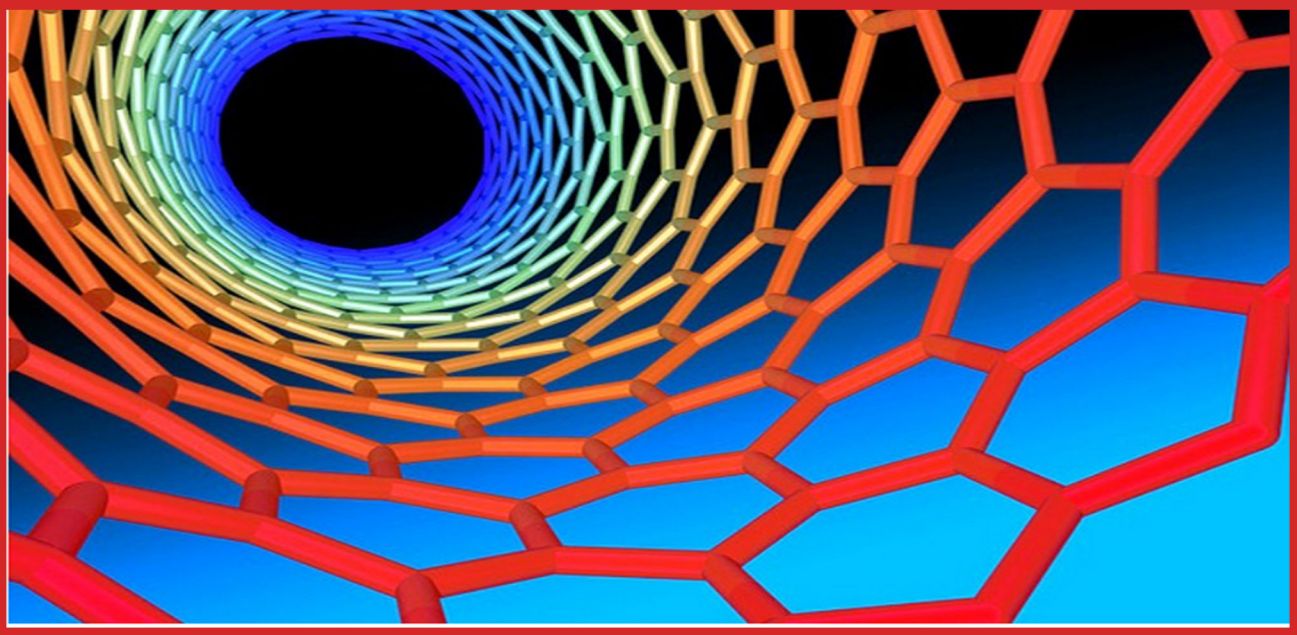
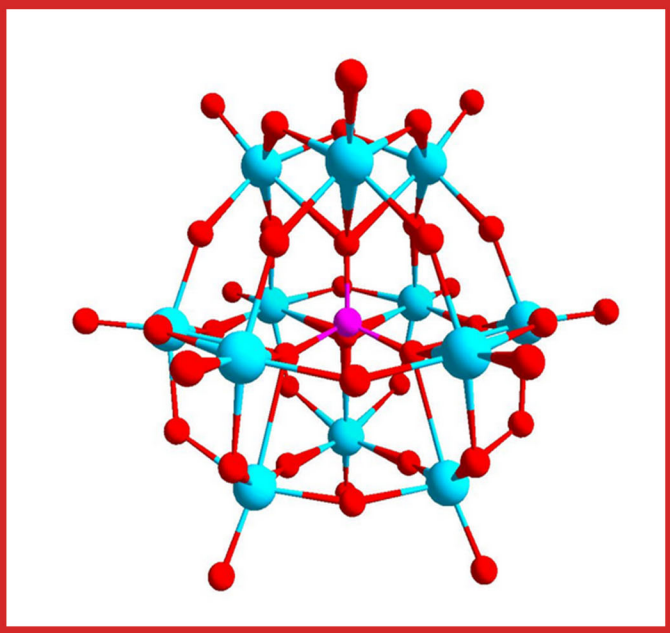
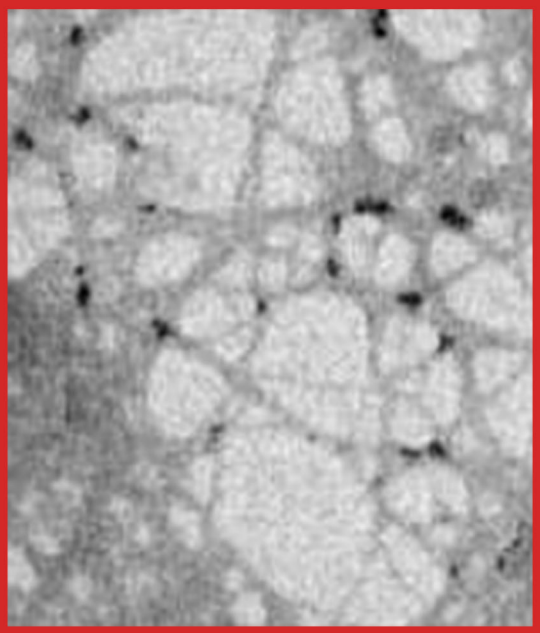
NEWSLETTER

2021-2022







COVER STORY:

Functional Materials: Fuelling the Future

NATIONAL INSTITUTE OF TECHNOLOGY TIRUCHIRAPPALLI 1964

CHEMICAL ENGINEERING ASSOCIATION
NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

ALCHEMY

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THEME OF THIS EDITION

NEXT-GEN ENGINEERING MATERIALS

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In today's day and age, when there is ever-increasing attention on the health of our environment, it is only logical that every chemical engineer plays their part in helping the cause. As chemical engineers, we often deal with the manufacturing and processing of materials put to use commercially. But we shouldn't forget that on the research side of things, there is always a buzz around synthesizing new materials that comply with today's lofty standards of nature compatibility.

One branch of materials that have started to gain attraction over the past decade is functional materials. Functional materials are those materials that have a unique and specific function. Most functional materials arise from composites or advanced materials, growing the possibilities of modern material science. Scientists and researchers usually go with a bottom-up approach for synthesizing functional materials because we often require specific properties, and they will need to be built meticulously. Also worth noting is the fact that advancements in nanotechnology have helped us expand the horizons of material synthesis.

The Students have taken up the right theme and Wish them a successful career as process engineers od next generation

ALCHEMY'22

EX-COM

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ANUPRIYA

GUEST LECTURES

ADITI PATIL

SRIVIDYA

MARKETING

MADHU

SHASHWAT

WEBOPS

VISWA

PRANAV

SHREYA

CONTENT

SHYAM

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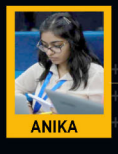
DESIGN



ANIKA

ANUSHA

RIYANSHI

RAHUL

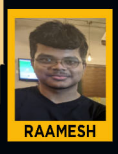
EVENTS

GOVARDHAN

MANOJ KUMAR

GAAYATHRI

PR & HOSPITALITY



RAAMESH

YEDAMALLA

JANAGAN

VAMSI

WORKSHOPS

MONEESH

ARVINDH RAJ

VARSHINI

PUBLICITY

HISTORY OF DEPARTMENT

The history of chemical engineering at NIT is inextricably bound with the history of the discipline itself. Established in 1967, the Department of Chemical Engineering, NIT Tiruchirappalli, is regarded as one of the premier centres for Chemical Engineering in India by industries and academia. It also distinguishes being ranked as one of India's top seven Chemical Engineering divisions with a group of well-qualified faculty, staff, and motivated students. The Department's vision is to be a global centre of academic and research excellence to serve society. It's the first HOD Ibrahim This course was designed to meet the needs of students who desire a general training in mechanical engineering and a portion of their time to study of applications of chemistry to the arts, especially to those engineering problems that relate to the use and manufacture of chemical products.

In 1968, the Department of Chemistry granted Bachelor's degrees for Chemical Engineering, the first of their kind to be bestowed anywhere. After Dr. Ibrahim's death, esteemed Professors led the program through a continued rise in popularity. It began a new era and the be ginning of the Ph.D. in 1973 and the first Mtech in 1975. In 1974, NIT became one of la new era and the beginning of the Ph.D. in 1973 and the first Mtech in 1975. In 1974, NIT became one of India's first schools to award Ph.D. degrees in chemical engineering. Since that time, the the Department of Chemical Engineering has led the nation in awarding graduate degrees. With over 6,000 living alumni, the Department's remarkable history is alive and continuing to make an impact in research labs, corporate R&D facilities, and universities around the world.

OVERVIEW OF ALCHEMY '21

With the vision of enhancing the knowledge and enthusing an intelligent community of chemical engineers, the Chemical Engineering Association was set up under the Department of Chemical Engineering at National Institute of Technology, Tiruchirappalli. It stands as a stage for sharing ideas, developing technical expertise and gaining valuable knowledge for students from all over India that are interested in Chemical Engineering.

Alchemy, the Chemical Engineering technical symposium organized by the institute is among the best Chemical Engineering symposia in India. Under the broad wings of Alchemy fall insightful Guest Lectures by eminent personalities, informative workshops on in-demand technologies that are essential for the chemical engineer and innovative competitions for future chemical engineering pioneers.

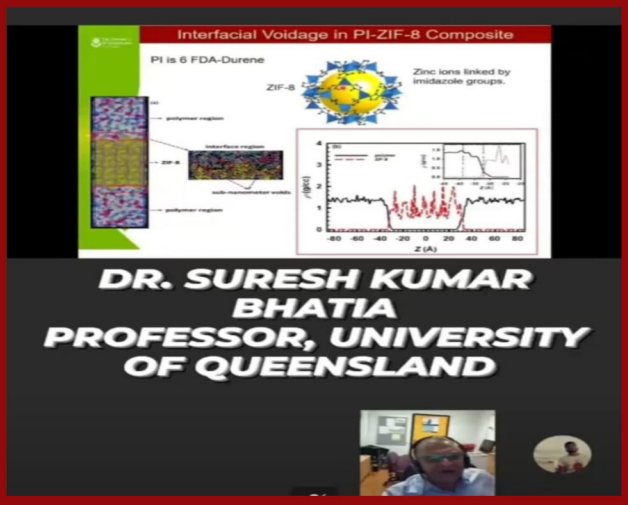
Owing to the pandemic, Alchemy '21 swiftly transitioned into a virtual gathering with most of the events taking place over the three days - between April 23rd and April 25th 2021. Students and members of the chemical engineering community from all over India took part and made sure that this online edition of Alchemy on par with its previous editions in terms of success.

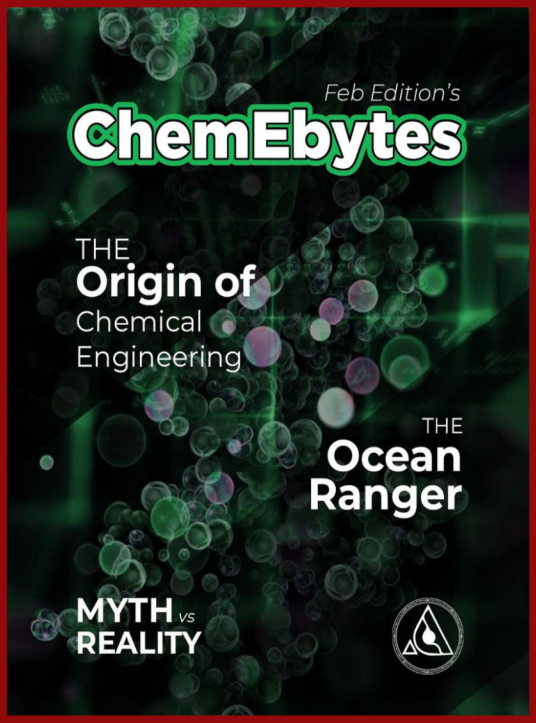
Across the three days, students got the opportunity to partake in three workshops and three events. The workshops were on the essential technologies MATLAB and ASPEN, along with one on research paper writing. Paper presentation and a chemical engineering quiz were among the events conducted. Apart from these, a special event ' Safe-a-thon' was conducted in January which encouraged participants to apply their analytical skills to problems involving chemical engineering safety.

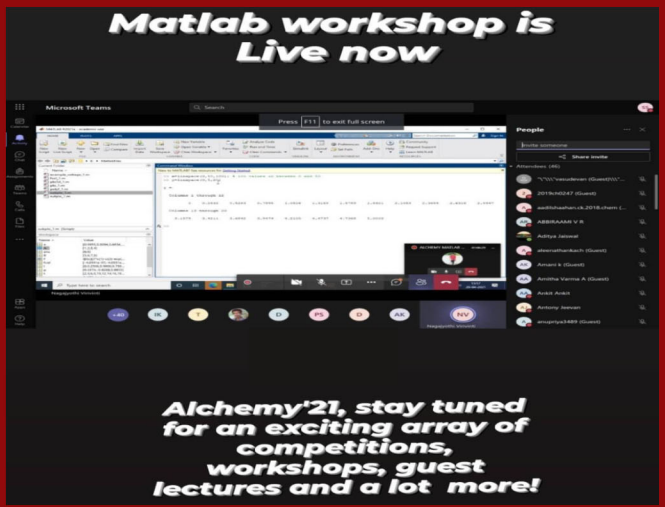
Guest Lectures were rendered by Dr. Sudhhasatwa Babu, the Director of CSIR-IMMT and Dr. Suresh Kumar Bhatia, Professor at University of Queensland on topics covering entrepreneurship and design of composite membranes for gas separation.

This edition of Alchemy was sponsored by Dare2Compete, BadeLog.in and NoticeBard. Prizes worth 21000 INR were awarded to the winners. In every way, Alchemy '21 was a grand success.

OVERVIEW OF ALCHEMY'21







Functional materials: An Overview

Functional materials are widely used in various fields because of their excellent properties, such as magnetism, catalysis, electrical and optical properties, high specific surface area, and good mechanical properties.

Functional materials can be roughly divided into several types:

1. Carbon nanomaterials
2. Metal nanoparticles
3. Metal compounds
4. Supramolecular compounds
5. Composite functional materials

Scientists found that by using filters made of carbon nanotubes, pollutants could be removed more effectively from contaminated water as compared to common charcoal filters. CNTs have a very large surface area (e.g., 500 m2 per gram of nanotube) that gives them a high capacity to retain pollutants such as water soluble drugs.

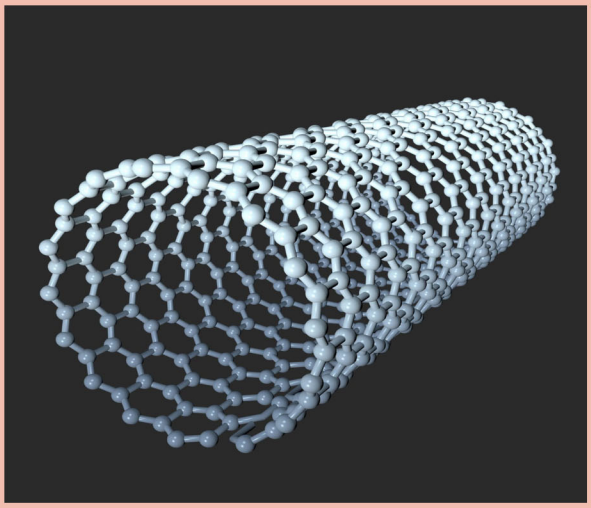


Fig 1: A typical carbon nanotube. Source-www.britannica.com

Carbon Quantum Dots (CQDs) are small carbon nanoparticles, less than 10 nm in size with passivated surfaces. The nontoxicity and biocompatibility of CQDs enable them with broad applications in biomedicine as drug carriers, fluorescent tracers as well as controlling drug release. This is exemplified by the use of CQDs as photosensitizers in photodynamic therapy to destroy cancer cells.

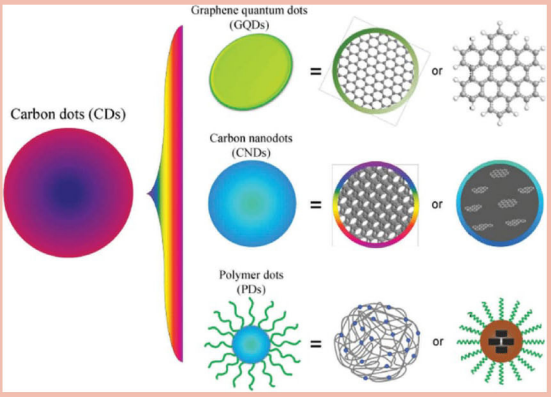


Fig 2: Carbon Quantum Dots. Source- Advances in Physics

Silver nanoparticles are most widely used sterilizing nanomaterial in consuming and medical products, for instance, textiles, food storage bags, refrigerator surfaces, and personal care products. It has been proved that the antibacterial effect of silver nanoparticles is due to the sustained release of free silver ions from the nanoparticles.

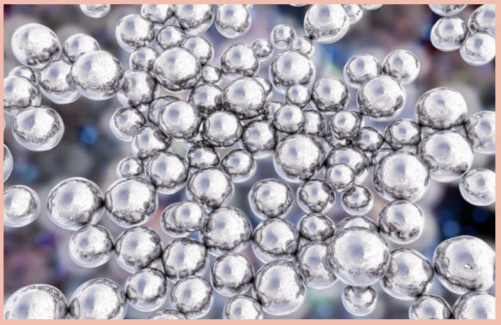


Fig 3: Silver nanoparticles. Source-www.azonano.com

Palladium nanoparticles on graphene oxide have also been used as recyclable heterogeneous catalysts for the reduction of nitroarenes using sodium borohydride. Since the recovered catalyst can be used for five cycles, it can be used on a large-scale reduction of nitroarenes.

It has also been used in the reduction of methylene blue, methyl orange and nitrophenol. The nanoparticles exhibited excellent degradation of the above dyes, and therefore, they can be used to treat the affluents containing dyes.

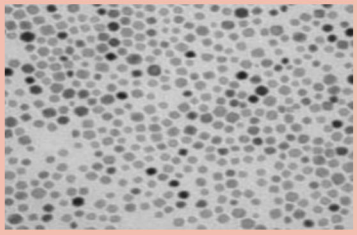


Fig 4: Palladium nanoparticles. Source- www.nanoshel.com

Cyclodextrins are a family of cyclic oligosaccharides, consisting of a macrocyclic ring of glucose subunits joined by α-1,4 glycosidic bonds. The inclusion compounds of cyclodextrins with hydrophobic molecules are able to penetrate body tissues, these can be used to release biologically active compounds, helping with drug delivery.

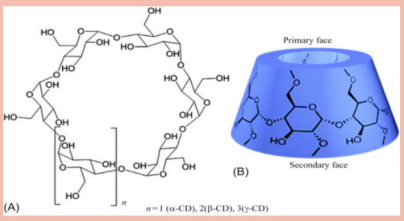


Fig 5: Structure of Cyclodextrin. ScienceDirect

A calixarene is a macrocycle or cyclic oligomer based on a hydroxyalkylation product of a phenol and an aldehyde.Calixarenes have hydrophobic cavities that can hold smaller molecules or ions. Calixarene-functionalized resins can be used to remove Cr(VI) from water during industrial wastewater treatment.

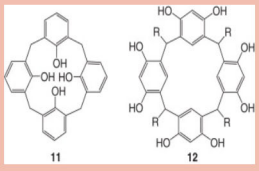


Fig 6: Calixarene structure. Source: ScienceDirect

Polypyrrole (PPy) is an organic polymer obtained by oxidative polymerization of pyrrole. It is a solid with the formula H(C4H2NH)nH. It is an intrinsically conducting polymer, used in electronics, optical, biological and medical fields.Together with other conjugated polymers such as polypyrrole has been studied as a material for "artificial muscles", and nerve-tissue engineering.

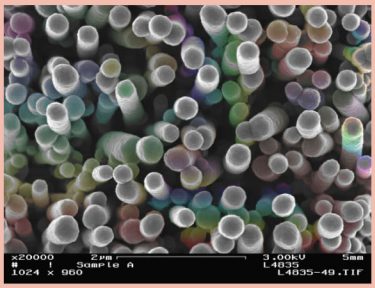


Fig 7: SEM image of Polypyrrole coating on carbon nanotubes. Source- Flickr

Manganese dioxide (MnO2) has emerged as one of the most promising electrode materials for high theoretical specific capacitance, wide potential range, high electrochemical activity, and environmental friendliness. Carbon-based nanomaterials are added to enhance the electrical conductivity of MnO2. MnO2- carbon composites can be used to manufacture supercapacitors in automobiles, buses, trains, cranes and elevators to supply short, intense bursts of power.

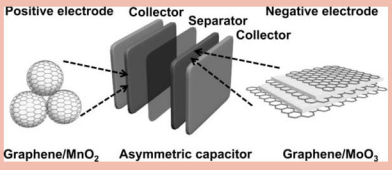


Fig 8: MnO2- graphene composite supercapacitor. Source- Wiley Online Library

Polymer Composites and Nanomaterials in Biomedical Applications

The biomedical engineering field serves the purpose of developing materials, instruments, and devices used in medical applications and diagnostic purposes. Furthermore, it tells us how a particular drug or material can be targeted to a site or tissue and how it achieves a therapeutic effect. Here we will discuss the role of materials in different medical applications. Polymers and nanomaterials are widely used materials in biomedical applications. We will discuss different types of polymer composites and nanomaterials used in various medical applications.

1. Polymers

Polymers have been widely used in different biomedical applications due to their high mechanical strength, biocompatibility, controlled degradation rate, non-toxic and biodegradable properties. One such polymer is Polycaprolactone, used in tissue regeneration support structures. Due to its long degradation profile, it is suitable for use in tissues with a longer regeneration process.

1.1 Cardio-related treatments

The stent and the pacemaker are biomaterials used in cardio-related treatments. Stents are used to prevent blood clots in the flow channels such as in the heart, peripheral arteries, veins and digestive system These materials are also used temporarily during surgical operations to keep such channels open For these purposes, polymer composites are better alternatives than stainless steel, , titanium due to their low cost and biodegradability. The pacemaker is a lightweight electrochemical system used to maintain the proper pumping and circulation of the blood in the heart by monitoring and controlling the heart rhythms. Composites have taken over the metals like platinum alloys nowadays due to their lightweight and resistance to corrosion.

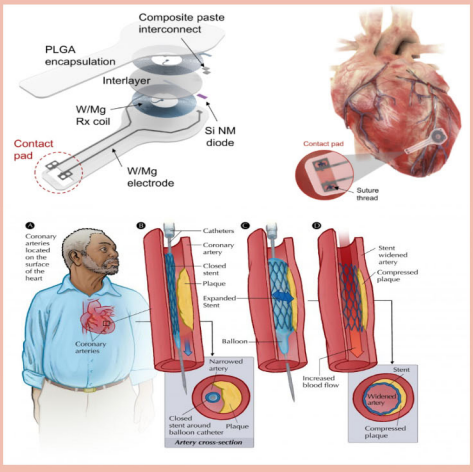


Fig. 1 : Polymer composites as Pacemakers and Stents

Source: physicsworld.com

1.2 Bone treatment

Polymeric composites such as poly 2-hydroxyethyl methacrylate (PHEMA) reinforced with polyethylene terephthalate (PET) can be used as cartilage which is soft and slightly flexible bone structure that can be found in the joints, nose, rib cage, and ears. Its main function is to connect bones together.

2.Nanomaterials.

Nanomaterials have wide applications in biomedical due to their nano size, and other properties like high stability, high carrier capacity, hydrophilicity, hydrophobicity makes it a more suitable material than polymers. They were used in drug transporting, gene delivery, pathogens and protein bio-detection, DNA structure probing, tissue engineering, tumor detection, purification of biological molecules

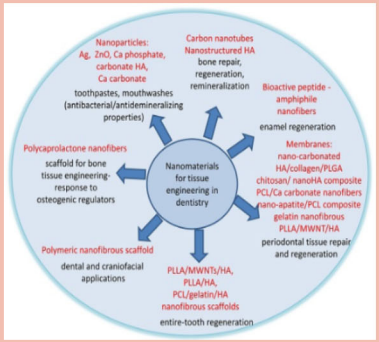


Fig. 2 : Nanomaterials in tissue engineering
Source: mdpi.com

2.1 Biosensors

Carbon nanotubes are one of the nanomaterials used as biosensors due to their exceptional electronic and optical properties. Due to its fast electron transfer rate property, it is being used to sense chemicals in a solution, for example, CNT-glucose biosensors are developed to sense glucose from a glucose oxidase-impregnated polyvinyl alcohol solution. These carbon nanotubes are also used as an anticancer molecule to target the cancer cells in the lymph nodes due to their non-spherical structure which makes them retain in the lymph nodes for a longer period. Iron oxide nanoparticles coated with peptides are used to enhance the Magnetic Resonance Imaging (MRI) scan images and gold nanoparticles are used in vitro diagnostics and cancer treatment.

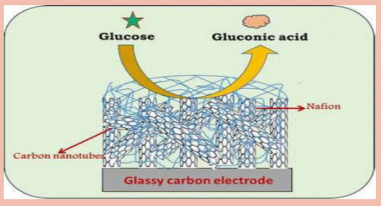
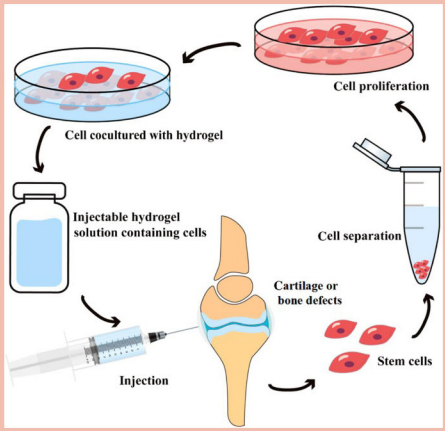


Fig. 3 : CNT-glucose biosensors
Source: researchgate.net

2.2 Nanomaterials in drug delivery

Polymers were widely used in the 1970s for transporting anti-tumor agents, proteins and peptides. It was during the late 1990s, nanocrystals came into existence. Diseases such as cancer, AIDS and cardiovascular devices can be treated using a new technique called as gene therapy. Here, the gene materials are transferred into the specific cells of a patient to supply defective genes responsible for disease development. The encapsulation of genes is necessary to avoid the disposition of macromolecules and degradation of the gene by serum until it reaches its target.



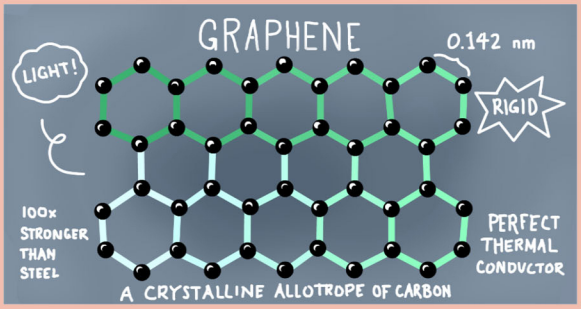
Source : Bone Research/nature.com

There are also challenges that are currently being faced in the nanotechnology field which will be addressed in the future to induce nanomaterials in the biomedical field.

Scope of Functional Materials in Energy Domain

In the past few decades, the world has become increasingly aware of the need for efficient and sustainable methods of energy production and storage. This awareness has led to significant research in improved energy applications, with the development and application of functional materials taking center-stage. These materials are employed in the capture, transformation, and storage of energy. Some also facilitate efficient utilization of already stored energy. Let's take a look at some of the functional materials that have shown promising results and may play a vital role in creating a sustainable future.

Graphene – Graphene is an allotrope of carbon consisting of a single layer of atoms arranged in a two-dimensional honeycomb lattice nanostructure. Justifiably hailed as "the wonder material of the 21st century", graphene has multiple exceptional properties. It's the world's strongest material, has excellent electrical and thermal conductivity, and it's thin, light, flexible and transparent. As for energy applications, it can be used to enhance energy storage and energy conversion. The performance of conventional batteries can be significantly improved by enhancing the electrode materials with graphene. It improves the charge/discharge cycle performance, increases capacity and extends battery life.Graphene can also be used in solar cells to make them more effective. Particularly, solar cells can make use of graphene's high conductivity and transparency.Supercapacitors can utilize graphene's larger surface area for better storage of charges,while also nbenefiting from its lightweight ature and mechanical strength.



Graphene illustration

Conducting polymers – Conducting polymers are organic polymers that can conduct electricity due to the presence of conjugated double bonds along the polymer backbone. Some examples are polyindole, polyaniline, and poly(3-alkylthiophenes). Conducting polymers have a wide range of applications. Their most promising application is in energy storage, but they have been studied and also shown results for use in organic solar cells, supercapacitors, fuel cells, chemical sensors, biosensors and much more. Such a range of applications is possible largely due to a number of desirable properties like a wide range of conductivity, mechanical stability, flexibility, lightweight nature, and ease of synthesis. It's particularly useful for energy storage applications due it's fast charge-discharge kinetics, high charge density, and low cost. They can also be easily nanostructured for specific applications, but such nanostructures can be fragile, difficult to reproduce on a scaled-up level, and can have poor electrochemical stability, which limits their applicability.

Cadmium telluride (CdTe) – Cadmium telluride is a stable crystalline compound formed from cadmium and tellurium. It's used to make thin film solar cells, which are the most common photovoltaic technology in the world after silicon based solar cells..

. The p-n junction solar cell is usually made by sandwiching CdTe with Cadmium Sulfide. CdTe thin film solar cell is more efficient than crystalline silicon PV cell, due to its high absorption. It has a bandgap energy of 1.4 to 1.5 eV, which is optimal for absorbing sunlight close to an ideal (shorter) wavelength, using just a single junction. Another appeal of CdTe solar PV cells is its low ecological impacts. CdTe thin film PV's greenhouse emissions are one of the lowest, and its environmental footprint, among the smallest. Although, there are still some environmental concerns about the production and disposal of the panels due to the toxic nature of cadmium. The limited abundance of tellurium may also be a cause of concern in the future.

The utility-scale Waldpolenz Solar Park in Germany uses CdTe PV modules
(JUWI Group, CC BY-SA 3.0 , via Wikimedia Commons)

HIGHLIGHTS OF OUR DEPARTMENT

•An appreciation award named, "Tech Samaritan" has been received from Institution of Engineers(IE) to a team of Myself, Dr. N.Anantharaman, Mr. Kannan, Mr. Robinson for in-house Sanitizer preparation during COVID

•A new annexure building has been inaugurated by the honorable Minister for Education, Government of India in the Golden Jubilee Celebration which is meant for enhancing the research facilities and also to accommodate the increased student strength.

• Our department has received the ‘’Best Department award for the year 2019-20” and continued to maintain its first position in 2021-22 too among engineering departments of NITT.

• Prime Minister Research Fellowship has been granted to two of our Research Scholars.

• The Department has organized an International Conference RTAMGESE’21 sponsored by Shastri Indo-Canadian Institute which involved National and International Speakers and participants.

• A guest lecture series was initiated by the Indian Institute of Chemical Engineers’ (IIChE) student chapter at NIT, Trichy on “Accelerating Materials Research by Computational Methodologies” by Dr. Y. Soujanya, CSIR-IICT with the aim of providing knowledge about recent trends in chemical engineering by inviting leading scientists from academia and industry from all over the world

• that our department has published 84 research articles in SCI and SCOPUS indexed journals and more than 50 % of them come under Q1 category with a significant number of citations and we have also published 5 book chapters.

• Apart from this, one patent is also granted.

• Department research activities are also supported by DST-FIST and various other schemes worth 135 lakhs.

• 5 Research Scholars have defended their thesis and were awarded PhD degrees in the year 2020-21.

• Our faculty members have delivered 43 guest lectures in various prestigious Institutions on various Research topics.

• Faculty members and Research Scholars have presented their research findings in a public forum and were awarded with Best Paper and poster awards.

• Two of our B.Tech students, Mr. Shivam Negi and Mr. S. Ananthanarayanan Potti has secured All India Rank 08 and 220 in GATE 2021, Chemical Engineering Stream.

ALCHEMY

alchemy.nitt.edu