thin films grown on glass, quartz and silicon substrates were calculated and are represented in Table 2.



From the Table 2. it has been observed that the lattice constant for the thin film deposited on the glass, quartz and silicon substrates decreases. The change in lattice constant for the thin films deposited over the bulk clearly suggests that the film's grains are under stress and

that may be due to a change in the nature and concentration of the native imperfections.

This causes either elongation (tensile) or compression of the lattice parameters. The density of film is, therefore, expected

Table 2. Structural information of ZnO thin films deposited on different substrates.

sample	$2\theta(^{\circ})$	Lattice parameter (nm)	FWHM (mrad)	Grain size (nm)	Strain (10^{-3})	Stress (GPa)	Dislocation density (10^{15} lines/m ²)	Number of grains/unit area (10^{16} m ⁻²)
ZnO/glass	34.01	0.5271	3.405	42.58	12.29	-5.53	0.5515	0.1295
ZnO/quartz	34.17	0.5240	3.433	42.25	6.33	-2.84	0.5602	0.1325
ZnO/silicon	34.31	0.5222	2.512	57.76	2.88	-1.29	0.2997	0.0518

to change in accordance with changes in the lattice constant. The average internal stress for the ZnO films deposited at RT is found to be compressional in nature. The negative sign indicates that the films are in a state of compressive stress. The total stress in the film commonly consists of two components. One is the intrinsic stress introduced by impurities, defects and lattice distortions in the crystal, and the other is the extrinsic stress introduced by the lattice mismatch and thermal expansion coefficient mismatch between the film and substrate. The extrinsic stress in the thin films normally relaxes if the thickness of the film is larger [16]. In the present case, thickness of all the films is 100 nm. Thus, the extrinsic stress will not be present and the total estimated stress values seem to be dominantly intrinsic. In present case of sputtering deposition, this intrinsic stress arises due to the bombardment of the energetic species. The films deposited at lower temperature exhibits strong compressive stress. In the sputtering process, the highly energetic species could be implanted below the ZnO surface, which is likely to induce high intrinsic stresses by creating the defects [17]. The microstrain (ϵ), the dislocation density (δ) and, the number of crystallites (N) are observed to exhibit a slow decreasing trend from glass to Si substrate. The decrease in ϵ , δ and N may be due to the movement of interstitial Zn atoms from inside the crystallites to the grain boundary, which leads to a reduction in the concentration of lattice imperfections.

4. CONCLUSION

Highly oriented and smooth ZnO thin films have been grown on glass, quartz and Si substrates using the RF magnetron sputtering technique. The influence of the substrate on the

crystalline and oriented properties of ZnO films was investigated. Each film showed a preferred orientation along the (0 0 2) plane. The average internal stresses developed in the films were compressional in nature.

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Thin Film Coatings & Applications

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number of deposition methods available and in use today.

Abstract— Thin film processes are used to produce protected metal mirrors, low emittance thermal shields, lenses, band pass filters, graphite antenna coatings, and high temperature coatings for composite structures and dielectric mirrors. A thin film is a layer of material ranging from fractions of a nanometer (monolayer) to several micrometers in thickness. Electronic semiconductor devices and optical coatings are the main applications benefiting from thin film construction. A familiar application of thin films is the household mirror, which typically has a thin metal coating on the back of a sheet of glass to form a reflective interface. The process of silvering was once commonly used to produce mirrors. A very thin film coating (less than a nanometer thick) is used to produce two-way mirrors.

Keywords: *Technology Focus, Types of coating, Classification of thin films, Properties of thin Films.*

I. INTRODUCTION

Thin film is the branch of optics that deals with very thin structured layers of different materials.

The thin film will provide thin film deposition methods, their possibilities and limitations. Hands-on demonstrations and experiments in our Laboratories will help the participants to better understand the possibilities of each deposition method and stimulate informal discussions between participants and experts. Essential fundamental aspects, as well as the technology of thin-film growth from the vapor phase - evaporation, PVD and CVD, etc, it will help us to learn how to test and characterize film structure and related properties after deposition.

II. TECHNOLOGY FOCUS

Thin film technology is pervasive in many applications, including microelectronics, optics, magnetic, hard resistant coatings, micro-mechanics, etc.

- Progress in each of these areas depends upon the ability to selectively and controllably deposit thin films - thickness ranging from tens of angstroms to micrometers - with specified physical properties.
- It requires control - often at the atomic level - of film microstructure and microchemistry. There are a vast

- All methods have their specific limitations and involve compromises with respect to process specifics,
- Substrate material limitations, expected film properties, and cost. This makes it difficult to select the best technique for any specific application.

A. Thin Film Coating Process

Thin-film coatings play a prominent role on the manufacture of many electric devices. They are used to apply dopants and sealants to chips and other microelectronic parts

III. TYPES OF COATING

Electro chemical coating: Electrochemical deposition is used in the manufacturing of products for our everyday lives-it is a process by which a film of solid metal is deposited from a solution of ions onto an electrically conducting surface.

A. Conversion coating

Conversion coatings are coatings for metals where the part surface is converted into the coating with a chemical or electro-chemical process. Examples include chromate conversion coatings, phosphate conversion coatings, luring, black oxide, coatings on steel, and anodizing

B. Vapour deposition:

Vapor deposition refers to any process in which materials in a vapor state are condensed through condensation, chemical reaction, or conversion to form a solid material. These processes are used to form coatings to alter the mechanical, electrical, thermal, optical, corrosion resistance, and wear properties of the substrates. They are also used to form free-standing bodies, films, and fibers and to infiltrate fabric to form composite materials. Vapor deposition processes usually take place within a vacuum chamber. There are two categories of vapor deposition processed



C. Chemical vapour deposition:

Chemical vapour deposition or CVD is a generic name for a group of processes that involve depositing a solid material from a gaseous phase

D. Physical vapour deposition:

Physical vapour deposition (PVD) is fundamentally a vaporization coating technique, involving transfer of material on an atomic level. It is an alternative process to electroplating. The process is similar to chemical vapour deposition (CVD) except that the raw materials/precursors, i.e. the material that is going to be deposited starts out in solid form, whereas in CVD, the precursors are introduced to the reaction chamber in the gaseous state

E. Spraying:

Spraying can provide thick coatings (approx. thickness range is 20 micrometers to several mm, depending on the process and feedstock), over a large area at high deposition rate as compared to other coating processes such as electroplating, physical and chemical vapour deposition. Coating materials available for thermal spraying include metals, alloys, ceramics, plastics and composites. They are fed in powder or wire form, heated to a molten or semi molten state and accelerated towards substrates in the form of micrometer-size particles. Combustion or electrical arc discharge is usually used as the source of energy for thermal spraying. Resulting coatings are made by the accumulation of numerous sprayed particles. The surface may not heat up significantly, allowing the coating of flammable substances. Coating quality is usually assessed by measuring its porosity content, macro and micro-hardness and bond strength and surface reference generally, the coating quality increases with increasing particle velocities.

F. Welding

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld pool that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the work pieces.

G. Molecular beam epitaxial:

- 1) Beams of atoms and/or molecules are directed onto a substrate where layer by layer growth (epitaxial) of a crystalline film occurs.
- 2) The atomic/molecular beams are created by evaporation from solid/liquid sources just as in vacuum evaporation, however the timing and flux of

these beams is carefully controlled through the use of shutters which separate the source(s) from the substrate.

- 3) The MBE growth chamber must be maintained at Ultra High Vacuum (background vacuum $\sim 10^{-11}$

torr) Examples: Gas, $\text{Al}_{1-x}\text{Ga}_x\text{As}$, InP , $\text{Si}_{1-x}\text{Ge}_x$, $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$

IV. CLASSIFICATION OF THIN FILMS

A. Single crystals

A single crystal or mono crystalline solid is a material in which the crystal lattice of the entire sample is continuous and unbroken to the edges of the sample, with no grain boundaries. The absence of the defects associated with grain boundaries can give mono crystals unique properties, particularly mechanical, optical and electrical, which can also be anisotropic, depending on the type of crystallographic structure. These properties, in addition to making them precious in some gems, are industrially used in technological applications, especially in optics and electronics. Because entropic effects favor the presence of some imperfections in the microstructure of solids, such as impurities, inhomogeneous strain and crystallographic defect such as dislocations, perfect single crystals of meaningful size are exceedingly rare in nature, and are also difficult to produce in the laboratory, though they can be made under controlled conditions.

On the other hand, imperfect single crystals can reach enormous sizes in nature: several mineral species such as beryl, gypsum and feldspars are known to have produced crystals several meters across. The opposite of a single crystal is an amorphous structure where the atomic position is limited to short range order only. In between the two extremes exist polycrystalline, which is made up of a number of smaller crystals known as crystallites and paracrystalline phases.

B. Epitaxial:

Epitaxial refers to the deposition of a crystalline over layer on a crystalline substrate, where the over layer is in registry with the substrate. In other words, there must be one or more preferred orientations of the over layer with respect to the substrate for this to be termed ep. The over layer is called an epitaxial film or epitaxial layer. The term epitaxial comes from the Greek roots epi, meaning "above", and taxis, meaning "in ordered manner". It can ataxia growth be translated "to arrange upon". For most technological applications, it is desired that the deposited material form a crystalline over layer that has one well-defined orientation with respect to the substrate crystal structure (single-domain epitaxial).

Epitaxial films may be grown from gaseous or liquid precursors. Because the substrate acts as a seed crystal, the deposited film may lock into one or more crystallographic orientations with respect to the substrate crystal. If the over



layer either forms a random orientation with respect to the substrate or does not form an ordered over layer, this is termed non-epitaxial growth. If an epitaxial film is deposited on a substrate of the same composition

of the melting temperature. For higher values, the surface diffusion of deposited atomic species would allow for the formation of crystallites with long range atomic order.

C. Polycrystalline

Polycrystalline is a key component for integrated circuit and central processing unit manufacturers such as AMD and Intel. At the component level, poly silicon has long been used as the conducting gate material in MOSFET and CMOS processing technologies. For these technologies it is deposited using low-pressure chemical-vapour deposition (LPCVD) reactors at high temperatures and is usually heavily doped n-type or p-type.

More recently, intrinsic and doped poly silicon is being used in large-area electronics as the active and/or doped layers in thin-film transistors. Although it can be deposited by LPCVD, plasma-enhanced chemical vapour deposition (PECVD), or solid-phase crystallization (SPC) of amorphous silicon in certain processing regimes, these processes still require relatively high temperatures of at least 300 °C. These temperatures make deposition of poly silicon possible for glass substrates but not for plastic substrates. The deposition of polycrystalline silicon on plastic substrates is motivated by the desire to be able to manufacture digital displays on flexible screens. Therefore, a relatively new technique called laser crystallization has been devised to crystallize a precursor amorphous silicon(a-Si) material on a plastic substrate without melting or damaging the plastic. Short, high-intensity ultraviolet laser pulses are used to heat the deposited a-Si material to above the melting point of silicon, without melting the entire substrate. The molten silicon will then crystallize as it cools. By precisely controlling the temperature gradients, researchers have been able to grow very large grains, of up to hundreds of micrometers in size in the extreme case, although grain sizes of 10 nanometers to 1 micrometer are also common. In order to create devices on poly silicon over large-areas however, a crystal grain size smaller than the device feature size is needed for homogeneity of the devices. Another method to produce poly-Si at low temperatures is metal-induced crystallization where an amorphous-Si thin film can be crystallized at temperatures as low as 150C if annealed while in contact of another metal film such as aluminum gold, or silver

D. Amorphous

Amorphous phases are important constituents of thin films, which are solid layers of a few nm to some tens of μm thickness deposited upon an underlying substrate. So-called structure zone models were developed to describe the micro structure and ceramics of thin films as a function of the homologous temperature T_h that is the ratio of deposition temperature over melting temperature. According to these models, a necessary (but not sufficient) condition for the occurrence of amorphous phases is that T_h has to be smaller than 0.3 that is the deposition temperature must be below 30%

Regarding their applications, amorphous metallic layers played an important role in the discussion of a suspected superconductivity in amorphous metals.[4] Today, optical coatings made from TiO_2 , SiO_2 , Ta_2O_5 etc. and combinations of them in most cases consist of amorphous phases of these compounds. Much research is carried out into thin amorphous films as a gas separating membrane layer.[5] The technologically most important thin amorphous film is probably represented by few nm thin SiO_2 layers serving as isolator above the conducting channel of a metal-oxide semiconductor field-effect transistor (MOSFET). Also, hydrogenated amorphous silicon a-Si:H in short, is of technical significance for thin film solar cells. In case of a-Si:H the missing long-range order between silicon atoms is partly induced by the presence by hydrogen in the percent range.

The occurrence of amorphous phases turned out as a phenomenon of particular interest for studying thin film growth. Remarkably, the growth of polycrystalline films is often used and preceded by an initial amorphous layer, the thickness of which may amount to only a few nm. The most investigated example is represented by thin multi crystalline silicon films, where such as the un oriented molecule. An initial amorphous layer was observed in many studies.[6] Wedge-shaped poly crystals were identified by transmission electron microscopy to grow out of the amorphous phase only after the latter has exceeded a certain thickness, the precise value of which depends on deposition temperature, background pressure and various other process parameters. The phenomenon has been interpreted in the framework of Ostwald's rule of stages[7] that predicts the formation of phases to proceed with increasing condensation time towards increasing stability.[4][6] Experimental studies of the phenomenon require a clearly defined state of the substrate surface and its contaminant density etc., upon which the thin film is deposited.

V. PROPERTIES OF THIN FILMS

- 1) High surface to volume ratio
- 2) geometrical control (dictated by substrate)
- 3) compact

A. Advantages:

- Very low defect concentration
- Excellent uniformity
- Layer by layer growth allows for novel architectures
- Artificial hetero structures, quantum wells, etc.



- Used primarily for semiconductor research

B. Disadvantages:

- Expensive (set up ~ \$1 million)
- Slow deposition rates (~ 10 – 300 Å/min)
- Industrial application only in highly specialized cases
- Single crystal like properties.

C. Applications:

- Microelectronics - electrical conductors, electrical barriers, diffusion barriers . . .
- Magnetic sensors - sense I, B or changes in them
- Corrosion protection
- Wear resistance etc.
- Special Properties of Thin Films

Thin films may be:

- Not fully dense
- Under stress
- Different defect structures from bulk
- Quasi - two dimensional are very thin films
- Strongly influenced by surface and interface effects
- This will change electrical, magnetic, optical, thermal, and mechanical property

Typical steps in making thin films:

- Heat, high voltages are the emission of particles from source
- Transport of particles to substrate. Either free or direct
- Condensation of particles on substrate .how do they condensed of particles.

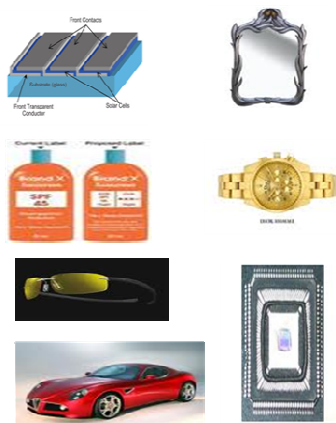
Real World Applications of thin film technology

Microelectronics
(cpu processors, cell phones, ipod, watches)

Solar Panels, Fuel Cells

AR (anti-reflective coatings) On cars, jewelry, mirrors, night vision goggles

Corrosion/oxidation resistance on cutting tools, chemical factories



VI. THIN FILM COATINGS AND ITS APPLICATIONS

A. PVD (Physical Vapor Deposition):

Low pressure coating processes in which the coating flux is produced by a physical process

1. Thermal Evaporation
2. Electro-deposition
3. Magnetron sputtering (DC, RF)
4. Pulsed Laser Deposition
5. Spraying
6. Welding:

- The same methods which can be used for joining materials can be used to deposit wear resistant coatings (hard facings). Coating materials range from low alloy steels to tungsten carbide composites.
- High deposition rates are possible and very thick coatings can be produced. It is impractical to produce layers less than 2-3mm thick.

There can be problems with cracks in weld de

- Molecular beam epitaxial: Beams of atoms and/or molecules are directed onto a substrate where layer by layer growth (epitaxial) of a crystalline film occurs.
- The atomic/molecular beams are created by evaporation from solid/liquid sources just as in vacuum evaporation, however the timing and flux of these beams is carefully controlled through the use of shutters which separate the source(s) from the substrate.
- The MBE growth chamber must be maintained at Ultra High Vacuum (background vacuum ~ 10-11 torr)

Examples :

- Gas, Al_{1-x}Ga_xAs, InP, Si_{1-x}Gex, YBa₂Cu₃O_{7-x}
- Thermal Evaporation
- Electro-deposition
- Magnetron sputtering (DC, RF)
- Pulsed Laser Deposition

B. CVD (Chemical Vapor Deposition)

Gaseous compounds react to form a dense layer on a heated substrate. The most widely deposited wear-resistant

Figure 1: Real World Applications of thin film technology



Proceedings of the "National Nanotechnology Meet on Energy and Environment" organized by Centre for Nanoscience & Nanotechnology, Sathyabama University in association with Ministry of Earth Sciences (MoES), New Delhi, 3-5 September, 2012

coatings are TiC, TiN, chromium carbide and alumina.

Deposition temperatures are generally in the range 800-1000°C which restricts the range of materials which can be coated and can lead to component distortion. Thicknesses are limited to about 10mm due to the thermal expansion mismatch stresses which develop on cooling which also restrict the coating of sharp edged components

e) Conducting

f) Storage

- a) APCVD (atmospheric CVD)
- b) LPCVD (low-pressure CVD)
- c) PECVD (Plasma-enhanced CVD)
- d) LECVD (Laser-enhanced CVD)
- e) MOCVD (Metal-organic CVD)

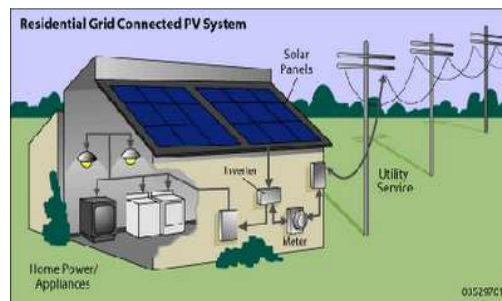
VII. WHAT CAUSES THIN FILMINGS TO GROW?

The causes of thin film to grow

- a) Kinetic Energy
- b) Pressure
- c) Temperature
- d) Laser Energy
- e) Laser Frequency
- f) Type of material
- g) Type of Substrate

VIII. HOW FUNDAMENTAL THIN FILMS IS IMPORTANT IN OUR LIVES?

- a) Energy
- b) Protection
- c) Electronics
- d) Decoration



IX. CONCLUSION

This paper explains thin film technology to find applications in various fields like microelectronic devices, telecommunication devices, wear resistant coatings, decorative coatings, optical coatings (windows, solar cells, etc.), Sensors catalysts. Thin Film is one of the prominent area in aero space industry, various research is going on to reduce the thin film coating to lower level and shorter time period.

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Nano Particals & Its Implementation

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Abstract: Nanoparticles proved to be at the leading edge for the rapid development in the field of nanotechnology. This brief review tries to summarise the most recent developments of nanoparticles in this field, in particular to their universal applications which include optical, magnetical, thermal, mechanical, electronic, energy and even biomedical also. Apart from this, it will also deal with how nanoparticles are also playing a major role in medical applications as well as laser applications.

Keywords: Nanotechnology; Nanoparticles; biomedical; electronic; mechanical.

I. Introduction

A nanometer is a *unit of measure* just like inches, feet and miles. By definition a nanometer is one-billionth of a meter. A meter is about 39 inches long. A billion is a thousand times bigger than a million, as a number you write it out as 1,000,000,000. That is a big number and when you divide a meter into one billion parts, well that is very small. A nanometer is used to measure things that are very small. Atoms and molecules, the smallest pieces of everything around us, are measured in nanometers.

Typically, your average nanoparticle will measure anywhere from 100 to 2500 nanometers (or in other words, extremely small.) Ultrafine nanoparticles are

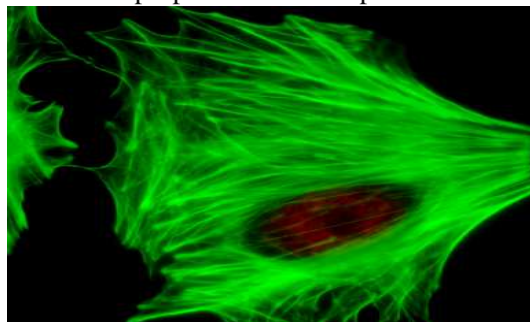
This microscopic particle holds the key to much of what science hopes to accomplish in the near future. In some cases when a substance is broken down into its individual nanoparticles it suddenly assumes behaviors and characteristics that were not previously associated with the unit as a whole.

This seems to have something to do with the overall number of surface atoms; the more

A. What are nanoparticles?

Nanotechnology may be the next big thing in science, and before long we will probably find ourselves immersed in it. Currently, however, intimate knowledge of what nanotechnology is and how it works tends to be rather limited. Essentially this field studies materials at their most basic level; it breaks substances down into particles and then either uses their natural properties or manipulates them in order to achieve desired effects.

Hence, any discussion of nanotechnology—its processes, its applications, its impacts—must of necessity revolve around one of the tiniest things in the world: the nanoparticle. Wondering what are nanoparticles? A nanoparticle is defined as the smallest unit that can still behave as a whole entity in terms of properties and transport.



classified as even tinier than that, weighing in at only 1 to 100 nanometers in size.

individual pieces there are, the more surface area there is, and a surface atom tends to react differently than one that is at the center of a substance.

This unique size and behavior also bridges the scientific gap between large materials, which are often too bulky to interact on a delicate scale, and molecules or atoms, which do not exhibit



the large-scale properties that nanoparticles are capable of.

Having such capabilities means that nanoparticles are extremely versatile, so it is difficult to discuss one overarching purpose for the nanoparticle in future technology. As a matter of fact, the nanoparticle will probably be everywhere doing everything.

For example, researchers have recently discovered that individual silicon nanoparticles can be affixed to a piece of paper in order to create an electricity-conducting circuit without recourse to the creation of a metallic or plastic chip. If the technology is refined enough to be released publicly, it could revolutionize the entire electronics industry.

Paper is many times cheaper than either silicon or plastic and also much more cost-effective and environmentally friendly to produce. If we could design and manufacture delicate electronics on the nanoscale and use a paper base for them, we could greatly reduce our technological carbon footprint while at the same time increasing our efficiency.

This is all thanks to the fact that nanoparticles typically are better at conducting an electrical current than elements that have not been broken down into particles. Hence, they don't need the silicon base that most microchips are famous for.

This doesn't mean that the Silicon Valley days are over; far from it. It simply means that while silicon will continue to be a major player in the technology industry, it will have to be broken down into particles and adjust to the demands of nanotechnology.

Actually, it turns out that silicon nano-components, also known as transducers, are the perfect materials for constructing what nanotechnologists call the nanorobot. This tiny mechanical entity, also known as a nanobot, has the potential to drastically alter everything in our lives but especially the way we practice medicine. The ideal nanobot has not yet been fully developed, although it is anticipated that they will make their public debut sometime in the next 25 years.

Researchers want to achieve a microscopic autonomous robot that measures no more than six nanometers across and can be controlled by remote. Swarms of these nanobots could clean

your house, and since they're invisible to the naked eye, their effects would appear to be magical. They could also swim easily and harmlessly through your bloodstream, which is what medical scientists find exciting.

With such technology at their disposal, doctors could simply inject a team of nanobots into a patient and automatically be able to identify and destroy everything from bacteria and viruses to cancerous growths. Nanobots are small enough that they can interact with these pathogens and malignant tumors on a molecular level—and this is something that no trained surgeon, however skilled he or she may be, can do effectively.

Humans are simply too big. Nanobots, however, are so tiny that they can even rebuild damaged tissue one cell at a time; they can repair bleeding veins and remove cholesterol buildup from a clogged artery. They could also provide revolutionary new insight into the human body. Scientists expect that the nanobots will be fully capable of supporting a tiny camera system on their microscopic bodies, so that as they swim through the human system they can send data back to doctors and researchers.

There is so much we still don't know about our own bodies that we could discover with tools like these. It has even been suggested that nanobots could swim harmlessly up through the spinal column and investigate the way the human brain functions on a cellular level, thereby solving one of the greatest mysteries of nature.

All of these possibilities grow directly from the implications of the nanoparticle. Without it, we wouldn't be able to interact so effectively with the molecules and atoms of different substances, including our own bodies.

Nanotechnology has even been developed to the point where if the natural substance doesn't change simply by being broken down into particles, scientists can go in and manually adjust their properties in order to create the effect they want.


In some cases this means mixing them with another substance; sometimes it means coating the larger material unit with a layer of its own modified nanoparticles in order to increase and magnify its abilities, as has been recently discovered with solar panels—their ability to absorb ultraviolet light was increased tenfold




when the normal silicon panels were coated with an altered layer of silicon nanoparticles. But in all cases it has been shown over and over again that nanoparticles are the future of technology, and that this future will be glorious indeed.

III.Properties



 Silicon nanopowder



 1 kg of particles of 1 mm^3 has the same surface area as 1 mg of particles of 1 nm^3

Nanoparticles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecular structures. A bulk material should have constant physical properties regardless of its size, but at the nano-scale size-dependent properties are often observed. Thus, the properties of materials change as their size approaches the nanoscale and as the percentage of atoms at the surface of a material becomes significant. For bulk materials larger than one micrometer (or micron), the percentage of atoms at the surface is insignificant in relation to the number of atoms in the bulk of the material. *The interesting and sometimes unexpected properties of nanoparticles are therefore largely due to the large surface area of the material, which dominates the contributions made by the small bulk of the material.*

Other size-dependent property changes include quantum confinement in semiconductor

particles, surface plasmon resonance in some metal particles and superparamagnetism in magnetic materials. Ironically, the changes in physical properties are not always desirable. Ferromagnetic materials smaller than 10 nm can switch their magnetisation direction using room temperature thermal energy, thus making them unsuitable for memory storage.

Suspensions of nanoparticles are possible since the interaction of the particle surface with the solvent is strong enough to overcome density differences, which otherwise usually result in a material either sinking or floating in a liquid.

The high surface area to volume ratio of nanoparticles provides a tremendous driving force for diffusion, especially at elevated temperatures. Sintering can take place at lower temperatures, over shorter time scales than for larger particles. This theoretically does not affect the density of the final product, though flow difficulties and the tendency of nanoparticles to agglomerate complicates matters. Moreover, nanoparticles have been found to impart some extra properties to various day to day products. For example the presence of titanium dioxide nanoparticles imparts what we call the self-cleaning effect, and the size being nano-range, the particles can not be observed. Zinc oxide particles have been found to have superior UV blocking properties compared to its bulk substitute. This is one of the reasons why it is often used in the preparation of sunscreen lotions, and is completely photostable.

Nanoparticles with one half hydrophilic and the other half hydrophobic are termed Janus particles and are particularly effective for stabilizing emulsions. They can self-assemble at water/oil interfaces and act as solid surfactants.

IV.Synthesis

There are several methods for creating nanoparticles, including both attrition and pyrolysis. In attrition, macro or micro scale particles are ground in a ball mill, a planetary ball mill, or other size reducing mechanism. The resulting particles are air classified to recover nanoparticles. In pyrolysis, a vaporous precursor (liquid or gas) is forced through an orifice at high pressure and burned. The resulting solid (a version of soot) is air classified to recover oxide



particles from by-product gases. Pyrolysis often results in aggregates and agglomerates rather than single primary particles.

A thermal plasma can also deliver the energy necessary to cause evaporation of small micrometer size particles. The thermal plasma temperatures are in the order of 10,000 K, so that solid powder easily evaporates. Nanoparticles are formed upon cooling while exiting the plasma region. The main types of the thermal plasma torches used to produce nanoparticles are dc plasma jet, dc arc plasma and radio frequency (RF) induction plasmas. In the arc plasma reactors, the energy necessary for evaporation and reaction is provided by an electric arc which is formed between the anode and the cathode. For example, silica sand can be vaporized with an arc plasma at atmospheric pressure. The resulting mixture of plasma gas and silica vapour can be rapidly cooled by quenching with oxygen, thus ensuring the quality of the fumed silica produced.

In RF induction plasma torches, energy coupling to the plasma is accomplished through the electromagnetic field generated by the induction coil. The plasma gas does not come in contact with electrodes, thus eliminating possible sources of contamination and allowing the operation of such plasma torches with a wide range of gases including inert, reducing, oxidizing and other corrosive atmospheres. The working frequency is typically between 200 kHz and 40 MHz. Laboratory units run at power levels in the order of 30–50 kW while the large scale industrial units have been tested at power levels up to 1 MW. As the residence time of the injected feed droplets in the plasma is very short it is important that the droplet sizes are small enough in order to obtain complete evaporation. The RF plasma method has been used to synthesize different nanoparticle materials, for example synthesis of various ceramic nanoparticles such as oxides, carbours/carbides and nitrides of Ti and Si (see Induction plasma technology).

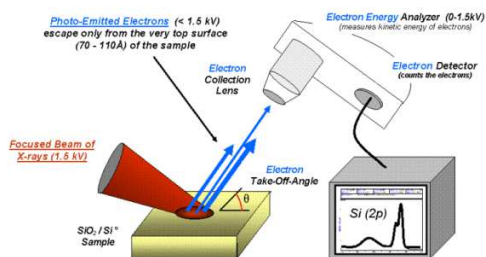
Inert-gas condensation is frequently used to make nanoparticles from metals with low melting points. The metal is vaporized in a vacuum chamber and then supercooled with an inert gas stream. The supercooled metal vapor condenses into nanometer-sized particles, which

can be entrained in the inert gas stream and deposited on a substrate.

Nanoparticles can also be formed using radiation chemistry. Radiolysis from gamma rays can create strongly active free radicals in solution. This relatively simple technique uses a minimum number of chemicals. These including water, a soluble metallic salt, a radical scavenger (often a secondary alcohol), and a surfactant (organic capping agent). High gamma doses on the order of 10^4 Gray are required. In this process, reducing radicals will drop metallic ions down to the zero-valence state. A scavenger chemical will preferentially interact with oxidizing radicals to prevent the re-oxidation of the metal. Once in the zero-valence state, metal atoms begin to coalesce into particles. A chemical surfactant surrounds the particle during formation and regulates its growth. In sufficient concentrations, the surfactant molecules stay attached to the particle. This prevents it from dissociating or forming clusters with other particles. Formation of nanoparticles using the radiolysis method allows for tailoring of particle size and shape by adjusting precursor concentrations and gamma dose.

.VI.Characterization

Nanoparticle characterization is necessary to establish understanding and control of nanoparticle synthesis and applications. Characterization is done by using a variety of different techniques, mainly drawn from materials science. Common techniques are electron microscopy (TEM, SEM), atomic force microscopy (AFM), dynamic light scattering (DLS), x-ray photoelectron spectroscopy (XPS), powder X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF), ultraviolet-visible spectroscopy, dual polarisation interferometry and nuclear magnetic resonance (NMR). Whilst the theory has been known for over a century (see Robert Brown), the technology for Nanoparticle tracking analysis (NTA) allows direct tracking of the Brownian motion and this method therefore allows the sizing of individual nanoparticles. solution.



VII. Safety

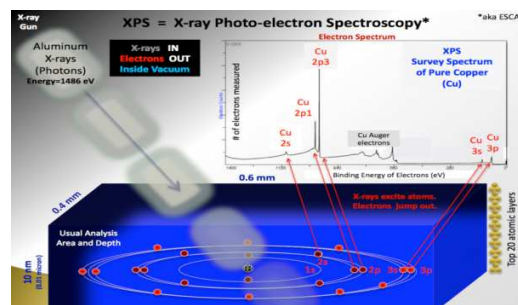
Nanoparticles present possible dangers, both medically and environmentally. Most of these are due to the high surface to volume ratio, which can make the particles very reactive or catalytic. They are also able to pass through cell membranes in organisms, and their interactions with biological systems are relatively unknown. A recent study looking at the effects of ZnO nanoparticles on human immune cells has found varying levels of susceptibility to cytotoxicity.

Whether cosmetics and sunscreens containing nanomaterials pose health risks remains largely unknown at this stage. However considerable research has demonstrated that zinc nanoparticles are not absorbed into the bloodstream in vivo. Diesel nanoparticles have been found to damage the cardiovascular system



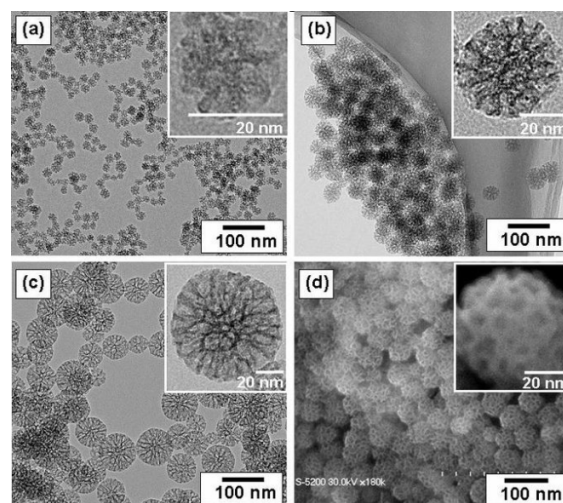
Researchers have already developed a series of products based on nanoparticles, some of which have been released for public consumption.

in a mouse model. Concern has also been raised over the health effects of respirable nanoparticles from certain combustion processes.^[7]



VIII. Nanoparticles and Their Applications

Nanoparticles and their applications, are essentially very small pieces of material that measure no more than an atom or two across. They are small enough that they can interact easily on the same level with microscopic pathogens such as bacteria or viruses. Since they can literally be particles from any substance, they are also versatile enough that they can be used in many types of technological applications, from delicate electronics to revolutionary medical procedures.



Nanotechnology has given rise to house cleaning chemicals that appear to have miraculous effects; the nanoparticles inside these cleaning fluids have been engineered on the molecular



level so that when they encounter unwanted dirt or grime, they “eat” it. Housewives everywhere can rejoice in the knowledge that it will soon be common practice to spray the dirt and watch the nanoparticles make it magically disappear.

They might also be interested in self-cleaning fabrics. In some cases the nanoparticles inside these materials have been similarly engineered to “eat” stains; in others nano-hairs have been applied in a thin, invisible layer over the fabric itself so that stains cannot penetrate.

In both cases, the resulting fabric is either extremely stain-resistant or virtually impossible to soil. Most of these successes have been with wool and silk, but other fabrics are being stain-proofed daily. Eddie Bauer has already released a line of stain-proof khakis.

But perhaps the timeliest use for nanoparticles lies in their medical applications. Their pathogen-sized proportions naturally make them prime candidates for the fight against various unwanted invaders of the human body; they can be injected into your bloodstream to fight viruses and bacteria in much the same way as your immune system’s helper-T cells do.

This can either give you a much-needed boost, or in the case of AIDS sufferers it may make the difference between life and death. For those with severe auto-immune diseases like HIV and AIDS, nanoparticles could essentially serve as a synthetic immune system.

It seems likely that nanoparticles will also be key players in the fight against cancer. Our current cancer treatments tend to be traumatic and painful for the patient while at the same time providing unpredictable levels of success, especially when it comes to chemotherapy. Chemotherapy uses the bloodstream, and—as the name “circulatory system” suggests—this method of transportation distributes the lethal chemical throughout several parts of the body in its quest to find the cancer’s location.

By doing so, it kills off healthy, useful cells along with malignant tumors. And since the chemical dosage is typically not fine-tuned to the molecular level, some cancer cells may still survive this treatment. If even one malignant cell lives and makes a comeback, then the chemotherapy will have been a painful and costly failure.

But nanoparticles can be equipped with sensors and cameras as well as cancer-killing drugs. They would then be able to swim through the bloodstream, using their sensors to locate the exact site of the cancer where it grows. Their cameras could beam back images to doctors and nurses, or in some cases the nanoparticles could also be equipped with fluorescent markers and/or iron oxide cores so that they can be located on both optical imaging devices and MRI.

In essence, researchers could track these tiny particles as they make their way through the human system and deliver doses of anti-cancer drugs to the cancer site, killing off every last molecule of the tumor without painful side effects or unnecessary damage. This would not only make cancer treatment much less uncomfortable for patients, but also faster and more effective.

Some other universal applications of the nanoparticle include:

1. *Optical*-. Nanoparticles could be engineered and used for anti-reflection product coatings, producing a refractive index for various surfaces, and also providing light based sensors for use in diagnosing cancer.
2. *Magneti*-. Nanoparticles have the potential to increase the density of various storage media, and also when magnetized they can improve the detail and contrast of MRI images as previously alluded to.
3. *Thermal*-Specifically engineered particles could improve the transfer of heat from collectors of solar energy to their storage tanks. They could also enhance the coolant system currently used by transformers in these types of processes.
4. *Mechanical*-. Nanoparticles could provide improved wear and tear resistance for almost any mechanical device. They could also give these devices previously unseen anti-corrosion abilities, as well as creating entirely new composites and structural materials that



are both lighter and stronger than those we use today.

5. *Electroni-*. Because of their tiny size, nanoparticles are inherently poised to aid in the production of high performance delicate electronics; they may provide not only materials with a high rate of conductivity, but also sleeker parts for small consumer electronics like cell phones. And when it comes to advertising, nanoparticle electronics can create digital displays that are more electricity-efficient, less expensive to produce, brighter in color, and also bigger.
6. *Energy-* Nanoparticle batteries would be longer-lasting and have a higher energy density than those we use today. Metal nanoparticle clusters could also have revolutionary applications for hydrogen storage; they could also produce extremely efficient fuel cells by acting as electrocatalysts for these devices. Nanoparticles may also pave the way for practical and renewable energy; they have already demonstrated an ability to improve solar panel efficiency many times over. Not only that, but when nanoparticles are used as catalysts in combustion engines, they have shown properties that render the engine more efficient and therefore more economic.
7. *Biomedical-* You may soon find that your wounds are dressed with antibacterial coatings of silver nanoparticles. Nanoparticles have also been used to produce “quantum dots,” which can detect diseases, as well as interactive foods and drinks that change flavor and color based on your tastes, or in some cases may even alter their nutrient content based on your state of health.

IX. Conclusion

As it stands now, the majority of commercial nanoparticle applications in medicine are geared towards drug delivery. In biosciences,

nanoparticles are replacing organic dyes in the applications that require high photo-stability as well as high multiplexing capabilities. There are some developments in directing and remotely controlling the functions of nano-probes, for example driving magnetic nanoparticles to the tumour and then making them either to release the drug load or just heating them in order to destroy the surrounding tissue. The major trend in further development of nanomaterials is to make them multifunctional and controllable by external signals or by local environment thus essentially turning them into nano-devices.

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Analysis of Dropwise Condensation Using Nano Fluids as Coolant

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Abstract— Improving the efficiency of the thermal power plant by introducing a newer technology Dropwise condensation (DW C) with Nano fluids as coolant in condensation unit. Drop wise condensation (DWC) is under development as it offers extremely high heat transfer (4-8 times higher) by preventing the build up of the condensate liquid layer formed in the film wise condensation (FWC). This project work is an experimental based and objective is to break the condensate formed on the cold surface so as to improve the heat transfer rate. Hence an analysis has been done over circular, and bundle of tubes. In this present project work vapour deposition method is used for coating the copper tubes by POLY TETRA FLUORO ETHYLENE (TEFLON) is used to promote the drop wise condensation. Instead of cooling water Nano fluids are used to improve the heat transfer rate. The characteristics of drop wise condensation on circular, and bundle of tubes are experimentally studied and their results are compared. Correlations have been derived.

I. INTRODUCTION

Condensation is a vital process in power generation industries and its result been an area of research for over hundred years. Over this period understanding of condensation process has gradually improved. Theories and models have become more accurate and are known applicable to a wider range of condensation.

II. CONDENSATION

Condensation occurs when the temperature of a vapour is reduced below its saturation temperature, i.e., when the temperature of the wall surface is lower than saturation temperature of the adjacent vapour. Currently existing modes of condensation are film wise condensation (FWC) and drop wise condensation (DWC).

A. Film Wise Condensation

When the surface is kept cold by some cooling process, the steam or vapour is condensed. This is called film wise condensation. It can be removed from the surface by the motion of gravity.

B. Drop Wise Condensation

When the condensing surface is covered by non-wet table (non oxide) coating then the vapour will condense in drops rather than continuous film.

C. About The Project

In this experimental project two types of coolants were used and tested in a circular copper tube coated with Teflon. In this present work POLY TETRA FLUORO ETHYLENE commercially known as TEFLON and Nano fluid Silver Nitrate is used to promote the DWC. Result has been proved in DWC when properly promoted has been known to produce heat transfer coefficient up to 4-8 times that of DWC using water as coolant in circular tubes. Hence to improve the condensation characteristics, circular single tube and bundle of tubes have been tested. So analysis had been performed for drop wise condensation using water and nano fluids as coolant in circular tubes and bundle of tubes. Correlations are derived for DWC for each type of the tube.

III. FABRICATION DETAILS

The experimental setup has two major units and they are, Steam Generation Unit. 2. Condensing Unit.

1. Steam generation unit consists of the following parts:

- Pressure Cooker
- Safety Valve.
- pump Stove
- Rotameter.
- Steam Outlet Pipe.

2. Condensing unit consist of the following parts:

- LPG refrigerator
- Test tubes
- Steam outlet pipe
- Cooling water controlling pipe
- Thermometer
- Measuring beaker
- Stop watch
- Condensate control valve
- Insulation



IV. EXPERIMENTAL SETUP

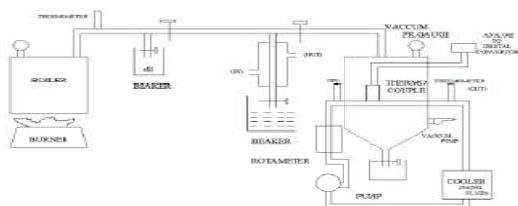


Fig. Thermocouple and Multimeter.

V. EXPERIMENTAL PROCEDURE

Measured amount of water is poured inside the pressure cooker and the heating is started with the help of Pressure Stove. Start the coolant circuit by controlling the ball valve. The time is to be noted and allow the steam continuously to get the condensation on tube surfaces.

Measure the coolant inlet and outlet temperature with the alcohol thermometer at regular interval of time. Readings are taken for various mass flow rate of coolant and amount of condensate for each flow rate is taken. Test tube can be changed with the provision made in the condenser. In this project analysis has been done for drop wise condensation using circular shape single tube and Bundle of tubes. Condensation process can be photographed for observation.

VI. CALCULATION PROCEDURE

FORMULAE USED:

Theoretical Heat Transfer Rate:

$$Q = M_s \cdot X \cdot h_{fg} \text{ (Kw)}$$

Theoretical Heat Transfer co-efficient:

$$h = Q / A \cdot (T_{sat} - T_{sur}) \text{ (Kw/m}^2\text{K)}$$

Actual Heat Transfer Co-efficient:

From graph 'hactual' is calculated (Kw/m²K)

Actual Heat Transfer Rate:

$$Q_{actual} = h_{actual} \cdot A \cdot (T_{sat} - T_{sur}) \text{ (Kw)}$$

Overall Heat Transfer co-efficient:

$$U = Q_{actual} / A \cdot (LMTD) \text{ (Kw/m}^2\text{K)}$$

$$LMTD = (T_{sat} - T_{wi}) - (T_{sat} - T_{wo}) / \ln [(T_{sat} - T_{wi}) / (T_{sat} - T_{wo})] \text{ (oC)}$$

OBSERVATIONS

DWC-SINGLE TUBE-WATER AS COOLANT

S.No	M _w (lit/min)	T _{wi} ° C	T _{wi} ° C	T _s ° C	M _s (lit/min)
1	0.75	31	36	41	17
2	1.00	30.5	34	42	18
3	1.10	30	33	42	18
4	1.25	30	33	43	19.5
5	1.40	30	33	43	20
6	1.50	30	33	44	20.5
7	1.75	30	32	44	21
8	1.90	30	32	46	21.5
9	2.00	30	32	48	22
10	2.35	29	31	48	24

MODEL CALCULATION:

For Circular DWC 1st reading

Dia of tube = 15.9*10⁻³m

Length of tube = 45.72*10⁻²m

T_{sat} = 100°C

h_{fg} = 2257 KJ/Kg

P_{boiler} = 2bar

M_s = 17 ml/min

T_s = 41°C

Surface area = 3.14*D*L

$$= 3.14 \cdot 15.9 \cdot 10^{-3} \cdot 45.72 \cdot 10^{-2}$$

$$= 0.02282 \text{ m}^2$$

Heat transfer rate Q = M_s * X * h_{fg}

$$= (17 \cdot 0.8 \cdot 2257) / 60000$$

$$= 0.51158 \text{ Kw}$$

S.No	M _w (kg/sec)	Q (w)	h (Kw/mk)
1	0.125	511.58	0.3799
2	0.1066	541.68	0.4092
3	0.0183	541.68	0.4092
4	0.0208	586.82	0.4511
5	0.0233	601.86	0.4627
6	0.025	616.93	0.4827
7	0.0129	631.96	0.4945
8	0.0316	647.00	0.5250



9	0.0333	666.05	0.5579
10	0.0391	722.24	0.6084

Theoretical heat transfer co-efficient:

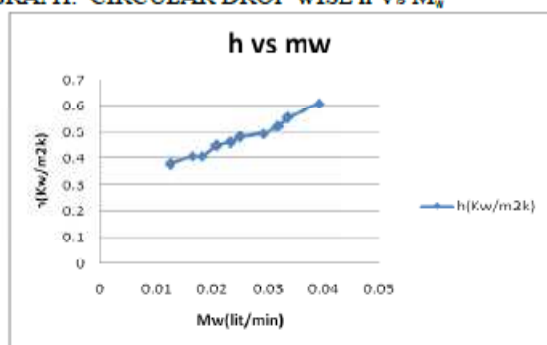
$$h = Q/(A*(T_{sat} - T_{sur}))$$

$$= 0.51158/(0.02282*(100-41))$$

$$= 0.3799 \text{ Kw/m}^2\text{k}$$

The graphs are drawn between heat transfer co-efficient h

GRAPH: CIRCULAR DROP WISE h Vs Mw



The graph shows that the heat transfer coefficient increases.

From the graph or curve fitting the relation between heat transfer co-efficient (h) and mass flow rate of cooling water (Mw) can be obtained from the package MICROSOFT EXCEL

RELATIONS FOR CALCULATING h_{actual} (Circular DWC)

- Linear → $h = 8.518 \text{ Mw} + 0.265$
- Logarithmic → $h = 0.196 \ln(\text{Mw}) + 1.212$
- Polynomial → $h = 73.88 \text{ Mw}^2 + 4.725 \text{ Mw} + 0.309$
- Power → $h = 2.207 \text{ Mw}^{0.411}$
- Exponential → $h = 0.304e^{17.66\text{Mw}}$
- Model calculation of h_{actual} for 1st reading is shown below by taking the linear relation
- $h = 0.1417 * .75 + 0.2655$
- $= 0.371775 \text{ (Kw/m}^2\text{K)}$

Actual heat transfer co-efficient for all the relations
h_{actual} for the relations of Circular DWC

S.N o	LINEA R	LO G	POL Y	POWE R	EXPO N
1	0.3714	.3531	.3796	.3644	.3790
2	.4063	.4087	.4077	.4095	.4075
3	.4208	.4278	.4202	.4262	.4199

4	.4421	.4529	.4392	.4492	.4389
5	.4634	.4751	.4592	.4707	.4587
6	.4889	.4889	.4733	.4845	.4727
7	.5187	.5187	.5090	.5157	.5082
8	.5348	.5348	.5320	.5335	.5311
9	.5486	.5451	.5482	.5451	.5473
10	.5980	.5766	.6.66	.5823	.6063

Finding Error Percentage between h_{theoretical} and h_{actual} by the following formulae

$$\text{Error percentage} = [(h_{\text{theoretical}} - h_{\text{actual}})/h_{\text{theoretical}}] * 100$$

Sample for linear h_{actual} for Circular DWC

$$\text{Error percentage} = 0.0138 - 0.468533 / 0.0138 * 100$$

$$= 2.389002\%$$

Similarly error percentages for all the relations are calculated. Error percentages for all the relations

Error percentages for the single tube DWC relations

S.N	LINEA	LOG	POL	POWE	EXPO
1	2.2374	7.054 4	.0789 6	4.0800	.2369
2	0.7086	.1221	.3665	-.07331	.4154
3	-2.8347	- 4.545 4	- 2.688 1	-4.1544	- 2.6148
4	1.9951	- .3990	2.637 9	.4211	2.7045
5	-1512	- 2.679 9	.7564	-1.7299	.8644
6	.9944	- 1.284 4	1.947 3	-.3729	2.0716
7	-3.7007	- 4.893 8	- 2.932 2	-4.2871	- 2.7704
8	-1.7333	- 1.866 6	- 1.333	-1.6190	- 1.1619
9	1.6669	2.294	1.738	2.2943	1.8999



		3	6		
10	1.7094	5.2268	.2958	4.2899	.3451

From the above error percentages for the POLYNOMIAL relation is found to have lesser error than the other relations. Hence it is used for the further calculations.

Actual heat transfer co-efficient:

$$h_{act} = .3527 \text{ kw/m}^2\text{K (from graph)}$$

Actual heat transfer rate:

$$\begin{aligned} Q_{act} &= h_{act} * A * (T_{sat} - T_{sur}) \\ &= .3527 * 0.02282 * (100 - 41) \\ &= 0.4748 \text{ Kw} \end{aligned}$$

Overall heat transfer coefficient:

$$LMTD = ((100 - 31) - (100 - 36)) / \ln((100 - 31) / (100 - 36))$$

$$= 66.46^\circ\text{C}$$

$$U = Q / A * LMTD$$

$$= 0.4748 / (0.02282 * 66.46)$$

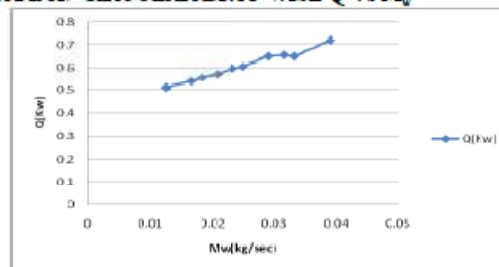
$$= .3130 \text{ kw/m}^2\text{K}$$

Similarly actual heat transfer co-efficient (h_{actual}), actual heat transfer rate (Q_{actual}) and overall heat transfer co-efficient (U) is calculated for all the readings.

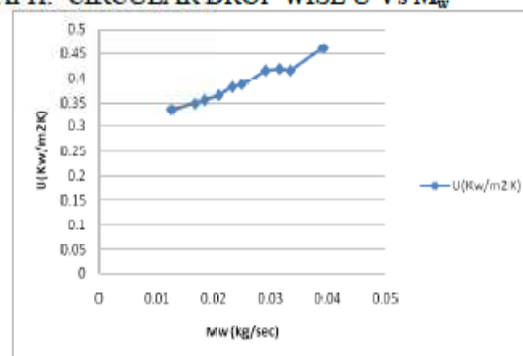
VII. RESULTS OF CIRCULAR DWC

S.No	Q (Kw)	LMTE °C	U (Kw/m ² K)
1	0.5110	66.46	.3369
2	0.5396	67.73	.3491
3	0.5561	68.48	.3558
4	0.5712	68.48	.3655
5	0.5972	68.48	.3821
6	0.6048	68.48	.3870
7	0.6504	68.99	.4161
8	0.6555	68.99	.4194
9	0.6505	68.99	.4162
10	0.7198	69.99	.4606

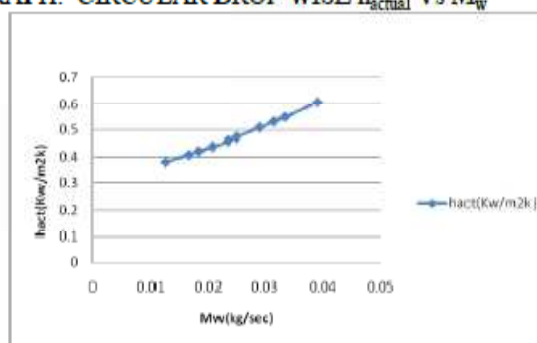
GRAPH: CIRCULAR DROP WISE Q Vs M_w



GRAPH: CIRCULAR DROP WISE U Vs M_w



GRAPH: CIRCULAR DROP WISE h_{actual} Vs M_w



Similar way of readings, calculations was taken to single tube, banks of tubes with water and nano fluid (silver nitrate) as coolants were used.

DROP WISE CONDENSATION OF SINGLE TUBE WITH NANO FLUID AS COOLANT

S.No	M_w (Kg/sec)	T_{wi} °C	T_{wo} °C	T_s °C	M_s (ml/min)
1	0.0125	29.5	32.5	38	33.5
2	0.0166	29	32	38	34
3	0.0183	29	32	38	34.5
4	0.0208	29	31	38	35
5	0.0233	28	31	39	36
6	0.25	26.5	29.5	39	37
7	0.0291	26	29	40	38
8	0.0316	26	29	40	38.5
9	0.0333	25	28	41	39
10	0.0391	25	27	41	46



DROP WISE CONDENSATION WITH BANKS OF TUBES USING WATER AS COOLANT (N=3)

S.No	M _w (Kg/sec)	Tw _i °C	Tw _o °C	Ts °C	M _s (ml/min)
1	.0125	37	39	51	26
2	.0166	37	38	51	26.5
3	.0183	37	37.5	51	27
4	.0208	36.5	37	52	28
5	.0225	36	37	52	30
6	.025	35.5	36.7	53	30
7	.0258	35	36.5	53	30.5
8	.0291	34.5	36	53	31
9	.0316	34	35.5	54	33
10	.0333	34	35	54	34

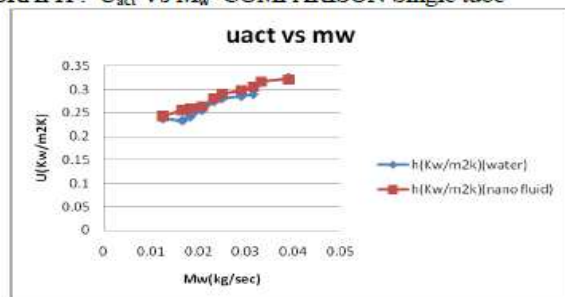
DROP WISE CONDENSATION WITH BANKS

S.No	M _w (Kg/sec)	Tw _i °C	Tw _o °C	Ts °C	M _s (ml/min)
1	.0125	39	40	44	31
2	.0166	38.5	39.5	45	32
3	.0183	38.5	39.5	45	32.5
4	.0208	38	39	45	33
5	.0225	37.5	38.5	46	34.5
6	.025	37	38	47	35
7	.0258	37	38	47	36
8	.0291	36	38	47.5	36.5
9	.0316	36	37.5	48	37.5
10	.0333	36	37	48	38

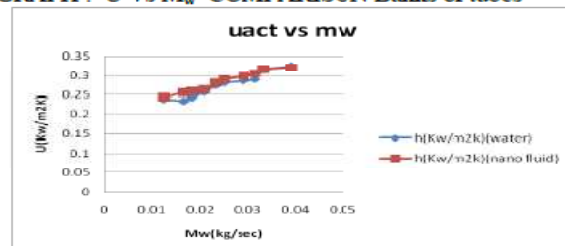
OF TUBES USING FLUID AS COOLANT (N=3)

VIII. COMPARISON OF DWC USING VARIOUS COOLANTS IN SINGLE TUBES

GRAPH : U_{act} Vs M_w COMPARISON Single tube



GRAPH : U Vs M_w COMPARISON Banks of tubes



IX. CORRELATION FOR TEFLON COATING

S. NO	NO OF TUBE	TYPES OF COOLANT	CORRELATION
1	1	WATER	Polynomial→ $h = 73.88 M_w^2 + 4.725 M_w + 0.309$
2	1	NANO FLUID	Polynomial→ $h = 421.1 M_w^2 - 10.79 M_w + 0.788$
3	3	WATER	Polynomial→ $h = 104.1 m_w^2 - 0.269 m_w + 0.218$
4	3	NANO FLUID	Logarithmic→ $h = 0.085 \ln(m_w) + 0.609$

X. CONCLUSION

From the above graphs it has been proved that the Overall heat transfer co-efficient, Heat transfer coefficient, heat transfer rate, increases with mass flow rate coolant.

Result has been proved that the overall heat transfer coefficient increases by introducing Nano fluids (silver Nitrate) as coolant instead of water.

- TEFLON has negligible heat transfer resistance and poses no contamination threat to the system.
- However the Durability of the TEFLON is to be determined before it can be commercialized.

XI. FUTURE SCOPE OF THE PROJECT

- Orientation of the tube has been changed to various inclined positions.
- Other coatings such as silicon paints, ceramics, etc., can be used.
- The test can be done for aluminium tubes.
- Other parameters such as thermal conductivity of the tube and density can be included in the correlations.

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Carbon Nanostructures and Devices

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Abstract— The science of nanotechnology, now a days is leaving trademark prospects for better living. The motto of nanotechnology is “ever smaller and ever faster”. An overview of the various carbon structures with characteristic sizes in the nanoscale region is presented, with special attention devoted to the structures and properties of ‘nanodiamond’ and carbon nanotubes. The term ‘nanodiamond’ is used broadly for a variety of diamond-based materials at the nanoscale ranging from single diamond clusters to bulk nanocrystalline films. Only selected properties of carbon nanotubes are discussed, with an aim to summarize the most recent discoveries. Current and potential applications of carbon nanostructures are critically analyzed. This ppt also includes the explanation for the carbon nano devices Like OLEDs, OPVs, OTFTs.

Keywords- nanoscale, nanodiamond, Nano crystalline, Nano technology.

I. INTRODUCTION

At the present time, carbon nanostructures are regarded as artificially composed structures with the nanometer size. Their properties are the subject of both theoretical and experimental investigation; nowadays they have a very wide range of possible applications (see, for example, [1]).

The history of carbon nanostructures begins in 1985, when the Buckminsterfullerene C₆₀ was discovered by Kroto [2]. Since that time, the number of discovered structures is rapidly increasing. The examples of them are: the nanotubes discovered by Iijima [3], the family of fullerenes C₇₀, C₇₆ [4], C₈₄ [5], C₆₀ in a crystalline form, carbon nanocones [6], carbon nanohorns [3], nanoscale carbon toroidal structures [7] and helicoidal tubes [8], periodical carbon structures Schwarzites (proposed in [9]) and Haeckelites [10], etc. These carbon structures could be singlewalled or multiwalled; they may have zero, positive or even negative Gaussian curvature (Schwarzites).

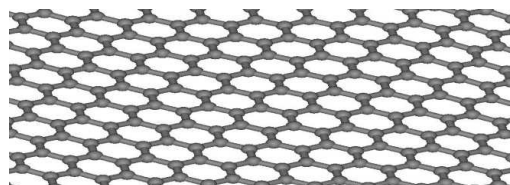


Figure 1. The bended graphene layer

As it was well known before 1985, carbon could form two types of lattice: the diamond lattice with sp³ - hybridization, where each atom is connected with four others, and the graphite lattice. Graphite is formed by flat hexagonal layers of carbon atoms, separated by 3.35 Å (angstroms), and the distance between each two nearest carbon atoms in the layer is 1.42 Å. The bonding energy of two atoms located in the same layer exceeds the same energy for different layers, and as a good approximation one can consider these atoms as having sp² - hybridization.

It is interesting to note that the bonding energy for the graphite between atoms in the same layer is as strong as the bonding in the diamond structure, although the solidity of graphite, determined by interlayer bonding, is very low. All the carbon nanostructures known at the present time could be constructed from an ordinary hexagonal graphene layer.

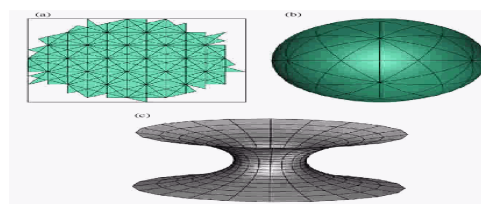


Figure 2. The plain (a), the positively (b) and the negatively (c) curved surfaces

According to the fact, that our plane is made of the hexagons, we can cut the sector with the angle multiple of $2\pi/6$. When the cut is made, there will appear five-, four- or even threefold. The lattice, trying to minimize its potential energy, will bend into a conical surface. Finally we got the most simple carbon nanostructure - the carbon nanocone (see Fig. 3). On the other hand, we can insert the sector of the lattice between the cuts, which gives the sevenfold, or octagon, etc. In the first case, the Gaussian curvature of the surface (a well-known local geometrical parameter) will be positive. In the second case, it will be negative.

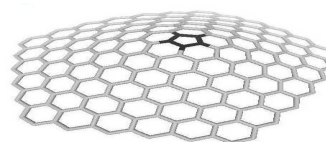


Figure 3. The carbon nanocone

Carbon nanocones, discovered in 1994 [6], are the most simple example of the nanostructured carbon. They are made, as a rule, of the hexagonal plane with a different number of



pentagonal defects, more precisely, from one to five. Each cut, or the pentagonal disclination, has the angle $2\pi/6$. As it was shown in [14], the fivefold (or positive disclination) could be stable, but the most stable configuration for more than one defect is the configuration, where they are separated by hexagons (the isolated pentagon rule) [15].

The nanocones are produced by carbon condensation on a graphite substrate [6], and by pyrolysis of heavy oil [16]. Another method of their formation is laser ablation of graphite targets [17].

There is also one special class of nanocones, called "nanohorns" (they look like animal's horns) with exact five defects (fivefolds) on the tip [3], Fig.4. They could be produced by the method similar to the nanocones, by use of laser ablation, even on the open-air [18]. These structures with good electron emission properties are easy to get and stable enough [19]. Both nanohorns and nanocones are believed to have good field emission properties, which determine their usage as electron field emitters.

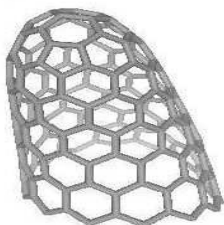


Figure 4. The carbon nanohorn

III. FULLERENES

The history of fullerenes begins in 1985, when Kroto with colleagues carried out an experiment to simulate the condition of red giant star formation, when cold carbon clusters are produced. With the use of the mass-spectrometer, they found a large peak commensurate with 60 carbon atoms. After intensive discussions, they concluded that this construction could be a truncated icosahedron, or the Buckminsterfullerene C₆₀ (see Fig. 5). Since that time, the family of fullerenes (closed spherical carbon structures) increased, and now it consists of C₇₀, C₇₆, C₈₄, C₂₄₀, C₅₄₀ and so on. A careful reader, when looking at Fig. 5, could find the same hexagons and fivefolds, as in the nanocones.

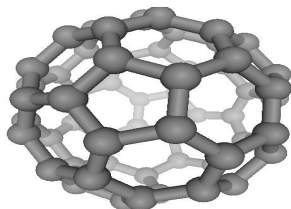


Figure 5. The Buckminsterfullerene

Indeed, one can produce the fullerene from the graphene layer with the same imaginary cut-and-glue procedure but with one important difference: the number of cuts (fivefolds) should be exactly twelve. Actually, in view of the fact that the fullerene is a closed structure, one could notice, that to produce the bounded piece of lattice, we need to cut the sector with the full angle 2π . Thus the fullerene could be made of two such pieces (the upper and the lower one), and the full cutting angle for the fullerene is 4π , or twelve times by $2\pi/6$. More precisely, we need to take into account the genus of the structure: as it is shown in [15], it determines the number of squares, fivefolds, sevenfolds and octagons in the lattice. For the closed structure with genus zero, when the lattice is composed of pentagons and hexagons, the number of pentagons should be exactly twelve.

The fullerenes, being closed structures with zero genus, differ by their shape and symmetry. The Buckminsterfullerene C₆₀, shown in Fig. 5, has a spherical-like shape and the full group of symmetry of the icosahedron I_h. This fact means that it could be rotated by the angle of $2\pi/5$ around the center of each pentagon and reflected in the mirror located on the each plane of its symmetry. Another class of spherical fullerenes like C₁₄₀ and C₂₆₀ (proposed in [15]) lacks the mirror symmetry *h*, and their maximum symmetry group is icosahedral (I).

When one is speaking about the fullerenes, one should mention an interesting property of these closed structures – the ability for holding the molecules inside (hence the fullerenes are potential nano - capsules). The nano – capsule is a closed nanostructure (the fullerene or the nanotube) with one or more atoms of the substance inside the structure. Experimentally there were detected the nano - capsules like a metal – inside - fullerenes La@C₆₀, La@C₇₀, La@C₇₄, La@C₈₂, capsulated radioactive materials U@C₂₈, Gd@C₈₂, the peapod structures (fullerenes inside the nanotube) C₆₀@SWNT, and so on. For the substance enclosed in the fullerene nano-capsule, carbon atoms act like a defense shield: the experiments show that the fullerene containers are good for protecting their contents from water and acid. Some interesting magnetic properties of the ferromagnetic metals (Fe, Co, Ni) inside the fullerenes were observed; namely, the magnetic properties of the metals remain unchanged. As for the capped radionuclides, the stability of these metallic fullerenes could bring the new effective solution of the radioactive waste elimination.

IV. CARBON NANOTUBES

The nanotubes, discovered by Ijima (see [3] and Figs. 6,7), are for now the most studied carbon nanostructures. The nanotubes are the tubes made from graphene plain, with one (Single Walled) or more than one (Multiwalled) layers. Sometimes they could have the cap at their ends (see Fig.6).

The carbon nanotubes (CNTs) are produced using four main methods: arc discharge of graphite electrodes in inert atmospheres [3], pyrolysis of hydrocarbons over catalysts [21], laser vaporization of graphite targets [22], and electrolysis of graphite electrodes in the molten salts [23]. Generally



speaking, the number of techniques used to produce CNTs is growing day by day, and according to the recent data [24], even the methane burning in our kitchen produces some quantity of nanotubes and other carbon nanocrystals! This fact raises an important question about the nano-pollution of the environment and the influence of the nanostructures over our health, and this is the question still to be solved.

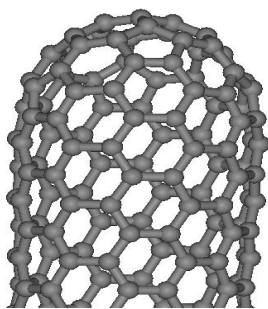


Figure 6. The capped carbon nanotube

The carbon nanotubes (CNTs) are produced using four main methods: arc discharge of graphite electrodes in inert atmospheres [3], pyrolysis of hydrocarbons over catalysts [21], laser vaporization of graphite targets [22], and electrolysis of graphite electrodes in the molten salts [23]. Generally speaking, the number of techniques used to produce CNTs is growing day by day, and according to the recent data [24], even the methane burning in our kitchen produces some quantity of nanotubes and other carbon nanocrystals! This fact raises an important question about the nano-pollution of the environment and the influence of the nanostructures over our health, and this is the question still to be solved.

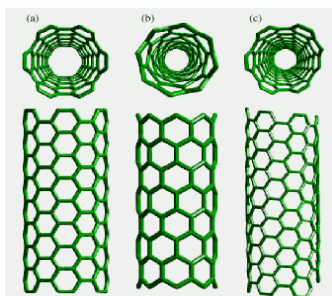


Figure 7. Some types of nanotubes: (a) armchair, (b) zigzag, and (c) chiral tubes. From the review [15]

The main parameters determining their type are their diameter and chirality. The chirality, or the orientation of six-folds in the nanotube, is an “internal” property, but it determines their stability (their quantity in the experiment) and electronic properties (theoretically shown by Hamada in [25]). The plain graphene, being a semiconducting material, in the form of the nanotubes could have the dielectric, and even the metallic properties. This fact determines the usage of the metallic CNTs as field emitters, even their commercial

application – in the flat panel displays (the prototype of flat panel display for TV on the carbon nanotubes was presented

by Samsung in 1999), and as emitters in the electronic microscopy. It is interesting to note that recently the similar silicon nanotubes were produced [26], and they have the common dependence between chirality and metallization. One can speculate, that this fact could be applied also for other two-dimensional systems; but unfortunately the other materials suitable for nanotubes, like boron nitride and molybdenum disulfide, are dielectric.

Another interesting property of carbon nanotubes is their strength. Indirect measurements [27] revealed that multi-walled carbon nanotubes possess a Young’s modulus around 1.8 TPa, i. e. 100 times larger than steel! The robustness of the nanotubes, in combination with their low weight, leads to the rising of some fantastic technical projects, such as a space lift.

V. NEGATIVELY CURVED NANOSTRUCTURES

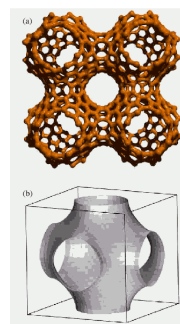


Figure 9. The four cells of Schwarzite (a) and the TPMS (b). From the review [10]

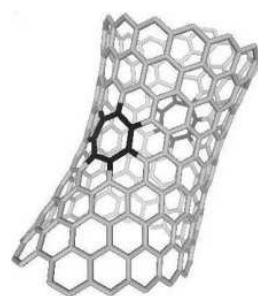


Figure 8. The nanotube with two sevenfolds (black)

Figure 10. The “high genus fullerene”. From the review [10]

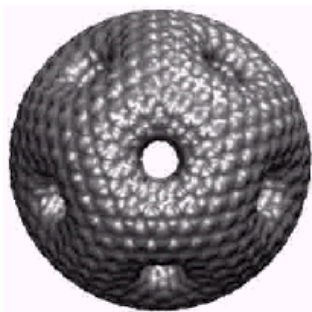
As it was mentioned earlier, the inclusion of the heptagons in the hexagonal lattice leads to the appearance of negative curvature.

The single sevenfold in the plain graphene lattice was theoretically studied in [14], but this situation, unfortunately, has not been observed in the experiment yet. The heptagons



were observed in the nanotubes ([28], Fig. 8), and in the work [29] the magnetic properties of negatively curved structures were calculated. The heptagon included into the graphene layer bends it into a buckled surface; and symmetrical adding

of the heptagons into the nanotube leads to the geometry of one-sheet hyperboloid, as it is shown in Fig.8.



Another type of negatively curved periodical nanostructures was proposed by Terrones [10]; he supposed that a mathematical object called "Triple Periodical Minimal Surface" (TPMS) could be found in the nature, in the form of carbon zeolite-like structures; he called them "Schwarzites" (Fig.9). They appear to be some kind of cubic lattice, but they are two-dimensional structures and thus their properties differ from those we have in the ordinary crystalline materials. The energetic calculations performed for Schwarzites in the work [30], shows, that they are more stable than C60. Some possible applications of Schwarzites, according to Terrones [10], are semiconducting nanodevices, new catalysts and molecular sieves. So, the presence of the heptagons in the lattice could lead to the increase of stability for such structure. That's why Terrones proposed also the existence of such exotic structures, like "high genus fullerenes" (Fig. 10). Although this strange structure has a quasi-spherical shape, it contains only hexagons and heptagons, and therefore its curvature is negative. It is topologically similar to the sphere with twenty-one handles. An important feature of the complex graphitic structures is that they exhibit holes of labyrinths, in which molecules can be inserted. The calculations showed that around the holes (necks), the electronic behavior is metallic [31].

VI. DEVICES

The different types of devices based on the carbon nano structures are-organic electronics (OLEDs, OPVs, OTFTs, etc), graphene-, carbon nanotube-, and nano diamond-based prototype devices (cancer diagnosis/cure, biological/chemical sensing, energy conversion/harvesting, catalysis, etc)

A. graphene :

Graphene is an allotrope of carbon. Its structure is one-atom-thick planar sheets of sp²-bonded carbon atoms that are

densely packed in a honeycomb crystal lattice.[1] The term graphene was coined as a combination of graphite and the suffix -ene by Hanns-Peter Boehm,[2] who described single-layer carbon foils in 1962.[3] Graphene is most easily visualized as an atomic-scale chicken wire made of carbon

atoms and their bonds. The crystalline or "flake" form of graphite consists of many graphene sheets stacked together.

The carbon-carbon bond length in graphene is about 0.142 nanometers.[4] Graphene sheets stack to form graphite with an interplanar spacing of 0.335 nm. Graphene is the basic structural element of some carbon allotropes including graphite, charcoal, carbon nanotubes and fullerenes. It can also be considered as an indefinitely large aromatic molecule, the limiting case of the family of flat polycyclic aromatic hydrocarbons.

a. Solar cells

The USC Viterbi School of Engineering lab reported the large scale production of highly transparent graphene films by chemical vapor deposition in 2008. In this process, researchers create ultra-thin graphene sheets by first depositing carbon atoms in the form of graphene films on a nickel plate from methane gas. Then they lay down a protective layer of thermoplastic over the graphene layer and dissolve the nickel underneath in an acid bath. In the final step they attach the plastic-protected graphene to a very flexible polymer sheet, which can then be incorporated into an OPV cell (graphene photovoltaics). Graphene/polymer sheets have been produced that range in size up to 150 square centimeters and can be used to create dense arrays of flexible OPV cells. It may eventually be possible to run printing presses laying extensive areas covered with inexpensive solar cells, much like newspaper presses print newspapers (roll-to-roll)

b. Graphene oxide paper:

Graphene oxide paper or graphite oxide paper is a composite material fabricated from graphite oxide. The material has exceptional stiffness and strength, due to the intrinsic strength of the two-dimensional graphene backbone [1] and to its interwoven layer structure which distributes loads.

The starting material is water-dispersed graphene oxide flakes, which typically contain a single graphene layer. These flakes may be chemically bonded[citation needed], leading to the development of additional new materials. Like the starting material, graphene oxide paper is an electrical insulator; however, it may be possible to tune this property, making the paper a conductor or semiconductor, without sacrificing its mechanical properties.[2]

B. Organic electronics

Organic electronics, plastic electronics or polymer electronics, is a branch of electronics dealing with conductive polymers and conductive small molecules. It is called 'organic' electronics because the polymers and small molecules are



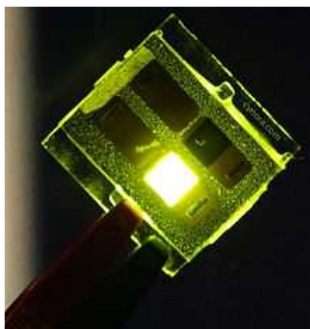
carbon-based. This contrasts with traditional electronics, which relies on inorganic conductors and semiconductors, such as copper and silicon, respectively. the different types are:

a. Oled:

An OLED (organic light-emitting diode) is a light-emitting diode (LED) in which the emissive electroluminescent layer is

a film of organic compound which emits light in response to an electric current. This layer of organic semiconductor material is situated between two electrodes. Generally, at least one of these electrodes is transparent. OLEDs are used to create digital displays in devices such as television screens, computer monitors, portable systems such as mobile phones, handheld games consoles and PDAs.

There are two main families of OLEDs: those based on small molecules and those employing polymers. Adding mobile ions to an OLED creates a light-emitting electrochemical cell or LEC, which has a slightly different mode of operation. OLED displays can use either passive-matrix (PMOLED) or active-matrix addressing schemes. Active-matrix OLEDs (AMOLED) require a thin-film transistor backplane to switch each individual pixel on or off, but allow for higher resolution and larger display sizes.



b. Organic solar cell

An organic solar cell or plastic solar cell is a type of polymer solar cell that uses organic electronics, a branch of electronics that deals with conductive organic polymers or small organic molecules,[1] for light absorption and charge transport to produce electricity from sunlight by the photovoltaic effect.

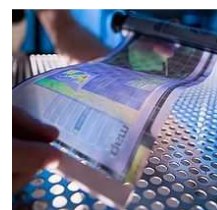
The plastic used in organic solar cells has low production costs in high volumes. Combined with the flexibility of organic molecules, organic solar cells are potentially cost-effective for photovoltaic applications. Molecular engineering (e.g. changing the length and functional group of polymers) can change the energy gap, which allows chemical change in these materials. The optical absorption coefficient of organic molecules is high, so a large amount of light can be absorbed with a small amount of materials. The main disadvantages

associated with organic photovoltaic cells are low efficiency, low stability and low strength compared to inorganic photovoltaic cells.

c. Organic field-effect transistor

An organic field-effect transistor (OFET) is a field effect transistor using an organic semiconductor in its channel. OFETs can be prepared either by vacuum evaporation of small molecules, by solution-casting of polymers or small

molecules, or by mechanical transfer of a peeled single-crystalline organic layer onto a substrate. These devices have been developed to realize low-cost, large-area electronic products and biodegradable electronics. OFETs have been



OFET-based flexible display

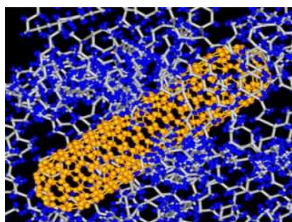
fabricated with various device geometries. The most commonly used device geometry is bottom gate with top drain- and source electrodes, because this geometry is similar to the thin-film silicon transistor (TFT) using thermally grown Si/SiO₂ oxide as gate dielectric. Organic polymers, such as poly(methyl-methacrylate) (PMMA), can also be used as dielectric.

C. Carbon nanotube

Carbon nanotubes, a type of fullerene, have potential in fields such as nanotechnology, electronics, optics, materials science, and architecture. Over the years new applications have taken advantage of their unique electrical properties, extraordinary strength, and efficiency in heat conduction.

Medical implants made of porous plastic, coated with carbon nanotubes. Therapeutic drugs, which are attached to the nanotubes can be released into the bloodstream, for example, when a change in the blood chemistry signals a problem. NASA is developing these implants, called a "biocapsule", to protect astronauts from the effects of radiation however the implants may also be useful for releasing insulin for diabetes patients or for delivering chemotherapy drugs directly to tumors.

Aircraft using carbon nanotubes to increase strength and flexibility in highly stressed components. The properties of nanotubes have caused researchers and companies to consider using them in several fields. For example, because carbon nanotubes have the highest strength to weight ratio of any known material, researchers at NASA are combining carbon nanotubes with other materials into composites as shown in the photo below that can be used to build lightweight spacecraft.



D. Nano-Diamond

The cure for cancer may be just around the corner with all these development in nano structures Scientists are combining cancer medicine with tiny particles of carbon called nanodiamonds. These diamonds are nothing like the gems used in jewelry. They're just a few nanometers across. A nanometer is one billionth of a meter.

First a group of diamonds is assembled and then is coated with cancer killing drugs. Then it is studded with protein receptor.

Once nano diamonds enters blood streams it skips over the healthy tissue until they find the cancer cells. the Y shape proteins on nano diamonds fits more effectively with triangular shape in cancer cell. Diamond then taken into cancer cells by tumor itself and the drug released. This destroys cancer cells.

Traditional ways to treat cancer patient is to use chemotherapy .that uses radiation to kill cancer cells. The main problem is it doesn't distinguished between healthy and cancer tissue. Nanodiamond dramatically reduces the side effect.

VII. CONCLUSION

There are some types of the nanostructures (the quantum dots, semiconducting heterostructures and the carbon nanostructures described above) which are investigated enough, and some of them have commercial applications The most important thing we need to do now is to develop the present technologies in accordance with the present state of the science and with the requirements of the mankind. The highly advertised nanorobots would be just a little part of the wonders of future engineering. Both the development and use of the novel technologies are in our hands; our duty is to manage them in the worthy way.

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Nano Materials

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Abstract— This presentation shows about Nanomaterials. Nanomaterials are at the leading edge of the rapidly developing field of nanotechnology. Their unique size-dependent properties make these materials superior and indispensable in many areas of human activity. This brief review tries to summarise the most recent developments in the field of applied nanomaterials, in particular their application in industry and medicine, and discusses their commercialisation prospects.

Keywords: *nanomaterials; nanoparticles; quantum dots; nanotubes; medicine; nanocoating; applications*

I. INTRODUCTION

Nanotechnology is enabling technology that deals with nano-meter sized objects. It is expected that nanotechnology will be developed at several levels:

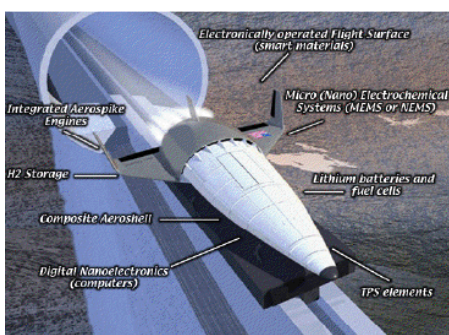


Figure 1 Future Model Air Craft



Figure 2 Nano Technology Industry

materials, devices and systems [1]. The nanomaterials level is the most advanced at present, both in scientific knowledge and in commercial applications. A decade ago, nanoparticles were studied because of their size-dependent physical and chemical properties. Now they have entered a commercial explor

II. APPLICATION OF NANO MATERIALS IN AERONAUTICS:

- A. Airframes and Components
- B. Coatings and Paints
- C. Engines and engine components
- D. Interior equipments and Furnishing

A. *Aircraft Structure : Lightweight materials that do not compromise strength and reduce fuel consumption*

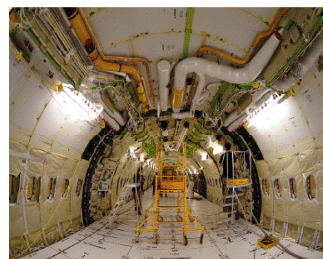


Figure 3 Interior structure of air craft

1. Polymer nanocomposites (CNTs, BN, NCF) for high strength - to - weight ratio, high impact resistance and radiation protection.
2. Self - healing or repair materials.
3. Clay based nanocomposites for structural reinforcement and heat resistance.
4. Nanomaterials for sound absorption.
5. Nanostructured metal coatings for landing gear - better wear and corrosion resistance.
6. Nanopowder deposition on glass surfaces - self cleaning and anti - glare.
7. Electrically conducting aircraft topcoats - dissipate electrostatic build - up.
8. Nanoreinforced metals and ceramics - improve brittleness and fracture toughness.



B. Coatings and Paints

Ceramics already in use; e.g. $\text{ZrO} - 8\text{mol}\% \text{Y}_2\text{O}_3$ in coatings for gas turbines and jet engine skirts. Current developments:

1. Nanocoatings for Mg alloys – improved corrosion resistance.
2. Nanocoatings for reduced drag – improve aerodynamic efficiency.

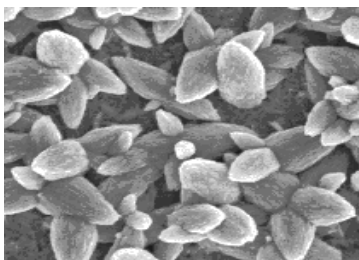


Figure 4 Nano Coatings

Diamond like films for improved wear resistance

4. Thermal barrier coatings – ZnO (1).
5. Superhydrophobic coatings (2); e.g. a gas turbine blade whose parts repel grime.
6. Ceramic nanopigments: paints that do not lose colour when exposed to UV radiation.

C. Nanomaterials and Aircraft Engines:

Drivers:

- 1) Increased engine efficiency and functionality
- 2) Reduced environmental impact
- 3) Increased strength
- 4) Increased temperature capability – temperature extremes
- 5) Reduced cost

Application:

- 1) Nano-grained alloys
- 2) Nano dispersion strengthened alloys and polymers
- 3) Nano-structured protective coatings
- 4) Electrical and magnetic materials
- 5) Sensors and actuators

D. Interior Equipments and Furnishing



Figure 5 Aircraft Interior

1. Polymer nanoclay composites for improved flame resistance.
2. Sensors for chemical and biological toxins and gaseous emissions.
3. Hygiene; addition of nanoparticles having anti-microbial activity. E.g. nanosilver to upholstery and carpets.
4. Nanomaterials for blast and ballistic application

Other Aerospace Applications of Nanomaterials

Addition of nanoparticles (Al with liquid hydrogen) to increase propulsion energy. Addition of nanoparticles (Iron oxide) as a catalyst for solid propellants.

Lubricants; non-hazardous nano-fluids for hydraulic use.

Technical textiles (clothes and equipment for space exploration)

Nanoscale electronic devices (long-lasting batteries)

Some of the applications of nanomaterials to biology or medicine:

- a) Fluorescent biological labels
- b) Drug and gene delivery
- c) Bio detection of pathogens
- d) Detection of proteins
- e) Probing of DNA structure
- f) Tissue engineering
- g) Tumour destruction via heating (hyperthermia)
- h) Separation and purification of biological molecules & cells
- i) MRI contrast enhancement

Phagokinetic studies

As mentioned above, the fact that nanoparticles exist in the same size domain as proteins makes nanomaterials suitable for bio-tagging or labelling. However, size is just one of many



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characteristics of nanoparticles that itself is rarely sufficient if one is to use nanoparticles as biological tags. In order to interact with biological target, a biological or molecular coating or layer acting as a bioinorganic interface should be attached to the nanoparticle. Examples of biological coatings may include antibodies, biopolymers like collagen, or monolayers of small molecules that make the nanoparticles biocompatible. In addition, as optical detection techniques are wide spread in biological research, nanoparticles should either fluoresce or change their optical properties. The approaches used in constructing nano-biomaterials are schematically presented below.

Typical configurations utilised in nano-bio materials applied to medical or biological problems.

Nano-particle usually forms the core of nano-biomaterial. It can be used as a convenient surface for molecular assembly, and may be composed of inorganic or polymeric materials. It can also be in the form of nano-vesicle surrounded by a membrane or a layer. The shape is more often spherical but cylindrical, plate-like and other shapes are possible. The size and size distribution might be important in some cases, for example if penetration through a pore structure of a cellular membrane is required. The size and size distribution are becoming extremely critical when quantum-sized effects are used to control material properties. A tight control of the average particle size and a narrow distribution of sizes allow creating very efficient fluorescent probes that emit narrow light in a very wide range of wavelengths. This helps with creating biomarkers with many and well distinguished colours. The core itself might have several layers and be multifunctional. For example, combining magnetic and luminescent layers one can both detect and manipulate the particles.

The core particle is often protected by several monolayers of inert material, for example silica. Organic molecules that are adsorbed or chemisorbed on the surface of the particle are also used for this purpose. The same layer might act as a biocompatible material. However, more often an additional layer of linker molecules is required to proceed with further functionalisation. This linear linker molecule has reactive groups at both ends. One group is aimed at attaching the linker to the nanoparticle surface and the other is used to bind various moieties like biocompatibles (dextran), antibodies, fluorophores etc., depending on the function required by the application.

III RECENT DEVELOPMENTS

A. Tissue engineering:

Natural bone surface is quite often contains features that are about 100 nm across. If the surface of an artificial bone implant were left smooth, the body would try to reject it. Because of that smooth surface is likely to cause production of a fibrous tissue covering the surface of the implant[3]. This layer reduces the bone-implant contact, which may result in loosening of the implant and further inflammation. It was demonstrated that by creating nano-sized features on the

surface of the hip or knee prosthesis one could reduce the chances of rejection as well as to stimulate the production of osteoblasts. The osteoblasts are the cells responsible for the growth of the bone matrix and are found on the advancing surface of the developing bone.

The effect was demonstrated with polymeric, ceramic and, more recently, metal materials. More than 90% of the human bone cells from suspension adhered to the nanostructured metal surface, but only 50% in the control sample. In the end this findings would allow to design a more durable and longer lasting hip or knee replacements and to reduce the chances of the implant getting loose.

Titanium is a well-known bone repairing material widely used in orthopaedics and dentistry. It has a high fracture resistance, ductility and weight to strength ratio. Unfortunately, it suffers from the lack of bioactivity, as it does not support cell adhesion and growth well. Apatite coatings are known to be bioactive and to bond to the bone. Hence, several techniques were used in the past to produce an apatite coating on titanium. Those coatings suffer from thickness non-uniformity, poor adhesion and low mechanical strength. In addition, a stable porous structure is required to support the nutrients transport through the cell growth.

It was shown that using a biomimetic approach – a slow growth of nanostructured apatite film from the simulated body fluid – resulted in the formation of a strongly adherent, uniform nanoporous layer. The layer was found to be built of 60 nm crystallites, and possess a stable nanoporous structure and bioactivity.

A real bone is a nanocomposite material, composed of hydroxyapatite crystallites in the organic matrix, which is mainly composed of collagen. Thanks to that, the bone is mechanically tough and, at the same time, plastic, so it can recover from a mechanical damage. The actual nanoscale mechanism leading to this useful combination of properties is still debated.

An artificial hybrid material was prepared from 15–18 nm ceramic nanoparticles and poly (methyl methacrylate) copolymer. Using tribology approach, a viscoelastic behaviour (healing) of the human teeth was demonstrated. An investigated hybrid material, deposited as a coating on the tooth surface, improved scratch resistance as well as possessed a healing behaviour similar to that of the tooth.

IV CANCER THERAPY



Figure 6 Testing for Cancer



Photodynamic cancer therapy is based on the destruction of the cancer cells by laser generated atomic oxygen, which is cytotoxic[4]. A greater quantity of a special dye that is used to generate the atomic oxygen is taken in by the cancer cells when compared with a healthy tissue. Hence, only the cancer cells are destroyed then exposed to a laser radiation. Unfortunately, the remaining dye molecules migrate to the skin and the eyes and make the patient very sensitive to the daylight exposure. This effect can last for up to six weeks.

To avoid this side effect, the hydrophobic version of the dye molecule was enclosed inside a porous nanoparticle. The dye stayed trapped inside the Ormosil nanoparticle and did not spread to the other parts of the body. At the same time, its oxygen generating ability has not been affected and the pore size of about 1 nm freely allowed for the oxygen to diffuse out.

V. MULTI COLOUR OPTICAL CODING FOR BIOLOGICAL ASSAYS

The ever increasing research in proteomics and genomic generates escalating number of sequence data and requires development of high throughput screening technologies. Realistically, various array technologies that are currently used in parallel analysis are likely to reach saturation when a number of array elements exceed several millions. A three-dimensional approach, based on optical "bar coding" of polymer particles in solution, is limited only by the number of unique tags one can reliably produce and detect.

Single quantum dots of compound semiconductors were successfully used as a replacement of organic dyes in various bio-tagging applications. This idea has been taken one step further by combining differently sized and hence having different fluorescent colours quantum dots, and combining them in polymeric microbeads. A precise control of quantum dot ratios has been achieved. The selection of nanoparticles used in those experiments had 6 different colours as well as 10 intensities. It is enough to encode over 1 million combinations. The uniformity and reproducibility of beads was high letting for the bead identification accuracies of 99.99%.

VI MANIPULATION OF CELLS AND BIOMOLECULES

Functionalised magnetic nanoparticles have found many applications including cell separation and probing; these and other applications are discussed in a recent review. Most of the magnetic particles studied so far are spherical, which somewhat limits the possibilities to make these nanoparticles multifunctional. Alternative cylindrically shaped nanoparticles can be created by employing metal electrodeposition into nanoporous alumina template. Depending on the properties of the template, nanocylinder radius can be selected in the range of 5 to 500 nm while their length can be as big as 60 μm . By sequentially depositing various thicknesses of different metals, the structure and the magnetic properties of individual cylinders can be tuned widely.

As surface chemistry for functionalisation of metal surfaces is well developed, different ligands can be selectively attached to different segments. For example, porphyrins with thiol or carboxyl linkers were simultaneously attached to the gold or nickel segments respectively. Thus, it is possible to produce magnetic nanowires with spatially segregated fluorescent parts. In addition, because of the large aspect ratios, the residual magnetisation of these nanowires can be high. Hence, weaker magnetic field can be used to drive them. It has been shown that a self-assembly of magnetic nanowires in suspension can be controlled by weak external magnetic fields. This would potentially allow controlling cell assembly in different shapes and forms. Moreover, an external magnetic field can be combined with a lithographically defined magnetic pattern ("magnetic trapping").

VII PROTEIN DETECTION

Proteins are the important part of the cell's language, machinery and structure, and understanding their functionalities is extremely important for further progress in human well being. Gold nanoparticles are widely used in immunohistochemistry to identify protein-protein interaction[5]. However, the multiple simultaneous detection capabilities of this technique are fairly limited. Surface-enhanced Raman scattering spectroscopy is a well-established technique for detection and identification of single dye molecules. By combining both methods in a single nanoparticle probe one can drastically improve the multiplexing capabilities of protein probes. The group of Prof. Mirkin has designed a sophisticated multifunctional probe that is built around a 13 nm gold nanoparticle. The nanoparticles are coated with hydrophilic oligonucleotides containing a Raman dye at one end and terminally capped with a small molecule recognition element (e.g. biotin). Moreover, this molecule is catalytically active and will be coated with silver in the solution of Ag(I) and hydroquinone. After the probe is attached to a small molecule or an antigen it is designed to detect, the substrate is exposed to silver and hydroquinone solution. A silver-plating is happening close to the Raman dye, which allows for dye signature detection with a standard Raman microscope. Apart from being able to recognise small molecules this probe can be modified to contain antibodies on the surface to recognise proteins. When tested in the protein array format against both small molecules and proteins, the probe has shown no cross-reactivity.

VIII COMMERCIALEXPLORATION

The majority of the companies are small recent spinouts of various research institutions. Although not exhausting, this is a representative selection reflecting current industrial trends[6]. Most of the companies are developing pharmaceutical applications, mainly for drug delivery. Several companies exploit quantum size effects in semiconductor nanocrystals for tagging biomolecules, or use bio-conjugated gold nanoparticles for labelling various cellular parts. A number of companies are applying nano-ceramic materials to tissue engineering and orthopaedics..



IX VARIOUS APPLICATION'S OF NANO MATERIAL IN INDUSTRIES



Figure 7 Paper Industry

1. Furniture

As with other product groups, although nanomaterials are not widely used in furniture (and just one research example is provided in Annex I), they may be applied in protective coatings.

2. Basic metals

Two examples are presented in Annex I. As already mentioned, nano-iron is being used for watertreatment and groundwater remediation. The other identified use is that of nanospheres ophosphorous which are added to copper alloy for use in brazing.

3. Fabricated metal products, except machinery and equipment

Nanotechnology is being applied to the development of military hardware and other products with a particular focus on those applications which require high strength/low weight ratio. Six examples (mainly research) are presented in Annex I.

4. Computer, electronic and optical products , Electrical equipment

Eight examples (mainly research) are included in Annex a. Nanotechnology is key to the development of computers, etc. and, as such, nano-products are found in electrical and electronic equipment. One of the key areas for development is likely to be new compact energy sources such as lithium-ion batteries.

5. Motor vehicles, trailers and semi-trailers , Other transport equipment

Nanotechnology is being used to provide additional material performance within the transport sector . According to Observatory NANO, there is a particular interest in the development of nano-composites based on nanoclays.

6. Leather and related products

Nanomaterials are not generally found in leather and leather products (and no examples are presented in Annex I) – although additional protective coatings may be applied.

7. Wood and of products of wood and cork, except furniture;

articles of straw and plaiting materials , several opportunities for the application of nanotechnology to wood products have been identified and associated research has been supported through the NANOFORREST projects funded through the 6th Framework Programme

(STC, 2005). Particular attention was given to improving protective coatings and improved processing efficiencies.

8. Paper and paper products , Printing and recording services

Although some paper and printing products contain nanomaterials, particular products such as photocopier toners, inks, etc. are classified under chemical products (C20). One interesting example is presented in Annex I of ongoing research into filter papers with nanowires which may be used to clean up oil from water.

9. Coke and refined petroleum products

Although some petroleum products contain nanomaterials, particular products such as catalysts and additives are classified under chemical products (C20).

10. Chemicals and chemical products

nano-products appear under this product classification since this covers not only personal care products but also additives and coatings. Some of the less common substances identified in current (and near-future) products include calcium peroxide (toothpaste), cerium oxide (fuel additive), alumina (water repellent coating for wood), polyethylene terephthalate (PET as a coating on windows, etc.), polyesters (toner), ruthenium (catalyst) and tungsten disulphide (lubricant).

12. Basic pharmaceutical products and pharmaceutical preparations

Five examples are presented in Annex I. Nano silver is used as an antimicrobial agent in dressings and implants and, surprisingly, as a spermicidal. More generally, nanotechnology is being developed to assist with drug delivery systems with many new nano-products being

Explored.

13. Rubber and plastics products

The main nanomaterial found in this product category is carbon black which is used in vehicle tyres . However, there are moves towards the replacement of carbon black with nano-silica to produce 'green' tyres

14. Food products

The current use of nanomaterials within EU food products is limited but is likely to grow (EFSA, 2009; TA-Swiss, 2009) As can be seen from these, most involve nanomaterials derived from less common parent substances although nano-silica is used to improve the flow of condiments and spices.



15. Beverages

Beverages containing nanomaterials have not been identified and so no examples are presented in Annex I. However, nanotechnology may be used in the associated processing with particular reference to coatings on process pipework¹¹ and packaging¹². Such coatings will be categorised under chemical products.

16. Tobacco products

Nanomaterials do not appear to be used in tobacco products although there are some references to Chinese research into the use of carbon nanotubes in cigarette filters.

17. Textiles & Wearing apparel

Four (representative) examples are presented in Annex I. Nano-silver is widely used to provide an anti-microbial function in textiles and clothing (especially socks). Other nanomaterials in use (and under development) include carbon nanofibres, nano-composites and nano-gold. The functionality of the nanomaterials in textiles ranges from physical protection in clothing to colour fastness.

X CONCLUSION

Most major and established pharmaceutical companies have internal research programs on drug delivery that are on formulations or dispersions containing components down to nano sizes. Colloidal silver is widely used in anti-microbial formulations and dressings [7]. The high reactivity of titania nanoparticles, either on their own or then illuminated with UV light, is also used for bactericidal purposes in filters. Enhanced catalytic properties of surfaces of nano-ceramics or those of noble metals like platinum are used to destruct dangerous toxins and other hazardous organic materials. It is seen that government bodies, companies, and university researchers are

joining forces or competing to synthesize, investigate, produce, and apply these amazing nanomaterials.

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Synthesis and Thermal Energy Storage Analysis of Copper Oxide (CuO) Nanofluid for Heating Application

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Abstract: In this paper we have discussed about the synthesis and thermal analysis of nanofluid as phase change material (PCM). Enhancement of thermal conductivity rate serves as a greatest challenge in the present scenario and to overcome this hindrance, nanofluid synthesis was made. Copper oxide nanoparticle was synthesised by double precipitation method and the nanofluid was prepared by two step method. Paraffin was selected as a base material in which the CuO-nanoparticle was dispersed. The synthesised nanoparticle was subjected to studies like Particle size analyser (PSA) and Transmission electron microscope (TEM) to know the particle dispersion and average size and the exact dimension of the particle respectively. To check the thermal storage enhancement Differential scanning calorimetry (DSC) test was carried out. With the melting and solidification curve analysis we were able to infer that the latent thermal storage enhancement was increased drastically with the nanoparticle dispersed sample, than with the ordinary base material. The above nanofluid was subjected to laser flash analysis (LFA) to obtain the thermal conductivity enhancement rate. Thus, we can come up with a suggestion of using CuO nanofluid as an effective phase change material (PCM) for heating applications.

Keywords: nanoparticles nanofluid, phase change material, paraffin.

I. INTRODUCTION

Phase Change Material (PCM) are those materials which changes its phase with slight change in temperature. They are widely used in storing latent heat. They have many applications like heating, cooling, etc., They are generally classified into two types 1. Organic PCM's (Eg: paraffin, fatty acids) 2. Inorganic PCM's (Eg: metals, salt

hydrates). Generally PCM's have low thermal conductivity and heat transfer rate (HTR). Thermal conductivity and HTR of PCM's can be improved by various techniques like 1. Ceramic particles, 2. Metallic particles, 3. Carbon particles.

Recent new technology is implemented to enhance thermal conductivity and HTR with the help of NANOTECHNOLOGY. Such a new fluid is synthesised by dispersing nanoparticle into base fluids (PCM) called NANOFLUID. These nanoparticles have a more surface to volume ratio which helps in the enhancement of thermal conductivity and HTR.

As far as thermal properties are concerned, the shape of nanoparticles and concentration of the nanoparticle play a significant role. Spherical and cylindrical shape of particles has more surface area which helps in storing more latent heat and improving HTR. The factor that affects thermal conductivity is agglomeration of particles at the bottom. Surfactant and long time ultrasonication can be done to avoid sedimentation. Homogenous mixture gives high thermal characteristics.

In recent times copper oxide (CuO) nanoparticles are becoming more popular for its mechanical, thermal, electrical properties and its application in various fields. There are many methods to synthesis nanoparticles but the method which we select must be environmental friendly, user friendly (safe) and cost effective. Among the PCM's paraffin is considered to be one of the best for heating application. But its disadvantage is poor thermal conductivity (0.22 W/mK). Paraffin has a melting point of 52-54°C density= 0.9 Kg/cm³ n=1.42 Cp=2.13K J/KgK molecular weight=353.77 g/mol.

This paper discusses CuO nanoparticles with paraffin as base fluid is best suitable for heating application. CuO nanoparticle is prepared by double precipitation method. Nanofluid is synthesised by two step method. The CuO nanoparticles is subjected to characteristic analysis like particle size analyser (PSA) and transmission electron microscope (TEM). The CuO nanofluid is subjected to thermal characteristics analysis like



differential scanning calorimetry (DSC) and LFA. The results of the above analysis recommend that CuO/paraffin is the best for latent heat storage during heating application.

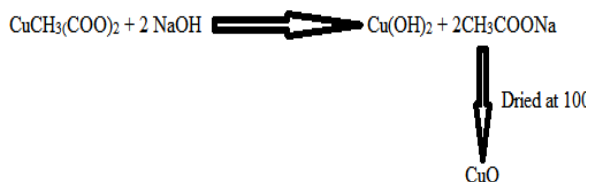
II. MATERIALS AND METHODS

A. MATERIAL

Copper acetate ($\text{Cu}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$) and glacial acetic acid (CH_3COOH) were purchased from SRL, India. Sodium hydroxide (NaOH) pellets were purchased from Lobha Chemie. 2D water (two times deionised water) was used throughout the experiment. Paraffin is used as base fluid.

B. PREPARATION OF NANOPARTICLES

Copper acetate of 3.993 g was dissolved into 250 mL deionised water in the round bottom flask for obtaining aqueous solution. Glacial acetic acid of 4 mL was added into the above aqueous solution and then, heated at 100°C for two hours with constant magnetic stirring at the speed of 700 rpm. Desired quantity of NaOH pellets was added to the solution during heating in such a way that pH value of the solution reached in between 6 and 7. The large amount of CuO black precipitate was formed immediately. Then, it was centrifuged and washed with 2D water for 5 times in order to remove the impurities present in the black precipitate. It was dried in oven at 100°C for 36 h and grinded by using agate mortar, for obtaining CuO particles.



Equation 1: reaction showing the synthesis of CuO

C. PREPARATION OF NANOFLUID

A two-step method was preferred to prepare the CuO -paraffin nanofluids as PCM. Paraffin wax is melted using hot plate device at 70°C for 15mins. It changes its state from solid to liquid. Preparation of nanofluids is the main factor in applying nanophase particles to change the heat transfer performance of base fluid. During the preparation of nanofluids, special attention is required to ensure stable

dispersion, low agglomeration of particles and no chemical change of the fluid. In order to ascertain the particles dispersion and minimum aggregation of the nanofluids, ultrasonication technique was preferred. Preparation processes were performed using an ultrasonic vibrator at a frequency of 40 kHz. There is no surfactant or dispersant added to the nanofluid as it may affect the thermal properties.

D. CHARACTERISTICS ANALYSIS STUDIES

1) Particle size analyser (PSA):

Particle size analyser is a device used to measure the average size of the particle at nano level. This machine was manufactured by Malvern Company, Germany. A very tiny amount of CuO nanoparticle is dispersed in DI water and dropped in ultrasonification for 15mins. So that homogeneous mixture is obtained. The solution is partially filled in polystyrene cuvettes container and placed in the chamber. Laser beams are passed through the solution and average size of the particle was determined.

2) Transmission electron microscope (TEM):

This microscope is manufactured by Philips Company, Japan. Transmission electron microscope (TEM) is a device in which a beam of electron is passed through the ultra thin specimen and image of the sample is obtained in the fluorescent screen. This technique is used in nanotechnology to measure the size of the particle and to get bright magnified image of the nanoparticles.

A tiny amount of the sample is dispersed in water and dried for few minutes. Then it is placed in the sample chamber, and electron beam is passed through the specimen. Highly magnified image of the individual particle is reflected in the fluorescent screen. By adjusting the zoom (100nm level), particle image and size is obtained.

3) X-Ray diffraction analyser (XRD):

X-ray diffraction instrument manufactured by SII Germany, XRD is used to find the crystal structure and chemical compositions. Small amount of the sample is loaded in specimen plate and placed in X-ray chamber. High intensity X-rays are passed through the sample and made to scatter. By measuring the scattering

intensity and scattering angle, the crystal structure and chemical composition were determined.

E. THERMAL CHARACTERISTICS ANALYSIS STUDIES

4) Differential scanning calorimetry (DSC):

This instrument is manufactured by S II Company, Japan. DSC is used to measure melting point temperature, solidification point temperature and latent heat storage of the PCM mixture for different amount heat applied.

A tiny amount of mixture is filled in aluminium pan and placed in chamber. Nitrogen is used as cooling medium. Firstly, heat is applied and peak is obtained corresponding to melting point temperature of the mixture. Secondly, heating setup is replaced to cooling setup and peak is obtained corresponding to solidification point temperature.

5) Laser flash analysis (LFA):

In order to investigate the heat transfer characteristics of composite PCMs, thermal conductivity acts as an essential parameter which predicts the energy storage and release rate of the thermal energy storage system. Thermal conductivity of paraffin and composite PCMs was measured at room temperature using LFA 447 NanoFlash analyzer (NETZSCH, Germany).

III. RESULTS AND DISCUSSION

A. CHARACTERISTICS ANALYSIS OF NANOPARTICLE

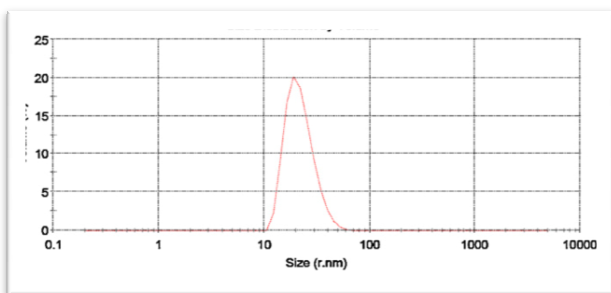


Figure 1: Particle size distributions.

Particle size analyser (PSA) refers that particles dispersed in DI water was in the size range of 1 to 100nm. It also indicates there is no sedimentation of particles at the bottom. The single peak in the graph

shows that all the particles dispersed was nano sized and dispersion was homogeneous without any agglomeration. It is represented in graph Fig: 1

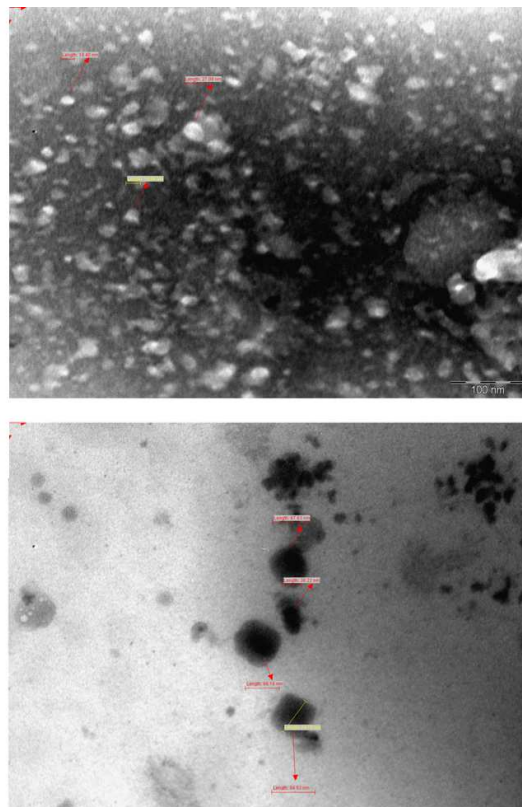


Figure 2: TEM images of CuO nanoparticles.

Transmission electron microscope (TEM) analysis indicates that there is no cluster formation of particles. All the particles were individual and size ranges from 1 to 80nm. TEM results also indicate that all particles are in spherical shape. The bright TEM image is represented in Fig: 2

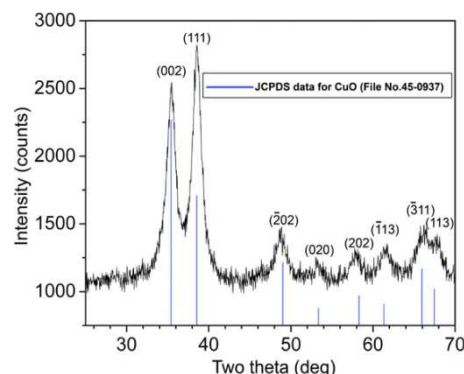


Figure 3: XRD pattern of CuO nanoparticles.

X-Ray diffraction results infer that samples are CuO crystals. It does not contain any form of impurities. The broadening of the peak indicates that the particles are in nanolevel. The XRD graph is shown in Fig:3

B. CHARACTERISTICS ANALYSIS OF NANOFLUID

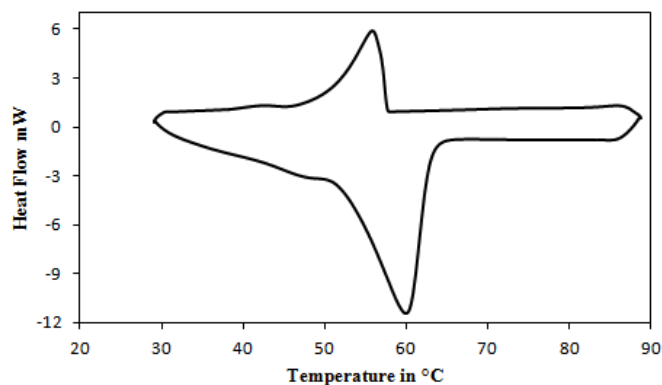


Figure 4: DSC measurements of CuO-paraffin nanofluids

Results obtained from DSC indicate that melting of the PCM starts from 48.4°C and ends at 62.8°C. Between the above mentioned temperature the phase change of paraffin from solid to liquid occurs. The latent heat stored during heating process is 99.4KJ/Kg. solidification of the PCM composite starts from 57.68 °C and ends at 46.1 °C. The latent heat stored during cooling process is 104 KJ/Kg. The left small peaks between 46.6°C and 48.9°C present in the heating curves represent solid-solid phase transition of paraffin and composites. The complete result is available in graph form in Fig:4

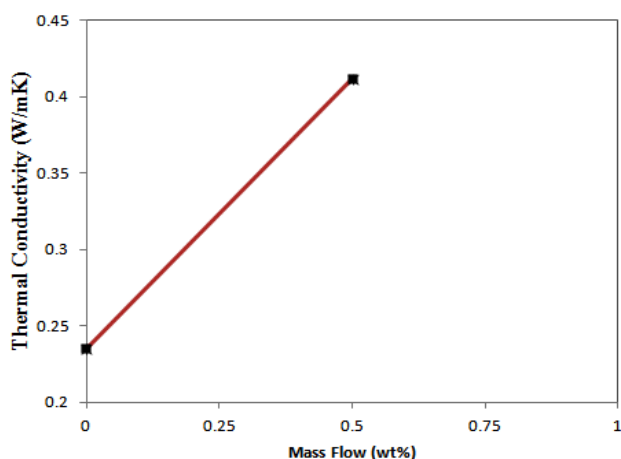


Figure 5: Thermal conductivity of the CuO-paraffin nanofluids

LFA 447 nanoflash analyser results are represented in Fig:5. This result indicates that thermal conductivity increases with increase in concentration of nanoparticles. For 50% (0.5gms) concentration the thermal conductivity was enhanced by 75.2%. Thermal conductivity of pure paraffin is 0.235 W/mK. After dispersion of nanoparticles in PCM, it has improved to 0.412 W/mK.

IV. APPLICATION

The major application of this CuO nanofluid is heating application. When it comes for heating application, renewable source of energy can be used to get effective and efficient heating and also it doesn't create any hazard to the environment. So, for solar based hating application we can use this pcm effectively. Solar water heater, for which this packed pcm can increase the efficiency of the system and helps storing more energy than normal, which is very useful for the present as well as the future.

V. CONCLUSION

The investigation of CuO-paraffin nanofluid as phase change material (pcm) for heating application was carried out successfully. The particle size analyser infers that cuo nanoparticles dispersed in paraffin was a homogeneous mixture which in turn enhances the thermal conductivity and HTR. The chemical bond between paraffin and CuO is more stable that the nanoparticle does not settle down for six months. The thermal stability test infers that the dispersion of CuO nanoparticles in paraffin could be considered to be a good method to enhance the thermal conductivity of nanofluid which in turn will help in increasing the heat transfer rate, making it a better phase change material (pcm).

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Studies on the photo catalytic degradation of acid yellow 110 using ZnO nanoparticles

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Abstract— ZnO nanoparticles were synthesised by sol-gel process. The as prepared ZnO nano particles were characterised by SEM, EDX, XRD & BET analysis. Further, these nano particles were utilised for the photodegradation of the dye, acid yellow 110 by uv irradiation in a batch reactor. The different operational parameters such as the initial concentration of the dye, weight of photo catalyst and pH on the photo catalytic degradation of the dye were investigated. It was observed that the degradation of the dye to be more pronounced in acidic medium. The optimum catalyst loading was found to be 2g /L.

Keywords: Nano ZnO, Acid Yellow 110, degradation, photo catalysis.

1. Introduction

Environmental pollution triggered by pesticides, dyes, industrial effluents and heavy metals have grabbed the attention of fundamental and applied researchers to seek environmental remediation [1,2], as host of pollutants can be decomposed completely by photo catalytically active nanostructural semiconductor metal oxides such as TiO_2 and ZnO, under UV irradiation. Ample information has been documented in literature, as regards to higher photo catalytic efficiency of ZnO over TiO_2 in the degradation of several organic contaminants in both acidic and basic medium and this has attracted the attention of many researchers to further explore the potential of ZnO in various photo catalytic reactions [3-5]. Among a variety of nanostructural semiconductor metal oxides, ZnO nanomaterial, naturally n-type semiconductor have been recognised as excellent materials for photo catalytic processes due to their high photosensitivity, high catalytic activity, suitable band gap, low cost and environmental friendliness [6-9].

Titanium di oxide (TiO_2) is generally considered to be the best photo catalyst and though it has the ability to detoxificate water from a number of organic pollutants [10-12], wide spread use of TiO_2 is uneconomical for large scale water treatment. Hence, attempts have been made to study the photo catalytic activity of different semiconductors such as SnO_2 , ZrO_2 , CdS and ZnO [13-17]. Lizama et al [16] reported the photo catalytic decolourisation of Reactive Blue 19 (RB 19) in aqueous solutions containing TiO_2 or ZnO as catalysts and concluded that ZnO is a more efficient catalyst than TiO_2 in

the colour removal of RB 19. Daneshvar et al [18] reported that Zinc Oxide (ZnO) is a suitable alternative to TiO_2 for the degradation of Acid Red 14, an azo dye. The biggest advantage of ZnO is that it absorbs over a larger fraction of solar spectrum than TiO_2 .

The main focus of this study is to synthesise nano ZnO by Sol-gel method from aqueous solution of Zinc nitrate and estimate the photo catalytic activity of ZnO nanoparticles under UV irradiation on Acid Yellow 110. The effect of various process parameters such as catalyst loading, initial dye concentration and effect of pH have been studied in detail and identify the suitable optimum condition, in relevance to the specific zero point charge of nano ZnO catalyst in particular. The micro structure and morphology of the synthesised photocatalyst have been characterised by XRD, SEM, EDX & BET studies.

2. Materials and methods:

2.1 Materials

The dye and other chemicals used in the present study were of AR grade from Merck. The Acid Yellow 110, the dye was used without further purification. Reagents used in the synthesis of ZnO nanoparticles, such as $\text{Zn}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$, NaOH & ethanol were of AR grade. The double distilled water was used for the preparation of all the reagents. pH of the experimental solution was adjusted using 0.1M HCL or 0.1M NaOH, as the case may be.

2.2 Synthesis of ZnO nanoparticles

Nanocrystalline ZnO particles were synthesised by Sol-gel method. In a typical synthetic procedure 0.45M of $\text{Zn}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ and 0.9M of NaOH were dissolved in double distilled water. The beaker containing NaOH solution was heated to a temperature of about 60°C . To this solution of NaOH, the $\text{Zn}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ solution was added drop wise under high speed stirring. The beaker containing the above solution mixture was then securely covered and left aside for 2h. The precipitated ZnO nanoparticles were then cleaned with double distilled water and ethanol and then dried in an air oven maintained at 60°C .

2.3 Batch photo reactor set-up:

The photo catalytic degradation of the dye was carried out in a batch reactor of 500ml capacity double walled reaction vessel made of borosilicate having dimensions 16cm x 5cm, mounted suitably on a magnetic stirrer. The photo catalytic experiments were performed under identical conditions by using a low pressure mercury vapour lamp (6W, 18cm along) emitting UV radiation at a peak wavelength of 254nm. Constant stirring of the solution was ensured with the use of a magnetic stirrer. The light source was standardised by ferrioxalate actinometry and its intensity was found to be $2.48 \pm 0.1 \times 10^{19}$ quanta per second. The temperature of the reaction mixture was maintained constant throughout the reaction time.

2.4 Absorbance measurement:

In the present investigation, a batch volume of 250ml of dye solution was kept at a distance of 7cm from the UV source with a constant stirring of 60 rpm and the initial absorbance of the dye solution was measured by using UV-Visible spectrophotometer. A calculated weight of ZnO nanoparticles were added to this dye solution and the mixture was stirred in dark for about 30 minutes to ensure adsorption/desorption equilibrium. A 3ml aliquot was then withdrawn from this reaction mixture, centrifuged and then the absorbance was measured. Now the reaction mixture was irradiated with UV source. Subsequently, samples of 3ml of aliquot were withdrawn at regular intervals of time, centrifuged and the absorbance of the supernatant solution was measured by using UV-Visible spectrophotometer and then the solution was returned back to the reactor.

3. Results and Discussion

3.1 Characterisation of the catalyst:

3.1.1 XRD

Figure 1 shows the XRD patterns of ZnO nanoparticles. The diffraction peaks indicate the nanocrystalline nature [JCPDS card no. 0-3-0888]. These peaks at scattering angles $[2\theta]$ of 31.8078, 34.4187, 36.2471, 47.5370, 56.6238, 62.8397, 66.4630, 67.9366 and 69.0378 corresponds to reflection from 100, 002, 101, 102, 110, 103, 200 and 112 crystal planes respectively [19]. The XRD pattern is identical to the hexagonal phase with Wurtzite structure with space group $[C6V = P6_3mc]$ and unit cell parameters $a=b=3.248 \text{ \AA}$ and $c=5.2 \text{ \AA}$. The crystalline size was calculated using the Scherer formula. The crystalline size was calculated from the following eqn.

$$\beta \cos \theta / \lambda = 1 / \varepsilon + \tau \sin \theta / \lambda$$

where β is the measured FWHM (full-width at half maximum), θ is the Bragg peak angle of the peak, λ is the X-ray diffraction wavelength (in

this case, it is 0.154 nm), ε is the effective particle size and τ is the effective strain. The average crystalline size was obtained based on the intercept inverse (i.e) $1/\varepsilon = 0.30 \times 10^8$, $\varepsilon = 33 \times 10^{-9} \text{ m}$ or 33nm. No characteristic peak of other impurities was observed in this pattern. The sharp diffraction peaks indicated the good crystallinity of the prepared catalyst.

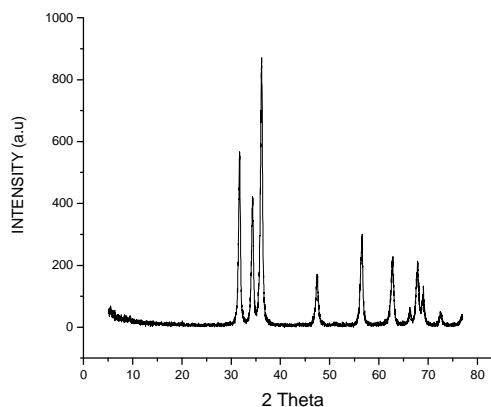


Fig.1. XRD pattern of ZnO nanoparticles

3.1.2 SEM:

The particle size and morphology of nanoparticles analysed by SEM is shown in figure 2. This image reveals that the entire product is comprised of spherical nanoparticles with the average size of 30- 35nm which is in good agreement with that estimated by Scherer formula based on the XRD pattern.

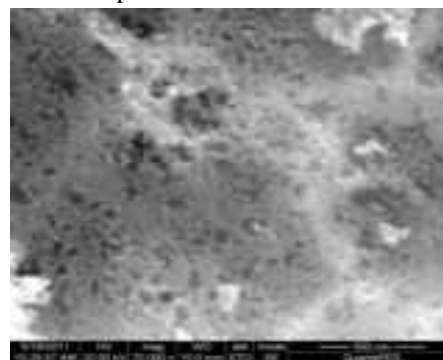


Fig.2. SEM image of ZnO nanoparticles

3.1.3 BET:

The specific surface area is an important micro structural parameter of ZnO nanoparticles which is given by figure 3 depends on the geometrical shape and porosity of the particles and was found to be $15 \text{ m}^2/\text{g}$. The samples show broad distribution of pores, with an average pore diameter of 36nm and the corresponding single-point total

pore volume at $p/p_0 = 0.9946$ is observed to be $0.0816 \text{ cm}^3/\text{g}$.

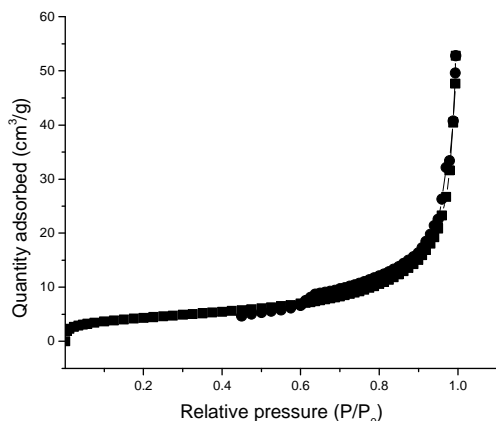


Fig.3. BET isotherm of ZnO nanoparticles

3.1.4 EDX:

The EDX studies also confirm the presence of zinc and oxygen as the primary components which are given by Figure 4.

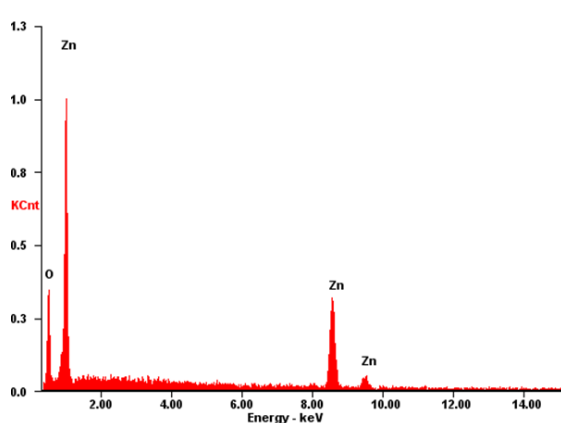


Fig.4. EDX pattern of ZnO nanoparticles

3.2 Photo degradation of Acid Yellow 110

The progress in the absorption spectrum of the reaction solution was monitored by changing the various operational parameters such as initial dye concentration, catalyst loading and the pH. The changes in the absorption spectra of the dye, Acid Yellow 110 during the photo degradation at various time intervals are shown in the figures accordingly.

3.2.1 Effect of initial concentration of the dye

The effect of initial dye concentration on the photo degradation was investigated by varying the concentration of the dye from $20 \mu\text{M}$ – $100 \mu\text{M}$ (Figure 5) at constant catalyst concentration, pH and temperature. The experimental results observed

establish the fact that the photo degradation efficiency is inversely related to the dye concentration. This negative effect may be attributed to the fact that as the dye concentration is increased, the equilibrium adsorption of the dye on the catalyst surface active sites increases. Hence, as a consequence the competitive adsorption of OH^\cdot on the same sites decreases leading to a lower formation rate of OH^\cdot which is a principle oxidant towards the degradation in the present investigation. On the other hand, going by Beer-Lambert's law, as the initial dye concentration increases, the path length of photons entering the solution decreases, resulting in lower photon adsorption on catalyst particle, and hence lower photo degradation rates [20].

$$\text{Removal Efficiency: } X = (C_0 - C/C_0) \times 100$$

where C_0 is the initial dye concentration and C is the concentration of dye at time t .

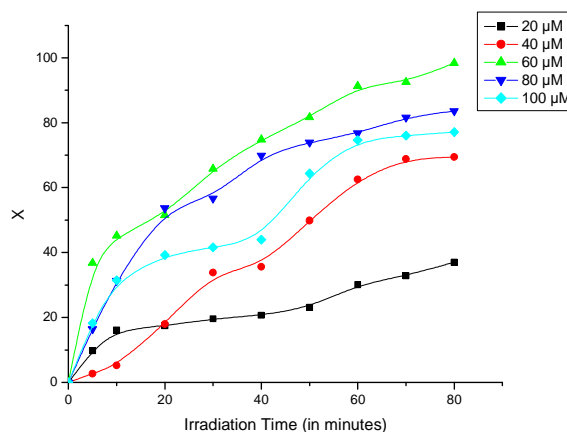


Fig 5 : Effect of initial concentration of the dye. Reaction conditions: pH=6.2, weight of catalyst=0.5g/250ml, Temp=30°C, incident wavelength=254nm, Absorbance measured at 420nm

3.2.2 Effect of catalyst loading

The effect of added ZnO nano catalyst on the photo degradation of Acid Yellow 110 was carried out by varying the amounts of ZnO from 0.25g –1.0 g (Figure 6). The photo degradation efficiency was found to increase with increase in the amount of added photo catalyst; it reaches a maximum for added catalyst of 0.5g and then found to decrease. The catalyst had both positive and negative impact on the photo degradation rates. The increase in the amount of catalyst possibly increases the quantity of photons absorbed and consequently the degradation rate. At the same time

due to increase in turbidity of the reaction solution with high load of photo catalyst, one would expect decrease in the penetration of UV light and consequently, photo activation leading to degradation decreases [18].

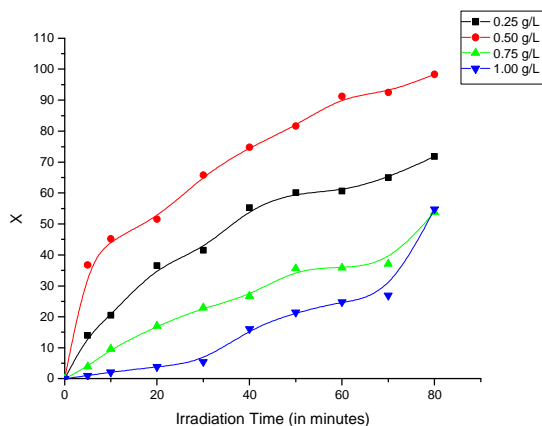


Fig 6: Effect of catalyst loading. Reaction conditions: pH=6.2, concentration of acid yellow 110=60 μ Mol, Temp= 30°C, incident wavelength=254nm, Absorbance measured at 420nm

3.2.3 Effect of pH

The photo catalytic degradation of acid yellow 110 was carried out in the pH range of 5-8. As shown in the (Figure 7), the photo degradation efficiency was observed to reach a maximum at a pH of 6.2. The effect of pH on this photo catalytic degradation of the dye has to be explained by multiple approach. First it is related to the acid base property of the metal oxide surface and can be explained by taking into consideration zero point charge of ZnO which is reported as 8 [20]. The catalyst surface was positively charged in acidic medium and negatively charges in basic medium. It was observed that on increasing the pH of the solution the rate of decolourization of acid yellow 110 was found to decrease, as the dye has sulphonate group and as well as the carboxylate group, which are negatively charged. Hence the acidic solution at pH 6.2 favours the adsorption of the dye on to ZnO surface. This accounts for the effective decolourization of the dye. Moreover at this pH there is also formation of OH \cdot radicals which also react dye molecule and enhance the decolourization process. [21 and 22].

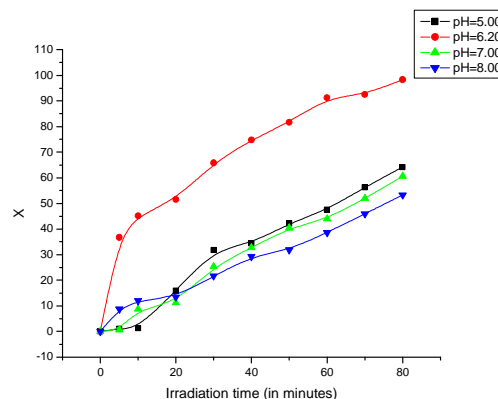


Fig 7: Effect of pH. Reaction conditions: concentration of acid yellow 110=60 μ Mol, weight of catalyst=0.5g/250ml, Temp= 30°C, incident wavelength=254nm, Absorbance measured at 420nm

4. Conclusions

The present investigation showed that UV/ZnO process could be used for effective removal of Acid Yellow 110. The degradation rate was found to be inversely related to the initial concentration of the dye and reached a limiting value at higher concentrations of the dye. The optimum catalyst loading under the present trial was found to be 0.5g/250ml. Experimental trials conducted at a pH range of 5-8 exhibited maximum photo degradation efficiency at pH 6.2.

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Carbon Nanostructures for Energy Conservation

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Abstract- This paper reviews the details about the various methods of conservation of energy using carbon nano structures. The nanotube and C60 structures are highly applicable in the conservation process. Properties of nano carbons such as high surface area, good electronic conductivity, excellent chemical and electrochemical stability and high mechanical strength make them applicable in the energy conservation devices are defined in this paper in depth. Nanotechnologies offer different possibilities to increase the conservation efficiencies of fuel cells and the structural configurations of nano carbons have tremendous potential for increasing the efficiency of solar cells. Two nanostructures that have received much attention in recent years are hollow carbon-based, cage like architectures: nanotubes and fullerenes, also known as buckyballs. Carbon nanotubes (Single-wall nanotubes-SWNTs, multwalled nanotubes-MWNTs) are being considered for energy production and storage. Graphite, carbonaceous materials and carbon fiber electrodes have been used. For decades in fuel cells, battery and several other electro chemical applications And C60 fullerenes are common configurations. Opportunities exist for carbon nanotubes and graphene sheets to facilitate capture and transport of electrons in nanostructure semiconductor based solar cells.

KEYWORDS: Fullerenes, nanotube, SWCNT-TiO₂, Quantum dots. Pt/SWCNT, CNT Electrodes, carbon supports

1. INTRODUCTION

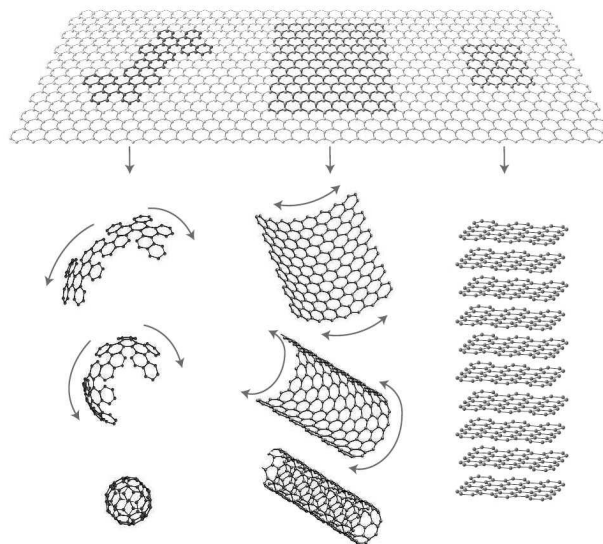
A nanostructure is an object of intermediate size between molecular and microscopic (micrometer-sized) structures, the particle is between 0.1 and 100 nm in each spatial dimension. Graphene is the mother of all carbon nanostructures. Graphene is an allotrope of carbon. Its structure is one-atom-thick planar sheets of sp²-bonded carbon atoms that are densely packed in a honeycomb crystal lattice. Graphene is most easily visualized as an atomic-scale chicken wire made of carbon atoms and their bonds. The small dimensions, strength and the remarkable physical properties of these structures make them a very unique material with a whole range of promising applications. Carbon nanostructures which are basically derived from graphene sheets are found to be applicable in energy conservation process. They are used in solar and fuel cells to improve their efficiency. They

are also being used for energy storage, hydrogen storage and several other electrochemical application.

II. CARBON NANOSTRUCTURE

Two nanostructures that have received much attention in recent years are hollow, carbon-based, cage-like architectures: nanotubes and fullerenes, also known as buckyballs. Single-wall nanotubes (SWNTs), multiwall nanotubes (MWNTs), and C60 fullerenes are common configurations. The size, geometry, and surface characteristics of these structures make them appealing for energy conservation usage. SWNTs and C60 fullerenes have diameters on the order of 1nm, about half the diameter of the average DNA helix. MWNTs have diameters ranging from several nanometers to tens of nanometers depending on the number of walls in the structure. Fullerenes and carbon nanotubes are typically fabricated using electric arc discharge (EAD), laser ablation (LA), chemical vapour deposition (CVD), or combustion processes.

Graphene- the mother of all carbon nanostructure (fig2.1)





A. Nanotubes

Carbon nanotubes (CNTs) are amongst the most explored one dimensional nanostructures and have attracted tremendous interest from fundamental science and technological perspectives. Albeit topologically simple, they exhibit a rich variety of intriguing electronic properties, such as metallic and semiconducting behaviour. Furthermore, these structures are atomically precise, meaning that each carbon atom is still three-fold coordinated without any dangling bonds. CNTs have been used in many laboratories to build prototype nanodevices. These Devices include metallic wires, field-effect transistors, electromechanical sensors and displays. They potentially form the basis of future all-carbon electronics.

To understand the atomic structure of CNTs, one can imagine taking the structure of graphite, as shown in figure 1, and removing one of the two-dimensional planes, which is called a graphene sheet. A single graphene sheet is shown in figure 2(a). A CNT can be viewed as a rolled-up graphene strip which forms a closed cylinder as shown in figure 2.2. The basis vectors $\mathbf{a}_1 = a(\sqrt{3}/2, 0)$ and $\mathbf{a}_2 = a(\sqrt{3}/2, 3/2)$ generate the graphene lattice, where $a = 0.142$ nm is the carbon-carbon bond length. A and B are the two atoms in the unit cell of graphene.

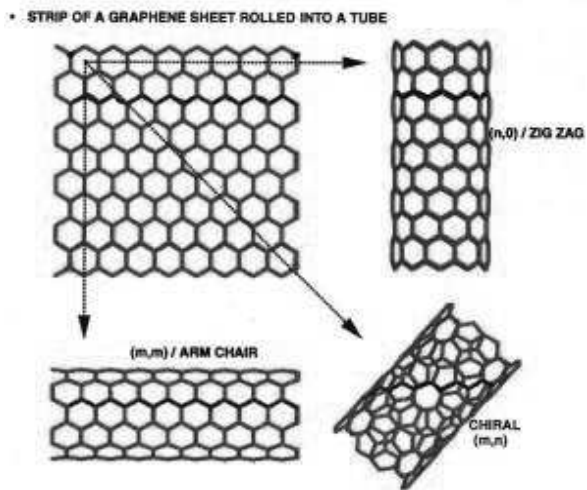


Fig2.2

Among the nanotubes, two varieties, which differ in the arrangement of their graphene cylinders, share the limelight. Multi-Walled Nanotubes (MWNT), are collections

of several concentric graphene cylinders and are larger structures compared to Single-Walled Nanotubes (SWNTs) which are individual cylinders. Carbon nanotubes have the right combination of properties – nanometersize diameter, structural integrity, high electrical conductivity, and chemical stability – that make good electron emitters. Electron field emission from carbon nanotubes was first demonstrated in 1995, and has since been studied intensively on various carbon nanotubematerials. Compared to conventional emitters, carbon nanotubes exhibit a lower threshold electric field. There have been great improvements in synthesis techniques, which can now produce reasonably pure nanotubes in gram quantities. Studies of structure-topology-property relations in nanotubes have been strongly supported.

B. Fullerenes

The discovery of fullerenes [1] provided exciting insights into carbon nanostructures and how architectures built from sp^2 carbon units based on simple geometrical principles can result in new symmetries and structures that have fascinating and useful properties. During experiments aimed at understanding the mechanism by which long chain molecules are formed in interstellar space and circumstellar shells, graphite has been vaporised by laser irradiation, producing a remarkably stable cluster consisting of 60 carbon atoms. Concerning the question of what kind of 60- carbon atom structure might give rise to super stable species, scientists suggested a truncated icosahedrons, a polygon with 60 vertices and 32 faces, 12 of which are pentagonal and 20 hexagonal. This object is commonly encountered as a football as shown in the fig2.3

Few covalent bonds holding the molecules together butonly weak Vander Waals forces between molecules exist between bucky balls No movement of electrons available from one molecule to the next. The exception could be the formation of nano-tubes that are capable of conducting electricity along their length. These are the subject of some experiments in micro electronics.

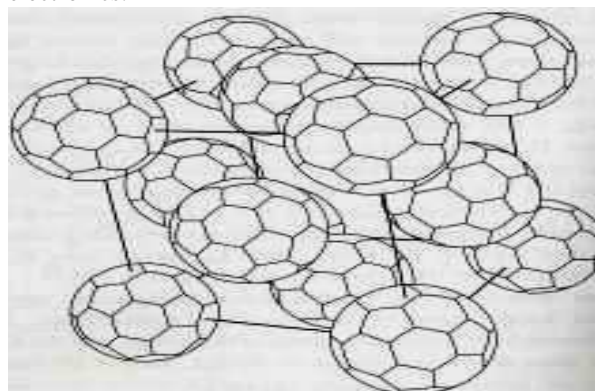


Fig2.3 They are soluble in polar solvents Absorbs weakly in the visible Reversible reductions (upto six reduction steps have been recorded) Electron sponge! (PCBM is used in Organic hybrid solar cells) Relatively long-lived triplet excited state Capable of generating singlet oxygen (Photodynamic therapy) Electro catalytic and sensing properties

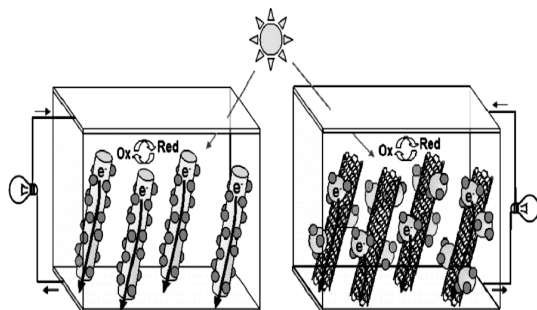
I. CARBON NANOSTRUCTURES AS CONDUITS TO TRANSPORT CHARGE CARRIERS

The advantages of carbon nanostructure which are applicable in this field are High surface area, Good electronic conductivity, and excellent chemical and electrochemical stability, Good mechanical strength which makes them conduits of charge carriers. They are used in batteries and capacitors, sensors, fuel cells and solar cells.

A. SWCNT-TiO₂ Composite Films

Nanostructured semiconductor films have been found useful for designing solar cells. The dye-sensitized solar cell (DSSC), which uses mesoscopic TiO₂ films modified with sensitizing dyes, has drawn significant attention as it can harvest visible light quite efficiently. Although power conversion efficiencies of the order of 10% have been attained with DSSC, further improvements in the performance of these solar cells are necessary.

SCHEME 1: Directing the Flow of Photogenerated Electrons Across Nanostructured Semiconductor Films: (A) Nanotube/Nanowires Modified with Light-Absorbing Dye Molecules and (B) Nanotubes as Support Architecture for Anchoring Dye Modified Semiconductor Nanoparticles



Semiconductor nanotube or nanowire assemblies, when Assembled on the electrode surface and then modified with dye molecules, offer the possibility to improve the charge collection and transport of charge carriers. Such one-dimensional nano- structures have recently been shown to direct the flow of photo generated charge carriers in DSSCs and quantum dot solar cells. Another approach involves the use of a SWCNT network on a conducting electrode surface to promote charge transport in mesoscopic TiO₂ films. The electrons injected from the excited dye into TiO₂ nanoparticles are then transferred through a SWCNT scaffold to generate photo current. The semiconducting property of SWCNT has been

successfully exploited to improve the performance of organic photovoltaic cells and fuel cells. these two approaches that illustrate. An effort was recently made to organize semiconductor (CdS, CdSe, CdTe) quantum dots on SWCNTs.

The electron- accepting ability of semiconducting SWCNTs thus offers an opportunity to facilitate electron transport and increase the photo conversion efficiency of nanostructured semiconductor- based solar cells. by employment of a SWCNT network as a conducting scaffold, were able to achieve 2- foldenhancement in the photo current generation of TiO₂ particulate films. The organizations of photo active donor accept or assemblies (e.g. porphyrinand C60) on the electrode surface has already been Shown to offer significant enhancement in the photo conversion Efficiency of solar cells. Increasing the TiO₂ concentration results in enhanced photocurrent as they are dispersed on SWCNT network. At concentrations greater than 2 mg/cm² the beneficial effect of SWCNT disappears. Under these conditions TiO₂ particles aggregate and the charge recombination dominates.

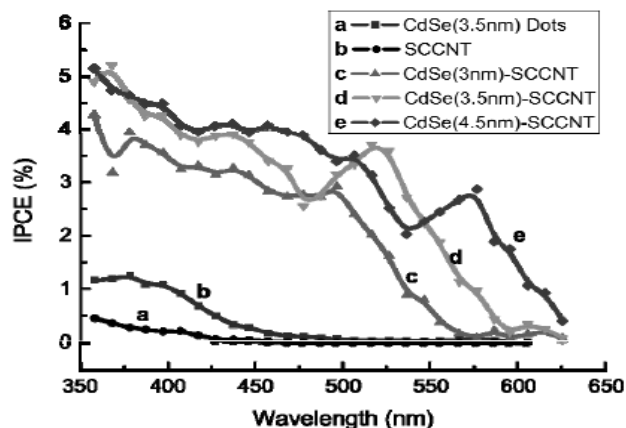
B. Quantum Dot Sensitized Solar Cell

Quantum dots are small devices that contain a tiny droplet of free electrons. Typical dimensions are between nanometers to a few microns. A quantum dot can have anything from a single electron to a collection of several thousands. The size ,shape and number of electrons can be precisely controlled.. In some quantum dots even if one electron leaves the structure there is a significant change in the properties. Quantum dots form when very thin semiconductor films buckle due to the stress of having lattice structures slightly different in size from those of the material upon which the films are grown Just a few percent difference in lattice size creates stresses (or pressures) in a film that are ten times larger than those present in the deepest oceans of Earth.

Quantum dot solar cells are an emerging field in solar cell research. They uses quantum dots as the photovoltaic material, as opposed to better-known bulk materials such as silicon, copper indium gallium selenide (CIGS) or CdTe(as in 2nd generation solar cells). Their bandgaps are tunable across a wide range of energy levels by changing the quantum dot size in contrast to bulk materials, where the bandgap is fixed.

Quantum dots which are linked with the stacked nano cups are the main quantum dots nanostructure used in energy conservation. This configuration is a variation of a recent promising new type of photovoltaic cell that is based on dye-sensitization of nanocrystalline TiO₂ layers. For the QD-sensitized cell, QDs are substituted for the dye molecules; they can be adsorbed from a colloidal QD solution or produced in situ. Mesoporous films, nanorods, nanowires and nanotubes are the most common nanostructures for providing a large surface

area for QD deposition. TiO_2 has been used as mesoporous film as well as nanotubes. ZnO has been used as mesoporous films and as nanorods.



C. Pt/SWCNTs Composites

Theoretical predictions suggest that it is possible to achieve 100% hydrogenation of single-walled nanotubes (i.e., one hydrogen atom for every carbon atom) through a chemisorptions mechanism in which stable C-H bonds are formed (2). As a result, carbon has been considered as an attractive option with its ability to store a high weight % of hydrogen. The mechanism of CNT hydrogenation would involve the breaking of the C-C π -bonds and the conversion of carbon atoms from sp^2 to sp^3 hybridization upon coordination with hydrogen. While previous studies have generated large concentrations of C-H bonds using atomic hydrogen sources, practical implementation of hydrogen storage in CNTs requires the development of low-barrier pathways for hydrogenation.

The concept of the “spillover” mechanism in heterogeneous catalysis was exploited to store hydrogen in carbon nanotubes. Researchers examined how the hydrogen uptake of single-walled carbon nanotubes (SWNTs) is influenced by the addition a platinum nanoparticle catalyst. *In-situ* electrical conductivity measurements showed that the electrical conductivity of platinum-sputtered single-walled carbon nanotubes (Pt-SWNTs) decreased upon gaseous hydrogen exposure. A steady increase in the resistance of the Pt-SWNTs during exposure to molecular hydrogen gas was observed. The rate of resistance change depended on catalyst particle size as well as nature of SWNTs. It was found that

composites with maximum density of platinum nanoparticles showed the highest resistance change.

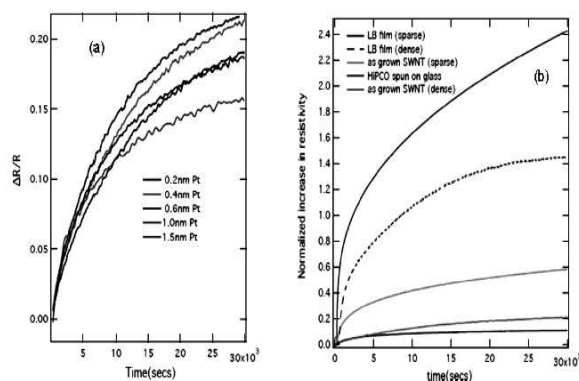
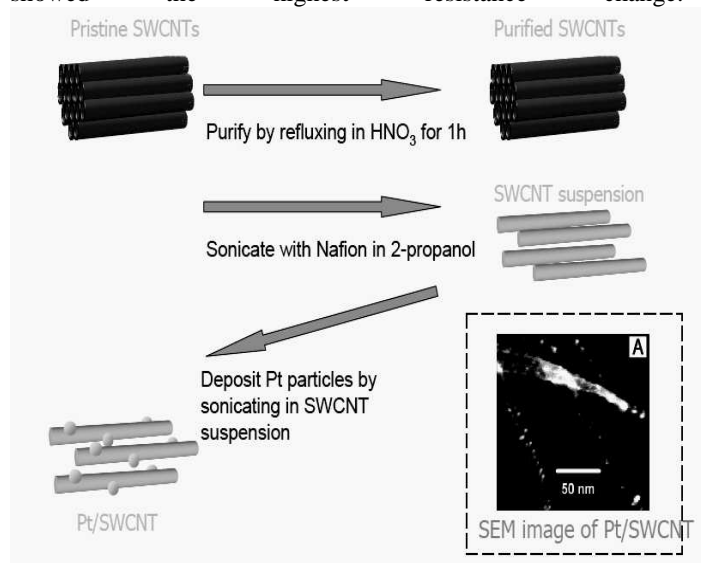


Fig 2 - (a) Change in resistance of Pt-SWNTs with different nominal thicknesses of Pt. (b) Change in resistance of different SWNT films with the same nominal thickness of Pt (6\AA).

Fig 1. Manufacturing of Pt/SWCNTs

II. CARBON NANOSTRUCTURE IN ENERGY STORAGE

Carbon nanotubes are being considered for energy production and storage. Graphite, carbonaceous materials and carbon fiber electrodes have been used for decades in fuel cells, battery and several other electrochemical applications. Nanotubes are special because they have small dimensions, a smooth surface topology, and perfect surface specificity, since only the basal graphite planes are exposed in their structure. The rate of electron transfer at carbon electrodes



ultimately determines the efficiency of fuel cells and this depends on various factors, such as the structure and morphology of the carbon material used in the electrodes. Several experiments have pointed out that compared to conventional carbon electrodes, the electron transfer kinetics take place fastest on nanotubes, following ideal Nernstian behaviour. Nanotube microelectrodes have been constructed using a binder and have been successfully used in bio electrochemical reactions (e.g., oxidation of dopamine). Their performance has been found to be superior to other carbon electrodes in terms of reaction rates and reversibility. Pure MWNTs and MWNTs deposited with metal catalysts (Pd, Pt, Ag) have been used to electro-catalyze an oxygen reduction reaction, which is important for fuel cells. It is seen from several studies that nanotubes could be excellent replacements for conventional carbon-based electrodes. Similarly, the improved selectivity of nanotube-based catalysts have been demonstrated in heterogeneous catalysis. Ru-supported nanotubes were found to be superior to the same metal on graphite and on other carbons in the liquid phase hydrogenation reaction of cinnamaldehyde. The properties of catalytically grown carbon nanofibers (which are basically defective nanotubes) have been found to be desirable for high power electrochemical capacitors.

A. Electrochemical Intercalation of Carbon Nanotubes with Lithium

The basic working mechanism of rechargeable lithium batteries is electrochemical intercalation and de-intercalation of lithium between two working electrodes. Current state-of-art lithium batteries use transition metal oxides (i.e., Li_xCoO_2 or $\text{Li}_x\text{Mn}_2\text{O}_4$) as the cathodes and carbon materials (graphite or disordered carbon) as the anodes. It is desirable to have batteries with a high energy capacity, fast charging time and long cycle time. The energy capacity is determined by the saturation lithium concentration of the electrode materials. For graphite, the thermodynamic equilibrium saturation concentration is LiC_6 which is equivalent to 372mAh/g. Higher Li concentrations have been reported in disordered carbons (hard and soft carbon) and metastable compounds formed under pressure. It has been speculated that a higher Li capacity may be obtained in carbon nanotubes if all the interstitial sites (inter-shell van der Waals spaces, inter-tube channels, and inner cores) are accessible for Li intercalation. Electrochemical intercalation of MWNTs and SWNTs has been investigated by several groups. Figure (top) shows representative electrochemical intercalation data collected from an arc-discharge-grown MWNT sample using an electrochemical cell with a carbon nanotube film and a lithium foil as the two working electrodes [1]. A reversible capacity (Crev) of 100–640mAh/g has been reported, depending on the sample processing and annealing conditions. In general, well-

graphitized MWNTs such as those synthesized by the arc-discharge method have a lower Crev than those prepared by the CVD method. Structural studies have shown that alkali metals can be intercalated into the inter-shell spaces within the individual MWNTs through defect sites.

III. CARBON NANOSTRUCTURE IN HYDROGEN STORAGE

The area of hydrogen storage in carbon nanotubes remains active and controversial. Extraordinarily high and reversible hydrogen adsorption in SWNT containing materials and graphite nanofibers (GNFs) has been reported and has attracted considerable interest in both academia and industry. Table 2 summarizes the gravimetric hydrogen storage capacity reported by various groups. However, many of these reports have not been independently verified. There is also a lack of understanding of the basic mechanism(s) of hydrogen storage in these materials which are of nanoscale size.

Material	Max. wt% H_2	$T(\text{K})$	$P(\text{MPa})$
SWNTs(low purity)	5–10	133	0.040
SWNTs(high purity)	~4	300	0.040
GNFs(tubular)	11.26	298	11.35
GNFs(herringbone)	67.55	298	11.35
GNS(platelet)	53.68	298	11.35
Graphite	4.52	298	11.35
GNFs	0.4	298–773	0.101
Li-GNFs	20	473–673	0.101
Li-Graphites	14	473–674	0.101
K-GNFs	14	<313	0.101
K-Graphite	5.0	<313	0.101
SWNTs(high purity)	8.25	80	7.18
SWNTs(~50% pure)	4.2	300	10.1

Materials with high hydrogen storage capacities are desirable for energy storage applications. Metal hydrides and cryo-adsorption are the two commonly used means to store hydrogen, typically at high pressure and/or low temperature. In metal hydrides, hydrogen is reversibly stored in the interstitial sites of the host lattice. The electrical energy is produced by direct electrochemical conversion. Hydrogen can also be stored in the gas phase in the metal hydrides. The relatively low gravimetric energy density has limited the application of metal hydride batteries. Because of their cylindrical and hollow geometry, and nanometer-scale diameters, it has been predicted that the carbon nanotubes can store liquid and gas in the inner cores through a capillary effect. A Temperature-Programmed Desorption (TPD) study on SWNT-containing material (0.1–0.2wt% SWNT) estimates a gravimetric storage density of 5–



10wt% SWNT when H₂ exposures were carried out at 300 torr for 10 min at 277K followed by 3 min at 133K. If all the hydrogen molecules are assumed to be inside the nanotubes, the reported density would imply a much higher packing density of H₂ inside the tubes than expected from the normal H₂-H₂ distance. The same group recently performed experiments on purified SWNTs and found essentially no H₂ absorption at 300K. Upon cutting (opening) the nanotubes by an oxidation process, the amount of absorbed H₂ molecules increased to 4–5wt%. A separate study on higher purity materials reports ~8wt% of H₂ adsorption at 80 K, but using a much higher pressure of 100 atm, suggesting that nanotubes have the highest hydrogen storage capacity of any carbon material. It is believed that hydrogen is first adsorbed on the outer surface of the crystalline ropes. An even higher hydrogen uptake, up to 14–20wt%, at 20–400°C under ambient pressure was reported in alkali-metal intercalated carbon nanotubes. It is believed that in the intercalated systems, the alkali metal ions act as a catalytic centre for H₂ dissociative adsorption. An electrochemical absorption and desorption of hydrogen experiment performed on SWNT-containing materials (MER Co, containing a few percent of SWNTs) reported a capacity of 110mAh/g at low discharge currents. Measurements performed on relatively large amount materials (~50% purity, 500mg) showed a hydrogen storage capacity of 4.2wt% when the samples were exposed to 10MPa hydrogen at room temperature. About 80% of the absorbed H₂ could be released at room temperature. The potential of achieving/exceeding the benchmark of 6.5wt% H₂ to system weight ratio set by the Department of Energy has generated considerable research activities in universities, major automobile companies and national laboratories.

IV. CONCLUSION

Unique properties of quantum dots can be exploited for developing low-cost and high efficiency solar cells. 1-D architectures are useful for designing next generation solar cells. Opportunities exist for carbon nanotubes and graphene sheets to facilitate capture and transport of electrons in nanostructure semiconductor based solar cells. This review has described several possible applications of carbon nanostructures,

with emphasis on materials for energy conservation applications. Hints are made to the electronic applications of nanotubes which are discussed elsewhere. The overwhelming message we would like to convey through this chapter is that the unique nanostructure, topology and dimensions of carbon have been intensively used for conservation process. The remarkable physical properties of nanotubes create a host of application possibilities, some derived as an extension of traditional carbon fiber applications, but many are new possibilities, based on the novel electronic and mechanical behavior of nanotubes.

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Nano Technology in Renewable Energy

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I. INTRODUCTION

Abstract— Today's crisis in the field of energy supplies, environmental control, population increase, poverty and shortage of food and materials are closely interrelated. It is gradually realized that they demand a holistic, systematic and integrated approach to deal with situation (Dabrase.et.al. 2000). The benefits to environmental and human health, producing clean, renewable and sustainable energy creates new green collar manufacturing and industrial jobs, from sourcing raw materials, the execution of large-scale production and building new power facilities. The entire renewable industry produces new economic growth opportunities that build and stabilize communities (SES 2010). A 5 % yearly increase in the use of energy not only points to fuel depletion, but is also a main cause for increase in pollution level and related disasters. The visual effect of the shortage we have already started picturing in terms of limited reserves of coal, oil, and gas which may last only for 197, 40, and 56 years respectively (Dabrase.et.al. 2000). Proven to Work in 2010 for 25-kilowatt-electric (kWe) solar dish Stirling system that simply takes the energy from the sun and converts it into grid quality energy. Its pure power made simple. The SunCatcher technology uses no fuel, is emissions free, and uses less water than other solar technologies; providing a clean, efficient, reliable source of energy (SES -2010). Nanomaterials have Extra-ordinary use in making more efficient solar cells and catalysts that can be used in hydrogen-powered fuel cells which are of the size of a 10-9m. The combination of suncatcher and hydrogen fuel cell process comprises of converting sun's energy into electricity which is used in electrolysis of water separated into hydrogen and oxygen through which the hydrogen fuel is used in fuel cell and other forms of converting energies. The conclusion obtained from the above topic is that should increase the use of renewable sources of energy and decrease the use of non renewable resources. Existing renewable resources are well established and proven. It has been seen through the various articles that available renewable energy resources are helping in the production of the other forms of energy which makes our energy system more strong and economical. The production of hydrogen, from the available wind energy, and its usage is more clean, safe and efficient. They are commercially available and are being utilized. The new upcoming technologies in renewable resources are very promising but a lot more research and infrastructure is required before it can be adapted (Taneja.2007).

A. SunCatcher Technology

The Sun Catcher is a 25-kilowatt-electrical (kWe) solar dish Stirling system which consists of a unique radial solar concentrator dish structure that supports an array of curved glass mirror facets, designed to automatically track the sun, collect and focus, that is, concentrate, its solar energy onto a patented Power Conversion Unit (PCU). The PCU is coupled with, and powered by, a completely re-engineered SES Stirling engine that generates power grid-quality electricity (SES 2010).

B. Power Conversion Unit (PCU)

The PCU converts the focused solar thermal energy into grid-quality electricity. The conversion process in the PCU involves a closed-cycle, high-efficiency four-cylinder, reciprocating Solar Stirling Engine utilizing an internal working fluid that is recycled through the engine. The Solar Stirling Engine operates with heat input from the sun that is focused by the Sun Catcher's dish assembly mirrors onto the PCU's solar receiver tubes which contain hydrogen gas. The PCU solar receiver is an external heat exchanger that absorbs the incoming solar thermal energy. This heats and pressurizes the gas in the heat exchanger tubing, and this gas in turn powers the Solar Stirling Engine (SES 2010).

C. New Radial Dish Design:

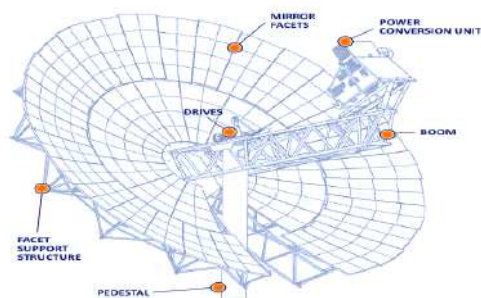
The Sun Catcher uses an innovative radial design for its concentrating mirrors. At sunrise, each Sun Catcher automatically rotates to face The Sun, and with sophisticated automation software, tracks, collects, and focuses the sun's energy onto a single point, the Power Conversion Unit (SES 2010)

D. The Next Generation CSP Technology:

The Sun Catcher solar dish Stirling system technology enables power plants to BUILD CAPACITY with modular 'building-block' simplicity, and fundamentally shift the way



we look at our 21st century utility energy infrastructures. The Sun Catcher solar dish Stirling system is the latest innovation in CSP engineering design combining THE BEST OF THREE TECHNOLOGIES that result in the world's most efficient solar-electric power generation (SES 2010).



E. Dual Axis: Alignment

The Sun Catcher is a mirrored concentrator dish powered by a proven high-performance Stirling engine, specifically redesigned for high conversion efficiencies of reflected, focused sunlight to grid-quality electricity at utility-scale. The Sun Catcher offers advanced dual axis rotational tracking capability, which means the parabolic dish moves continuously maintaining the optimal angle at 90 degrees with the sun's most direct solar radiation pattern; which optimizes collection and concentration of the highest quality of sunlight 100% of the time. As a result, the Sun Catcher provides the world's highest on-peak solar-to-grid electricity conversion generation efficiency ever recorded (SES 2010).



Fig-1: Suncatcher (SES, 2010)

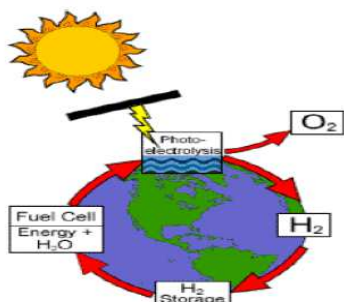


Fig-2: Generation of Hydrogen-Clean, Cyclic Process (Taneja.2007)

F. Heat Engine Efficiency :

Each Sun Catcher is powered by its own Stirling dish engine, which produces 25kW of grid-quality solar-electric power. The Stirling engine has earned its reputation as the preeminent CSP-to-grid quality electricity generation technology after nearly 200 years of research, development and testing, by leading engineering scientists across several continents. The Stirling engine is the consummate PCU/heat engine, with proven and unequalled performance efficiency and reliability for given operating temperatures for electrical generation; and has powered industrial strength agricultural, manufacturing, Naval, commercial and automotive application(SES 2010).

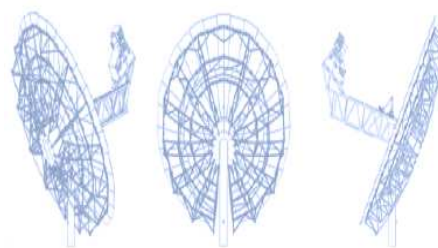


Fig-3: Suncatcher (SES 2010).

G. Three Controllers Command:

The Sun Catcher's three specialized computer controllers optimize the two-axis concentrated parabolic Dish technology on-sun tracking performance, and the PCU/heat engine performance efficiency for given operating temperatures for electrical generation, and facility Control & Data Acquisition designed to maximize the overall efficiency of solar-to-grid quality electricity generation and cost of plant operations and management(SES 2010)

Advantages

With over a decade of extensive development work by scientists and engineering teams, coupled with long term investment funding, the Sun Catcher Solar Dish is ready to produce large scalable utility grid-quality electricity from the most abundant energy resource, solar thermal heat(SES 2010).

H. Optimized Performance:: Lowest Cost

The Sun Catcher represents over a decade of re-engineering and redesign of the most advanced Concentrating Solar - Thermal Power (CSP) generation equipment

technology offering highest efficiency, reliability and performance at the lowest competitive costs(SES 2010).

I. Terrain Tolerance Flexibility

The Sun Catcher unique modularity allows the units to be installed on sloping land with up to a 10% grade. This significantly reduces the requirements for grading of sites and minimizes the ground disturbance. The most advanced



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Concentrating Solar-Thermal Power (CSP) generation equipment technology available, offering the highest efficiency, proven reliability and performance, at the lowest competitive costs (SES 2010).

J. Modular:: Scalable

Each Sun Catcher generates 25kW of grid-quality electricity immediately, as they're connected to the power grid. Now 21st century solar power plants will be able to scale daily, from 25MW to over 1,000MW. And, should a subsystem need replacing, the Sun Catcher offers a modular 'plug & play' design that simply replaces a subsystem when needed on site, with minimal impact on operations. There are no wait times for parts or engines which optimizes on - grid availability. The Sun Catcher sets a new standard for cost effective modularity and scalability(SES 2010).

K. vs. Concentrating Solar Power

Highest Conversion Efficiency: Solar-To-Grid Electricity:

The Sun Catcher consists of an innovative concentrating mirrored radial design that automatically rotates to track the sun, focuses and concentrates solar energy onto a single point, the Power Conversion Unit, which generate the world's highest solar energy - to - grid quality electricity peak conversion efficiency, at 31.25%(SES 2010).

Lowest Water Use: Significant Cost Savings:

The Sun Catcher does not need water for electricity generation or cooling cycles. Only a fraction of the amount of water required by competitive CSP technologies is used for washing its mirrors(SES 2010).

Maximize Performance:

Other CSP technology designs require certain turbine generator power capacities as energy demands change. For example, a 10MW facility would require a 10MW turbine. However, as energy consumption increases, let's say to 50MW, the solar facility would then require a new 50MW turbine generator. This process continues as demand dictates, whether it's a 100MW, 1GW, or anywhere in between. Changing out large turbines to match capacity is costly, and, impacts the solar power plant on-line availability at risk. And, should turbine generators require service or need replacement, long lead times take the power plant off line, an extremely costly scenario to both power facilities and their customer communities (SES 2010).

L. Power of Sustainability:

The power generation sector is the largest contributor to Greenhouse Gas emissions (GHGs), over 60%, worldwide. Projections indicate global electricity demand will increase 80% by 2030. However, SES has secured two of the world's largest solar plant build projects, and is preparing for full-scale production of the Sun Catcher; enabling power facilities to provide the next generation of clean, reliable, cost competitive

and truly sustainable solar electricity solution to their customers, meet renewable portfolio targets and actively tackle global climate change(SES 2010).

Sun Catchers produce grid-quality solar power, adding new solar power to the grid daily and are based on the uniquely modular Sun Catcher plug & play' design. Working with San Diego Gas & Electric and Southern California Edison, our Imperial Valley and Calico projects will produce up to a combined 1,600MW of clean, renewable energy. Both projects include up to 64,000 Sun Catcher units and over the next several years, other projects will follow, further validating the commercial appeal of this modular and scalable technology. Solar energy at a scale the world has never seen (SES 2010).

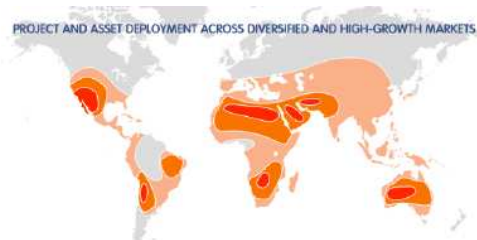


Fig-4: World Deployment across Diversified and High -Growth Markets (SES 2010)

To conserve and establish the new renewable sources, many countries are trying hard to develop new projects and harness the new renewable forms of energy. These countries are trying to tap the energy from relatively unexplored sectors. Nanomaterials and Hydrogen fuel cell have the advantage of being smaller and portable. Therefore they have many more applications.

Nanomaterials

DOE is also active in research and development of nanotechnology [1]. Nanomaterials, from the same materials in normal form. They can be adopted in new technologies. Nanomaterials have the potential use in making more efficient solar cells and catalysts that can be used in hydrogen-powered fuel cells. Which are of the size of a 10-9 of a meter, offer different chemical and physical properties

Due to small size and excellent conductivity, CNTs (carbon nanotubes), can possibly be used as foundation of future electronic devices. CNT cables could be used to make electricity transmission lines. CNT cables could be used to make electricity transmission lines, which will give us large performance improvement over present day power lines. (Source:<http://usinfo.state.gov/journals/ites/0504/ijee/garman.htm>)

Hydrogen Fuel Cell:

Hydrogen can be used in a fuel cell which basically operates like a battery. The fuel cell consists of two electrodes and an electrolyte. Hydrogen and Oxygen are passed over the electrodes to generate electricity and Water. Hydrogen cells are used in Auto industry. Compressed hydrogen tanks are used to supply the Hydrogen and Oxygen is used from the air directly. There is no pollution caused by hydrogen fuel cell



autos and the only emission is water. If the hydrogen fuel cell autos become main stream instead of exception, we can eliminate autos from the global pollution problem.

Hydrogen Economy:

The hydrogen economy is an energy system of the coming generations in the near future. The hydrogen can be generated using the renewable energy sources which are readily available. One of such sources is the wind energy that is playing the major role in the generation of hydrogen. The hydrogen economy is capable of fulfilling the human needs of the coming generations. Hydrogen Production:

Several technologies have been developed to produce hydrogen. Some of the ways have been attempted to describe regarding the hydrogen production. Hydrogen is mainly being produced from fossil fuels in refineries or in industries. The fossil fuels which are used for hydrogen production are in the form of coal, crude oil or natural gas. These fuels produce carbon-dioxide gas during their production process. The processes involved are hydro-treating and hydro-cracking. To avoid the emission of carbon-dioxide gas many other technologies are coming up to produce cost effective hydrogen. Water electrolysis is one of the efficient methods to produce hydrogen but it needs electricity which is expensive.

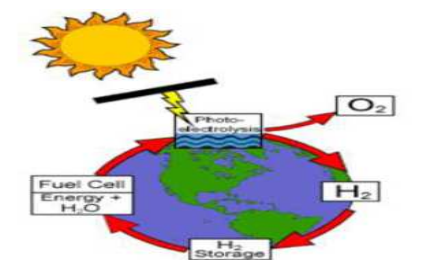


Figure 1: Generation of Hydrogen-Clean, Cyclic Process
Source: DOE H2 Network

(Source:http://www.stirlingenergy.com/hydrogen_overview.htm)

There's always the need for clean, efficient, convenient forms of energy which the user can easily access. Hydrogen is one of the many other convenient forms of energy which forms an energy system and satisfies the human energy needs [3].

(Bockris, 1975; Bockris and Veziroglu, 1985; Bockris et al., 1991). Characteristics of Hydrogen: (Veziroglu and Babir, 1992)

- Hydrogen in chemistry has the following properties:
- Available in huge quantity.
- Can be stored in solid, liquid or gas form.
- Can be converted into other forms of energy efficiently.
- Renewable source as made from the product of water or water vapor.

- Easily transportable.
- Hydrogen as an energy carrier is environmentally compatible.

Wind energy is the other way to produce hydrogen at a low cost but this energy can be utilized in the areas where the wind energy is easily available. The energy required to produce hydrogen is more than what it releases during its utilization.

a. Hydrogen Storage:

After production storage becomes an important issue which needs to be taken care of. Hydrogen can be stored as solid, liquid or gas in the form of glass micro-spheres, chemical hydrides, metal hydrides or cryo-adsorbers.

Hydrogen storage in caverns, aquifers are costly and cause loss of gas and pressurized gas storage systems are similar as conventional gas storage systems. Liquid hydrogen storage is being used only in the condition of high need of hydrogen. Metal hydride storage system has an advantage of storing hydrogen in terms of safety aspect. This process requires system set up and the release of heat during the process is another important factor to make this storage system more popular [3].

b. Hydrogen Transport and Distribution:

Hydrogen transportation by pipeline is up to 200 km from production to utilization sites but for effective transportation high capacity reciprocating compressors are used. The pipelines used for hydrogen transportation require large diameter and more compression power. Due to low volume of hydrogen and lower pressure losses, less recompression stations are required and that too placed far apart. It has been estimated that transportation of hydrogen is cheaper comparative to electricity transport [3].

c. Hydrogen Utilization

The use of hydrogen as a fuel in the internal combustion engines has been found to a great extent. The hydrogen is more efficiently used by 20% in the internal combustion engines. The greater advantage is its more clean that is the use of hydrogen causes less amount of pollution compared to other gasoline engines. Hydrogen use in jet engines and turbines produces the only pollutant nitrogen oxides. Use of hydrogen in biomedical technology is becoming popular in the form of micro steam generator. Catalytic burners in household appliances are coming up with the use of combustion of hydrogen only.

d. Hydrogen Safety

Every process has its own risks and benefits. Similarly hydrogen can be a risk-full factor if the proper care is not done starting from the process of production until the process of utilization. Hydrogen has the smallest molecule so high tendency to leak through the smaller openings. Also due to low ignition energy of hydrogen the flame becomes nearly invisible and that could be a dangerous issue as it becomes



hard to detect if there is a fire. Liquid hydrogen also causes the risk of cold burns.

II. CONCLUSION

The conclusion obtained from the above topic is that we should increase the use of renewable sources of energy with use of nanotechnology and decrease the use of non renewable resources. Existing renewable resources are well established and proven. It has been seen through the various articles that available renewable energy resources are helping

in the production of the other forms of energy which makes our energy system more strong and economical. Likewise the production of hydrogen with the use of process electrolysis, from the available wind energy, and its usage is more clean, safe and efficient. The new upcoming technologies in renewable resources are very promising but a lot more research and infrastructure is required before it can be adapted.

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Experimental studies on enhancement of heat transfer in a solar dryer incorporating pcm containing nano particles

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Abstract— Solar dryer is a device mostly used for drying agricultural products like seeds, fruits, vegetables, food grains etc., The drying rate is faster in the case of solar dryer compared to open drying. Still in many food processing, textile industries conventional dryers are used to remove the moisture present in the product. The conventional dryers use fossil fuels like kerosene and diesel. In this energy crisis days, it is wise to utilize renewable energy source. The main problem with solar energy is, it is not available continuously and it is diffuse in nature, especially it is not available throughout the day. In order to extend the period of operation of the solar dryer, it is mandatory to incorporate thermal energy storage system along with the solar dryer. The best way of thermal energy storage is by utilizing the phase change materials (PCM). The phase change materials also have limitations like low thermal conductivity. To improve the thermal conductivity of PCM nano particles can be blended with PCM so that its thermal conductivity can be improved. In this work various nano particles are to be blended with PCM and other heat transfer enhancing techniques are also to be adopted to increase the rate of heat transfer of the solar dryer. Basically there are two ways by which heat transfer enhancing techniques are available like, Active method and Passive method. Among these methods it is proposed to adopt passive method of heat transfer enhancing technique. After conducting various experiments, the expected outcome is to suggest suitable nanoparticle for a particular type of PCM.

Keywords---PCM, Nano-Particles, Thermal Conductivity, Paraffin Wax

I. INTRODUCTION

In the industries more amount of heat is dumped to the surrounding, without recovering them properly. Also solar energy is available abundantly among the other renewable energy sources. The availability of solar energy is not continuous and available only during the daytime and hence to properly utilize solar energy, an effective thermal energy storage system is mandatory. The effective thermal energy storage system can increase the period of operation of solar energy

utilization devices. There are various methods available to store thermal energy, but each and every method has its own advantages and disadvantages. Therefore we have to select an optimum method of thermal energy storage method for the specific application.

A. Various Methods of Storing Thermal Energy

The storage of thermal energy is performed by increasing the internal energy of a material as sensible heat, latent heat, and thermo-chemical heat, or combination of these.

1) Sensible Heat Storage (SHS) system

It uses the specific heat capacity of the substance, and the temperature of a material (in solid or liquid state). Temperature of the substance increases during charging and decreases during discharging.

$$Q = m C_p (T_f - T_i)$$

2) Latent Heat Storage Systems

Latent Heat Storage (LHS) is based on absorption or release of heat when a storage material undergoes a phase change. The storage capacity of the LHS system with a PCM medium is given by

$$Q = m C_p (T_m - T_i) + m L + m C_p (T_f - T_m).$$

3) Thermo – Chemical Systems

Thermo-chemical systems rely on the energy absorbed and released in breaking and reforming molecular bonds in a completely reversible chemical reaction. In this case, the stored heat depends on the amount of storage material, the endothermic heat of reaction, and the extent of conversion. Amongst various thermal energy storage techniques, latent heat energy storage is attractive. The problems with latent heat storage are low thermal conductivity, variation of properties of



PCM when used repeatedly, incongruent melting, and high cost.

B. Need for PCM as LTES

- Melting temperature of the PCM is in the desired operating temperature range.
- High latent heat of fusion per unit volume so that the required volume of the container to store a given amount of energy is less.
- High specific heat to provide for additional significant sensible heat storage.
- High thermal conductivity of both solid and liquid phases to assist the charging and discharging of energy of the storage systems.
- Small volume changes on phase transformation and small vapor pressure at operating temperatures to reduce the containment problem.

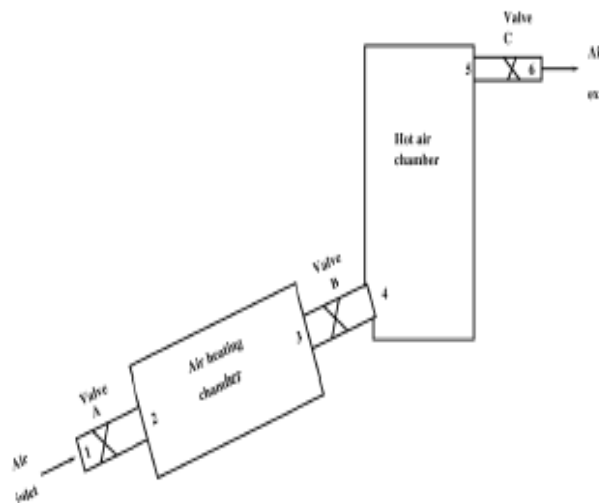
Low Temperature Energy Storage System (LTES) stores the thermal energy from solar, exhaust gases and waste heat from industries. To achieve this energy storage, the medium adopted is Phase Change Materials (PCM). PCM is preferred because of their higher storage density, with less volume. The disadvantage of PCM for using as LTES is that, the thermal conductivity of PCM is less and this requires more time period and more surface area of contact, for loading and unloading of thermal energy. To overcome this problem, an attempt was made to incorporate CuO Nano particles in the paraffin PCM to improve its thermal conductivity. The thermal conductivity of LTES is determined both analytically and experimentally. Incorporating nano-particle in the PCM has improved the thermal conductivity of the LTES. Maxwell- Garnett Equation is used to determine the thermal conductivity of PCM analytically and Transient Hot Wire Thermal Conductivity Measuring Apparatus KD2 probe is used to determine the thermal conductivity experimentally.

II. WHY TO IMPROVE THE THERMAL CONDUCTIVITY OF PCM FOR LTES?

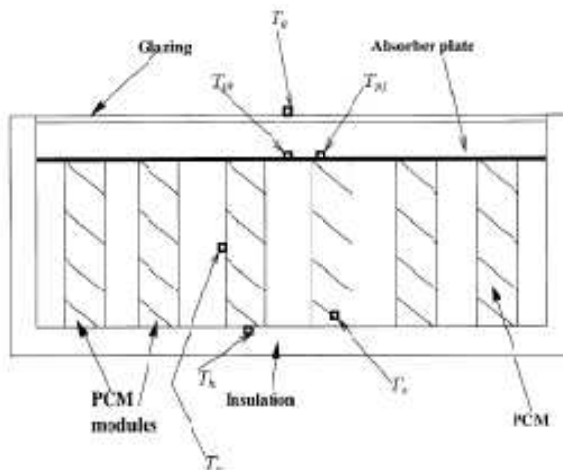
In a latent heat storage system, the solid-liquid interface moves away from the heat transfer surface during phase change. During this process, the surface heat flux decreases due to the increasing thermal resistance of the growing thickness of the molten / solidified medium. In the case of solidification, conduction is the only transport mechanism, and in most cases, it is very poor. In the case of melting, natural convection can occur in the molten layer and this generally increases the heat transfer rate compared to the solidification process (if the layer is thick enough to allow natural convection to occur).

However, low rate of heat transfer can be increased considerably by using a suitable heat transfer enhancement technique.

III. METHODS OF INCREASING THERMAL CONDUCTIVITY OF LTES



Several methods are there to enhance the heat transfer in latent heat storage system of LTES. Increasing the thermal conductivity of the PCM will increase the rate of heat transfer in latent heat energy storage. The various methods to improve the thermal conductivity of PCM are, use of finned tubes with different configurations, inserting metal matrix in the PCM, using PCM dispersed with high conducting particles, micro encapsulation of PCM, using metal screens/spheres placed inside the PCM, employing aluminum foam to enhance the heat transfer process in latent heat storage system. In this paper an attempt is made to increase the thermal conductivity of the paraffin PCM by dispersing CuO nano-particles. Thus the thermal conductivity of the PCM is improved and the thermal energy loading and unloading time of PCM is also considerably reduced. Paraffin is the most widely used PCM for LTES, because of its easy availability and its properties remain unaltered even after multiple cycles of charging and discharging.



IV. BLENDING OF NANO PARTICLES WITH PCM

VOLUME OF CONCENTRATION	AMOUNT OF NANO MATERIALS USER in gm
.01	5
.02	10
.03	15
.04	20
.05	25
.10	50
.15	100

Ultra sonic stirrer is used for blending nano particles with PCM. Ultrasonication is an advanced mixing technology providing higher shear and stirring energy without scale-up limitations. It does also allow, to control the governing parameters, such as power input, reactor design, residence time, particle, or reactant concentration independently. The ultrasonic cavitation induces intense micro mixing and dissipates high power locally. Copper oxide is mixed with paraffin wax in ultrasonic frequency generated from the ultrasonic stirrer is 5- 10 MHz The stirrer is run for 8 hours for stable suspension of Nano particles with no precipitation. Nano particle is mixed with various proportions. The various concentrations of mixing are

V. DETERMINATION OF THERMAL CONDUCTIVITY

A. Analytical Method

Maxwell Garnett Equation is used to determine the thermal conductivity of PCM for LTES. The Maxwell – Garnett equation is

$$k_{\text{Maxwell}} = \frac{k_p + 2k_l + 2(k_p - k_l)\phi}{k_p + 2k_l - (k_p - k_l)\phi} k_l$$

Where k_p - is the thermal conductivity of the dispersed particles. Thermal conductivity of CuO= 6540 W/mK. k_l - is the thermal conductivity of the dispersion liquid, Thermal conductivity of paraffin = 0.214 W/mK ϕ - is the particle volume concentration of the suspension.

B. Experimental Method



Diagram.1 Transient Hotwire Thermal Conductivity Measuring Apparatus

Transient Hotwire Thermal Conductivity Measuring apparatus is used to determine the thermal conductivity of PCM blended with nano particles in various proportions.

VI RESULTS

Volume Concentration	Experiment al Value (W/mK) at 45°C	Ana,ytic al Value (W/mK)	ERRO R
0	0.214	0.214	0
.01	0.2291	0.220	4.1%
.02	0.2291	0.2266	5.51%
.03	0.2467	0.233331	5.83%
.04	0.2567	0.2397	7.09%
.0555	0.2706	0.2462	9.77%
.1	0.3420	0.2465	21.06%
.15	0.3802	0.3222	18%

Volume Concentratio n (Q)	Thermal Conductivity of Compostte (W.mK) at 45°C	Increcrso in thermal conductvity
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0	0.214	0
.01	0.220	2.8%
.02	0.226	4.04%
.03	0.2331	8.925%
.04	0.2397	12.05%
.0555	0.2465	15.1869
.1	0.2825	32%
.15	0.3222	50.56%

The thermal conductivity of the raw paraffin was 0.2 W/mK, the value of thermal conductivity was determined using transient hot wire thermal conductivity apparatus. After dispersing the nano particle with the paraffin the thermal conductivity of the PCM has increased to 0.3802 W/mK.

VII. CONCLUSION

The PCM are used in various applications i.e. space heating / cooling, solar cooking, green house heating, water heating and waste heat recovery systems. The problem with the most commonly used PCM (paraffin) is poor thermal conductivity. From the above experiment performed it is evident that dispersing nanoparticles with paraffin had resulted in the improved thermal conductivity of the PCM. This improved thermal conductivity of PCM overcomes the poor rate of heat transfer in the thermal energy storage applications. Further there is a scope to determine the correct proportion of mixing the nano particle to the paraffin and also there is scope to determine the better nano particle that can be dispersed with the paraffin.

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A Detailed Survey on Behavioral Characteristics of Quantum Dot Infrared Detectors

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Abstract-- Infrared Thermography, a non-contact, non-invasive, non-hazardous technique is widely used as Non-Destructive Testing (NDT) technique in industries for Quality Assessment. Also in recent years, Clinical Infrared Thermography is widely accepted as a reliable medical diagnostic technique for early detection of breast cancer. An infrared detector maps the temperature of the specimen under study into thermal maps called thermographs. These thermographs are then interpreted by certified thermologists. However thermographs are severely affected by the inherent detector limitations. The performance of a thermographic system can be improved by using high quality detectors. In recent years, extensive research has begun in the area of utilizing semiconductor quantum or nanostructures to improve the performance of the infrared detector. Owing to its better characteristics, Quantum Dot infrared detectors are of active interest to researchers. This paper provides an extensive review on various techniques used for improving the performance of Quantum Dot Infrared detectors (QDIDs).

Keywords--Quantum dots, Infrared detectors, dark current, normal incidence

I. INTRODUCTION

Non-Destructive Testing (NDT) techniques are widely used in industries to assess the quality of materials. Of the various NDT techniques, InfraRed Thermography (IRT) is a non-contact, non-invasive, non-hazardous technique that captures the heat of the specimen under study and maps it into thermographs. A thermograph is 2-Dimensional function $g(x,y)$ where x,y denotes the spatial co-ordinates and $g(x,y)$ denotes the radiance. These thermographs are assessed by trained thermologists in order to interpret the nature of the specimen under study. However thermographs are affected by infrared detector performance due to its bulk material characteristics. It can be enhanced if there is a precise control of the detector parameters. Such precise control is possible only when the detectors are manufactured in the nanoscale. In recent years extensive research is done in quantum thermal detectors. Quantum physics aims at improving the characteristics of the detector by reducing the size of the detector in the nanoscales. Motion of the charge carriers is confined in 1-D/ 2-D/3-D (Quantum well, Quantum wires, Quantum dots respectively) so that quasicontinuous energy levels begin to appear as discrete energy packets. Quantum dot Infrared detectors are chosen

because of its better performance and flexibility in controlling the characteristics. In this paper an extensive literature survey is done on the performance enhancement and applications of quantum dot InfraRed sensors. Section II reviews the applications of quantum dot infrared sensors and section III concludes the findings.

II. REVIEW ON QUANTUM DOT INFRARED PHOTO DETECTORS

Ariyawansa et al demonstrated a dual-band super lattice quantum dot infrared photo detector, providing bias-selectability of the response peaks. The major challenge associated with multiband detectors lies in selecting the operating wavelength without using external optical filters or multi terminal electrical contacts on the detector. Also external optical filters with complicated mechanical drives increase the weight of the system. Although detectors consisting of two active regions with more than two electrical contacts allow simultaneous detection of the photo signals in the two spectral bands, the arrays made of such detectors require sophisticated fabrication techniques. To avoid these drawbacks, a tunneling-QDIP (T-QDIP) was reported, which provided dual-band detection capability with a selection of the operating wavelength by alternating the applied bias voltage polarity. This work demonstrated the idea and the feasibility of using QDIP structures for developing detectors with specific capabilities. However, this detector did not demonstrate complete wavelength selectivity, i.e., the spectral crosstalk between the two bands was not eliminated [1].

Razeghi et al used Quantum Dot Infrared Photo Detectors (QDIPs) for detection in the Middle Wavelength InfraRed (MWIR) and Long Wavelength InfraRed (LWIR) ranges. This is due to the QDIPs' absorption of normally incident light, potential room-temperature operation, high responsivity and three-dimensional confinement potential achieved in quantum dots (QDs). High performance is due to the improvement of the barrier quality in the device structure which leads the lower noise in high bias regions brought by the double barrier structure [2].

McKerracher et al found that variation in the size of self-assembled quantum dots leads to a broadened spectral

response, which is undesirable for multi-color detection. Photonic crystal slabs can filter the transmission of normally-incident light using Fano resonances, and thus may be integrated with QDIPs to create a narrowband detector. Photonic crystals (PCs) have the ability to control light propagation with high spectral and spatial precision. Although 1-dimensional PCs have been around in the form of distributed Bragg reflectors, 2-dimensional and 3-dimensional PCs have attracted more attention recently. 'Fano resonance' is used to indicate the interference between two pathways, such that the resulting resonance typically resembles symmetric or asymmetric sharp peaks, superimposed on a smoother spectrum. Infrared detectors such as QDIPs have much to benefit from these structures as well. By tuning a narrow transmittance peak of the filter to the broad photo response band of a QDIP, an integrated device with a narrow photo response can be created [3].

Aivaliotis et al showed the impact of the growth parameters of an InAs dot within an InGaAs well (DWELL) QDIP. They controlled the absorption wavelength both during and after growth by altering the size of the dots and via the quantum confined Stark effect respectively. The addition of AlGaAs current blocking layers is shown to reduce deleterious dark current by over two orders of magnitude. It was found that increasing the size of the QDs via the number of deposited monolayers resulted in a controllable change in the absorption wavelength. Furthermore, the QDIPs displayed bias tuneability via the quantum confined Stark effect. Such control over the wavelength, both during and post growth gives the devices significant hyperspectral capability. Finally, they demonstrated that significant reductions in the dark current could be achieved by the use of AlGaAs barriers [4].

Shenoi et al reported fabrication of a DDWELL infrared detector where the overall strain in the structure was reduced by replacing the In_{0.15}Ga_{0.85}As well in the DWELL detector with a In_{0.15}Ga_{0.85}As/GaAs well. The DDWELL structure retains the dual color response and bias dependent tuning characteristics of the DWELL while increasing the number of stacks of active region to 30 [5].

Jamie et al discussed the physical properties of detectors based on infrared optical absorption in quantum dot. An extension of QWIPs is the Quantum Dot Infrared Photo Detector (QDIP), which uses optical transitions between bound states in the conduction/valence band in quantum dots. QDIPs are predicted to outperform QWIPs due to their inherent sensitivity to normal incidence radiation and reduced phonon scattering. QDIP performance has a distinct tradeoff between, and dependence on, quantum dot density and dopant concentration [6].

Sarney et al discussed ARL's (Army Research Laboratory) quantum dot infrared photodetector (QDIP), with a particular focus on the microstructural characterization of quantum dots systems that have been manipulated on a nanoscale level to tailor their electrical and optical properties. At the Sensors & Electron Devices Directorate of the Army Research Laboratory, several materials are grown by Molecular

Beam Epitaxy (MBE) and characterized to assess their suitability for use in infrared detector devices. Strain balancing is achieved by adjusting the mole fractions of the matrix material to compensate for the compressive strain induced by the dots [7].

Vukmirovic et al described the electron transport in vertical conductivity quantum dot infrared photo detectors (QDIPs). In order to reduce dark current, quantum dots used in QDIP are typically doped at a relatively uniform electric field throughout the structure as the formation of electric field domains is expected to occur only at high doping densities. Due to the discrete nature of states in quantum dots, transition rates between electronic states due to interaction with longitudinal optical (LO)-phonons have previously been considered to be vanishingly small unless the energy levels are separated by the energy of an LO-phonon. Furthermore, longitudinal acoustic (LA)-phonons, due to their small energy, cause transitions only between closely spaced energy levels. These expectations led to the predictions of extremely low dark currents and very small capture rates in QDIPs due to inhibited carrier dynamics. Consequently excellent QDIP characteristics were expected. Carrier transition rates in QDIPs are much smaller than the frequencies of external excitations; one is mainly interested in the steady-state response [8].

Sakoglu et al determines Quantum-dot infrared photo detectors (QDIPs) exhibit a bias-dependent shift in their spectral response. A novel signal-processing technique is developed that exploits this bias-dependent spectral diversity to synthesize measurements that are tuned to a wide range of user-specified spectra. The technique is based on two steps: the desired spectral response is first optimally approximated by a weighted superposition of a family of bias-controlled spectra of the QDIP, corresponding to a preselected set of biases. Second, multiple measurements are taken of the object to be probed, one for each of the prescribed biases, which are subsequently combined linearly with the same weights. The technique is demonstrated to produce a UN modal response that has a tuneable FWHM (down to $\Delta\lambda/\lambda$; 0.5 nm) for each centre wavelength in the range 3–8 μm , which is an improvement by a factor of 4 over the spectral resolution of the raw QDIP [9].

Chakrabarthi found that QDIPs with self organized InAs/GaAs quantum dot in active regions have the potential for lower dark current and higher photo response levels than QWIPs. These advantages are believed to arise from the three dimensional confinement of carriers within the dot. The technological significance of using an InGaAs cap in these structures is that it acts as a surface strain driven phase-separation alloy that is activated by surface strain modulation across the InAs QD layer. The device with a thick combination barrier has a substantially higher performance in terms of responsivity and detectivity around $10\mu\text{m}$ and has a low dark current density in the order of $1.36 \times 10^{-6} \text{ A/cm}^2$ at 77K and at 1V bias. The spectral responses at several temperatures and applied biases were measured with a Fourier transform infrared spectrometer using a glow bar source [10].



II. CONCLUSION

An extensive research is done in the applications of Quantum dots for Infrared Detectors. From the literature the following conclusions are arrived at. The normal incidence property of QDIDs avoids the need of fabricating a grating coupler which is a complex process. Also quantum dot arrays with high size uniformity and optimal band structure help in achieving the highest IR detector performance. Excellent infrared imagery can be obtained with over a 160% increase in the ratio of the signal voltage to the noise voltage of the QDID camera at the resonant wavelength of $\lambda = 6.1 \mu\text{m}$.

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Review of Investigation on Performance of Quantum Well Laser

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Abstract— Semiconductor Lasers find extensive applications in medicine and communications. However, in conventional homogeneous lasers, in addition to Auger effect, electrons and holes can freely move from conduction band of N-type to P-type and from valence band of P -type to N-type thereby drastically reducing the amount of photon emission. Though double heterogeneous lasers overcome the above disadvantages, they do need high lasing energy and controlling the behavioural properties is difficult due to its bulk nature. Quantum Well (QW) Lasers have gained importance as they have discrete energy levels and precise control over the structural behaviour of the laser can be obtained due to carrier confinement. Due to the above advantages, QW Lasers are widely used in potential areas such as Medicine and Communications. This paper provides an extensive survey on the applications of QW lasers in these areas and also throws light on the future enhancements that can be made on these Lasers to improve their performance.

Key Words— Quantum Well Lasers, RTA, low photon frequency, strain-split localized states

I. INTRODUCTION

Lasers are the most commonly used optical sources in communication and medicine. Accuracy, coherence, phase and wavelength of the Laser beam affects the performance of the optical inference system emitted by Lasers. Characteristics of the Laser beam is dependent on various physical parameters namely the nature of the substrate, energy gap in these substrates, optical gain and refractive index between the materials, lasing threshold etc. Precise control of these parameters results in high quality laser beam. Quantum physics offers such accurate and precise control of the beam characteristics through size reduction. As the size reduces, lasing threshold decreases, optical gain increases, refractive index changes, positive feedback increases, the energy gap increases and hence highly coherent laser beam is obtained. The above is possible because of the carrier confinement in 1-Dimension or 2-Dimension or 3-Dimension. Due to well established fabrication technologies, quantum well Lasers (carrier confinement in 1-Dimension) are widely used in

communication. In this paper, an extensive survey is performed on the applications of quantum well Lasers, various methods of enhancing the performance of quantum well lasers and is presented in Section II. Section III concludes the work.

II. REVIEW OF INVESTIGATION ON PERFORMANCE OF QUANTUM WELL (QW) LASERS

Bulaev et al proposed that heterostructure design and technological conditions of the quantum-well growth are optimized to increase the output power and reduce the laser emission divergence. Semiconductor lasers are fabricated with a CW (continuous wave) output power as high as 4 W and the emission divergence of less than 30 degree in the plane perpendicular to the p-n junction plane. The most important technical parameters of an LD are its emission power and operating lifetime. However, the LD (Laser diode) can be efficiently used only when the full width at half- maximum (FWHM) of its emission pattern (angular divergence) does not exceed 30degree because the angular aperture of objective is 30-40 Degree in most cases. The emission divergence in the plane of the LD active layer is determined by the localization of the emitted light flux in optical channels, which randomly arise during pumping. In this case, the typical FWHM of the emission pattern is 10-15degree. It is found that the FWHM of the emission pattern was slightly dependent on the emission Wavelength in the spectral range of 0.85- 1.06 μm at the given thickness of the waveguide and compositions of the waveguide and emitter layers. The underlying principle is that the refractive index of the AlGaAs solid solution decreases linearly with wavelength at concentrations of AlAs $C = 0.15 - 0.45$. By studying the dependence of the differential efficiency and the threshold current density on the LD cavity length, they found that the internal losses in the layers of the grown heterostructures were $3-5 \text{ cm}^{-1}$ and the inversion current density was $80 - 120 \text{ A cm}^{-2}$. [1]

Vera Gorfinkel et al have illustrated a powerful and convenient way of analyzing the situation when the optical gain in a semiconductor laser is a strong function of a parameter other than the carrier concentration. The only example of such a parameter is the effective carrier temperature, which has a strong influence on the operation of all long wavelength quantum well lasers. The phase portrait of the laser gain function, represented by the "isogain" contours $g=a$ on the surface $g(n, T_e)$ contains valuable information and offers a unique view of the highly nonlinear device. Hot electron effects enter the description of the semiconductor laser operation owing to the dependence of the optical gain g on the carrier temperature T_e . In near infrared lasers, hot electron effects are relatively small and arise mainly from heterostructure barrier injection and free-carrier absorption of cavity radiation. Hot electron effects are more dramatic in longer wavelength materials. This happens because of the substantial release of power that accompanies non-radiative recombination. An important component of the non-radiative current in all long-wave materials is owing to Auger recombination. Recently, Silver et al. estimated that Auger processes give a dominant current contribution already at communication wavelengths, 1.75-1.3 Pm.

W.S. Rabinovich et al proposed that Modulating retro-reflectors (MRR) couple passive optical retro -reflectors with electro-optic modulators to free-space optical communication with a laser and pointing/acquisition/tracking system required on only one end of the link. In operation a conventional free space optical communications terminal, the interrogator, is used on one end of the link to illuminate the MRR on the other end of the link with a cw beam. The MRR imposes a modulation on the interrogating beam and passively retro-reflects it back to the interrogator. These types of systems are attractive for asymmetric communication links for which one end of the link cannot afford the weight, power or expense of a conventional free-space optical. Recently, MRR using multiple quantum well (MQW) modulators have been demonstrated using a large area MQW placed in front of the aperture of a corner-cube. For the MQW MRR, the maximum modulation can range into the gigahertz, limited only by the RC time constant of the device. This limitation, however, is a serious one. The optical aperture of an MRR cannot be too small or the amount of light retro-reflected will be insufficient to close the link. 5-1 cm and maximum modulation rates less than 10 Mbps. In this paper they described a new kind of MQW MRR that uses a cat's eye retro-reflector with the MQW in the focal plane of the cat's eye. Modulating retro-reflectors (MRR) couple passive optical retro-reflectors with electro-optic modulators to allow long-range, free-space optical communication with a laser and pointing/acquisition/tracking system.

S.K.Buratto et al addressed a new contrast method in near-field scanning optical microscopy in which the near-field probe is used to excite photocurrent in a semiconductor sample. They found that the use of near-field optics results in an order-of-magnitude improvement in spot size and a fivefold

improvement in resolution over previous methods of photocurrent imaging. The application of this near-field photoconductivity technique to a multi-quantum well laser provides direct visualization of carrier transport throughout the structure, yielding information on growth in homogeneities, carrier leakage and isolation, and the overall quality of p-n junctions. The resolution of the Near-Field Photoconductivity (NPC) technique, for this particular sample (a multi-quantum well laser), is at least 53 better than in previous photoconductivity imaging as well as in Electron-Beam Induced Current (EBIC) imaging, which are both $>1\mu\text{m}$. Additional advantages of NPC over EBIC reside in the inherent flexibility of NPC. NPC affords the ability to tune the energy of the exciting light around the absorption edge of the sample and does not require a vacuum environment. The NPC image yields a map of minority carrier transport with a resolution of approximately 250 nm. The technique is applicable to a wide variety of electronic and optoelectronic materials such as transistors, light emitting diodes, photo detectors, and lasers, where understanding transport properties on a nanometer scale is important. Such applications have been made possible by the development of a near-field optical fibre probe² which provides a factor-of-104 enhancement in throughput over earlier designs.

R. Jones et al demonstrated a real-time holographic imaging system that provides $\sim 50\mu\text{m}$ depth and transverse resolution. Customized photorefractive quantum well devices have been developed for real-time video acquisition. Photorefractive Multiple Quantum Well (MQW) devices satisfy many of the requirements needed for such recording media, such as high sensitivities and very fast response times. Fast recyclable holographic media have a wide range of real time applications such as interferometry, image correlation and 3-D imaging, including imaging through turbid media, such as biological tissue, via coherence gating. In this technique they have used time-gated holography in conjunction with photorefractive MQW devices to give whole 2-D image field acquisition without the need for pixel by pixel transverse scanning. Direct depth-resolved image acquisition to a video recorder has been demonstrated. The technique has been applied to 3-D imaging through turbid media with $50\mu\text{m}$ transverse and $60\mu\text{m}$ depth resolution being achieved using near infrared light through a phantom of 13 mean free paths scattering depth.

M. Razeghi and S. Slivken proposed the technological development. It is shown that, for strict control of material and fabrication technology, peak power in excess of 7 W is possible from a single $20\mu\text{m}$ wide aperture. Scaling of the output is demonstrated by increasing the number of emitting regions in the waveguide core. At $l = 9\mu\text{m}$, over 7 W of peak power has been demonstrated at room temperature for a single diode, with an average power of 300 mW at 6% duty cycle. At shorter wavelengths, laser development includes the use of highly strain-balanced heterostructures in order to maintain a high conduction band offset and minimize leakage current. At $l = 6\mu\text{m}$, utilizing a high reflective coating and epilayer-down

mounting of the laser, 225 mW of average power from a single facet at room temperature have been demonstrated. The authors have also addressed the state-of-the-art for high peak and high average power quantum cascade laser technology. Also, advances in mirror coating and epilayer-down die bonding are demonstrated, leading to even better device performance.

Frank K. TITTEL et al proposed that there is an increasing need in many chemical sensing applications ranging from environmental science to industrial process control as well as medical diagnostics for fast, sensitive, and selective trace gas detection based on laser spectroscopy. The recent availability of novel pulsed and continuous wave (cw) quantum and interband cascade distributed feedback (QC and IC DFB) lasers as mid-infrared spectroscopic sources addresses this need. A number of spectroscopic techniques have been demonstrated worldwide. The authors have employed infrared DFB QC and IC lasers for the detection and quantification of trace gases and isotopic species in ambient air at ppmv, ppbv and even sub-ppbv levels by means of direct absorption, cavity enhanced, photo acoustic and wavelength modulation spectroscopy. The performance optimization of various cw and pulsed single frequency QC and IC laser based trace gas sensors that use different sensitivity enhancement schemes and achieve minimum detectable absorbances (10-4 to 10-6) limited by laser, optical and detector noise sources have been described.

M.Maziarz et al demonstrates that wide-range wavelength tuning of semiconductor lasers can be achieved by applying high pressure and low temperature. They report the experimentally measured dependence of the threshold current and emission energy on pressure and temperature in InGaAs/GaAs quantum-well lasers and provide the simple theoretical explanation of the physics behind the experimental findings. Lasers based on InGaAs/GaAs heterostructures demonstrates that the possible tuning range of the emission energy is about 200 meV, if one uses 20 kbar cell, and 80 meV, if the device is cooled down from room temperature to 100 K. The increase in the emission energy happens also with almost constant output power in the whole tuning range. It is clearly shown that the simple model describes very well not only qualitative physics but also gives quantitative predictions that are in fairly good agreement with experiments.

D. Pendse et al addressed that the Aluminium-Free laser diodes are InGaAsP/GaAs devices whose epitaxial layers do not contain aluminium. They also compare the GaAlAs/GaAs and InGaAsP/GaAs high power laser diodes. It allegedly indicates that Aluminium-Free lasers are more reliable due to a reduction of dark-line defects, sudden failures, and gradual degradation. The present data shows that highly reliable GaAlAs/GaAs lasers can be produced with good manufacturing practices. Refinements in MOCVD epitaxial growth through use of high purity reagents, low-pressure and low-temperature growth techniques have lead to high quality epitaxial material with sharp interfaces. Uses of quantum well

structures have resulted in laser devices with high performance. Improved facet coatings and broad waveguide structures have significantly increased COD values. As a result, the power outputs have increased from milliwatts to several Watts with simultaneous increase in lifetime. Laser bars and arrays are in widespread use for achieving even higher powers. The improved reliability of Aluminium-Free lasers is presumed to result from the elimination of oxidation of the aluminium-containing epitaxial layers at the laser facets. So they reviewed and compared the performance and reliability of GaAlAs/GaAs and InGaAsP/GaAs high power laser diodes.

Garnachea et al have proposed that the DFB lasers, micro cavity and External-cavity VCSELs exhibit narrow single-frequency operation and wide mode-hop-free tuning range, especially well adapted for gas spectroscopy application in the 2-2.7 μ m window. They had presented a review of the results achieved and a systematic comparison, with such Sb-based lasers emitting near 2.3 μ m. These sources operate in CW above 300K, with up to 5mW output power in a single transverse mode and linear light polarization. Diode-pumped V(E)CSELs and electrically-pumped DFB lasers were designed, grown, processed, and the spectral, spatial, thermal properties characterized. These sources are now being applied in high sensitivity spectroscopy instruments for in-situ measurements.

L.W.Sung et al described the highly strained InGaAs/GaAs quantum wells grown at very low temperature (380 °C). The critical thickness of the In_{0.38}Ga_{0.62}As quantum well is 8.8 nm and the photoluminescence peak is at 1.24 μ m. An edge-emitting In_{0.388}Ga_{0.612}As/GaAs quantum-well laser demonstrates an emission wavelength of 1.244 μ m at 18 °C. The threshold current density is 405 A/cm² for an as-cleaved diode laser with 873- μ m cavity length. The internal quantum efficiency and laser cavity loss are 93% and 6.4 cm⁻¹. The high characteristic temperature T₀, that comes from better electron confinement, and the availability of AlAs/GaAs distributed Bragg reflector that can be directly deposited in vertical-cavity surface-emitting laser fabrication make GaAs-based long-wavelength lasers outperform the currently used InP-based lasers. The authors have demonstrated a highly strained InGaAs QW laser with low threshold current density grown by low-temperature-growth method. Moreover, the proper growth control of highly strained InGaAs QW growth is also an important step in the optimization of InGaAsN QW lasers. Different approaches, such as the introduction of GaAsP strain-compensated barrier, and the use of Sb surfactant, have been applied to inhibit the relaxation of highly strained InGaAs QWs grown on GaAs substrate, and extended the transition wavelength to 1,200.

Craig Angelos et al have conducted a numerical study on spreading of the current in a bottom emitting Vertical Cavity Surface Emitting Laser (VCSEL) with oxidation at the substrate. It was found that the current density profiles of etched VCSELs with small active diameters (< 125 micrometre) are similar to unetched VCSELs with a 500

micro metre active diameter. Vertical cavity surface emitting lasers (VCSELs) are a key advancement for optical interconnects in future micro photonics technology, resulting in a wide range of potential applications for a growing market of high power semiconductor lasers in medicine, material treatment, free space communications and laser pumping. In general, current VCSELs consist of a thin quantum well type active layer sandwiched between n and p-doped distributed Bragg reflectors (DBR), a technological breakthrough that serves as a high quality reflector. The purpose of the study was to obtain higher output powers through the simulation of current spreading with the oxidation of the AlAs layer at the substrate, than oxidation at the active region. By oxidation at the substrate, current crowding effects in conventional VCSELs are eliminated and the desired fundamental mode lasing is encouraged for higher output powers than previously reported through experimental fabrication and numerical simulations. Depending on the geometrical and electrical-optical properties of the simulated unetched VCSELs, a required high output power VCSEL can be designed for specific applications. This can also be applied to etched VCSELs, as the simulated current density profiles of both the etched and unetched VCSEL are similar to each other. Technological limitations in the oxidation fabrication process have led to burning of large fabricated etched and un-etched VCSELs as a result of high temperatures at prolonged exposure times.

III.CONCLUSION

An extensive research is done in the applications of Quantum well laser diodes. From the literature the following conclusions are arrived at. By studying the dependence of the differential efficiency and the threshold current density on the LD cavity length, It is found that the internal losses in the layers of the grown heterostructures were $3-5 \text{ cm}^{-1}$ and the inversion current density was $80 - 120 \text{ A cm}^{-2}$. InAsSbN diodes are widely used in optical communication systems. Threshold current density for can be reduced with Rapid Thermal Annealing (RTA). It is due to the decrease in the non-radioactive recombination centers upon RTA. Room temperature operation will be possible by the improvements of the laser structure as well as optimization of RTA conditions. In Quantum well InGaAs/(Al)GaAs structures, high emission power can be achieved with high characteristic temperature, low series resistance of the emitting element. For a QW structure with a resonant state, Laser operations with photon frequencies as lower as 1THz can be obtained by adjusting the relative energies of the strain-split localized states and the continuous states. Band gap measurements indicate that quantum well structures for ZnCdSe/ZnCdMgSe these structures could be used in entirely lattice-matched blue, green and yellow wavelengths. The advances in mirror coating and epilayer-down die bonding leading to even better device performance, and the current state of quantum cascade laser technology was studied.

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Composites and its Interfaces

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should be highly resistant to chemical attack or to penetration of species from the environment.

Abstract— The composite materials are displacing the traditional engineering materials. Nevertheless, the manufacturing of multifunctional composites based on nanostructures is still open. The study of the interfacial properties of the composite is important to enhance the properties of the composites. This paper reviews the important interfacial properties responsible for the mechanical properties of CNT-reinforced composite. The effect of both soft and stiff interfaces on the Tensile Elastic Modulus (TEM) of nanocomposites is investigated for the case of both long and short CNTs. With the increase of thickness of stiff interface, the stiffness of the composite increases significantly for both the short and long CNT cases. On the other hand the increase of thickness of soft interface reduces the stiffness of the overall composite in a considerable amount. This paper reviews the main technical activities in this field, focusing on the most important parameters that influence the behavior of their interface.

Keywords:- Composites, Carbon nanotube, Stiff Interface, Soft Interface, Tensile Elastic Modulus.

I. INTRODUCTION

Composites are made up of individual materials referred to as constituent materials. There are two categories of constituent materials: matrix and reinforcement. At least one portion of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combination.

The interface between matrix and reinforcement is important in all types of composite material. The nature of the interface can influence various aspects of the performance of the composite.

For example, it may be essential to ensure that load is transferred efficiently between the two constituents, so as to capitalise on the high load-bearing capacity of the reinforcement. This can be particularly important if the aspect ratio of the reinforcement is relatively low. In other cases, it may be desirable for the mechanical characteristics of the interface to be such that debonding can occur, so as to deflect propagating cracks within the material and thus to promote energy absorption and raise the toughness. A further requirement concerning the interfacial region may be that it

Note that there is no one-material-fits-all solution in the engineering world. Also, the characteristic factors may not always be positive in all applications. An engineer has to weigh all the factors and make the best decision in selecting the most suitable material(s) for the project at hand.

Composites have been widely used in a wide variety of products, e.g., advanced spacecraft and aircraft components, boat and scull hulls, sporting goods, sensor/actuator, catalysts and pollution processing materials, biomedical materials, and batteries, etc.

II. COMPOSITES

Composites are the combination of two different materials which have different properties. The aim is to get good output property of the resultant material. In a composite, the properties of the materials are shared. Generally, a composite material is composed of reinforcement (fibers, particles, flakes, and/or fillers) embedded in a matrix (polymers, metals, or ceramics). The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. When designed properly, the new combined material exhibits better strength than would each individual material.

Fibers or particles embedded in matrix of another material are the best example of modern-day composite materials, which are mostly structural.

Laminates are composite material where different layers of materials give them the specific character of a composite material having a specific function to perform. Fabrics have no matrix to fall back on, but in them, fibers of different compositions combine to give them a specific character. Reinforcing materials generally withstand maximum load and serve the desirable properties.

Further, though composite types are often distinguishable from one another, no clear determination can be really made. To facilitate definition, the accent is often shifted to the levels at which differentiation take place viz., microscopic or macroscopic.

In matrix-based structural composites, the matrix serves two paramount purposes viz., binding the reinforcement phases in place and deforming to distribute the stresses among the constituent reinforcement materials under an applied force.

The demands on matrices are many. They may need to temperature variations, be conductors or resistors of electricity, have moisture sensitivity etc. This may offer



weight advantages, ease of handling and other merits which may also become applicable depending on the purpose for which matrices are chosen.

Solids that accommodate stress to incorporate other constituents provide strong bonds for the reinforcing phase are potential matrix materials. A few inorganic materials, polymers and metals have found applications as matrix materials in the designing of structural composites, with commendable success. These materials remain elastic till failure occurs and show decreased failure strain, when loaded in tension and compression.

Composites cannot be made from constituents with divergent linear expansion characteristics. The interface is the area of contact between the reinforcement and the matrix materials. In some cases, the region is a distinct added phase. Whenever there is interface, there has to be two interphases between each side of the interphase and its adjoint constituent. Some composites provide interphases when surfaces dissimilar constituents interact with each other. Choice of fabrication method depends on matrix properties and the effect of matrix on properties of reinforcements. One of the prime considerations in the selection and fabrication of composites is that the constituents should be chemically inert non-reactive.

III. CLASSIFICATION OF COMPOSITE MATERIALS

Since the reinforcement material is of primary importance in the strengthening mechanism of a composite, it is convenient to classify composites according to the characteristics of the reinforcement. The following three categories are commonly used.

1. Fiber Reinforced – In this group of composites, the fiber is the primary load-bearing component.
2. Dispersion Strengthened – In this group, the matrix is the major load-bearing component.
3. Particle Reinforced – In this group, the load is shared by the matrix and the particles.

A. Fiber Reinforced Composites

Fiberglass is likely the best known fiber reinforced composite but carbon-epoxy and other advanced composites all fall into this category. The fibers can be in the form of long continuous fibers, or they can be discontinuous fibers, particles, whiskers and even weaved sheets. Fibers are usually combined with ductile matrix materials, such as metals and polymers, to

make them stiffer, while fibers are added to brittle matrix materials like ceramics to increase toughness. The length-to-diameter ratio of the fiber, the strength of the bond between the fiber and the matrix, and the amount of fiber are variables that affect the mechanical properties. It is important to have a high length-to-diameter aspect ratio so that the applied load is effectively transferred from the matrix to the fiber.

Fiber materials include:

- a) Glass – glass is the most common and inexpensive fiber and is usually used for the reinforcement of polymer matrices. Glass has a high tensile strength and fairly low density (2.5 g/cc).
- b) Carbon-graphite - in advance composites, carbon fibers are the material of choice. Carbon is a very light element, with a density of about 2.3 g/cc and its stiffness is considerably higher than glass. Carbon fibers can have up to 3 times the stiffness of steel and up to 15 times the strength of construction steel. The graphitic structure is preferred over the diamond-like crystalline forms for making carbon fiber because the graphitic structure is made of densely packed hexagonal layers, stacked in a lamellar style. This structure results in mechanical and thermal properties are highly anisotropic and this gives component designers the ability to control the strength and stiffness of components by varying the orientation of the fiber.
- c) Polymer – the strong covalent bonds of polymers can lead to impressive properties when aligned along the fiber axis of high molecular weight chains. Kevlar is an aramid (aromatic polyamide) composed of oriented aromatic chains, which makes them rigid rod-like polymers. Although very strong in tension, it has very poor compression properties. Kevlar fibers are mostly used to increase toughness in otherwise brittle matrices.
- d) Ceramic – fibers made from materials such as Alumina and SiC (Silicon carbide) are advantageous in very high temperature applications, and also where environmental attack is an issue. Ceramics have poor properties in tension and shear, so most applications as reinforcement are in the particulate form.
- e) Metallic - some metallic fibers have high strengths but since their density is very high they are of little use in weight critical applications. Drawing very thin metallic fibers (less than 100 micron) is also very expensive.

B. Dispersion Strengthened Composites

In dispersion strengthened composites, small particles on the order of 10⁻⁵ mm to 2.5 x 10⁻⁴ mm in diameter are added to the matrix material. These particles act to help the matrix resist deformation. This makes the material harder and stronger. Consider a metal matrix composite with a fine distribution of very hard and small secondary particles. The matrix material is carrying most of the load and deformation is accomplished by slip and dislocation movement. The

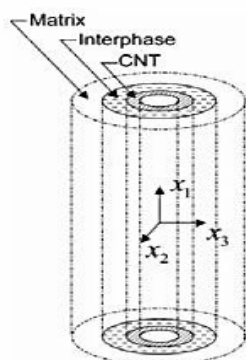
secondary particles impede slip and dislocation and, thereby, strengthen the material. The mechanism is that same as precipitation hardening but effect is not quite as strong. However, particles like oxides do not react with the matrix or go into solution at high temperatures so the strengthening action is retained at elevated temperatures.



C. Particle Reinforced Composites

The particles in these composite are larger than in dispersion strengthened composites. The particle diameter is typically on the order of a few microns. In this case, the particles carry a major portion of the load. The particles are used to increase the modulus and decrease the ductility of the matrix. An example of particle reinforced composites is an automobile tire which has carbon black particles in a matrix of polyisobutylene elastomeric polymer. Particle reinforced composites are much easier and less costly than making fiber reinforced composites. With polymeric matrices, the particles are simply added to the polymer melt in an extruder or injection molder during polymer processing. Similarly, reinforcing particles are added to a molten metal before it is cast

IV. COMPOSITE INTERFACES



The interface is a bounding surface or zone where a discontinuity occurs, whether physical, mechanical, chemical etc. The matrix material must "wet" the fiber. Coupling agents are frequently used to improve wettability. Well "wetted" fibers increase the interface surface area. To obtain desirable properties in a composite, the applied load should be effectively transferred from the matrix to the fibers via the interface. This means that the interface must be large and exhibit strong adhesion between fibers and matrix. Failure at the interface (called debonding) may or may not be desirable. This will be explained later in fracture propagation modes. Bonding with the matrix can be either weak van der Waals forces or strong covalent bonds. The internal surface area of the interface can go as high as 3000 cm²/cm³. Interfacial strength is measurable.

The matrix, besides holding the fibers together, has the important function of transferring the applied load to the fibers. It is of great importance to be able to predict the properties of a

composite, given the component properties and their geometric arrangement. An interphase can be both soft and stiff compared to the matrix.

Interphase is inevitable in the production of polymer matrix composites due to several reasons. Among these the presence of absorbed contaminants on the fiber surface, diffusion of

chemical species to the interface between fiber and matrix, acceleration or retardation of polymerization at the interface, the deliberate inclusion of sizing resin at the time of fiber manufacture are mainly responsible for interphase generation. Both Scanning Force microscopy (SFM) and Scanning probe microscopy (SPM) have been used to examine the mechanical and thermal properties of nanocomposites in the immediate vicinity of reinforcing carbon nanotubes. It is also established experimentally that an interphase can be both soft and stiff compared to the matrix.

From their previous investigations it is found that the single walled zigzag nanotubes would induce higher interfacial bonding stress at both bonded end regions.

Previously in most molecular dynamics model, nonbond interaction between carbon nanotube and polymer matrix was considered.

But Frankland et al shows that even a relatively low density of cross-links between fiber and matrix can have a large influence on the properties of nanotube/polymer interface.

From the investigation of Lu et al it was obtained that adding a small amount of coiled carbon nanotubes, instead of the straight ones, to the polymer-based materials can improve the thermal and mechanical properties of composite, as well as the bonding strength at the interface. The effects of an interphase layer between the nanotubes and the polymer matrix as result of fictionalization is also investigated using a multilayer composite cylinders approach.

Thus effective properties associated of CNT based composites can be greatly changed by the presence of an interphase region, particularly if that interphase region is a compliant interphase and therefore representative of poor load transfer from the matrix to the fiber.

Various previous researches has explored interphase thickness, volume fraction, poisson's ratio and stiffness effect on the axial modulus, transverse modulus, axial shear modulus and transverse shear modulus of carbon nanotube based composites.

The interphase thickness is varied relative to matrix and CNT thickness, to examine the effect on the TEM of polymer composites in case of both soft and stiff interphases. Both long and short CNT models are examined to observe this effect.

In previous studies, in order to investigate interphase thickness effect, thickness is widely varied between 0.2 nm to 3 nm. But in most of the cases, interphase thickness varies from 0.5 times to 4 times the CNT thickness. In the present study interphase thickness is varied from 0.5 times to 2.0 times CNT thickness (which is a thin interphase) in order to investigate

whether thin interphase thickness variation significantly affect the TEM of nanocomposites and the range considered here is also reasonable.

In previous studies, in order to investigate interphase thickness effect, high TEM of the matrix has been considered



that corresponds to the thermosetting plastic²⁰. In this work the matrix material and interphase stiffness is varied within a narrow range and is taken around 2.5 to 15 GPa which is corresponding to thermoplastic polymer (thermoplastic ethylene, polypropylene etc.). Here comparatively low value of TEM of matrix and interphase stiffness is considered; as a result interphase thickness effect will be conspicuous. Previous researchers has considered the interface thickness effect on TEM of CNT based nanocomposites.

i. Effect of Soft Interphase Thickness

From the previous investigation and simulation results obtained from FEM it is found that for both long and short CNT based polymer composite effective tensile modulus (TEM) of elasticity decreases with increase in the thickness of the soft interphase.

With the increase of interphase thickness, volume fraction of interphase also increases from 0 to 10.95 % in the composite. Stiffness (TEM) of this interphase is less than the matrix (soft interphase). The increased percentage of soft interphase decreases the stiffness of composite in this case. For long fiber the TEM of nanocomposites decreases almost 1% with the increase of only 0.8 nm interphase thickness. But for the short CNT, the TEM of composite decreases to 3.86 % with the increase of 0.8 nm interphase thickness. It seems interphase thickness affects short CNT more than the long CNT.

The maximum first principal stresses developed in the polymer based CNT composite also decreases with the increase of the thickness of the soft interphase for both the case of long and short CNT. Soft interphase load carrying and transfer capability is less than the matrix. As a result maximum first principal stresses of nanocomposites decreases in this case.

ii. Effect of Stiff Interphase Thickness

For long CNT based polymer composite effective tensile modulus (TEM) of elasticity increases with increase in the thickness of the stiff interphase. As the stiff interphase elastic modulus is higher than matrix, with the increase of its volume fraction (0% to 10.95%) in nanocomposites the TEM of composite increases in this case.

For short CNT based composite the TEM of composite also increases with the increase of interphase thickness. Increase of the stiffness of the composite is significant in the axial direction though the rate of increment of the interphase thickness is not rapid. While the increase in TEM is only 1.1 % for long CNT it is 4.03 % for short CNT. It seems interphase thickness affects short CNT composites more than long CNT based composites. The maximum first principal stresses developed in nanocomposites increases with the increase of stiff interphase thickness for the case of long CNT. The rate of

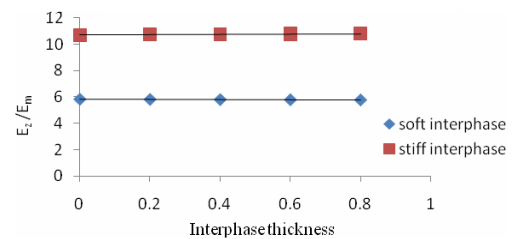
increase of the maximum first principal stresses decline with the increase of the thickness of stiff interphase.

But the maximum first principal stresses developed in the short CNT based composite decreases with the increase of the thickness of the stiff interphase. As the cross sectional area of

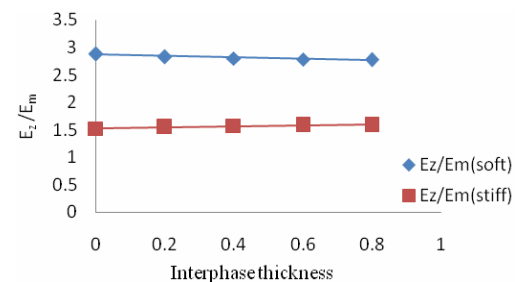
interface between CNT and matrix increases with the increase in interphase thickness, it results in larger end caps. These larger end cap areas take more transverse load than the smaller end caps though the load in the RVE is axial. This may lead to lower maximum first principal stresses of the composite with the increase in interphase thickness.

iii. Comparison Between Soft and Stiff Interphase

From the results it is found that, the TEM of composite increases in case of stiff interphase but decreases for soft interphase with the increase of interphase thickness. The results are similar for both the long and short CNT based composite. It is also observed that short fiber is more sensible than long fiber. The results are shown in Fig.2(a,b).



(a) Comparison Between soft and stiff interphase CNT Model (E_z/E_m Vs Thickness of interphase) for long CNT



(b) Comparison Between soft and stiff interphase CNT Model (E_z/E_m Vs Thickness of interphase) for short

All these results suggest that interphase thickness and volume fraction has significant effect on nanocomposites but short CNT based composite is induced more by the thickness variation.

Moreover increase in interphase stiffness can increase the stiffness of overall composite.

V. CONCLUSIONS

In this study the effective mechanical properties of carbon nanotube based composites, presented in several numerical examples, demonstrate that interphase thickness and stiffness has significant impact on the stiffness of composite. With only

about 0 to 0.8 nm of the interphase thickness variation in a matrix, the stiffness of the composite in the CNT axial direction can increase as many as 1.1 and 4.3 times for the cases of long and short CNT fibers, respectively. The conclusions that can be summarized are presented below:



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1. Thin interphase can affect considerably on the TEM of nanocomposites even if the change of thickness variation is comparatively less.

2. In case of soft interphase, effective tensile elastic modulus of elasticity decreases with the increase of the thickness for both long and short CNT based polymer composite.

3. In case of stiff interphase, effective tensile elastic modulus of elasticity increases with the increase of the thickness for both long and short CNT based polymer composite.

4. The effective tensile modulus (TEM) of elasticity of nanocomposites increases linearly with increase in the relative

stiffness of the interphase with the matrix for both the case of long and short CNT.

5. Short CNT is affected more than long CNT with the variation of interphase thickness and stiffness.

6. When interphase thickness is increased then stiff interphase is better than soft interphase because it exhibits much better mechanical properties of nanocomposites.

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Green synthesis of palladium nanoparticles using anti-cancer potent *Piper longum* leaves broth and their spectroscopic studies

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Abstract: Metal nanoparticles have been intensively studied in the past decade. Nanosized materials have been an important subject in basic and applied sciences. Environmentally harmless investigational process for green nanoparticles has potential applications in the areas of catalysis, medical, drug delivery and biosensors. In this paper, we report the green synthesis of palladium nanoparticles using *Piper longum* leaves extract as reducing and stabilizing agent. The optical properties of grown nanoparticles were investigated by UV-Vis spectra. Particle morphology and size was estimated by Transmission electron microscopy, structural properties of palladium nanoparticles were characterized by selected area electron diffraction and X-ray diffraction. The presences of the bio-organic moieties, which are responsible for the formation of palladium nanoparticles and were analyzed with the Fourier transform infrared spectroscopy.

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Palladium nanoparticles: Single-step biological preparation using Karpuravalli leaves broth and their Characterization

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Abstract: The green synthesis of metal nanoparticles has made broad spectral progress in recent times due to their novel optical, catalytic, chemical and electronic properties. In recent years, the utilization of bio-organic moieties from different biological sources has a modern technology for the nanoparticles synthesis. We fabricate the palladium nanoparticles using *Karpuravalli* leaf extract as reducing and capping material, it can reduce the toxic chemicals, multiple steps in synthesis procedure and environmentally harmless. The surface plasmon resonance of growing palladium nanoparticles was investigated by UV-Vis spectra. Particle morphology and size was estimated by Transmission electron microscopy, crystalline nature of the palladium nanoparticles were characterized by selected area electron diffraction and X-ray diffraction. The presences of the bio-organic moieties, which are responsible for the formation of palladium nanoparticles and were analyzed with the Fourier transform infrared spectroscopy.

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A Study of Wideband Code Division Multiple Access Codes

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Abstract -We propose this survey report gives an overview on various codes used in W-CDMA. The proposed WCDMA method can be used to multiplex users by distinct codes and in this method all the users share the same bandwidth. The important feature of this method is to increase the resource utilization like the number of users and to enhance the performance of WCDMA using different QOS profile configuration.

Wideband Code Division Multiple Access (WCDMA) is the air interface for one of the International Telecommunications Union's (ITU's). W-CDMA is an ITU standard derived from Code-Division Multiple Access (CDMA), is officially known as IMT-2000 direct spread. W-CDMA is a third-generation (3G) mobile wireless technology that promises much higher data speeds to mobile and portable wireless devices than commonly offered in today's market. It Provides a global mobility with wide range of services support like mobile/portable voice, images, telephony, broadband data, messaging and video communications at up to 2 Mbps (local area access) or 384 Kbps (wide area access). The input signals are digitized and transmitted in coded, spread-spectrum mode over a broad range of frequencies. A 5 MHz-wide carrier is used, compared with 200 KHz-wide carrier for narrowband CDMA.

The Process of different codes are allocated to different connections is called as Code Assignment. Here the User can perform different operations with different codes. It is mainly used to reduce the new call blocking probability and thus improve the system utilization for W-CDMA.



The effect of nano materials in the development of nano technology

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Abstract - Nanoparticles or nanocrystals made of metals, semiconductors, or oxides are of particular interest for their mechanical, electrical, magnetic, optical, chemical and other properties. The Aviation Industry depends on reduction of weight, availability of materials with multifunctional properties, eco-friendly fuels, less fuel consumption, faster and highly responsive communication systems, less or no repairs, extended and safe life, reduced time frame of development cycle from concept to implementation and many material-based catalysts. In Airframe Structure Light Weight, High Strength, High Toughness, Corrosion Resistance, Easy Reparability & Reusability, Less Maintenance & Durability. Nanomaterials finding application in these markets include nanoclays, carbon nanotubes, metal nanoparticles, nanofibers, fullerenes and POSS, and more recently graphene and nanocellulose.



RECENT DEVELOPMENTS IN NANO MATERIALS

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Abstract: Nanomaterials (nanocrystalline materials) is a field that takes a -based approach to. It studies materials with morphological features on the, and especially those that have special properties stemming from their nanoscale dimensions. Nanomaterials (nanocrystalline materials) are materials possessing grain sizes on the order of a billionth of a meter. They manifest extremely fascinating and useful properties, which can be exploited for a variety of structural and non-structural applications. There are many types of intentionally produced nanomaterials, and a variety of others are expected to appear in the future. An important aspect of nanotechnology is the vastly increased ratio of surface area to volume present in many nanoscale materials, which makes possible new quantum mechanical effects. One example is the "quantum size effect" where the electronic properties of solids are altered with great reductions in particle size. This effect does not come into play by going from macro to micro dimensions. However, it becomes pronounced when the nanometer size range is reached. A certain number of physical properties also alter with the change from macroscopic systems. Novel mechanical properties of nanomaterials is a subject of nanomechanics research. Catalytic activities also reveal new behaviour in the interaction with biomaterials.

X- RAY DIFFRACTOMETER



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