The Biennial National Conference
supported by the
Department of Science and Technology

26th-27th APRIL 2019

Hosted by
International and Inter University Center for Nanoscience and Nanotechnology
Mahatma Gandhi University
Kottayam- 686 560, Kerala

contact@nanoindia2019.com
www.nanoindia2019.com
APRIL 26 – 27, 2019

Supported by
Department of Science and Technology

Hosted By
International and Inter University Centre for Nanoscience and Nanotechnology (IIUCNN)
Mahatma Gandhi University
Kottayam - 686560, Kerala, India
Foreword

“We keep moving forward opening new doors, and doing new things, because we are curious, and curiosity keeps leading us down new paths” an inspirational quote by Walt Disney expresses about the value of innovation. That is exactly true with our thirst to explore new findings that makes the world, what is today, we must always keep that sense of curiosity as the world has so much to explore.

Nanotechnology is a broad interdisciplinary area of research. Development and industrial activity in nanotechnology have been growing rapidly worldwide for the past decades. It is a multidisciplinary grouping of physical, chemical, biological, engineering and electronic processes, in which the defining characteristic is the size. It involves the manufacture, processing and application of materials that are in the size range of up to 100 nm.

Today, in the young field of nanotechnology, scientists and engineers are taking control of atoms and molecules individually, manipulating and putting them to use with an extraordinary degree of precision. World of the promise of the nanotechnology is spreading rapidly, and the air is thick with news of nanotech breakthroughs. There is still a wide range of processes being used, and those will be commercially successful. Recent reports from several working groups have highlighted the need for increased examination of the health, environmental, and ethical aspects of nanotechnology, and this is an area that the industry needs to understand more.

The associated research and applications are equally diverse, ranging from extension 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. To gain up-to-date knowledge we need to explore and review the current development and applications.

Mahatma Gandhi University, Kottayam, Kerala, India, and Department of Science and Technology, Government of India have over the years been instrumental in providing a platform for several collaborative research programmes involving scientists, technologists and other scholars from various countries. MGU have so far organised and played host too many national and international conferences with the linkages worldwide, MGU is also involved in collaborative research programmes with universities around the world.

MGU will now host the “Biennial National Conference Nano India 2019” to be held on 26th and 27th April 2019.

Young professionals and students will have the challenge of being rated competitively for the best poster presentation. The conference will be an ideal platform for the researchers to present their work, compare notes, develop new interfaces, exchange views and widen the scope and range of their research activity through dynamic networking.

We wish you all fruitful scientific sessions and a very pleasant stay in Kottayam.

Co-Patron
Prof. Sabu Thomas

Chairman
Prof. Ajay K. Sood

Convener
Dr. Nandakumar Kalarikkal
## TECHNICAL PROGRAMME SCHEDULE OF NANO INDIA 2019

<table>
<thead>
<tr>
<th>Time</th>
<th>Session 1</th>
<th>Session 2</th>
<th>Lunch Break</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:50 AM - 9:00 AM</td>
<td><strong>Inaugural Session</strong>&lt;br&gt;<strong>Venue:</strong> Auditorium - School of Chemical Sciences (SCS), Mahatma Gandhi University</td>
<td><strong>Invited Lectures</strong>&lt;br&gt;Venue: Auditorium - School of Pure and Applied Physics (SPAP)</td>
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<tr>
<td>8:50 AM - 9:00 AM</td>
<td><strong>Welcome</strong></td>
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<tr>
<td>9:00 AM - 9:15 AM</td>
<td><strong>Overview of Nano Mission:</strong>&lt;br&gt;<strong>Shri Milind Kulkarni</strong></td>
<td><strong>Prof. P.S. Anil Kumar (IL 01 A)</strong></td>
<td></td>
</tr>
<tr>
<td>9:15 AM - 9:30 AM</td>
<td><strong>Inaugural Address &amp; Inauguration:</strong>&lt;br&gt;<strong>Prof. C.N.R. Rao</strong></td>
<td><strong>Prof. G.U. Kulkarni (IL 02 A)</strong></td>
<td></td>
</tr>
<tr>
<td>9:30 AM – 9:45 AM</td>
<td><strong>Award Ceremony:</strong>&lt;br&gt;<strong>Nano Research Awards in Nano Science &amp; Technology - 2019</strong></td>
<td><strong>Dr. S. Vijayakumar (IL 02 B)</strong></td>
<td></td>
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<tr>
<td>9:45 AM - 9:55 AM</td>
<td><strong>Prof. C.N.R. Rao Birthday Celebration</strong></td>
<td><strong>Prof. Navkanta Bhat (IL 03 A)</strong></td>
<td></td>
</tr>
<tr>
<td>9:55 AM - 10:00 AM</td>
<td><strong>Vote of Thanks</strong></td>
<td><strong>Prof. S. Sampath (IL 04 A)</strong></td>
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</tr>
<tr>
<td></td>
<td><strong>Session 1</strong>&lt;br&gt;Nano Research Awardee Lecture:&lt;br&gt;<strong>Prof. O. N. Srivastava</strong></td>
<td><strong>Dr. Avinash Bajaj (IL 03 B)</strong></td>
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<tr>
<td>10:00 AM - 10:45 PM</td>
<td><strong>Plenary Lectures PL-01</strong>&lt;br&gt;Presentation Details**&lt;br&gt;Nano Research Awardee Lecture:&lt;br&gt;<strong>Prof. O. N. Srivastava</strong></td>
<td><strong>Prof. G.U. Kulkarni (IL 02 A)</strong></td>
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<tr>
<td>10:00 AM - 10:45 PM</td>
<td><strong>Photo Session &amp; Tea Break</strong>&lt;br&gt;Presentation Details**&lt;br&gt;Plenary Talk: PL-02&lt;br&gt;<strong>Prof. D.D. Sarma</strong></td>
<td><strong>Dr. S. Vijayakumar (IL 02 B)</strong></td>
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<tr>
<td>11:15 AM - 12:00 PM</td>
<td><strong>Plenary Talk: PL-02</strong>&lt;br&gt;<strong>Prof. D.D. Sarma</strong></td>
<td><strong>Prof. Navkanta Bhat (IL 03 A)</strong></td>
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<td>12:00 PM - 12:45 PM</td>
<td><strong>Plenary Talk: PL-03</strong>&lt;br&gt;<strong>Prof. Pushan Ayyub</strong></td>
<td><strong>Dr. Avinash Bajaj (IL 03 B)</strong></td>
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<td>12:45 PM - 1:15 PM</td>
<td><strong>Young Research Awardee Lecture:</strong>&lt;br&gt;<strong>Dr. Murali Banavoth</strong></td>
<td><strong>Prof. S. Sampath (IL 04 A)</strong></td>
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<tr>
<td>1:15 PM - 2:15 PM</td>
<td><strong>Lunch Break</strong></td>
<td><strong>Prof. R.S. Jayasree (IL 04 B)</strong></td>
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</tr>
</tbody>
</table>

### Session 2A

<table>
<thead>
<tr>
<th>Time</th>
<th>Invited Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:15 PM - 2:45 PM</td>
<td><strong>Prof. P.S. Anil Kumar (IL 01 A)</strong></td>
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<tr>
<td>2:45 PM - 3:15 PM</td>
<td><strong>Prof. G.U. Kulkarni (IL 02 A)</strong></td>
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<tr>
<td>3:15 PM - 3:45 PM</td>
<td><strong>Prof. Navkanta Bhat (IL 03 A)</strong></td>
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<tr>
<td>3:45 PM - 4:15PM</td>
<td><strong>Prof. S. Sampath (IL 04 A)</strong></td>
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<td>4:15 PM - 4:45 PM</td>
<td><strong>Dr. Anindya Das (IL 05 A)</strong></td>
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</tbody>
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### Session 2B

<table>
<thead>
<tr>
<th>Time</th>
<th>Invited Lectures</th>
</tr>
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<tbody>
<tr>
<td>2:15 PM - 2:45 PM</td>
<td><strong>Prof. Sandeep Varma (IL 01B)</strong></td>
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<tr>
<td>2:45 PM - 3:15 PM</td>
<td><strong>Dr. S. Vijayakumar (IL 02 B)</strong></td>
</tr>
<tr>
<td>3:15 PM - 3:45 PM</td>
<td><strong>Dr. Avinash Bajaj (IL 03 B)</strong></td>
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<tr>
<td>3:45 PM - 4:15PM</td>
<td><strong>Prof. R.S. Jayasree (IL 04 B)</strong></td>
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<tr>
<td>4:15 PM - 4:45 PM</td>
<td><strong>Prof. A. K. Ganguli (IL 05 B)</strong></td>
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</tbody>
</table>

### Session- 3 Tea Break & Poster Session

**Venue:** St. Mary's Forane Convention Center, Athirampuzha

### Cultural Program & Dinner

**Venue:** St. Mary's Forane Convention Center, Athirampuzha
<table>
<thead>
<tr>
<th>Time</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session 4 - Plenary Lectures</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Venue:</strong> Auditorium - School of Chemical Sciences (SCS)</td>
<td></td>
</tr>
</tbody>
</table>
| **09:00 AM - 09:45 AM** | Plenary Talk: PL 04  
Prof. K George Thomas                                                                    |
| **09:45 AM - 10:30 AM** | Plenary Talk: PL 05  
Prof. Sabu Thomas                                                                |
| **10:30 AM - 10:50 AM** | Tea Break                                                                 |
| **Session 5** | **Invited Lectures**                                                                 |
| **Venue:** Auditorium - School of Pure and Applied Physics (SPAP)                                                                 |
| **10:50 AM - 11:20 AM** | Prof. Samit K. Ray (IL 06 A)                                              |
| **11:20 AM - 11:50 AM** | Prof. Manish Jain (IL 07 A)                                                |
| **11:50 AM - 12:20 PM** | Prof. Rupa Mukhopadhyay (IL 08 A)                                          |
| **12:20 PM - 12:50 PM** | Dr. Avinash Parashar (IL 09 A)                                             |
| **12:50 PM - 01:50 PM** | Lunch Break                                                                 |
| **01:50 PM - 02:20 PM** | Dr. Yogesh Singh Chauhan (IL 10 A)                                         |
| **02:20 PM - 02:50 PM** | Prof. Subodh Kumar De (IL 11 A)                                            |
| **02:50 PM - 03:20 PM** | Prof. Prasenjit Sen (IL 12 A)                                              |
| **03:20 PM - 03:50 PM** | Dr. Sayan Bhattacharyya (IL 13 A)                                          |
| **03:50 PM - 04:10 PM** | Tea Break                                                                 |
| **04:10 PM - 04:40 PM** | Dr. Praveen Kumar (IL 14 A)                                                |
| **04:40 PM - 05:10 PM** | Prof. Dipankar Bandopadhyay (IL 15 A)                                      |
| **05:10 PM - 05:40 PM** | Prof. Vamsi K Komarala (IL 16 A)                                           |
| **05:40 PM - 07:00 PM** | Presentation of Poster awards, Closing Ceremony  
Venue: Auditorium - School of Chemical Sciences (SCS)                         |
| **Dinner** | |
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CO-PATRON
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Prof. Ajay K. Sood, FRS (Indian Institute of Science)

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Prof. Samit Ray, SN Bose Institute
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Prof. M K Jayaraj (CUSAT, Kerala)
ABSTRACTS

Plenary Lecture
Role of Nano Materials in Enhancing Viability of Climate Friendly Fuel: Hydrogen

Onkar Nath Srivastava
Nano-Science Unit, Dept. of Physics, Institute of Science, Banaras Hindu University, Varanasi
e-mail: heponsphy@gmail.com

Hydrogen is not just another alternative fuel. It is a class in itself. The Jupiter planet is made up completely of Hydrogen (Gaseous, Liquid and Solid). On our planet Earth, Hydrogen is available in plenty but not freely. It is available through hydrocarbon or water. It can be produced from either of these through some input energy. From the point of view being renewable and climate friendly hydrogen production through dissociation of water by solar energy i.e. photovoltaic, photoelectrochemical or photocatalytic electrolysis are viable routes. Production of Bio-hydrogen by agro and other waste are also feasible routes. In this presentation, we will discuss the role of nano-materials in shifting the total efficiency upward of photovoltaic driven electrolysis by enhancing the efficiency of the electrolysis component by using CNT-graphene composite based electrode.

As regards storage out of the three upcoming technologies namely high pressure gaseous, liquid hydrogen and solid state (hydride) storage modes, it is the last one namely hydride which is the safest and most efficient storage mode. We have carried out R&D on a variety of hydrides. Recent focus has been on MgH₂ which is one of the frontier storage materials (7.6 wt% and 110 kg/m³); (the required values of DOE are 4.5 wt% and 60 kg/m³). We have developed special nano catalyst to take care of the issues related with MgH₂, the high desorption temperature and slow kinetics. The details and effect of these catalysts on de/re-hydrogenation of MgH₂ will be discussed in detail. Another interesting light weight storage material is Li-Mg-N-H, admixed with quaternary additive (Li₄(NH₂)₃BH₄) and pulverizer cum co-catalyst ZrFe₂. The details of application of Hydrogen will be discussed.

Bio-Sketch

Professor O. N. Srivastava is a Professor of Physics. At present, he is the PI & Coordinator of Hydrogen Energy Centre and Nanoscience Unit, Department of Banaras Hindu University, Varanasi. He received Shanti Swaroop Bhatnagar Award in Physical Sciences, Awarded from Council of Scientific and Industrial Research, New Delhi, which is the top scientific award of the country. Apart from the he is a FNA: Fellow of Indian National Science Academy, New Delhi, FNASc.: Fellow of National Academy of Sciences, Allahabad. He achieved IPA Award (BARC) for Excellence in Applied Physics in 2014, Lifetime Achievement Award in the field of Electron Microscope-EMSI in 2014, and Padma Shri Award in 2016. He has a total of 700 research papers in International journals, 15 reviewed articles and 1 book. He guided 72 PhD theses. His major research areas include, Physics of Materials including Nano Materials: Carbon Nanotubes, Carbon Nanofibres, Graphene, Quantum Dots of Carbon and TiO₂, Composites of CNT/Graphene, Metal (Ag, An) Nanomaterials and TiO₂ nanotubes, Fe₃O₄ Graphene, NiCoFe@Graphene. Application of Nano Materials to Hydrogen Energy.
Electronic structure of the elusive metastable state in chemically exfoliated few layer MoS$_2$

D. D. Sarma

Solid State and Structural Chemistry Unit
Indian Institute of Science, Bengaluru 560012

An elusive metastable phase, existing only as small patches in chemically exfoliated few-layer, thermodynamically stable 2H phase of MoS$_2$ is believed to influence critically properties of MoS$_2$ based devices. Its electronic structure is little understood in absence of any direct experimental data and conflicting claims from theoretical investigations. I shall present data$^{1,2}$ to conclusively resolve this issue based on probing the electronic structure of chemically exfoliated few layer systems using spatially resolved photoemission spectroscopy and show that the dominant belief in the community is qualitatively incorrect, requiring reinterpretations of almost all existing literature claims. This work is carried out in collaboration with Banabir Pal, Anjali Singh, Sharada, G. Pratibha Mahale, Abhinav Kumar, S. Thirupathaiah, H. Sezen, M. Amati, Luca Gregoratti, Umesh V. Waghmare, Debasmita Pariari, Mit Naik, Rahul Varma, Maya Nair, Arindam Ghosh, and Manish Jain.

References
2. Debasmita Pariari et al., Unpublished results.

Bio-Sketch

D. D. Sarma obtained a 5-year Integrated MSc degree in Physics from Indian Institute of Technology, Kanpur in 1977 and a Ph.D. Degree in 1982 from Indian Institute of Science (IISc), Bangalore. He worked in Kernforschungsanlage, Jülich, Germany, as a Visiting Scientist during 1984-1986. Since 1986, he has been a faculty member at Solid State and Structural Chemistry Unit of IISc and currently he holds the J. N. Tata Chair of IISc. His research interest spans the science of strongly correlated electron systems, primarily based on transition metal compounds, and semiconductor nanocrystals using a wide range of experimental as well as theoretical tools. He has published more than 450 scientific papers and holds several patents. He is an elected Fellow of all three Science Academies and the Engineering Academy in India and The World Academy of Sciences (TWAS) and American Physical Society. He has received many national and international awards and recognitions, including multiple Honoris Causa Doctorate degrees. He has held a number of academic positions outside of his parent organisation (IISc), including many Honorary/Guest/Visiting Professorships, such as Gaspard Monge Visiting Professor at Ecole Polytechnique (May-July 2019), University Professor of “Computational Material Physics”, University of Vienna (May 2017), Guest Professor of Physics, Uppsala University (2011-2016), Visiting Professor at Department of Complexity Science and Engineering, University of Tokyo (2001-2002), Distinguished Scientist of CSIR (2011-2016), MLS Chair Professor at IACS (2006-2009), Adjunct Professor at TIFR (2003-2009 and 2011-2014), Honorary Professor at JNCASR (2003-to date) and SNBNCBS (2014-2020), and Distinguished Visiting Professor (2009-2014) and Eminent Visiting Fellow (2018-2023) at IACS. Further details can be found on his group webpage (http://sscu.iisc.ac.in/people/DDSarma/).
PL 03

Growing up with Nanoscience

Pushan Ayyub

Tata Institute of Fundamental Research, Mumbai 400005
Homepage: www.tifr.res.in/~pushan

It is not easy to identify the first contribution on Nanotechnology from India: nanoscience may lie hidden in various other forms, and the current keywords did not even exist before the 1990s. This is why several recent reviews have – rather unfortunately – traced the birth of Indian nanoscience to the establishment of the DST initiative during the turn of the century. This initiative, which has rapidly succeeded in catapulting India to one of the most prolific producers of papers on nanoscience, clearly does not signal its birth in the country.

In TIFR, for example, activity in this area started in the late 1970s with a motley group of material scientists, chemists and engineers, sustained by a small funding from the Electronics Commission. Starting with minimal experience and knowhow, this group could rapidly fulfil its stated objectives of utilizing ‘microparticle technology’ to synthesize extremely high-grade ceramic materials for transducer and microwave applications. Building on its initial success in nanoparticle synthesis, the group soon diversified to the study of many basic aspects of dimensional confinement.

After a brief, and therefore incomplete, overview of the early history (lest it be forgotten!) I would jump-cut to some of our recent studies on certain important structural aspects of nanomaterials.

Bio-Sketch

Pushan Ayyub is a Senior Professor and ex-Chairperson of the Department of Condensed Matter

Physics at the Tata Institute of Fundamental Research. In the general area of nanoscience, he has about 160 publications in international journals and has given invited talks at over 60 international conferences and many more national meetings. Prof. Ayyub was a member of the International Committee on Nanostructured Materials during 1998-2008, the Nanoscience Advisory Group (2008-14) and the Nano Mission Council of the Govt. of India (2014-18). His awards include the National Research Award in Nanoscience and Technology (2010). He is a Fellow of the Indian National Science Academy.

Pushan Ayyub completed his M.Sc. (Physics) from Jadavpur University (Kolkata) in 1980 and Ph.D. from TIFR in 1986 on the physics of nanomaterials. He carried out post-doctoral studies at the University of Florida and re-joined TIFR in 1990.

His research interests concern the size dependence of physical properties such as superconductivity, ferroelectricity, ferromagnetism, and optoelectronics in the nano meter regime. He showed that size-induced changes in crystal symmetry produce significant deviations in important properties and may also stabilize novel crystal structures. His studies have helped to define a lower limit to the miniaturization of ferroelectric devices and led to a deeper understanding of size effects in conventional superconductors. His research on one-dimensional nanomaterials has uncovered novel nanotechnology applications in devising new electron and x-ray emitters, environmental remediation, and biochemistry. He has also developed several innovative techniques for nanomaterial synthesis. Professor Ayyub has conducted his research almost exclusively in India, and many of his papers are highly cited.
PL 04

Excitons and plasmons: A tale of two elementary excitations and their interaction

K. George Thomas

School of Chemistry, Indian Institute of Science Education and Research Thiruvananthapuram, Vithura, Thiruvananthapuram – 695551.

E-mail: kgt@iisertvm.ac.in

Coupling of elementary excitations in the presence of light results in several newer optical phenomena.1 The coupling can be categorized as strong, weak and very weak, depending on the magnitude of the interaction. We have earlier demonstrated several examples of these interactions and its consequence on their optical properties.1 Our group has recently demonstrated examples of exciton-exciton coupling in molecules, and plasmon-plasmon coupling in plasmonic systems by organizing them in asymmetric fashion.2-4 As a consequence of such interactions, several fascinating chiroptical properties emerge.2-4 These aspects, along with our recent results on the generation of plexcitonic states5 will be presented in the first part of the talk. Precise assembly of plasmonic materials of desired size and shape allows further modulation of their optical and field effects, opening up several plasmonically powered processes such as surface enhanced spectroscopy.6-9 We have translated the principles of surface-enhanced spectroscopy for the design of plasmonic platforms, which can identify molecules of importance in health, environment and safety.9 These aspects will be discussed.

Reference
3. J. George, S. Kar, E. S. Anupriya, A. D. Das, C. Sissa, A. Painelli and K. George Thomas ACS Nano, 2019, 13, 000

Bio-Sketch

George Thomas has made significant contributions in several areas of photo sciences and nanomaterials, and his group is currently focusing on the studies related to light-matter interaction, particularly at the nanoscale, using various spectroscopic and microscopic techniques. He received his PhD degree in Chemistry from the University of Kerala and afterwards worked as senior scientist in the Photo sciences & Photonics Section of the CSIR-National Institute for Interdisciplinary Science & Technology from July 1994 to April 2010. In May 2010, he accepted an invitation from the newly established Indian Institute of Science Education and Research Thiruvananthapuram and joined as a Professor.
He served as the Dean (Academics and Faculty Affairs) of IISER Thiruvananthapuram during the period 2010-2015 and the currently the President of the Asian and Oceanian Photochemistry Association (APA). He was the member of editorial advisory committee of the Journal of Physical Chemistry of the American Chemical Society during the period 2012-2015.

George Thomas is a recipient of several awards and distinctions: these include the J C Bose National Fellowship and Shanti Swarup Bhatnagar Prize in Chemical Sciences (2006). He is an elected fellow of Indian National Science Academy, New Delhi (2015) and Indian Academy of Sciences, Bangalore (2007) and Honorary Professor of the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore.

For details of his publications refer, https://scholar.google.co.in/citations?user=fgW35woAAAAJ&hl=en.

PL 05

“Interfacial Modification in Nanocomposites to Tailor Functionalities”

Sabu Thomas

International and Inter University Centre for Nanoscience and Nanotechnology, School of Chemical Sciences, Mahatma Gandhi University, Priyadarshini Hills P. O. Kottayam, Kerala, India -686 560,
e mail:sabuchathukulam@yahoo.co.uk

The talk will concentrate on various approaches being used to engineer materials at the nanoscale for various applications in future technologies. In particular, the case of clay, carbon nanostructures (e.g. nanotubes, graphene), metal oxides, bionanomaterials (cellulose, starch and chitin) will be used to highlight the challenges and progress. Several polymer systems will be considered such as rubbers, thermoplastics, thermosets and their blends for the fabrication of functional polymer nanocomposites. The interfacial activity of nanomaterials in compatibilizing binary polymer blends will also be discussed. Various self-assembled architectures of hybrid nanostructures can be made using relatively simple processes. Some of these structures offer excellent opportunity to probe novel nanoscale behaviour and can impart unusual macroscopic end properties. I will talk about various applications of these materials, taking into account their multifunctional properties. Some of the promising applications of clay, metal oxides, nano cellulose, chitin, carbon nanomaterials and their hybrids will be reviewed. Finally, the effect of dewetting up on solvent rinsing on nano scale thin films will also be discussed.

Reference

1. S. Thomas et al. Macromolecules, 2017
2. S. Thomas et al. Langmuir, 2016, 32 (14), 3514-3524
Bio-Sketch

Prof. Dr. Sabu Thomas PhD, FRSC (UK), DSc (UL, France) is currently Vice Chancellor of Mahatma Gandhi University and the Founder Director and Professor of the International and Interuniversity Centre for Nanoscience and Nanotechnology. He is also a full professor of Polymer Science and Engineering at the School of Chemical Sciences of Mahatma Gandhi University, Kottayam, Kerala, India. Prof. Thomas is an outstanding leader with sustained international acclaims for his work in Nanoscience, Polymer Science and Engineering, Polymer Nanocomposites, Elastomers, Polymer Blends, Interpenetrating Polymer Networks, Polymer Membranes, Green Composites and Nanocomposites, Nanomedicine and Green Nanotechnology. Dr. Thomas’s ground-breaking inventions in polymer nanocomposites, polymer blends, green bionanotechnological and nano-biomedical sciences, have made transformative differences in the development of new materials for automotive, space, housing and biomedical fields. In collaboration with India’s premier tyre company, Apollo Tyres, Professor Thomas’s group invented new high-performance barrier rubber nanocomposite membranes for inner tubes and inner liners for tyres. Professor Thomas has received a number of national and international awards which include: Fellowship of the Royal Society of Chemistry, London FRSC, Distinguished Professorship from Josef Stefan Institute, Slovenia, MRSI medal, Nano Tech Medal, CRSI medal, Distinguished Faculty Award, Dr. APJ Abdul Kalam Award for Scientific Excellence – 2016, Mahatma Gandhi University Award for Outstanding Contribution –Nov. 2016, Lifetime Achievement Award of the Malaysian Polymer Group, Indian Nano Biologists award 2017 and Sukumar Maithy Award for the best polymer researcher in the country. He is in the list of most productive researchers in India and holds a position of No.5. Because of the outstanding contributions to the field of Nanoscience and Polymer Science and Engineering, Prof. Thomas has been conferred Honoris Causa (D.Sc) Doctorate by the University of South Brittany, Lorient, France and University of Lorraine, Nancy, France. Very recently, Prof. Thomas has been awarded Senior Fulbright Fellowship to visit 20 Universities in the US and most productive faculty award in the domain Materials Sciences. Very recently he was also awarded with National Education Leadership Award – 2017 for Excellence in Education. Prof Thomas also won 6th contest of "mega-grants" in the grant competition of the Government of the Russian Federation (Ministry of Education and Science of the Russian Federation) designed to support research projects implemented under the supervision of the world’s leading scientists. He has been honored with Faculty Research Award of India’s brightest minds in the field of academic research in May 2018. Professor Thomas was awarded with Trila – Academician of The Year in June 2018 acknowledging his contribution to tyre industry. This year, Prof Thomas was also awarded with H.G. Puthenkavu Mar Philoxenos Memorial Best Scientist Award. For his outstanding contribution in the field of composite materials he has been selected for the position of Professor Lorraine at University Lorraine.in 2018. Very recently Prof Thomas has been awarded has been selected by Materials Research Society of India (MRSI) for the CNR Rao Prize Lecture in Advances materials for the year 2019.
ABSTRACTS
Invited Lecture
Cooper pairs, being Bosons, can exist in one of two states: a localized insulating state, or a superfluid state with zero resistance. However, in two dimensions, experiments over the last two decades have shown surprising evidence for a metallic state of Cooper pairs. It is not clear why such a state occurs. Various theoretical models have approached the subject from different directions, however a clear consensus is far from reached. While it is understood that quantum fluctuations that become strong in reduced dimensions may lead to this state, the lack of a direct proof that, this metallic state known as the Bose metal phase, is of quantum mechanical origin is at the heart of the controversy surrounding this field. In this work, we lay this controversy to rest by unambiguously demonstrating that the Bose metal phase is entirely driven by quantum phase fluctuations, and that killing the quantum phase fluctuations also leads to a complete suppression of the Bose metal phase and restores a fully superconducting state.

Our experiments are performed on clean 2D layers of NbSe$_2$ where the Bose metal phase has been recently observed [1]. To prove that the Bose metal phase originates from quantum phase fluctuations, we use a simple but ingenious method to suppress quantum fluctuations of the order parameter. This is achieved by coupling the device to an environment with very low impedance. Quantum phase fluctuations lead to fluctuations of the voltage across the sample in the microwave regime. A low impedance environment acts as a sink for these voltage fluctuations, thereby suppressing the quantum phase fluctuations. When quantum phase fluctuations are left untouched (high impedance environment), clear signatures of the Bose metal phase are observed with the sample resistivity saturating to a non-zero value in the zero-temperature limit. However, when the same device is coupled to a low impedance environment, quantum phase fluctuations are strongly damped, and the Bose metal phase is fully quenched restoring a perfectly superconducting state. This is a striking, and direct signature of the fact that the Bose metal is a true "quantum" metal.

Our experiment [2], for the first time, proves the quantum mechanical origin of the Bose metal phase and paints a crystal-clear picture of this phase in NbSe$_2$. Using this technique, we perform a thorough characterization of the Bose metal resistance, obtaining a new phase diagram, and power law exponents that are in complete agreement with the recent theory treating Bose metals as a phase glass [3], while providing new insights that are not captured by any known model yet.

References


Bio-Sketch

**P. S. Anil Kumar** obtained PhD (Physics) degree in 1998 from University of Pune. He was a Dutch Technology Foundation Post Doctoral Fellow at University of Twente, in The Netherlands until 2000. Then he moved to Max-Planck Institute of Microstructural Physics, Germany with Max-Planck Postdoctoral Fellowship. Subsequently he received the Alexander von Humboldt Research Fellowship. He joined the Department of Physics of Indian Institute of Science in 2004. He is currently a Professor and the dean of the prestigious undergraduate program of IISc. His research interests are in experimental Condensed Matter Physics/Applied Physics/Material Science covering topics like spintronics, magnetic nano-structures, magnetotransport in metallic multilayers and oxides, magnetic properties of ultra-thin ferromagnets, spin polarized electron scattering, topological matter etc. He has authored more than 180 research publications. He is the recipient of Department of Atomic Energy (DAE) young scientist research award (2005), Max-Planck India Fellowship (2004-2008), DAE Young Achiever Award (2008), Appointed as Head, Max-Planck Partner Group on Surface Magnetism, at IISc (2010-2015), Material Research Society (India) Medal (2011), NASI-Scopus Young Scientist Award 2010 (2011), Microsoft Research India outstanding young faculty award (2011), DAE Raja Ramanna Lecture award (Physics) by JNCASR (2012), Prof. Y.T. Thathachari Prestigious Research Award for Science (2013), Material Research Society (India) silver jubilee medal (2014), Young Career Award in Nanotechnology by Nanomission, Dept. of Science and Technology, Govt. of India (2015). He is an associate editor of the journal “Science and Technology of Advanced Materials”.

IL 01 B

**Conversion of Nanosheets-to-Nanofibers in Metal-Adenine Framework: Studies of Elastic and Capacitive Properties**

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Layered bulk crystals are amenable to exfoliation to yield two-dimensional nanosheets, through isolation and intercalation processes, which could be further converted to one-dimensional nanoscale structures. Latter inherit gross morphological and physical properties associated with precursor structures. We recently reported purine-based crystal structures, which undergo sonication-assisted liquid exfoliation to morph coordination framework into nanosheets and nanofibers in a solvent-dependent process. Determination of Young’s modulus and surface potential of bioinspired CdII-based nanostructures was achieved using Amplitude Modulation-Frequency Modulation and Kelvin Force Probe Microscopy, respectively, revealing interesting elastic and capacitive properties of this bioessential ligand. In the initial studies, electron impedance spectroscopy measurements further established a higher value of capacitance for exfoliated CdII framework as compared to the ligand alone. These studies provide insight into the potential use of such nanostructures in electronic applications.
Reference:

Funding:
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Bio-Sketch
Sandeep Verma currently serves as Secretary, Science and Engineering Research Board (SERB) and is a Professor of Chemistry and Adjunct Professor of Biological Sciences and Bioengineering at Indian Institute of Technology Kanpur. His work has been recognized by J C Bose Fellowship, Shanti Swarup Bhatnagar Prize, and is an elected fellow of all the three national academies; Indian National Science Academy, Indian Academy of Sciences and National Academy of Sciences, India. His research interests include programmable soft matter for neuronal regeneration, peptide nanofibers, small molecule-stem cell modulation and bionanotechnology. He is an Associate Editor of Chemical Communications and serves on the Advisory Board of Cell Chemical Biology, ChemBioChem and Journal of Peptide Science.

IL 02 A
Diffraction imaging of non-FCC gold in bipyramid shaped microcrystals using a nanoprobe X-ray beamline

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Cubic lattice structure preferred by noble metals (e.g., Au, Ag, Pd and Pt) is thermodynamically highly stable. Lower symmetry crystal structures are not known to stabilize relative to the face-centered cubic (fcc) bulk even at high pressures. Observing a structural transformation in these metals is therefore fundamentally exciting and can be possibly useful in tuning their otherwise noble behavior. Recent explorations in this direction have focused on nanocrystals, as the energy needed for lattice distortion is relatively low when the size is only a few nanometers. Inducing lattice strain at larger length scales to cause structural transformation in the crystallite is indeed a herculean task. The same has been achieved by us by stabilizing a nanocorrugated morphology through a simple synthetic method involving thermolysis of a metal-organic precursor in air.

The presentation will briefly describe the synthesis and characterization of bipyramidal Au microcrystals with penta-twinned tips, exhibiting nanofacets of unusually high indices. Using a laboratory X-ray source, the presence of non-fcc phases, body-centered tetragonal (bct) and body-centered orthorhombic (bco), have been readily detected. The remarkable occurrence of non-fcc phases of Au is related to the geometrically induced strains in the bipyramids; annealing at high temperatures, application of high pressures or exposure to energetic ions relieves the stress thus destabilizing the non-fcc phases. Interestingly, the bco(t) phases are chemically highly stable; the microcrystals can withstand mercury treatment and exhibit low dissolution rate in aqua regia unlike the conventional gold. Nanofocus X-ray diffraction measurements on an individual
crystallite at a synchrotron beamline have provided a deeper insight into the distribution of the various phases in relation to the crystal morphology.

References:

Bio-Sketch

**Dr. G. U. Kulkarni** is the Director of Centre for Nano and Soft Matter Sciences (CeNS), Bangalore and is a Professor (on lien) at Chemistry and Physics of Materials Unit, Jawaharlal Nehru Centre for Advance Scientific Research (JNCASR). He received his PhD from Indian Institute of Science in 1992 and has held visiting/adjunct positions at Cardiff, Tokyo, TASC-INFM, Trieste; Scuola Normale Superiore, Pisa; Purdue etc. His research interests are focused on new strategies in synthesis of nanomaterials, nanopatterning and nanodevice fabrication including of molecular systems. His recipes emphasize the importance of simple design, near ambient working conditions, solution-based processing as well as low cost instrumentation. His group strives to translate nanoresearch findings into affordable technologies.

Dr. Kulkarni has published over 280 research articles and secured several national and international patents. He has contributed to 13 books and coauthored a book on Nanocrystals. He has to his credit, Sir C. V. Raman Young Scientist award, the MRSI-ICSC Superconductivity and Materials Science Annual Prize, Bangalore Nano National Award, MRSI-Distinguished Lectureship Award, SASTRA-CNR Rao Award for Excellence in Chemistry & Materials Sciences, among others. He is a Fellow of National Academy of Sciences, Indian Academy of Sciences and Asia Pacific Academy of Materials.
Can nano turn farming more eco friendly?

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In the modern agricultural practice, both in the crop production and protection large number of chemicals play an important role. Further in the post-harvest stage till the consumption as well the pest/diseases control and preservatives role cannot be ignored. But the residues are becoming a huge alarm, because of the over use of the poorly specificity of the chemical. Hence in our approach we have tested various strategies to improve the targeting by reducing the nontarget loss; which can lead to residue free ecofriendly approach. This talk will explain following strategies\(^1\). Graphene oxide based targeted pesticide application\(^{1,2}\). Graphene oxide wrapper based programed fruit preservation\(^2,3\). Stimuli drift controlled fertilizer application\(^2,3\).

Reference


Bio-Sketch

Vijayakumar P. Shanmugam obtained his PhD from Tamil Nadu Agricultural University, India. Following this, from 2007 he took postdoctoral experience in National Chemical Lab, National Science council Taiwan. Currently he is working in Institute of Nanoscience and Technology, Mohali. His interest is to explore nanoscience for agricultural field application especially in crop production, food technology and sensor.
IL 03 A

Nanostructured materials for High Performance Gas Sensors

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Nanostructured metal oxide gas sensors help in pushing the boundaries of sensitivity and limit of detection. I will present various device architecture and process technologies, such as suspended core-shell, metal-semiconductor GasFET exploiting work function modulation, harnessing electromigration and plasma oxidation to create core-shell structures, polystrene beads to achieve lithography free hexagonal nanostructures for high performance gas sensing. We demonstrate the limit of detection down to parts per billion range for various gases including CO, H2S, and H2.

Bio-Sketch

Prof. Navakanta Bhat received his PhD from Stanford University, in 1996. He joined Indian Institute of Science, Bangalore, in 1999, where he is currently professor and chairperson of Centre for Nano Science and Engineering. His research interests include nanoelectronics, electrochemical biosensors and gas sensors. He co-founded a start-up PathShodh Healthcare in 2015, which has introduced first of its kind point-of-care diagnostic device, performing 5 blood tests and 3 urine tests for diabetes, anemia and malnutrition, kidney and liver disease. He is an elected fellow of INAE and IEEE. He research has been recognized through many awards, including Infosys prize in 2018, for his contributions in the field of Engineering and Computer Science.

IL 03 B

Engineering of Future Nanotherapeutics for Cancer Treatment

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Chemotherapy, the most preferred first-line therapy for treatment of cancer, exhibit many disadvantages including anaphylactic hypersensitivity, nephrotoxicity, cardiotoxicity that could be due to toxic excipient or the drug itself. Advancement in nanotechnology is able to reduce these drug-associated toxicities, but problems associated with uncontrolled release of drugs, use of toxic excipients and unspecific targeting of nanoparticles still exist. To meet these challenges, we engineered phospholipid-based bile acid-drug conjugates and bile acid-peptide conjugates that has ability to self-assemble to form nanomicelles or hydrogels. In first part of my talk, I will share the anticancer efficacy of the engineered nanomicelles in murine tumor models over commercial formulations. These nanomicelles were then tested for in-depth toxicological and pharmacokinetic studies in non-human primates. In second part of my talk, I will discuss
the ability of hydrogels to target the tumor microenvironment by sequential and sustained release of combination of drugs. This therapy is able to regress the tumor effectively and does not allow the tumor to develop drug resistance. My talk will provide the recent advancements in engineering of different biomaterials from my lab and their usage for cancer therapy.

Bio-Sketch

Dr. Avinash Bajaj is, a biomedical scientist, running an independent research group at Regional Centre for Biotechnology, NCR, Biotech Science Cluster, Faridabad since 2010. He did his PhD with Prof. Santanu Bhattacharya at Department of Organic Chemistry, Indian Institute of Science, Bangalore and post-doctoral training at University of Massachusetts Amherst, USA with Prof. Vincent M Rotello.

In August 2010, Dr. Bajaj started his independent research group at Regional Centre for Biotechnology, Faridabad with the theme of “engineering of nanomaterials for biomedical applications” where his group developed numerous synthetic materials for cancer therapy, gene therapy and antimicrobial applications. He has published more than 50 research articles in reputed international journals. He has developed an interdisciplinary research team where they are using synthetic chemistry, cell and molecular biology, animal studies, lipidomics and transcriptomics studies to understand the molecular mechanisms behind drug delivery systems synthesized in their laboratory.

IL 04 A

Layered MPX₃ (M=Ni, Fe, Mn etc; X=S,Se,Te) Materials for Electrochemical Energy Conversion and Storage

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A relatively recent family of two dimensional (2D) layered materials, namely phospho chalcogenides (MPX₃) are projected as potential candidates for electrochemical and electronic device applications. In this direction, our group has been working on various metal phospho chalcogenides, FePS₃, NiPS₃, MnPS₃ etc. They are found to possess interesting physical and chemical attributes that are found to be very good electrocatalysts and useful in various device applications. The present lecture will describe our efforts on water splitting and oxygen reduction reactions related to batteries and also the use of layered phospho chalcogenides in sensing applications.
Bio-Sketch

**Prof. S Sampath** is a Professor at the Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore. His current research interests are in the areas of interfacial electrochemistry including energy storage (rechargeable metal-air batteries, solid state batteries, in particular), electrochemical studies involving organic thin films, nanostructured, few-layered materials, transition metal nitrides, carbides and deep eutectics. Understanding interfacial phenomena using a combination of spectroscopy and electrochemistry is of interest in his group. He has published several papers and holds US and Indian patents in the areas mentioned above. His work has been recognized by various scientific bodies and he is a fellow of science and engineering academies in the country.

IL 04 B

**Solutions for organ specific Biomedical Imaging and Therapy - Nanotechnological approach**

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The emergence of nanotechnology has created innovations in various biomedical applications especially in the field of disease diagnosis, therapy and biosensing. Multifunctional nanoprobes for multimodal imaging and therapy can improve the diagnostic accuracy significantly. There has been tremendous advancement in the area of cancer research including early diagnosis and its effective treatment in the last few decades. But still it is an accepted fact that there is a huge gap in the management and treatment of cancer. This is mainly because of the limitations of conventional cancer treatment methods and in many cases the side effects associated with them. Similarly, brain disorders are also a major concern of the modern world in terms of economic cost and human suffering with increasing number of aged populations as an outcome of the long-life span. The main challenge in the treatment of many of the neurodegenerative diseases is the presence of a polarized layer of endothelial cells that comprises the BBB which precludes access of systemically administered medicines to brain tissue. Huge opportunities lie ahead for material science to contribute to this area.

With the advent of nanotechnology, there were many attempts to use nanoparticles in the areas of cancer diagnosis, treatment, biosensing and imaging. Translation from single to multiple nano systems to suit varied applications is a promising field of nanotechnology. Hybrid nanosystems are the outcome of recent efforts to incorporate multiple functions into a single unit. But there are very few reports on the use of nanotechnology for the effective brain permeability.

In this presentation, an overview of the works on the above applications using nanostructures like iron oxide nanoparticle, gold nanorods and gold quantum clusters, carbon and quantum dots will be discussed. The unique optical properties of size tunable emission properties of gold quantum cluster which originate due to the quantum confinement of electrons compared to widely studied metallic nanoparticles will be one of the highlights of the presentation. Modification of the nanosystems for target specificity for in vitro and in
vivo demonstration of imaging and therapy will be presented. A major concern of the nanomaterial’s use in biomedical field is its toxicity and their behaviour in physiological conditions. A good understanding of the nanomaterial-cell/tissue interaction and strong measures to reduce toxicity are to be taken care.

References

Bio-Sketch

**Dr Jayasree R S**, PhD, FRSC, FASCh is a senior scientist in Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram, Kerala and heads the Division of Biophotonics and Imaging. She completed her Post graduation from CUSAT and PhD from Kerala University in Physics. She is a leading scientist with interest focused on the applications of Nanotechnology in the healthcare field. Specific areas include spectroscopic techniques, nanophotonics and nano-biophotonics applied to health care field. Other than nano science, she also has high passion towards developing new methods of research and translate to clinics; like laser treatment for disc prolapse, osteoid osteoma, esophageal and bronchial tumor and varicose vein. Therapeutic aspects also include drug delivery, photodynamic therapy, photothermal therapy, hyperthermia etc. She also has exemplified flair in the design of nanosystems with desired properties for crossing BBB, drug delivery, cancer therapy and sensing.

She is a fellow of Royal Society of Chemistry and Fellow of Academy of Sciences, Chennai. She is the recipient of MRSI Medal in 2017. She has also received PSN National Award for excellent R&D in rural technology in 2011, Endeavour Research Fellowship by the Australian Government, 2009 and was nominated as Australia Award Ambassador by the Australian High Commissioner to India during 2012 to 2015. She has more than 80 publications and 5 patents in the field of spectroscopy, material science and nanoscience.
IL 05 A

Graphene Quantum Heat Conductor

Anindya Das
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In the last one decade, graphene, a single carbon atomic layer, has emerged as an ideal platform to experimentally verify many theoretical predictions in condensed matter physics. Among these predictions, two of the most remarkable ones are the quantization of electrical and thermal conductance. Although the quantization of electrical Hall conductance (in units of the quantum limit $e^2/h$) has been observed in graphene, the demonstration of quantization of thermal conductance in terms of its quantum limit $(\frac{\pi k_B^2}{3h})^2$ remains challenging due to the requirement of accurate measurement of very small temperature (few millikelvin) change. The quantum limit of thermal conductance has been demonstrated recently in GaAs-AlGaAs heterostructures but its measurement in graphene-based QH will open a new path to study the spontaneously symmetry-broken phases predicted to exist near the Dirac point, which can be directly identified by the thermal conductance measurements. Motivated by this we have carried out the thermal conductance measurement in the integer as well as fractional QH regime of hexagonal boron nitride (hBN) encapsulated monolayer graphene devices by sensitive noise thermometry setup with an accuracy of $\sim 2$ mK temperature change. We have measured the thermal conductance for integer $\nu = 1, 2$ and 6 plateaus and its values agree with the quantum limit within 5% error. We further show that the measured thermal conductance values for fractional plateau $\nu = 4/3$ and integer plateau $\nu = 2$ are same, emphasizing the universality of flow of information irrespective of the nature of quasi-particle. These thermal transport measurements in graphene QH will pave the way to get new insight into exotic systems like even denominator QH fractions in bilayer graphene as well as symmetry protected quantum spin Hall state in graphene.

Bio-Sketch

Anindya Das obtained his M.S. and PhD in Physics from the Indian Institute of Science, Bangalore in 2004 and 2009, respectively. He was employed as a Postdoctoral fellow at the Weizmann Institute of science, Israel from 2009-2013. After that he joined the Department of Physics, Indian Institute of Science, as an Assistant Professor in 2013. His main research area on quantum transport properties of mesoscopic structures in reduced dimensions like two-dimensional graphene, two-dimensional transition metal dichalcogenides, topological insulator and one-dimensional nanowires. He received Anil Kumar award for the best PhD thesis in physics, 2009-2010.
Design of nanomaterials and techniques for environmental mitigation

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Innovations of sustainable techniques and design of nanomaterial for environmental mitigation has become essential for protecting our environment from various pollutants. Some of our research in this direction will be highlighted. The physical and chemical properties of carbon nanotubes (CNTs) in combination with metal oxides as carbon composites show incredible potential in water treatment. MWCNT/Alumina (RMAC) nodules were designed with adsorption capacity of 187.5 and 597 mg g\(^{-1}\) at 25°C for MB and Cr (VI) respectively [1]. In situ photocatalysis with inexpensive yet highly PDMS and PMMA based microreactors were used to obtain Ag\(_3\)PO\(_4\) nanoparticles embedded in the microchannels [2]. Efforts for recycling of waste to reusable materials were directed to obtain SnO\(_2\)-Fe\(_3\)O\(_4\) nanocomposites from scrap tin plated steel and the use of these composites for the degradation of organic pollutants [3]. An eco-friendly approach for the synthesis of hierarchically porous Mo\(_2\)S\(_3\) nanoflowers in waste cooking oil has been developed (waste to wealth) and used for high-performance supercapacitors applications [4]. Mesoporous cobalt-aluminate spinel nodules with high porosity, appreciable surface area (410 m\(^2\) g\(^{-1}\)) and excellent dispersion of cobalt into alumina has been shown as an effective catalyst in selective oxidation of benzhydrol to benzophenone with 70% conversion [5].

References


Bio-Sketch

Professor Ganguli is currently Institute Chair Professor & Head of the Department of Chemistry, IIT Delhi. He is the founding Director of Institute of Nano Science and Technology in Mohali during 2013-2018. His main interest is in nanomaterials, especially in (a) microemulsions based synthesis (b) photoelectrochemical applications (c) water purification and (d) environmental mitigation. His other interests are in complex metal oxides and high temperature superconductivity. He has published over 290 papers and has filed five patents (two granted) and supervised 28 PhD students. He is a recipient of the CRSI bronze Medal (2006), MRSI Medal (2007), CNR Rao– CRSI National Prize (2013), National Award of Nano Science and Nanotechnology given by DST (2015), Government of India, the Prof CNR Rao Bangalore India Nano Award given by the Karnataka Govt (2017), the ISCB award (2018) for chemical sciences and the CRSI Silver medal (2019). He is a fellow of the Royal Society of Chemistry, London, Indian Academy of Sciences, the National Academy of Sciences, India and Fellow of the Asia – Pacific Assoc. of Materials. Dr. Ganguli is also a very keen speaker for science education in schools and
colleges from the beginning of Inspire series started by DST (as a Mentor) and has also spearheaded an Outreach program for rural school students in remote parts of India in which more than 300 schools/colleges have been covered in last six years.

IL 06 A

Heterostructures based on 2D Materials - Versatile Platforms for Silicon Photonic Devices

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Wafer scale, vertical 2D/3D hybrid heterojunctions using 2D metal dichalcogenides layers and nanocrystals have been realized on 3D Si platforms. The heterojunctions exhibit excellent photodiode characteristics suitable for multifunctional devices with significantly enhanced spectral response, making them attractive for Si CMOS compatible photonic devices. The integration of PbS QDs with MoS$_2$ leads to a hybrid heterostructure exhibiting two color band and tunable infrared photoresponse using a single device. On the other hand, novel PVP coated Ag$^+$ intercalation induced synthesis has led to the formation of an intercalated impurity-free n-WS$_2$ layer with reversed conductivity and plasmonic enhancement. Stabilized Ag nanoparticles embedded n-WS$_2$ has been used to fabricate plasmon enhanced silicon compatible broadband heterojunction photodetector. The dynamics of excitonic quasiparticles (exciton and biexciton) of mono-to-few layers dispersion of WS$_2$ have been explored using femtosecond pump-probe spectroscopy. The binding energies of AA (69 meV) and BB (66 meV) biexcitons have been experimentally determined. Furthermore, using time-resolved spectra, we have measured the non-radiative and radiative life-times of different excitonic quasiparticles, which decay into several ultrafast processes; starting from Auger recombination, defect or trapped state emissions to band-edge emissions.

References:
Bio-Sketch

Prof. Samit K. Ray is currently the Director S. N. Bose National Centre for Basic Sciences, Kolkata on lien from IIT Kharagpur. He has served as the Dean (Postgraduate & Research Studies), a Professor of the Department of Physics and founder Head, School of Nanoscience and Technology, IIT Kharagpur. His research interests are semiconductor nanostructures, quantum Dots, photovoltaics, nanodevices and electronic materials. Prof. Ray is a fellow of the National Academy of Sciences, India (NASI), Indian Nation Academy of Engineering (INAE) and West Bengal Academy of Science & Technology, and is the recipient of INSA Young Scientist Award, UGC Homi Bhabha Award, MRSI-ICSC Superconductivity & Materials Science award and MRSI medal lecture award. Prof Ray has published more than 325 research papers in peer reviewed journals, seven book chapters and co-authored a book on “Strained Silicon Heterostructures: Materials and Devices” published by IEE, UK. He has served as a visiting Professor / Scientist at the Tokyo Institute of Technology, Japan, University of Delaware, Newark, USA, University of Texas, Austin, USA, Max-Planck Institute for Solid State Research, Germany, Queen’s University of Belfast, UK and National Taiwan University, Taiwan.

IL 06 B

Perovskites Nanocrystals: Some Exciting Chemistry

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Perovskite nanocrystals are recently emerged as one of the leading energy materials in current research. The unprecedented high quantum yield enabled these nanocrystals as most efficient lighting materials for device applications. While 3D perovskites are extensively studied, the light emitting and other material properties of 2D perovskites are not widely explored. This talk would present the chemistry and physics of different layered perovskites and their conversion to layered CsPbX₃ (X = Cl and Br) perovskites. Doping of these nanostructures with Mn (II), the self-assembly and the quantum confinement related optical tuning would also be discussed.

Bio-Sketch

Narayan Pradhan did his PhD from IIT Kharagpur in 2001 and continued his post doc in Israel and USE. He joined in the Department of Materials Science at Indian Association for the Cultivation of Science, Kolkata in 2007 and currently he is working as a Professor there. He works on understanding the chemistry and physics of semiconducting nanomaterials. He has received Oxford Nanoscientist Award in 2017 and DST nano-mission young career award in 2015.
IL 07 A

Ultraflatbands and Shear Solitons in Moiré Patterns of Twisted Bilayer Transition Metal Dichalcogenides

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Ultraflat Bands in twisted bilayers of two-dimensional materials have the potential to host strong correlations, including the Mott-insulating phase at half-filling of the band. Using first-principles density functional theory calculations, we show the emergence of ultraflat bands at the valence band edge in twisted bilayer MoS2, a prototypical transition metal dichalcogenide. The computed band widths, 5 and 23 meV for 56.5° and 3.5° twist angles, respectively, are comparable to that of twisted bilayer graphene near “magic” angles. Large structural transformations in the moiré patterns lead to formation of shear solitons at stacking boundaries and strongly influence the electronic structure. We extend our analysis for twisted bilayer MoS2 to show that flatbands can occur at the valence band edge of twisted bilayer WS2, MoSe2, and WSe2 as well.

References

Bio-Sketch

Manish Jain obtained his B.Tech. in Materials and Metallurgical Engineering from IIT Kanpur in 1997. He then did his Ph. D. in Materials Science and Engineering at University of Minnesota in 2002. Following his Ph. D., he worked in Corporate Research Materials Laboratory, 3M Company as a senior research engineer for 6 years. In 2008, he joined the groups of Prof. S. G. Louie (University of California, Berkeley) and Prof. J. R. Chelikowsky (University of Texas at Austin) as a post-doctoral researcher till December 2012. Since 2012, he has been a faculty member at the Department of Physics, IISc.

IL 07 B

Nanoscale, Axial Organic Heterojunctions via Multi-Component Supramolecular Co-polymerization

Subi J. George

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Study of supramolecular polymers has entered an era that demands assemblies with more structural and dynamic control. Living supramolecular polymerization has emerged as a synthetic strategy to construct supramolecular nanostructures with well-defined structure and dispersity. On the otherhand, temporal
control over dynamic materials is now being extended to non-equilibrium regime. While both of these controls are desirable, strategies to achieve them have been mostly chemically distinct. The synergy between structural and temporal control is important for the advent of supramolecular polymers to be employed as functional adaptive materials. To gain this symbiosis it is imperative that common strategy is sought. Looking into the biological realm can provide a necessary inspiration for the conundrum.

We, in our laboratory, are driven by this philosophy and are currently trying to develop and study a chemical-fuel controlled supramolecular system that not only follows living supramolecular aggregating regime but also can be regulated temporally through various molecular cues. We have attempted to create thermodynamically stable dormant states for the monomers, which can be triggered by various chemical/bio-fuels to achieve a temporally modulated supramolecular polymerization.

This talk describes our efforts in designing multicomponent supramolecular block copolymers (Linear organic heterostructures) via kinetically and thermodynamically controlled Supramolecular Polymerization (unpublished results). These unique structures made from semi-conducting monomers would be interesting materials to control exciton migration, axial p-n junctions and many other new functional properties.

References:

2) Kumar, M.; George S. J. *et al.* *Nature Communications* 2014, 5, 5793.
8) Unpublished results

Bio-sketch

**Prof. Subi Jacob George** is currently leading a supramolecular chemistry group at the New Chemistry Unit of JNCASR, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore, India. He has obtained his PhD degree at the National Institute for Interdisciplinary Science and Technology, India in 2004 in the group of Prof. A. Ajayaghosh. During 2005-2008, he has been a post-doctoral fellow at the Laboratory of Macromolecular and Organic Chemistry, Eindhoven University of Technology, The Netherlands with Prof. Dr E. W. (Bert) Meijer. In 2019, he has been elected as a Fellow of Indian Academy of Sciences, Banaglore. He is the recipient of Swaranjayanti Fellowship from Department of Science and Technology of Government of India (2017), Asian Photochemistry Association (APA) Young Scientist award (2015), NASI-SCOPUS Young Scientist Award in Chemistry (2015), Chemical Research Society of India Bronze Medal (2015) and Materials Research Society of India Medal (2013). He was also the Young Associate of the Indian Academy of Sciences (2011). He is the member of Editorial Advisory Boards of Chemistry of Materials (ACS) and Material Horizons (RSC). He is also in the Editorial board of ChemNanoMat (Wiley) and also an Early Career Board Member of ACS Sustainable Chemistry and Engineering. His current research interests focus on Functional Supramolecular Polymers, Living and Non-equilibrium supramolecular polymerization, Supramolecular Chirality and Organic-inorganic hybrid assemblies.
Nanoscale Nucleic Acid Sensing Using Xeno Nucleic Acid Probes

Dr. Rupa Mukhopadhyay*, Hiya Lahiri, and Sourav Mishra
Indian Association for the Cultivation of Science, India

Development of robust, reliable, precise and sensitive strategies for nucleic acid analysis is of consistent research efforts worldwide, since analysis of nucleic acid interactions play a pivotal role in genomics-based medical diagnostics. Different types of nucleic acid analysis platforms are in practice, most of which depend on fluorescence or other types of labeling though and are time-consuming. Where direct readout is possible, so that the labeling steps can be eliminated from the protocol, the total analysis time can be reduced. One such possibility has been pursued using microcantilever arrays for more than a decade. Though the DNA-based nucleic acid detection has found wide applicability in microscale and nanoscale detection of nucleic acid sequences, the development of improved, cost-effective microarray platforms for producing fast, accurate, reproducible and valid data is still sought for. Especially, reduced bioactivity due to potential DNA-surface interactions through relatively exposed nucleobases, and chances of DNA nuclease-induced degradation of the DNA probes, point to the requirement of more robust and reliable alternatives. In this talk, will be exemplified how alternative nucleic acid or the xeno nucleic acid (XNA) probes like peptide nucleic acid (PNA) and locked nucleic acid (LNA) having different sugar backbones can be integrated in the nanomechanical sensing platform for improved molecularly resolved nucleic acid recognition, at the level of single base mismatch discrimination. We are testing this generic assay in detection of gene mutations of the multiple drug-resistant Mycobacterium Tuberculosis.

References

Bio-Sketch

Dr. Rupa Mukhopadhyay is a Professor in the School of Biological Sciences, Indian Association for the Cultivation of Science (IACS), India, and a member of the Nanobiotechnology Task Force of the Department of Biotechnology, Government of India. She got her B.Sc. and M.Sc. in chemistry with specialization in biological chemistry and obtained D.Phil. in interfacial biological chemistry from University of Oxford, UK. She conducted postdoctoral research in nanobiotechnology at the Interdisciplinary Nanoscience Centre (iNANO), Denmark. Her current research interest is the combined use of bio- and nano-systems to engineer surfaces for nanoscale biosensing, bioelectronics and single molecule level...
structural biology. This involves explorations with alternative nucleic acids as sensing probes, protein modification and assembly, and force-based microscopy/spectroscopy at single molecule level.

IL 08 B

Mechanically durable electrochemical energy storage device for wearable electronics

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Textiles constitute the primary interface between skin and surroundings, offering physical comfort and protection. Smart e-textiles and intelligent clothing provide functional versatility and operational portability for wearable computing, personalised healthcare, fitness and strategic sectors. Energy storage and delivery forms the heart of such rapidly-emerging technologies and demands large storage capacity, rapid power release and simultaneous tolerance to harsh mechanical duress. Addressing this, we demonstrate carbon nanotube-wire (CNT-wire) interwoven solid-state supercapacitive energy storage devices (sewcaps) exhibiting superior storage capacity (30 Wh/kg, compared to electrochemical capacitors ~10 Wh/kg) and fourteen-fold higher power density (3511 W/kg), compared to Li-ion batteries (~250 W/kg). While the high specific surface area, electrical conductivity of CNT-wires and high ionic conductivity of the electrolyte enable high energy density, the device design enables the combination of planar and radial diffusive pathways for ultra-low interface resistance (~0.2 mΩ per sewcap) and rapid charging-discharging ability (τ=1.16 ms). Thus, this versatile approach of interweaving to form functional devices provides tunable power delivery across six orders of magnitude (2 µW-2 W) through reconfiguration of the interweaving pattern and density. Importantly, such textiles integrated sewcaps exhibit unaltered performance (>95% retention across 4000 charge-discharge cycles) under extreme mechanical punishments such as repeated laundering, flexing (~68°), rolling (360°) and crushing (~21.8 kPa) implying direct interfacing with wearable platforms.

The ongoing scaling of CMOS technology is now reaching its limit, due to supply voltage reduction being restricted by the subthreshold swing (SS) of 60 mV/decade achievable at room temperature owing to Boltzmann transport of the charge carriers. Concept of negative capacitance proposed to achieve a sub-60 mV/decade SS is currently seen as one of the potential solutions to the problem. A “negative capacitance transistor (NCFET)” employs a ferroelectric material in the gate stack of a FET providing a negative capacitance and thereby an “internal voltage amplification” at the gate of the internal FET which helps in reducing SS. Several experiments have successfully demonstrated an improved SS with the bulk MOSFET, FinFET, and 2D FETs. The improvement in subthreshold characteristics is also accompanied with the advantage of an increased ON current relative to the reference FET as has been observed both in simulation studies and experiments. In this talk, I will discuss the physics and modeling of various Nanosheet and NCFET structures and impact of these new transistor on circuits including processors.
Bio-Sketch

C. Subramaniam worked under the supervision of Prof. T. Pradeep at Indian Institute of Technology Madras towards his Doctoral Degree in 2008, involving correlating the electronic transport and vibrational properties of nanocarbons and nanoparticle-nanocarbon hybrids. The understanding was subsequently used to develop a range of sensors. Subsequently, he worked as a postdoctoral researcher at National Institute of Advanced Industrial Science and Technology (AIST) Japan with Prof. S. Iijima. He was involved in developing electrically conducting composite of carbon nanotubes and copper that exhibited the highest current carrying capacity among all known materials. The science of this is currently being translated to technology for application in through-silicon-vias. In his current position at the Department of Chemistry, IIT Bombay, he is currently looking into the interfacial and surface science of energy-storage devices and electrocatalytic processes. He employs a combination of electrochemistry, device physics and operando vibrational spectroscopy (Raman) for ‘application-oriented fundamental’ research into various aspects of nanostructured materials. Besides peer-reviewed, high impact scientific publications and international patents, he is also a recipient of IUMRS-ICA Young Scientist Gold Award, Iijima Gold Medal and IIT Bombay Impactful Research award, to name a few.

IL 09 A

Atomistic simulations of pristine and defective 2D Nano materials

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Due to exceptional mechanical, thermal and sometimes electrical properties, two dimensional nanomaterials (e.g. graphene, h-BN nanosheet) are emerging as a promising material for future applications in the field of biotechnology, nanomembranes, desalination and reinforcing nanocomposites. Due to the limitations associated with the synthesizing techniques, geometrical defects are inadvertently introduced in these nanomaterials. So far, research was more focused on investigating the negative effect of these defects, but the author has successfully identified defects that can be further explored either to tailor or in some aspects to improve the mechanical or fracture properties of nanomaterials. It has also been predicted from the simulations that these defected nanosheets have better reinforcing capabilities for developing nanocomposites as compared to pristine form of the same nanosheet.

Bio-Sketch

Dr. Avinash Parashar is working as an Assistant Professor in the Department of Mechanical and Industrial engineering at Indian Institute of Technology Roorkee (IIT Roorkee). Prior to joining IIT Roorkee, he worked as attached scientist in the Department of Computational Reactor Physics in Canadian Nuclear Laboratories, Canada. In addition to post-doctoral research work at John Hopkins University, he also worked as Engineer in LML Vespa, Honda Siel Cars India Ltd and NTPC Ltd. He received bachelor’s in engineering from Maulana Azad National Institute of Technology Bhopal and later completed his doctoral studies from Department of Mechanical Engineering, University of Alberta in the year 2012. In addition to these qualifications, he is a registered professional engineer with the province of Alberta in Canada.
An excessive amount of CO$_2$ is the main cause of climate change, and the best approach is not only capture of CO$_2$ but rather its conversion to fuel, where CO$_2$ can act as a carbon feedstock with zero cost. This is a much-dreamed-of carbon-neutral carbon cycle and can be achieved by treating CO$_2$ as a carbon source rather than the waste byproduct of fossil fuel combustion. To realize this global vision of a carbon-neutral carbon cycle, there is an urgent need to discover and develop highly active, selective, stable and economical heterogeneous catalysts. On the other hand, a sustainable way to solve the energy problem is to generate alternative energy sources such as renewal electricity by using solar cells or hydrogen by conducting photo- or electrocatalytic water splitting. However, issues pertaining to the storage of electricity and hydrogen gas have made it difficult for these technologies to be developed. The catalytic conversion of CO$_2$ to methane using renewably produced hydrogen (Figure 1) can provide a direct solution to these two problems of excessive CO$_2$ levels, as well as temporal mismatch between renewable electricity production and demand and hydrogen storage. In this talk, I will present our recent work on dendritic plasmonic colloidosomes for “Cold Heating” and use of imperfection in nanomaterials for “CO$_2$ to Fuel” conversion.

Bio-Sketch

Prof. Vivek Polshettiwar after his Ph.D. in 2005 worked as a postdoc in France and USA for few years, before starting his own independent group at KAUST in 2009. In 2013, he moved to TIFR, and his group here working on development of novel nanomaterials for catalysis, energy harvesting and CO$_2$ capture-conversion. Guiding principle of his group is that catalytic efficiency (activity, kinetics, selectivity and stability) can be controlled by tuning the morphology of nanomaterials. He has published nearly 100 articles with h-index 51 and around 10000 citations in reputed journals. He is recipient of prestigious ORISE Research Fellowship at US-EPA and several other esteemed postdoc fellowships. He was awarded as Top-25 cited author in 2011 by Tetrahedron and Young Scientist Award at DSL-2012. He also received Asian Rising Star lectureship at 15th Asian Chemical Congress (ACC), Singapore (2013), from Nobel Laureate Professor Ei-ichi Negish. In 2015, he was admitted as a Fellow of Royal Society of Chemistry (RSC), United Kingdom. He was awarded Bronze medal by CRSI, India and recognized as emerging investigator-material science by RSC. Recently he was awarded prestigious Materials Research Society of India - MRSI Medal 2019.
The ongoing scaling of CMOS technology is now reaching its limit, due to supply voltage reduction being restricted by the subthreshold swing (SS) of 60 mV/decade achievable at room temperature owing to Boltzmann transport of the charge carriers. Concept of negative capacitance proposed to achieve a sub-60 mV/decade SS is currently seen as one of the potential solutions to the problem. A “negative capacitance transistor (NCFET)” employs a ferroelectric material in the gate stack of a FET providing a negative capacitance and thereby an “internal voltage amplification” at the gate of the internal FET which helps in reducing SS. Several experiments have successfully demonstrated an improved SS with the bulk MOSFET, FinFET, and 2D FETs. The improvement in subthreshold characteristics is also accompanied with the advantage of an increased ON current relative to the reference FET as has been observed both in simulation studies and experiments. In this talk, I will discuss the physics and modeling of various Nanosheet and NCFET structures and impact of these new transistor on circuits including processors.

Bio-Sketch

Yogesh Singh Chauhan is an associate professor at Indian Institute of Technology Kanpur (IITK), India. He was with Semiconductor Research & Development Center at IBM Bangalore during 2007 – 2010; Tokyo Institute of Technology in 2010; University of California Berkeley during 2010-2012; and ST Microelectronics during 2003-2004. He is the developer of several industry standard models: ASM-GaN-HEMT model, BSIM-BULK model (formerly BSIM6), BSIM-CMG model and BSIM-IMG model. His research group is involved in developing compact models for GaN transistors, FinFET, Nanosheet/Gate-All-Around FETs, FDSOI transistors, Negative Capacitance FETs and 2D FETs. His research interests are characterization, modeling, and simulation of semiconductor devices. He is the Editor of IEEE Transactions on Electron Devices and Distinguished Lecturer of the IEEE Electron Devices Society. He is the member of IEEE-EDS Compact Modeling Committee and fellow of Indian National Young Academy of Science (INYAS). He is the founding chairperson of IEEE Electron Devices Society U.P. chapter and Vice-chairperson of IEEE U.P. section. He has published more than 200 papers in international journals and conferences. He received Ramanujan fellowship in 2012, IBM faculty award in 2013 and P. K. Kelkar fellowship in 2015, CNR Rao faculty award, Humboldt fellowship and Swarnajayanti fellowship in 2018. He has served in the technical program committees of IEEE International Electron Devices Meeting (IEDM), IEEE International Conference on Simulation of Semiconductor Processes and Devices (SISPAD), IEEE European Solid-State Device Research Conference.
To meet the ever-increasing energy demands of mankind, there is a great demand for high performance, long lasting and safe large-scale energy storage devices. To achieve this goal, one of the frontline priorities has been to develop efficient electroactive materials. In the domain of rechargeable batteries, various layered structured materials have been demonstrated as potential electrodes for rechargeable batteries. The periodic layering or stacking in the 3-D geometric configuration presents unique transport and energy storage properties. Depending on the material and electrochemical conditions, the periodic structural stacking in the 3D crystal structure may not yield optimal energy output thus, drastically decreasing the cell performance. A way forward in this context would be to reduce the geometrical dimensions of the sample from 3D to 2D. Apart from applications, 2D materials are interesting as they provide several fundamental challenges. In this lecture, we will discuss 2D materials in the context of rechargeable batteries. Materials, their transport and storage characteristics and performance will be discussed via a few case studies in the context of rechargeable batteries based on alkali-ion and supercapacitors.

Bio-Sketch

**Aninda Jiban Bhattacharyya** is Professor and Chair of the Solid State and Structural Chemistry Unit, Indian Institute of Science, Bengaluru. Simultaneously, he is also the Amrut Mody Chair Professor at the Institute. Prof. Bhattacharyya works in frontline areas of experimental physical and materials chemistry. His research mainly focuses on studies related to diverse electrochemical processes and specializes in the chemical design of novel and advanced multifunctional materials having very high relevance to field of energy, environment and chemical biology.

Prof. Bhattacharyya has been awarded the C.N.R. Rao National Prize for Chemical Research, CRSI, 2016, Materials Research Society India (MRSI) Medal, 2013, Indo American Frontiers of Science Award (IAFOS), 2013 Fellow of the Indian Academy of Sciences, Bengaluru 2017 and Fellow of the National Academy of Sciences, Allahabad 2018. He is also a member of several scientific societies within India and abroad.

**IL 11 A**

**Ion Exchange Process: A Novel Route to Design Nanoscale Heterostructure**

**Subodh Kumar De**

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The ion exchange reaction in preformed nanocrystals is the versatile process to fabricate different types of complex nano-heterostructures depending upon miscibility of incoming ions with mother nanocrystals, ligand used in the synthesis, solubility of outgoing ion and many other important factors. Thermal decomposition of iron diethylidithiocarbamate in oleylamine leads to formation of Fe₇S₈ 2D nanoplatelet.
Addition and consequent increase of Cu(I) precursor concentration to pre-synthetic Fe$_7$S$_8$ nanocrystals leads to successive compositional and morphological transformations as follows: Fe$_7$S$_8$ (hexagonal nanoplate) $\rightarrow$ Fe$_7$S$_8$@Cu$_5$FeS$_4$ (multi-grained heterostructure) $\rightarrow$ Cu$_{1.97}$S/Cu$_5$FeS$_4$/Cu$_{1.97}$S (nano dumbbell) $\rightarrow$ Cu$_{1.97}$S/Cu$_5$FeS$_4$ (segmented nanohat) $\rightarrow$ Cu$_{1.97}$S (nanodisc). Native Fe vacancies in layered crystalline structure of Fe$_7$S$_8$ drive intercalation and cation exchange to stabilize a particular heterostructure. Simultaneous cation exchange at the corner, top and bottom facets of hexagon can result in Fe$_7$S$_8$@Cu$_5$FeS$_4$ multi-grained heterostructure. Different diffusion rates and channels of incoming Cu and outgoing Fe ions result in linear and bent nanodumbbells. The size of the nanodumbbells is found to be nearly 140 ± 20 nm along the length. Elemental mapping on a single nano dumbbell establishes that the two tip (hemisphere) ends are Cu$_{1.97}$S and the middle part is Cu$_5$FeS$_4$. Opposite direction ejection of Fe results in linear nano dumbbell whereas ejection at 120° or 30° leads to bent nanodumbbell. The twin dislocation in Cu$_5$FeS$_4$ might act as preferential nucleation sites for formation of segmented nanohat. The diameter of the Cu$_{1.97}$S disc is found to be 95 ± 20 nm and the width is 22 ± 5 nm.

Position of surface plasmon resonance band is tuned from visible region to infrared region by the variation of hole concentration originating from intrinsic Cu vacancy. Overlap and interaction among different plasmon modes originating from middle part and two lobes of dumbbell make plasmon band much broader from 700 nm to ~3000 nm. The nanodisc Cu$_{1.97}$S shows very strong plasmon absorbance centered at 1145 nm and the absorbance is sharper compare to the other structures as no plasmon coupling is expected here. Coexistence of surface plasmon and long-range magnetic order in semiconducting heterostructure suggests possible applications in multifunctional devices.

References:


Bio-Sketch

Prof. Subodh Kumar De is working as a Senior Professor in School of Materials Science, Indian Association for The Cultivation of Science, Kolkata - 700 032, India. He received his bachelor’s degree in Physics (in 1979) from Calcutta University and master’s degree in Physics (in 1982) from Calcutta University. He received Ph.D. degree from Calcutta University, India in 1990. He served as a Lecturer at Visva-Bharati, Santiniketan during 1991-1992. In 1992, he joined Department Materials Science, Indian Association for The Cultivation of Science, Kolkata as a Lecturer, where he is currently working as a Senior Professor.


He has 174 publications in peer reviewed journals. He received Materials Research Society of India Medal for 2009. He is a fellow of West Bengal Academy of Science and Technology. He is a member of Magnetic Society of India, Materials Research Society of India, Indian Physical Society, Indian Cryogenics Council and Indian Science Congress Association.

He is currently working in the field of Supercapacitor, Plasmon and Electrochromic effect in Semiconductor Nanocrystals and Magnetic Materials.
Defect-Engineered 2D MoS2 functionalized with rGO particles for efficient Room Temperature NO2 Sensor

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Continued growth of industrialization has led to the emission of various toxic and combustible gases. Among them, NO2 is one of the most poisonous gases which are mainly produced by the exhaust of automobiles and power plants. Exposure to even low concentration of NO2 results in several skin and respiratory diseases, so highly selective and sensitive gas sensors are required to detect the presence of ppm level of NO2. The emerged 2D materials have gained considerable attention in chemical sensing owing to its naturally high surface-to-volume ratio. However, the poor response time and incomplete recovery at room temperature remain a challenge to develop high-performance practical gas sensor. Herein, we developed ultrafast detection and reversible MoS2 gas sensor at room temperature. The sensor’s performance was investigated to NO2 at room temperature and under thermal as well as photo energy. Incomplete recovery and high response time ~250 sec of sensor were observed at room temperature. Thermal energy was enough to complete recovery, but it was at the expense of sensitivity. Further, under photo excitation, MoS2 exhibited an increment in response with ultrafast response time of ~30 sec and excellent recovery to NO2 (100 ppm) at room temperature. Moreover, sensor showed reliable selectivity toward NO2 against various other gases. These unprecedented results are discussed based on the degree of charge perturbation on the surface of sensing layer in the context of NO2/MoS2 interaction under optical-illumination. The large improvement in the sensing performance could be attributed to the synergistic effect of controllable defect and interface engineering. The defect engineering offers abundant active sites through creating sulfur vacancy in additionally rich edge active sites of vertically oriented MoS2 for more electronic interaction with gas molecules. While interfacing of p-type rGO particles with n-type MoS2 lead to out-of-plane vertical p-n heterojunctions as a sensitizing configuration for gas environment.

Bio-Sketch

Mahesh Kumar received his M. Tech from IIT Delhi (2005) and PhD from IISc Bangalore (2012). He worked at Central research Lab of Bharat Electronics Ltd. Bangalore as Scientist from 2005 to 2013. Currently, he is Associate Professor at IIT Jodhpur. He has received INSA Medal for Young Scientists-2014, the MRSI Medal-2016, Young Achiever Award-2016, ISSS Young Scientist Award 2017 and The Physics Emerging Leaders Award 2018 (Runner-up). He is founding Member and Chair of Indian National Young Academy of Sciences (INYAS), Member of Global Young Academy and National Academy of Sciences India. He has worked at University of Paderborn Germany through INSA Bilateral Exchange programme and South Dakota State University through prestigious BASE Fellowship supported by IUSSTF. He has published more than 85 research articles. His research interests are focused on 2D materials, Epitaxial layers, Sensors, Semiconductor materials and devices.
Atomic clusters containing a few to a few tens of atoms form an interesting class of materials in which properties can be tuned by changing a single atom or an electron. These materials have been studied extensively over the past few decades. In the first part of my talk I will present the insights we have developed on caged transition metal clusters. I will particularly focus on their stability and magnetic properties. In the process we will find that some of these clusters’ mimic properties of elemental atoms, and are called superatoms.

Designing permanent magnets without rare earth (RE) elements is an active area of research. A class of Co-carbide nano-particles have shown unexpectedly large magnetic anisotropy energy. In order to understand the origin of this behavior, magnetic properties of small Co-carbide and silicide clusters have been studied, although no definite conclusions were reached. In the second part of my talk, I will present some of our recent results on magnetic properties of small cobalt clusters doped with different non-magnetic elements from groups 14 and 15. Our attempt here is to understand the factors that govern magnetic anisotropy energy (MAE) in these clusters. I will argue that spin moments and gap in the electronic spectrum are the most important factors affecting MAE. We hope that insights gained from these small clusters will eventually help design magnets for practical applications.

References:

Bio-Sketch

Prof. Prasenjit Sen is working at the Harsh-Chandra Research Institute, Allahabad India since 2004, and is a Professor currently. He received his PhD from the Indian Institute of Technology, Kanpur in 1998. Following this he worked as postdoctoral fellow at TIFR-Mumbai, University of Illinois at Chicago and North Carolina State University Raleigh before joining HRI. Prof. Sen has been an Associate of the International Centre for Theoretical Physics, Trieste, and is a member of the Editorial Board of Physica Scripta, a journal published by the IoP. Prof. Sen has made theoretical contributions to a wide range of topics in Condensed Matter Physics and materials, including bulk oxides, atomic clusters, and 2D layered materials. He has written more than 50 papers in journals, and invited reviews and book chapters on various topics. He has delivered more than 30 invited talks in international conferences, workshops, schools, and at various institutes.
IL 12 B

**Engineered Carbon Nanostructures for Tailored Applications**

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Nanoscience and Nanotechnology research has made significant contributions addressing issues related to energy, water, food, air and health security issues. Hybrid nanostructures are found to be much more promising as we can integrate the properties of the constituents and achieve synergistic effects. Among the different nanostructures, the 2D carbon structure, graphene, is much promising for various applications. This talk will cover the recent works on hetero atom doped graphene hybrids especially for multifunctional applications. This will include boron, nitrogen-sulfur co-doped reduced graphene oxide-Ag nano hybrids for molecular oxygen reduction, nonlinear optical and SERS applications. The detailed synthesis strategies, the different characterizations performed will also be discussed.

References:
1. Anju K Nair et al., Scientific Reports, 6, 37731 (2016)

Bio-Sketch

Dr. Nandakumar Kalarikkal is a materials physicist currently working in the field of various nanostructured materials for diversified applications. He is the Director of International and Inter University Centre for Nanoscience and Nanotechnology & Director and Chair of School of Pure and Applied Physics, Mahatma Gandhi University. He is an established researcher having many international collaborative projects and having cooperation with Sweden, France, Poland, Germany, USA, Israel, South Africa, China, Australia, Malaysia etc. The very recent 4 projects sanctioned to his team under the SPARC scheme of MHRD-Govt. of India are highly appreciable.

IL 13 A

**Hydrogen Generation by Smart Transition Metal Nano-Solutions**

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Electrochemical splitting of water has been widely recognized as an efficient and renewable route to hydrogen fuel, the environmental-friendly energy source. The key challenge is to achieve the splitting at lower applied voltages particularly close to the thermodynamic potential of 1.23 V. In an electrolysis cell, although the hydrogen evolution reaction (HER) at the cathode is the major reaction of interest, the anodic oxygen evolution reaction (OER) is the most energy intensive step since water electrolysis is limited by the
large anodic overpotential of OER. A cost-efficient catalyst able to work at low overpotential for optimized energy conversion also needs to be stable to air, light, water, heat and oxidative deactivation. Our major focus is to develop nanoheterostructured transition metal oxide based electrocatalysts for OER and HER, thereby leading to overall water splitting. Starting from our initial experiments with an unconventional non-metal electrocatalyst, we have majorly focused on the solid-state alloy and oxide heterostructures. The best performances are obtained by optimizing the key factors namely chemical composition, morphology dependent spin state of the transition metal ions, electrical conductivity and electrochemically active surface area. Among the substrate scopes, common-paper and fabric based electrodes demonstrate extreme mechanical flexibility maintaining above par electrochemical activity for at least ten days of continuous operation. When solar cells are integrated in series with the designed electrolyzers, water photolysis with high solar-to-hydrogen efficiency can be achieved.

References
(2) Kumar, A.; Bhattacharyya, S. ACS Appl. Mater. Interfaces 2017, 9, 41906-41915.

Bio-Sketch

Sayan Bhattacharyya obtained his Ph.D. with Prof. N. S. Gajbhiye at the Indian Institute of Technology, Kanpur, India in 2006. He did his postdoctoral research with Prof. (Emeritus) Aharon Gedanken at Bar-Ilan University, Israel (2006-2008) and Postdoctoral research with Prof. Yury Gogotsi at Drexel University, USA (2008-2010). He joined IISER Kolkata in April 2010 as Assistant Professor of the Department of Chemical Sciences, IISER Kolkata. Later he worked as Associate Professor of the Department of Chemical Sciences, IISER Kolkata since February 2015. He is the founder & chair of the Centre for Advanced Functional Materials at IISER Kolkata. He is a Materials Chemist interested in photovoltaics, catalysis for energy, magnetism, and drug delivery. A combination of wet-chemical synthesis and self-assembly of smart nanomaterials, structure-property correlation and device applications are used to attain these research goals. In 2017, Dr. Bhattacharyya has been highlighted as one of the Emerging Investigators by the Journal of Materials Chemistry A, Royal Society of Chemistry. He is member of the American Chemical Society, American Nano Society, Chemical Research Society of India, Association for Iron & Steel Technology, and American Ceramic Society, USA
Spin-orbit interactions lead to a large spin-splitting of the valence band maximum at \( K \) in \( \text{MoSe}_2 \) monolayers. However, on stacking a second layer of \( \text{MoSe}_2 \) in the same manner (2H) as found in the bulk, one finds that there is no net spin splitting. This has been attributed to the presence of inversion symmetry. As exploiting the spin splitting at the \( K \) valleys allows us to increase the functionality, an obvious route to making the bilayers useful for exploring the coupled spin and valley physics is through breaking inversion symmetry. We examined this by rotating the top layer of the bilayer by an angle \( \theta \) with respect to the lower layer. While for rotation angles less than 30° we had one type of behavior leading to a net spin splitting, for angles between 30° and 60°, we had a net zero spin splitting. This unusual behavior, we find, is a consequence of the symmetry of the hexagonal Brillouin zone.

This is work done in collaboration with Poonam Kumari and Joydeep Chatterjee.

**Bio-Sketch**

**Priya Mahadevan** is the Senior Professor, Department of Condensed Matter Physics and Materials Science, S.N. Bose National Center for Basic Sciences, JD Block, Sector III, Salt Lake, Kolkata. She completed her Bachelor of Science (B. Sc) in 1991 from Bangalore University, Bangalore, India, and Master of Science (M. Sc) in Physics in 1993 from Indian Institute of Science, Bangalore, India. She acquired her PhD in 1998 from Indian Institute of Science, Bangalore, India. Later she worked as Post-doctoral fellow at Theory Group, Joint Research Centre for Atom Technology, Tsukuba, Japan (1998-2000) and Solid-State Theory Group, National Renewable Energy Laboratory, Golden, USA (Oct 2000-Sept. 2003). Prof. Priya Mahadevan received Martin Foster Medal for best PhD in Division of Physical and Mathematical Sciences, Indian Institute of Science, Bangalore in 2000 and L.A. Meera prize for best PhD, in the Department of Physics, Indian Institute of Science, Bangalore (2000). She worked as a junior associate, ICTP Trieste, Italy (2005-2010). She achieved TWOWS Prize for young woman scientist in Physics/Mathematics in Asia region for 2010 and NASI-SCOPUS young scientist award in Physics for 2010. She received DAE Raja Ramanna Prize Lecture in Physics in 2013, selected as Elected Fellow, Indian Academy of Sciences 2014, and MRSI Medal (2015). She is a member of IUPAP Commission on Computational Physics (C-20) (2015-) and 2nd Lakshmi Raman memorial lecture at IIT Madras, Chennai (2016).
Modified Nitrides Nanostructures for Next-generation Energy Harvesting

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Due to their wide direct bandgap tuning from ultra-violet (6.2eV) to infra-red (0.63 eV), advanced structural, optical, electrical and electronic properties, III-nitride (binary, ternary, quaternary) alloys have been attracted great attention for various practical high-end device applications. However, due to several unaddressed material science issues to grow high quality nearly defects free structures, such as direct growth on the large area of Silicon substrate, p- doping, green spectral gap, etc, the potential of these very futureistic alloys has not been fully utilized.

In my presentation, I will discuss our recent results on resolving these existing issues for the direct growth of nearly defect-free ordered III-nitrides nanostructures with micro/nano dimensions directly on Si substrate for various applications. I will show the surface modifications of these nanostructures for efficient, stable and cost-effective photoanode for hydrogen production from water via PEC water-splitting. I will also discuss our recent finding to develop next-generation tandem and inter-grade bandgap solar cells and LED emitters.

Finally, I will summarize my talk by discussing our ongoing research for the development of self-biased & transparent broad-band (IR-Vis-UV) detectors and next-generation sensors for various analytes.

References:

Bio-Sketch

Dr. Praveen Kumar is working as an Assistant Professor at IACS-Kolkata and a Chair of Marie Curie Alumni Association (MCAA) Indian Chapter funded by the European Commission. He received his Ph.D. from Department of Physics, Indian Institute of Technology, Delhi in 2011, followed by the postdoctoral studied at ISOM, UPM Madrid. He is a recipient of several recognized awards and fellowships, few of them are BRICS Young Scientist Award (2017), Marie Curie Postdoctoral Fellowship from European Commission (2012), INSPIRE Faculty Award from Department of Science and Technology Delhi (2013), 05 Best oral/poster award in various international conferences and Gold Medal in M. Sc. (Physics) From Rajasthan University (2003). He is elected as a sectional committee member for Materials Science in the Indian National Science Congress Association for the year 2019-20.

Dr. Kumar’s research contribution covers a broad spectrum of Materials Synthesis including III-V semiconductors, Oxides, Sulphides, Carbon Nanostructures, metal/semiconductor interfaces, etc for LED
emitters & solar cells, photoelectrodes, broad-band & self-powered photodetectors, and next-generation sensors applications. He has authored 02 books, 65 publications in peer-reviewed international journals, more than 45 in conference proceedings, and delivered around 32 invited/oral talks at various conferences/institutes around the globe.

IL 14 B

Multifunctional Nanocomposites for Clean Energy Generation

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With the ever-increasing demand for energy and also due to increase in environment pollution, there has been lot of interests to develop novel materials for clean energy generation. Recently thermoelectric generator and piezoelectric/triboelectric generator have attracted lot of attention due to its environmentally friendly way of harvesting heat/vibrational energy. Thermoelectric generator can directly convert thermal energy into electricity however the challenge is to develop efficient thermoelectric material to decouple thermal conductivity, electrical conductivity and Seebeck effect so that simultaneously larger electrical conductivity and lower thermal conductivity can be achieved. We have synthesized several nanocomposites such as Bi2Te3-CNT, Bi2Te3-RGO, Bi2Te3-CNR-R3HT, Sb2Te3-RGO etc. in which presence of conductiviting interfaces are demonstrated to enhance electrical conductivity and simultaneously decreasing thermal conductivity due to enhanced phonon scattering. The figure of merit of Bi2Te3 has been enhanced more than 70% by synthesizing Bi2Te3CNT-P3HT nanocomposite. Piezoelectric and triboelectric generator can convert electrical energy directly from to be wasted mechanical energy ranging from blinking of eyes to ocean waves. We have synthesized PVDF based nano composite using ZnO, BaTiO3, RGO, NaNbO3 nanostructures which demonstrated much enhanced Piezo and tribo effect. The enhancement in the piezoelectric and triboelectric properties are attributed to enhanced β-phase of PVDF, increased surface roughness and increased polarizability of the nanocomposite films.

Hydrogen is being considered as a clean energy fuel and using a Photoelectrochemical method is a very promising way of generating H2 by photoelectrolysis of water. We have designed and synthesized several nanocomposite materials by coupling semiconductor-semiconductor, semiconductor-polymer, semiconductor-ferromagnet, semiconductor ferroelectric and semiconductor-graphene nanostructures and explored its potentiality for enhancing the PEC H2 generation.

The present talk will review the progress made so far in our group at IIT Delhi in the above-mentioned area and will also present the main challenges.

Bio-Sketch

Prof. Neeraj Khare is currently Professor in Physics Department, IIT Delhi. He received his Ph.D. (Physics) from Banaras Hindu University, Varanasi in 1986 and MSc (Physics) from Allahabad University, Allahabad. After PhD, he visited Department of Chemical Physics Application, Polytechnic of Milan, Italy as ICTP fellow (1988). Subsequently, he joined National Physical Laboratory, New Delhi in Superconductivity Group as Scientist in Dec. 1988. He joined IIT Delhi in Physics Department in Oct 2005. He had various visiting positions at Department of Materials Science & Metallurgy, University of Cambridge, UK, IBM, T. J. Watson Research Center, Yorktown Heights, NY, USA, Department of Physics and Applied
Prof. Khare is internationally known for his research contributions in the area of Superconductivity and nanostructure materials. He has published over 200 research papers in referred journals, five patents and has edited three books. He is recipient of MRSI-ICSC Award, Platinum Jubilee lecture award of Material Science Section of Indian Science Congress Association, Rajib Goyal prize for young Scientist in Physics, Material Research Society of India (MRSI) Medal award, Council of Scientific and Industrial Research Young Scientist award and Indian Science Congress Association Young Scientist award. Prof. Khare is a Fellow of Institute of Physics (IOP), UK, fellow of National Academy of Sciences India (NASI), fellow of Asia Pacific Academy of Materials, Council member of Material Research Society India (MRSI), member of editorial board of Superconductor Science and Technology (2005-2008) and member of editorial board of Current Physics application from 2017.

IL 15 A

Micro or Nanoscale Soft-Assemblies of Liquid Crystals

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Engineering of the in-between length scales ranging from micro to nanoscale emerge some of the exceptional properties of soft-matter, which has the potential to develop gen-next sensors, energy harvesters, and health-care devices with higher efficacy. In this talk, this proposition is to be corroborated with a host of counterintuitive behaviors of a mesoscopic liquid crystal film or a droplet under the exposure of thermal or chemical potential gradients or an external field. Subsequently, emulating a liquid crystal thermometer, the reported phenomena are to be employed to develop self-healing coatings, volatile-organic-compound sensors, self-propellers, or light reflectors, among others. The applications are supposed to exploit some of the very fundamental properties of a soft-matter such as thermal or chemical potential induced phase transitions, confinement due to miniaturization, and Fréedericksz transition. In the process, an attempt will be made to connect the emerging fundamental properties of the micro or nanoscale liquid crystal objects to unbox a few high-efficiency miniaturized applications. A couple of one-step micro/nano fabrication techniques, namely, spin-dewetting and dynamic-contact-line lithography will also be discussed to develop a µ-VLSI of large area patterns employing liquid crystals, which are intended to host some of the aforementioned applications.

Bio-Sketch

Dr. Dipankar Bandyopadhyay is a B. Sc in Chemistry and B. Tech in Chemical Engineering from Calcutta University. After completion of M. Tech from the Department of Chemical Engineering at IIT Kanpur, he served Fluent India Private Limited for ~3 years as a CFD Application Engineer. He perused his PhD from IIT Kanpur before joining IIT Guwahati as an Assistant Professor. Presently, he is a Professor in the Department of Chemical Engineering and Head, Centre for Nanotechnology at IIT Guwahati. He has served as a visiting faculty at Yeungnam University at South Korea under the WCU Program, and KTH Sweden under the Erasmus Mundus program.
His research areas encompass Thin film Dynamics, Soft-matter Physics, Liquid Crystals and Smart Materials, Droplet and Digital Microfluidics, Health Care Point-of-Cater-Testing Devices, MEMS Theranostics, Clean energy, Harvesting, Computational Fluid Dynamics, Stability and Instability of Fluidic systems, Complex Fluids, Microrheology, among others.

He has authored over 90 research papers in the international journals and has filed 14 Indian and 7 international patents so far. He is also one of the PIs of the Upcoming “Centre for Excellence on the Research and Development of Nano electronic Theranostic Devices” at IIT Guwahati. He is the recipient of NCL’s Prof. K Venkataraman CHEMCON Distinguished Speaker Award in CHEMCON 2016. He and his group at the Indian Institute of Technology Guwahati is the recipients of Gandhian Young Technology award 2016 and BIRAC-SRISTI Appreciation Award 2017. He is a nominated member of American Chemical Society, Royal Society of Chemistry, and Indian Institute of Chemical Engineers.

IL 15 B

Single Molecule Sensing with Solid State Nanopores

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Growing demand for robust, selective molecular sensing technologies necessitate the development of novel sensors. Solid state nanopores have been long explored for single molecule DNA sequencing. However, these explorations have not met with success due to the limited ability of imparting chemical functionality to the solid state nanopore unlike biological nanopores. In this talk I will describe the efforts in our group to create DNA origami solid state hybrid nanopores. The DNA nanostructures impart chemical functionality while the solid state nanopores provide a scalable architecture for measurement. By grafting protein recognizing DNA sequences into origami structures integrated on solid state nanopores, they can be used as platforms to perform single molecule analysis. The fabrication of such devices and experiments conducted in our group will be described.

Bio-Sketch

Manoj Varma is an Associate Professor at the Centre for Nano Science and Engineering (CeNSE) at the Indian Institute of Science. He has been working in biosensors for close to 15 years, particularly in the development of optics-based sensing technologies. A large portion of his current research is in studying molecular sensing processes in living organisms to understand their robustness and noise tolerance combining experiments and theoretical modelling.
IL 16 A

Practical implementation of third-generation solar cell ideas for enhancing device performance by adopting nano-photonics and plasmonics concepts

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The talk focuses on the efficiency enhancement of silicon/dye-sensitized/perovskite solar cells by plasmonics, photon up-conversion, and down-shifting of incident photons. Under plasmonics, the role of metal nanoparticles (size, shape, core-shell, alloy metal particles, dielectric environment around them) in solar cell’s light trapping for enhancing absorption will be presented [1, 2]. Under up-conversion; the role of NaYF4:Yb3+, Er3+/NaYF4 core-shell nanoparticles in dye-sensitized solar cells efficiency augmentation by converting near infra-red photons into visible photons [3]. Under down-shifting; the nanophosphor layer as an optical filter with visible light transmission but UV light absorption, by placing on the front surface of silicon, dye-sensitized and perovskite cells to provide stability, and performance improvement will be presented [3, 4].

References

Bio-sketch

Vamsi Komarala is a Professor in IIT Delhi, before joining in the institute he worked in Trinity College Dublin, Ireland and the University of Arkansas, USA as a research associate. His primary interest is in optical properties of nanostructured materials, and implementation of nano-photonics concepts for enhancing solar cell performance, and silicon hetero-junction solar cells. He has co-authored around 50 articles in peer-reviewed International journals, and 7 in conference proceedings.

Vamsi Krishna is currently Professor in Centre for Energy Studies, IIT Delhi. He received M. Sc. Degree in Physics from Sri Venkateswara University Tirupati in 1996, M. Tech. Degree in Energy Science & Technology from Jadavpur University Kolkata in 1999, and a Ph. D. from IIT Delhi in 2004 for his thesis work on “Spray deposited CdTe thin films for Photovoltaic Applications”. He has 6 years of post-doctoral research experience on optical properties of semiconductor and metal nanostructures. Initially, he worked in School of Physics, Trinity College Dublin, Ireland from 2004 to 2007, on the topics of quantum dot excitons and metal surface plasmons interaction, nonradiative energy transfer between the quantum dots, and quantum dots interaction with polymers. Then, he moved to Department of Physics, University of Arkansas USA as a research associate, and continued his studies on optical properties of nanostructures from 2007 to 2010.
His primary interest is in optical properties of nanostructured materials, and implementation of nanophotonics concepts for enhancing solar cell performance, and also silicon hetero-junction solar cells. He has co-authored around 50 articles in peer-reviewed International journals, and 7 in International conference proceedings.

IL 16 B

Blink, Flicker and Sparkle: Optical Instabilities of Single Perovskite Crystals

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India Temporally random, photoluminescence (PL) intermittency between bright and dark intensity levels (blinking) has been long recognized to be characteristic of single quantum-emitters. Apart from fluorescent molecules, proteins and conjugated polymers, a variety of quantum-confined semiconductors (quantum-dots) also exhibit blinking. In contrast, such PL instability is seldom reported beyond nanoscale dimensions because (i) spatiotemporally uncorrelated intensity fluctuations average out over the ensemble, and (ii) contributions of surface-states in radiative-recombination processes become far less significant compared to that of the bulk. While there are a few rare examples of PL blinking in spatially extended (~μm) yet nano-confined (1 or 2-D) systems [1-2], such phenomenon is spatiotemporally inhomogeneous.

Recently, we showed that organo-metal (hybrid) halide microcrystals (MCs) without any dimensional confinement, such as thick films of methylammonium (MA) lead iodide, can exhibit optical instability (blinking) within local nanodomains [3]. Upon investigation of other hybrid halide perovskite polycrystal films, we discovered a bizarre phenomenon where entire individual micron-sized MAPbBr 3 disks undergo discrete, multi-level blinking on top of a dominant base intensity [4]. Intriguingly, such flickering or sparkling is found to be spatially-synchronous across each MC, which implies extremely long-range (&gt; μm) communication amongst carriers photogenerated at distal locations. Our studies on single-crystal nanorods of few microns length also reveal mesoscale instabilities (flickering and sparkling); however, the spatiotemporal correlation in nanorods is considerably diverse over space and time. Based on a phenomenological model which invokes transient non-radiative traps, I will discuss the possible mechanisms which lead to spatially-concerted blinking of individual crystalline entities.

References
Bio-Sketch

**Arindam Chowdhury** obtained a BSc (Hons) in Chemistry from University of Calcutta and a master’s from IIT Kanpur, followed by a PhD (2003) from Carnegie Mellon University in the field of Stark Spectroscopy. During post-doctoral stint at Columbia University, he developed an evanescent-field microscopy setup for single-molecule fluorescence spectroscopy and used super-resolution methods to visualize the dynamics of DNA-repair proteins. Dr. Chowdhury joined the faculty of Chemistry at IIT Bombay in 2006, where he established one of the first single-molecule fluorescence spectroscopy laboratories in India. His research focus has been to understand spatiotemporal heterogeneity in soft-matter matrices and semiconductor nanocrystals using single-emitter dynamics and spectroscopy. He is also involved in the development of methodologies for acquisition and analyses of single-emitter data, and sensing analyte in biological media. Recently, Dr. Chowdhury’s research interests have ventured into the study of optoelectronic instabilities and carrier dynamics in photovoltaic materials such as perovskite nanocrystals and films. Dr. Chowdhury is affiliated with the National Centre for Photovoltaic Research and Education (NCPRE) and the Wadhwani Research Center for Bioengineering (WRCB) at IIT Bombay.
ABSTRACTS

Posters
P 001

Stannous and Stannic Oxide Kinetics by Chemical Precipitation for Sensors

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Nano crystals of stannous and stannic oxide were synthesized by cost effective chemical precipitation method. X ray diffraction (XRD) studies showed the meta stable state of SnO and after calcinations SnO$_2$ was prepared which was phase indexed. Scanning Electron Microscope (SEM) studies were conducted, by which agglomerated morphology of the crystal was observed. Transmission Electron Microscope (TEM) studies were done for finding particle size which showed the range 2nm to 5nm. UV visible absorption studies Optical absorption wavelength was measured 272nm. Photo Luminescence (PL) studies showed the emission at around 395 nm, 437 nm, 450 nm and 468nm. Emission at 395nm is due to band edge emission by which the energy band gap may be about 3.14eV.

Brunauer-Emmett-Teller (BET) studies were also done for porosity studies for further application in sensor devices. The as-prepared SnO and SnO$_2$ nanoparticles exhibit the type IV isotherm revealing the characteristic of meso porous material and the presence of average pore size radius found to be 1.1860nm (pore diameter d= 1.1860*2=2.372nm>2nm i.e. mesopore). The specific surface area estimated by BET method is about 225.94m$^2$/g and Barrett-Joyner-Halenda method adsorption (BJH) is 18.1469m$^2$/g. The more pronounced uptake at high P/P0, being associated with the filling of micropores in mixed micro-mesoporous systems.

References:

P 002

Nano SnO$_2$ as electrode materials in intercalation Batteries: In operando XAS investigations

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To further utilize lithium-ion batteries (LIBs) to their maximum, advanced electrode materials should be developed, and the electrochemical performance and safety aspects of existing materials should be improved. Compared to positive electrode materials, negative electrode materials are required in excess in a LIB in terms of specific capacity. Electrode materials exhibiting fast Li$^+$ diffusion kinetics and high capacity are necessary to reduce the cell size and hence the production cost. In addition to LIBs, Na-ion
batteries (SIBs) are also emerging as promising intercalation-based battery, particularly due to the lower cost and high abundance of Na in compared to lithium. Several electrode materials used in LIBs are also investigated in SIBs due to the similarity of chemical reactions occurring in both. While there exist several positive electrode materials for SIBs, only limited number of negative electrode materials is found working. Conventional negative electrode in LIBs; graphite do not facilitate Na$^{+}$ intercalation.

SnO$_{2}$ is an attractive negative electrode material for LIBs due to its high theoretical specific capacity of 1491 mAh g$^{-1}$\cite{2}. It operates through a conversion mechanism. However, this material suffers from extreme volume changes which can lead to a drop in the electric contact and further to severe capacity fading during cycling. In the present work, SnO$_{2}$ nanoparticles (~50 nm) are synthesized via a one-pot hydrothermal process. The material was investigated as negative electrode candidate for both Li- and Na-ion batteries in corresponding half cells and the respective electrochemical mechanism was investigated by in operando and ex situ X-ray absorption spectroscopy. The details will be discussed in the poster.

Acknowledgement:

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References:


A Study on Nano-Scale Filtration

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Virus clearance is a major concern in the biopharmaceutical and water treatment industries as risk assessment and safety assurance are critical elements of these materials. Generally, virus clearance comprises two processes: virus inactivation and virus purification. In this, virus purification is achieved by a combination of methods including column chromatography, membrane absorbers, and membrane filtration. Ultrafiltration (UF), a membrane filtration technique, is employed for treating contaminated human blood derived products, antibodies and water since 1970s. UF membranes are capable of retaining particles with sizes in the retention range of few nanometers to few hundred nanometers, hence UF is used for virus filtration. Particle size is an important candidate in understanding the mechanism involved in fractionating or rejecting such virus particles in achieving the required regulated filtration efficiency values.

In virus capture or clearance operations, virus particles are distributed in the range of 15nm – 400nm depending upon the virus protein coat and the family. In this study, model virus particles employed fall in a similar range of sizes mimicking viruses, including reovirus, pseudorabies virus, adenovirus, herpes viruses and murine retro viruses.

This work contributes to the understanding of the influence of particle size on UF in the context of virus separation. An analysis of the particle permeation in crossflow mode considering two operating parameters, i.e. transmembrane pressure and crossflow rate for different particle size ranges will be presented. The nano-particle level study carried out in this work offers opportunity to academic and industrial researchers to gain fundamental insights into how the particle size properties are linked to the filtration quality.

References:
Synthesis and Characterization of LiGa$_5$O$_8$: Cr$^{3+}$ Nanoparticles Relevant to in-vivo Optical Imaging.


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2. Department of Electronics, D.M. College of Science, Imphal – 795001, Manipur (India)

Chromium doped lithium gallate LiGa$_5$O$_8$:Cr$^{3+}$ nanoparticles were synthesized by sol-gel method followed by sintering for 3 h at a temperature of 1000°C. XRD study shows the particle size in the range of 40.73 nm to 57.27 nm. Photoluminescence study shows a sharp emission peak at 720 nm by excitation at 293 nm. The 720 nm persistent luminescence and PSPL emission is in the tissue transparency window. LiGa$_5$O$_8$:Cr$^{3+}$ nanoparticles can be readily encapsulated by polyethylenimine (PEI) and polyvinylpyrrolidone (PVP) polymers, coated by silica shells indicating the LiGa$_5$O$_8$:Cr$^{3+}$ nanoparticles are the ideal nanoscale optical probes for long-duration and deep-tissue bio-imaging.

Key words: LiGa$_5$O$_8$:Cr$^{3+}$ nanoparticles, near-infrared, persistent luminescence, photostimulated persistent luminescence, in-vivo imaging.

References


**P 006**

**Synthesis of Layered MoS₂ Thin Films by Chemical Vapor Deposition**

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2D materials are unique class of materials in which in plane atomic bonding is much stronger than that along out of plane. Among different TMDCs MoS₂ is studied extensively due it’s intrinsic large bandgap and flexibility to control MoS₂ layers makes it a complementary candidate to zero bandgap graphene. MoS₂ flakes from mechanically exfoliated single layer MoS₂ has shown excellent on off ratio and high mobilities and the logic gates could also be made using them, making it a versatile compound. Practical application of MoS₂ requires the fabrication of MoS₂ thin films with controlled layer thickness [1]. Large-scale synthesis of layered MoS₂ thin films with controlled layer thickness opens a pathway for their integration into practical systems. Chemical Vapor Deposition (CVD), which gives high throughput, is therefore an important technique for the growth of MoS₂ atomic layers [2].

In this work MoS₂ was prepared by chemical vapor deposition technique using MoO₃ and sulphur powder as the starting material. The reaction was carried out on quartz substrate at different temperatures (550 to 750 °C with a step size of 50 °C) in argon atmosphere. X-ray diffraction studies revealed the formation of crystalline MoS₂ with diffraction peaks corresponding to 2H- MoS₂. Raman Spectra and PL spectra confirms the formation of few-layered MoS₂. Raman spectra also revealed that when the temperature was increased to 700 °C and more the layered structure transformed into bulk. There fore the number of layers in the MoS₂ thin films synthesized by CVD method was influenced by growth temperature. Thus, by optimizing the growth parameters, large area monolayered MoS₂ can be synthesized.

**References**


P 007

Nitrile Rubber Reduced Graphene Oxide/Organoclay Nanocomposites- Effect of Processing Methods

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Elastomeric nanocomposites based on two-dimensional nanoparticles are considered as an adequate solution to meet the future technological demands. The major concern in developing elastomeric nanocomposites is to maintain proper dispersion of nanoparticles in the matrix. This can be achieved to a certain extent by choosing appropriate processing methods and dispersing agents based on the nature of the polymer [1]. The present work deals with the fabrication of Nitrile rubber nanocomposites with layered fillers - reduced graphene oxide and organoclay. The tensile strength of Nitrile rubber increased by 150% with the addition of 3phr nanoclay and 63%; with the addition of 0.5 phr reduced graphene oxide when compared to unfilled rubber. The thermal, barrier and dynamic mechanical behavior of composites were also analyzed. The segregated interfacial morphology of the composites revealed proper dispersion of filler in the matrix.

References:

P 008

Nanoparticles of Anti-HIV drug as Milk Admixture for the treatment of HIV infections in children

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The HIV infections advancements swiftly in pediatric patients, wherein the global estimation of 3.3 million infected children below the age of 5 years is reported with 2.5 lakhs new infections every year. In spite of worldwide efforts to speed up the access to pediatric care and treatment of HIV infected children, several nations could not implement the WHO recommendations fully. The limitations include poor treatment adherence of the pediatric therapy due to unsuitable dosage forms for convenient administration. Consequently the need of the hour is the precisely developed age appropriate oral formulation to meet the need of the pediatric population. Hence, the aim of the present study is to develop suitable formulation to be administered as food admixture that can be mixed with either milk or porridge to avoid the contact of API with the mouth. The anti-HIV drug Efavirenz loaded Eudragit E100 nanoparticles were developed by spray drying technology and evaluated for its suitability as food admixture. The spray dried nanoparticles
(SDN) exhibited particle size <100 nm. The nanoparticles were characterized for molecular interaction (FTIR), solid state transition (XRD), thermal stability (TGA-DSC) and in-vitro cellular toxicity. The FTIR analysis confirmed the presence of drug in the nanoparticles with mild interaction in the polymer matrix. The XRD analysis showed crystalline nature of drug in SDN. The in vitro drug release studies of the nanoparticles by dialysis bag method showed maximum of 45% and 55% drug release at the end of 24 hours in 0.1 N HCl media with and without milk, respectively. The in vitro cellular toxicity assay showed CC50 value of the SDN as 205±1.0 µg/ml. Thus, the developed SDN could be a potential drug delivery system to treat HIV infections in pediatric patients.

References:


P 009

Development of novel peroxidase-like activity on chloramphenicol imine-amine redox probe entrapped multiwalled carbon nanotube and its sensing performance

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Chloramphenicol [D(-)-threo-2-dichloroacetamido-1-pnitrophenyl-1,3-propanediol] (CAP) is an antibiotic. It has been used for the treatment of Childhood Meningitis and Typhoid. However, toxic effects in humans such as aplastic anaemia have been reported. Hence, it has been banned for use in foodstuffs of animal origin in the European Union. There are several chemically modified electrodes developed for electrochemical sensing of CAP. For the first time we report, CAP immobilised carbon nanotubes (CNT) modified glassy carbon electrode (GCE), designated as GCE/CNT@CAP. The electrode was prepared by an in-situ electrochemical oxidation method, for efficient electrocatalytic sensing application of H2O2 in pH 7 PBS. The prepared GCE/CNT@CAP exhibited a quasi reversible redox peak at an E1/2 = -0.360 V vs Ag/AgCl with a favourable peak-to-peak potential value 0.12 V. No such electrochemical reaction was imminent when unmodified GCE was subjected to the electrochemical oxidation of CAP. The existence of CAP-imine-amine was confirmed by Liquid chromatography-mass spectrometer and FT-IR techniques. Morphological images clearly revealed that CAP was highly entrapped onto the CNT modified GCE. Peroxidase like catalytic activity of the developed interface was performed towards H2O2 reduction using cyclic voltammetry technique. Optimization experiments like effect of potential window, pH effect and scan rate effects were conducted on the GCE/CAP@CAP. A highly sensitive electrocatalytic oxidation of H2O2 by amperometric i-t and at an applied potential, -0.45 V vs. Ag/AgCl with detection limit values (signal-to-noise ratio = 3) of 0.62 µM, without any interference from other biochemicals like uric acid, dopamine, nitrite, cysteine, NADH and H2O2, unlike the conventional chemically modified electrodes with serious interferences, have been confirmed.
Nanomaterials find numerous applications in various technologies such as energy storage and conversion (Li-ion batteries and fuel cells), catalysis and sensors, water purification, etc. The durability and the performance of many systems based on these technologies greatly depends on the stability of structure as well as chemical nature of the nanoparticles. However, depending on the operating condition, external environmental conditions can often alter the structure as well as chemical nature of the nanoparticles leading to performance issues. Therefore, it is extremely important to investigate the nanomaterials in various systems under in operando conditions. Many spectroscopic techniques (XPS) as well as microscopic techniques (SEM, TEM) often fails in this respect as it needs ultra-high vacuum conditions. Other in operando techniques like XRD and neutron diffraction requires materials with long range order and therefore, often lacks complete information about nanomaterials. In this context X-ray absorption spectroscopy (XAS) can be considered as a unique tool as it does not require any ultra-high vacuum conditions. Moreover, material under investigation does not require any long-range order. In addition, the technique gives element specific information and therefore, the supporting materials associated with the systems (separator, current collectors, membranes etc.) do not interfere with the data.

In this work, an overview of the in operando XAS measurements conducted on fuel cell as well as Li-ion batteries which employ nanoparticles as active materials will be presented [1,2].

References:
P 011

Electrochemical and Electrochromic properties of mixed phase vanadium oxide thin films

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Electrochromic materials, which changes their colour induced by electrochemical reactions have been attracting attention because of their commercial applications in smart windows, display devices [1]. There are many electro-chromic materials like WO₃, MoO₃ and V₂O₅. Vanadium oxide is a good electrochromic material and also used as a common electrode material in Li-ion batteries. There are several approaches for vanadium oxide synthesis and tailored extensively in liquid-based Li battery applications. The layered-structure vanadium oxide exhibits efficient electron transport and short lithium ion insertion lengths [2]. The mixed phase of vanadium oxide films successfully deposited by reactive magnetron sputtering method on conductive glass (FTO) substrates. The crystallographic structure, surface morphology, electrochromic and electrochemical properties of the films were investigated. The process involved in Li⁺-intercalation has been explored in two voltage ranges: −1 V to 1 V versus Ag/Ag⁺, respectively. Electrochemical and electrochromic measurements of solution based and all solid state based thin film batteries revealed that the mixed phase vanadium oxide films exhibited good kinetic transport of Li ions, high charging capacity, good cyclic ability and coloration efficiency.

References:

P 012

Carbon Nanostructures for Improving Energetics of Complex Metal Hydrides

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In recent years, for realizing the solid-state storage of hydrogen various strategies have been tried to improve their kinetics and energetics such as admixing metal-based catalysts with hydrides, reducing the size of chemical hydrides into nano dimension, confining the hydrides in pores of mesoporous material and use of metal free catalysts [1-3]. Among various metal free catalysts, carbon nanostructures (CNs) have attracted lost of interest due to their stability and unique properties. However, there is lack of understanding about the role of pristine/doped CNs of variable curvature and underlying mechanism of their catalytic
behavior. In the present work we have presented results of our systematic investigation into the effect of the pristine, doped and defective CNs on the energetics of NaAlH₄ nanoclusters using density functional theory-based calculations. Fullerenes with variable curvature (Cₙ with n=20-60), small diameter carbon nanotubes (CNT (n,n) n=3-5) and graphene nanoribbons (GNRs) were considered for investigation. Our results have shown that CNs are effective in lowering the dehydrogenation energy (Eₚ) of surface supported NaAlH₄ clusters. NaAlH₄ cluster has been found to interact weakly with pristine CNs with interaction energy varying as C₂₈ > C₄₀ > C₆₀ > CNTs > GNRs. The interaction of NaAlH₄ with CNs, results in a significant decrease of Eₚ by 45%, 38% and 34% for fullerenes (C₄₀ & C₂₈), CNT(3,3) and GNR respectively w.r.t isolated NaAlH₄. The B doping in CNs has been found to further lower the Eₚ in the range of 49% - 65%. The vacancy defect has also been found to improve dehydrogenation similar to B doping. The combination of B doping and vacancy defect in CNs has been found to most effective in lowering Eₚ upto 70%. The sharp decrease in Eₚ can be explained based on the decrease in Al-H bond distance in AlH₄ anion due to change in the electrostatic interaction between Na⁺ and AlH₄⁻ due to interaction with CN surface which strongly depends on their surface curvature and electron affinity. The results are in qualitative agreement with the available experimental results and provides further motivation to explore the role of doped CNs as catalyst.

References:

P 013

Investigation of Magnetolectric Coupling Effect in BaTiO₃ - Sm₃Fe₅O₁₂ Multiferroic Composite Ceramics

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Multiferroics are advanced materials with a wide range of applications due to their strong magnetoelectric (ME) coupling effect at room temperature. Multiferroic materials possess two or more ferroic properties such as ferroelectricity, ferromagnetism, ferroelectricity or ferrotoroidicity which make them a potential candidate for many demanding applications include multiple state memory elements, spintronics, and sensors. Over the past few years, a lot of research works have been going on in this field to develop novel multiferroic materials with large ME coupling coefficients at room temperature. In this current work, Samarium iron garnet (SmIG) has been used as the magnetic counterpart due to its interesting magnetooptical properties and BaTiO₃ as electrical counterpart due to its intrinsic multiferroic properties at low temperature. Novel magnetoelectric (1-x) BaTiO₃ - xSm₃Fe₅O₁₂ composites were prepared by a sol-gel followed by a solid-state reaction. X-ray diffraction and transmission electron microscopic techniques are used for examining the crystal structure and microstructure of the samples. The ferroelectric and magnetic properties of the materials were confirmed by polarization versus electric field and magnetization versus magnetic field measurements respectively. In order to determine the coupling between ferroelectric and
magnetic orderings, magnetoelectric coupling studies were performed. Superior ME coupling behavior in these composites are expected to have significant applications in memory devices and sensors.

References:

P 014

Thematic Projects in Frontiers of Nano S&T on “Chemical Physics of Functional Nanostructures and Interfaces” at CeNS

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The major scientific and technological results and the research infrastructure achieved under the TPF Nanomission project will be presented. Topics such as soft hybrid nanomaterials and devices, carbon nanomaterials, nanoporous organic-inorganic hybrids, morphology-controlled metal nano crystallites and textured nanocrystalline oxide films for light trapping are covered under the project and specific results under these themes will be discussed. A liquid crystal device with enhanced electro-optic properties in terms of less threshold voltage and fast switching has been achieved by reinforcing with carbon nanotubes [1]. A simple joule heating of graphene on copper substrate is shown to improve graphene crystallinity with facilitation of polymer-free and direct transfer on any substrate [2]. We have also demonstrated a triboelectric nanogenerator from commonly available polymers with a good output of 1.5 V/N [3]. Vertical nanowall arrays of nickel hydroxide anchored on reduced graphene oxide films and molybdenum oxide films grown on tin oxide substrates are shown as good electro-catalysts towards electrochemical water splitting and energy storage [4,5]. All together 28 journal publications and 5 patents have resulted from the project.

References:
Formulation & Characterization of Bio Plant Based Nanofluid for Oil and Gas Field

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Demand for oil and gas has increased in this 21st century era due to increased population, Industrial development and high living standards. However much of the producing reservoir are getting depleted resulting in scarcity of early producability. Despite the fact that discoveries of new oil fields are explored to meet the demand, they along with some challenges. The most predominant challenge in producing from newly discovered oil fields are its complex reservoir environments such as High Pressure and High Temperature (HPHT, thus become a challenge while designing drilling fluid (also referred as drilling ‘mud’) planning.

The paper presents an experimental framework on the preparation of robust and appropriate drilling mud using, bio plant-based Nano fluids as additives. The mud formulated with variable concentrations of nanoparticles with aloe vera gel as base fluid have been characterized. It is cost effective, nontoxic and eco-friendly and can be applicable for HPHT reservoirs. Two step method was followed for the preparation of nanofluid in this experiment. The arrangement of particles in the prepared nanofluids and its stability were observed in the dispersed state using SEM. The particle size distribution in a range of nanofluids was measured using Dynamic Light Scattering (DLS). The thermal stability of the nanoparticles was measured using thermogravimetric analysis (TGA), thus the decomposition temperature of the synthesized nanofluid was determined.

This study is expected to form the basis for the development of natural bio plant based nanofluid as the primary additive for the drilling mud, enhanced oil recovery in the oil and gas industry.

References:
P 016

Mechanism of Thermal Degradation of In-situ Synthesized High Impact Polystyrene/Kaolinite Vinylclay Nanocomposites

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A comparative study on the evaluation of thermal activation energy with various integral and kinetic functions by Coats Redfern Method (CRM) and Phadnis-Deshpande Method (PDM) for in situ prepared High Impact Poly Styrene/Vinyl Clay NanoComposites (HIPS/VNCs) is depicted here. A comparative study on in situ polymerisation and melt mixing was conducted for the synthesis of high impact polystyrene and in situ polymerisation proved to be the best method. In in situ polymerisation, vinyl silane grafted nanoclay provided the best combination with poly butadiene rubber to yield best results. Thirteen samples of High Impact Polystyrene Vinyl Clay Nanocomposites (HIPS/VNCs) were prepared by varying the compositions of VC (Vinyl Clay) and PBR (Poly Butadiene Rubber) content. This was done by deploying Statistical Analysis, Response Surface Methodology (RSM) with design expert software version 8.0.7.1. Thermal degradation (onset degradation, maximum degradation and final degradation temperatures) was analysed from TGA thermal curves. Glass transition temperatures and Melting points were analysed from DSC curves. In kinetic studies, evaluation of activation energy showed a good agreement of the experimental data with CRM and PDM for Diffusion (Valensi, Jander and Brounshtein-Ginstling) and Phase boundary Models. A slightly higher activation energy than was obtained from PDM. Here, shrinking core model for heterogeneous fluid solid system is suggested as the mechanism of thermal degradation of high impact polystyrene vinyl clay nanocomposites.

P 017

Development and Optimization of Spray Drying Process of Dual Drug Loaded Nanoemulsion

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Atorvastatin calcium (AT) and trans-resveratrol (RS) individually reported have exhibited potential anticancer activity. Combination of these drugs might possess synergistic cancer effect in cancer. AT, RS are poorly soluble (BCS class II), possess low bioavailability which limits therapeutic applications. Nano drug delivery system overcomes these confines and improves the efficacy of drug. This work aimed to develop and characterize the dry nanoemulsion (DNE) containing dual drug AT and RS and to study the
effect of wall materials during spray drying process. Previously the nanoemulsion (NE) was developed by water titration method using oleic acid and capryol 90 (1:1), labrasol:2-propanol (Surfactant co-surfactant mix) at 20, 25, 30, 35 and 40% v/v and constructed the pseudo ternary phase diagram. NEs were characterized for size found to be 30-100 nm, zeta potential -0.5 to 0.205, pH 4.8-5, % transmittance 16-85%, confirmed as o/w type emulsion with Newtonian flow characteristics. The Transmission Electron microscopy (TEM) revealed the uniform nanometer globule size. Optimized NEs were spray dried with 0.5mm spray nozzle and parameters such as temperature, flow rate was optimized. The nanoemulsion containing 12 % w/v of wall material maltodextrin produced maximum yield (89%) of dry nanoemulsion. The free-flowing powder of dry nanoemulsion showed 65% encapsulation efficiency with 4% of moisture content. The instrumental analysis (FTIR, XRD and DSC) of dry nanoemulsion revealed that the drugs are compatible and endured solid state transition. The in-vitro drug release carried out using dialysis bag method showed rapid dissolution of two poorly soluble drugs when compared with pure drug. Cytotoxicity of dry nanoemulsion assessed by MTT assay was found to less toxic. Hence, the improved dissolution could benefit for the improved bioavailability and it reduces the burden in multiple therapeutic applications like atherosclerosis, antioxidant etc.

P 018

Nanostructure Tin Oxide: Precipitation method synthesis and Photocatalytic studies

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Nanostructured Tin oxide (SnO\textsubscript{2}) was prepared at room temperature by precipitation method from NaSn(OH)\textsubscript{6} aqueous solution using with and without the mineralizing agent. The effect of the mineralizer agent on the formation of the SnO\textsubscript{2} was investigated. The structural and optical properties of the prepared compounds were characterized using Powder X-ray diffraction (PXRD), Diffuse Reflectant Spectroscopy (DRS), Photoluminescence (PL) and Transmission Electron Microscopy (TEM). PXRD and HRTEM analysis confirmed single phase nanocrystalline tetragonal - SnO\textsubscript{2} formed in both the synthesis. Photocatalytic dye degradation of Rhodamine- B (RhB) in the UV light irradiation for the prepared SnO\textsubscript{2} photocatalysts were studied. The result shown higher degradation ability of mineralizer assisted prepared SnO\textsubscript{2} due to the presence of oxygen vacancies, which is supported by PL spectra.

Keywords: Tin oxide; Electron microscope; Photoluminescence studies. Photocatalytic studies.
Engineered Nanoparticles for Controlled Rectal Delivery of an Antihypertensive Drug

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Diltiazem is calcium channel blocker that helps in relaxation of heart muscles, smooth muscles and blood vessels and used in the treatment of hypertension, angina and other heart rhythm disorders as oral dosage forms. It is also effectively used in treatment of anal fissures through topical or anal application [1]. It has biological half-life of 3-4.5 h with oral bioavailability of only 40%, due to extensive first pass metabolism. In addition to adverse effects like nausea and loss of appetite by its chronic therapy, the intravenous administration had led to acute hypotension.

Drug-polymer nanoparticles as matrix or reservoir forms have been extensively researched for controlled release of entrapped drugs for extended time duration for prolonged activity with low dose and high bioavailability. To overcome the limitations of conventional dosage forms of Diltiazem, controlled release polymeric nanoparticles for rectal administration is experimented in this work, since the rectal pH 8 could favor the in vivo stability and release of Diltiazem (pKa 8).

Diltiazem polymeric nanoparticles were prepared by solvent evaporation method [2] using Eudragit RSPO as polymer (1:0.5 to 1:2 ratio) with 0.5% Pluronic F-127 as surfactant. Nanoparticles were obtained in the size range of 82 – 98 nm with maximum entrapment efficiency (99%). Increase in polymer concentration in the nanoparticles demonstrated sustained drug release profile (1:2 ratio with 60% at 6th hour in phosphate buffer pH 8) through Fickian diffusion mechanism. The sustained release phenomenon was supported by the formation of stable smooth spherical nanoparticles and mild interaction between drug and polymer, which was confirmed by SEM and FTIR analysis, respectively. Also, XRD and TG-DTA analysis proved the conversion of crystalline drug into amorphous matrix polymeric nanoparticles. The optimized nanoparticles could be used for in vivo studies to evidence its efficacy through rectal route of administration.

References:
Cost Effective and Environmentally Friendly Method for Production of Thin Film from Sugar Cane Bagasse

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The usage of waste materials for the fabrication of cost-effective materials having environmental impacts is always encouraging [1]. The developments of eco-friendly methods using green chemical approach are also fascinating. The present work adopts a new route for developing bioplastics derived from cellulose extracted from sugar cane bagasse. This includes a four-stage process bleaching of raw material using soapnut solution, isolation of cellulose, acetylation of cellulose via green chemical approach and casting of thin films. Acetylation of cellulose is normally carried out by using acetic anhydride, a hazardous and banned chemical [2]. The highlight of this work is pure cellulose acetate is produced from isolated cellulose through acetylation using an environmentally benign route, where the use of acetic anhydride is bypassed by a multicomponent one pot reaction.

This method of production of cellulose acetate uses only cheaper and easily available chemicals like sodium chloride, sulphuric acid and acetic acid. The reaction involves a temperature of 80-90°C, therefore charring of cellulose can be avoided. In this method AR. sodium chloride is used with glacial acetic acid under acidic condition which leads to acetylation of cellulose. This cellulose acetate was used for the production of thin films by solvent casting method using poly ethylene glycol (PEG) as a plasticizer. The characterisation of films was done using spectroscopic techniques like FT-IR and XRD. The degradability was tested by soil burial method in three different types of soils.

The bleaching was carried out using soapnut extract and non-hazardous chemicals were used for processing made the entire route environmental benign. Based on the investigations the fabricated thin films were found to be biobased, biodegradable and compostable in nature. This invention can contribute towards solving the issue of environmental pollution by non-degradable plastics.

References:


Nanoparticles for Wood Protection: Biological Synthesis of Copper Oxide and Zinc Oxide Nanoparticles Using Lantana Camara Leaf Extract and Evaluation of Its Wood Preservative Properties

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Nanoparticles are reported to be effective for wood protection in a more efficient way than the traditional methods of employing metal salts. Commercially available nanometals are synthesized by physical and chemical methods that produce toxic by-products and are expensive. The current study deals with a new approach for utilization of metal nanoparticle for wood protection in an ecofriendly and cost effective way. Metal nanoparticles were synthesised using plant extracts that are known to have wood preservative properties. The synergistic effects of the intrinsic property of plant extracts along with the biocidal property of metal nanoparticles were utilized. This research reports the synthesis of copper oxide and zinc oxide nanoparticles using Lantana (*Lantana camara*) leaf extracts and testing its efficacy as a wood preservative.

The synthesized copper oxide and zinc oxide nanoparticles were characterized using SEM-EDAX analysis. The efficacy of metal oxide nanoparticle formulation as wood protectant was evaluated as per Bureau of Indian Standards (BIS) for its antifungal (IS No-4873, Part I: 2008), antiborer (IS No-4873, Part II: 2008) and termiticidal activities (IS No-4833:1993) using rubber woods specimens. The results indicated that, the copper oxide nanoparticles synthesized using *L. camara* extract has a particle sizes ranging from 33 to 46 nm and zinc oxide nanoparticles around 37nm. The copper oxide *L. camara* leaf extract formulation was effective against termites for a period of six months in field condition (Graveyard test). The formulation also gave protection against wood decay fungi [*Trametes hirsuta* Wulf. ex Fr., White rot and *Oligoporus placenta* (Fr.) Gilb. & Ryvarden, Brown rot] and wood borer *Lyctus africanus* Lesne under laboratory conditions. The zinc oxide *L. camara* leaf extract formulation failed to protect the rubber wood from termites, wood decay fungi and wood borers. Studies are progressing in the direction of developing a stable and effective wood preservative formulation using plant extracts with metal nanoparticles.
In Vitro Evaluation and Invivo Toxicity Study of Phenytoin Sodium Loaded Nanolipid Carrier (Nlc) Intended For Intranasal Delivery in Treating Acute Epileptic Seizure

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Acute epileptic seizure or seizure emergency is a prolonged seizure or frequently occurring seizure which needs immediate medical attention. One common type of seizure emergency is called status epilepticus (SE). The main objective of the study was to reduce dose related peripheral side effects of an antiepileptic drug (AED) and provide early termination of seizures in emergencies with enhanced brain delivery by formulating it as a nano scale drug delivery system. The model drug phenytoin sodium is a second line drug used for treating acute epileptic seizure. Phenytoin sodium loaded NLCs were developed by melt emulsification - ultrasonication method using cholesterol as solid lipid, oleic acid as liquid lipid and poloxamer 188 as the polymer. Three different nanosized phenytoin sodium loaded NLCs (below 50 nm, above 100nm and below 100nm) were obtained by varying the probe sonication and magnetic stirring time and the results of particle size, zeta potential, % drug entrapment and % drug loading values were found within the satisfactory limits. In vitro drug release studies using dialysis membrane technique and HPLC analysis showed an immediate release of 99.19% ±1.07 within 15 min for the prepared below 50 nm sized phenytoin sodium loaded NLCs compared to below 100 nm sized phenytoin sodium loaded NLCs with 97.95% ±2.25 within 30 min and above100 nm sized phenytoin sodium loaded NLCs with 98.36% ±4.68 within 45 min. This immediate release is highly essential for the acute seizure control in epilepsy. Since nose-to-brain pathway has been indicated for delivering the drug to the brain, ex vivo permeation comparison studies using Franz diffusion cells were carried out for different nanosized phenytoin sodium loaded NLCs, control drug solution (drug in pH 6.6 buffer solution) and intranasal midazolam marketed formulation using freshly excised bovine nasal mucosa. The cumulative olfactory permeation of drug from below 50 nm sized phenytoin sodium NLC was found to be 3843.16 µg per cm² at the end of 20 minutes which showed a size dependant faster permeation compared to other formulations, ie from below 100 nm sized phenytoin sodium NLC was found to be 3962.56 µg per cm² in 45 minutes, from above 100 nm sized phenytoin sodium NLC it was 3929.34 µg per cm² in 60 minutes, from control drug solution it was 1.09 µg per cm² in 60 minutes and no drug permeation from intranasal midazolam nasal formulation was found at the end of 60 minutes. Similarly, the cumulative trigeminal mucosal drug permeation also showed similar profile. The permeation of drug from below 50 nm sized NLC was found to be very high through olfactory and trigeminal epithelium when compared to control drug solution. The statistical analysis by student t-test showed significant difference for steady state flux value between phenytoin sodium NLCs and control drug solution (P < 0.01 for olfactory mucosal permeation and P < 0.001 for trigeminal mucosal permeation). In vitro cytocompatibility studies of different formulations were carried out on L929 mouse dermal fibroblast cell lines and Human Brain Capillary Endothelial Cell Lines (HBCEC) by MTT assay and the result of the study confirmed that all the NLC formulations showed more than 80% cell viability and are non-toxic to normal L92 and HBCEC cell lines. The cell uptake studies of different phenytoin sodium NLCs in HBCEC cells were qualitatively determined using Flourescent Microscopy and were quantitatively determined by Flow cytometry analysis. The result of the flow cytometry analysis indicated that < 50 nm sized phenytoin sodium loaded NLC showed greater cell uptake (85.16%) compared to > 100 nm sized NLC formulation (47.0%) in BCEC cell lines. In vivo acute toxicity study done in both male and female wistar rats revealed that NLC formulation is non-toxic upto a drug dose of 250mg/ kg and showed liver toxicity at 500 mg/kg.
dose by intranasal route. Thus, Phenytoin sodium loaded NLCs offer promising advantages for intranasal delivery of phenytoin sodium for treating acute epileptic seizure.

**Keywords:** Acute epileptic seizure, intranasal formulation, phenytoin sodium, nanolipid carrier, acute toxicity

**P 023**

**Grain boundary Enriched Anisotropic Gold Nanoflowers Find Potential Candidate towards Catalytic Applications**

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Exploring the role of active sites or different crystal defects present in nanomaterials is an important feature for understanding the catalytic abilities of variable shaped nanoparticles [1]. To investigate the effect of crystal defects, we have designed different anisotropic gold nanomaterials (A^nGNPs) with growing disorder of crystal packing. The morphology and size of A^nGNPs was easily tuned from Bud (Au_{50}) to bloom or flower (Au_{75}) to over-bloom (Au_{150}) shape by mere variation in the concentration of reducing agent as observed from HRTEM analysis. These A^nGNPs are negatively charged and show satisfactory stability (with ξ ≥ -35mV) in room temperature for more than six months. *Despite of being negatively charged,* the synthesized A^nGNPs exhibit excellent catalytic activity (in contrary to the previously reported observations [2]) towards the reduction of 4-nitrophenol (4-NP). Although, the over-bloom shaped GNP{s} possesses greater apparent rate constant (k_{app}), in terms of turnover number (TON) and turnover frequency (TOF) which are the most significant parameters for any catalyst, the bloom shaped GNP{s} (TOF_{Au_{75}} TOF_{Au_{75}} \approx 8000 \text{h}^{-1}) exhibits superior catalytic performance than the over-bloomed (TOF_{Au_{150}} TOF_{Au_{150}} \approx 2000 \text{h}^{-1}) and bud shaped (TOF_{Au_{50}} TOF_{Au_{50}} \approx 500 \text{h}^{-1}) GNP{s}. Detail investigation suggest that, the presence of high-density grain-boundaries (GBs) as well as larger grain size plays the most crucial role in the observed catalytic performance. These nanomaterials were successfully employed further for the electrocatalytic reduction of hydrogen peroxide in neutral medium where the heterogeneous rate constant (k_{0}) is boosted by ~2000 fold for the bloom shaped GNP.

**References:**


Hepatocyte Targeted Carbohydrate Anchored Smart Nanostructured Lipid Carriers for Treatment of Malaria

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Introduction: In malaria caused by *P. vivax* and *P. ovale*, hypnozoites harbour in liver and skillfully remain dormant in hepatocytes resulting in relapse of malaria. Asialoglycoprotein receptors (ASGPR) expressed on hepatocytes can be exploited for targeting. **Objective** of project is to fabricate and evaluate hepatocyte targeted carbohydrate anchored lipid nanocarriers (NLCs) of anti-malarial drug that acts on pre-erythrocyte phase of *Plasmodium* parasite. **Methodology:** The affinity of lipid conjugated ligands for ASGPR was evaluated by molecular docking using Maestro Schrodinger 2014-2. Palmitoylated arabinogalactan [PAG] was synthesized and characterized by TLC, FTIR, $^1$H NMR and $^{13}$C NMR. On basis of solubility for Primaquine base (PQ), lipids and surfactants were screened. PQ loaded NLC dispersions were prepared by high pressure homogenizer (HPH) and probe sonication (PS). Box Behnken design was applied to get optimized NLC. **Results and discussion:** Docking score of Arabinogalactan (AG) and PAG were -7.17 and -6.3 respectively indicating no significant conformational changes in AG after conjugation with palmitoyl chloride (PC). In FTIR spectrum of PAG, bands at 1745.26 cm$^{-1}$ & 1160.94 cm$^{-1}$ indicate formation of ester bond between the hydroxyl group of monosaccharide unit of AG & carboxyl group of PC. Bands at 2852.2 cm$^{-1}$ and 1466.6 cm$^{-1}$ represent –CH$_2$– stretching & bending vibrations of palmitoyl chain, respectively. $^1$H NMR and $^{13}$C NMR spectroscopy confirmed intact nature of carbohydrate backbone of AG. PQ showed maximum solubility in oleic acid and Precirol ATO 5 and were selected as liquid and solid lipid respectively. Tween 20 was selected as surfactant. Optimized formulation prepared by HPH had particle size of 145.68 nm, -34 mV zeta potential, 0.25 PDI, 3.4 % drug loading and 79% entrapment efficiency. **Conclusion:** Docking studies demonstrated good affinity of PAG to ASGPR. Within scope of experimental design PAG anchored PQ loaded NLCs were successfully developed to target hepatocytes in malaria.

References:


Diatom Solar Panel

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Diatoms are photosynthetic unicellular brown algae with silica walls which synthesize, and store value added biologically important compounds as “diatom oil” in the form of lipid droplets. We fabricated micro fluidic micro resonating device measuring 30 mm x 30 mm x 200 µm on a silicon wafer of orientation <110> attached to a piezoelectric disc which is further connected to a function generator and oscilloscope to maintain a harmonic resonance frequency standardized to 250 KHz and a static voltage of 500 mV. A culture of diatoms is siphoned with a syringe pump at the one end of the chamber at the rate of ~ 10µl/min having ~12000 cells in the device of capacity 0.5ml. The resonating device is made to resonate at appropriate resonance frequency just enough to press the rigid diatom’s cell wall having mechanical stress of 750µN resulting them to exocytose oil while retaining the cell viability of about 45-50%. Further the live diatoms can be used again by sub culturing them on fresh f/2 media and oil can be re harvested without causing the cell death. A lab top bench model under patenting is now fabricated based on our fabrication on 2” silicon wafer.

References:
Designing of Multimodal Tumor Seeking Nanomedicine for Targeted Trimodal Photodynamic Therapy-mediated Photothermal and Chemotherapeutic Effects

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Despite the impressive progress in nanotechnology for the development of nanomedicine is a relatively young field of research in biomedical and clinical applications [1-4]. However, present cancer treatment demands a selective treatment option because of nonspecific toxicity often causes unexpected detrimental effects [5-6]. To increase the survival rate of cancer patients further, new combination therapy of different drugs are highly on-demand to improve specificity and avoid unfavorable biodistribution. The most useful NIR active window as the “therapeutic window” (650-950 nm) in PDT due to its deep tissue penetrating capacity of light at a specific wavelength [7]. Niels Fiensen used UV-light to treat smallpox, pustular infections eruptions, cutaneous tuberculosis, for his experimental outcome, he obtained the Nobel Prize for Medicine in 1903 [8]. Although, a clear disadvantage of light energy in the UV range has been noticed due to phototoxicity and very limited penetration range in biological tissues.

The present study strongly reveals that an integrated proof-of-concept of tumor seeking nanomedicine (TSN) is to achieve high therapeutic anticancer effect is highly desirable for effective cancer treatment to overcome detrimental effects of conventional therapies. However, the direct administration of drugs cannot achieve a high level of specificity which remains a formidable challenge. To address the confines, incorporation of multifunctionalities to maximize specificity of TSN pickup multiple cargoes of two types that are initially arrested at core location and delivers each type simultaneously to a specified destination. Here, a valuable approach of Her2/neu-rich tumor cell surface-receptor-targeting TSN is highly pH-responsive were significantly realizing the selective triple-therapeutic effects of blocking the Her2/neu functions, chemotherapy, and phototherapy (PDT/PTT). Using an animal model, a dramatic reduction in tumor growth without any evidence of significant long-term toxicity to organs after administration of NPs for trimodal therapy subjecting to NIR illumination. Thus, the in vivo satisfactory antitumor trimodal combined efficacy concurrent with complete tumor eradication and promising potential for advanced clinical phototherapy. Therefore, the unprecedented selectivity of TSN provides triple-therapeutic effect is to outspreading the repertoire of ‘TSN’ targets for future clinically relevant translation to improve selective cancer therapy.

References:
In this study, an attempt was made to devise a simple effective method to fabricate pluronic (P123) capped Ag nanoparticles decorated g-C₃N₄ (Ag-g-C₃N₄/P123) coated GCE electrode for electrochemical sensing applications. Initially, Pluronic (P123) capped Ag nanoparticles (18.1–40.7 nm) were synthesized and added to the surface of g-C₃N₄ to obtain the Electro active nanocomposites (EANCs). Pluronic (P123) acts both as a reducing agent and stabilizer for Ag nanoparticles. The pluronic (P123) capped Ag NPs were decorated on g-C₃N₄ (1:1 ratio) and thus produced Electro active nanocomposites (EANCs). This EANCs were characterized using FTIR, FT-Raman, DRS-UV-Vis, XRD, SEM and HR-TEM techniques. The results of TGA indicated enhanced thermal stability also showed enhanced antibacterial properties. The cell viability experiments demonstrate that the prepared EANCs can find use in paper industries and also in tissue engineering. Subsequently, this EANCs materials was coated on GCE electrode and produced stable and active EANCs coated Glassy carbon electrode (GCE-EANCs). This electrode in turn is demonstrated for sensing of notable antibiotic at negligible concentration through cyclic voltametry. The observed results are highly encourage.
Fabrication and Characterization of Piezoelectric “Gelapin” Films for Cardiac Regeneration

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The death rate due to cardiovascular diseases (CVDs) in India increased from 155.7 to 209.1 per lakh population from 1990 to 2016.1 Current therapeutic limitations of cardiac repair include the limited regenerative ability and the insufficient number of transplants donor organs. It paved the way for the development of the tissue-engineered myocardial patch. In this study, Genipin crosslinked Gelatin (Gelapin) films were employed as the scaffold. Gelatin is rich in arginine–glycine–aspartate (RGD) sequences which help in cell adhesion. For the improved mechanical stability, it is cross-linked with genipin, a non-toxic, geniposide, present in the fruit of the gardenia plant, Gardenia jasminoides Ellis2. Piezoelectric Boron nitride nanotubes (BNNTs) were incorporated as the response element in the Gelapin films which will induce an electric charge on applying mechanical stress and thereby stimulating the cardiac tissue. H9c2 rat cardiomyoblasts were cultured on the scaffold and was investigated using biochemical and electrophysiological techniques. These scaffolds can be explored as a potential material for cardiac tissue engineering as they integrate mechanical and chemical cues to mimic the native environment.

References:

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Spherical Nanocarbon Interface for Electrochemical Determination of 2, 4 Dinitrophenol

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2,4-Dinitrophenol (DNP) which is a sparingly water-soluble organic compound is immensely popular as an explosive and an integral component in herbicides, pesticides and fungicides and a potent uncoupler of oxidative phosphorylation in biological cells. Most importantly, it is a highly toxic pollutant widely prevalent in water bodies. Carbon black (CB) is one such material with a nanostructured phase which provides a surface area >1000 m²/g. In CB, electron transport is expedited resulting in oxidation or reduction of several bioactive molecules and environmental pollutants. For the first time, the present work involves the preparation of graphitic nanocarbon i.e. carbon black (CB) interface for sensing of 2, 4 dinitrophenol. The ethanolic dispersion of nanocarbon forms a thin film on the electrode surface which exhibits a larger surface area leading to enhanced electrocatalytic behaviour. DNP reduction mechanism was assessed in PBS (pH 6) solution using different electrochemical techniques. Two reduction potentials were noted at -0.48 and -0.64 V for o-NO₂ and p-NO₂ moieties respectively at CB/GCE (Carbon black modified glassy carbon electrode) while bare GCE shows a single reduction potential at -0.7 V. The electrocatalytic effect and adsorption ability of the nano interface was studied from the DNP concentration effect. Scan rate and pH influence results suggests that the graphitic nanocarbon has a tendency to acquire 4 electrons for NO₂ reduction by diffusion phenomena. For sensor studies, differential pulsed voltammetry (DPV) has been employed for the reduction of DNP at identical conditions. The broad range of concentration of 10-250 µM with very low LOD of 0.15 µM was observed at the nanocarbon interface. Real-time applicability of the fabricated sensor was analysed using commercial beverages with significant recovery values. Stability, repeatability and reproducibility of the CB interface was satisfactory.

References
Mesoporous Carbon-Based Electrochemical Sensor for Sensing Paraben And Its Derivatives

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Parabens (Para hydroxy benzoic acid and its derivatives) are synthetic chemical preservatives used in cosmetic and some of the food products available in the market, because of their anti-microbial and anti-fungal properties. Parabens are found to cause breast cancer, genotoxicity and endocrine disrupting effects in humans [1]. So, it becomes mandatory to monitor the presence of parabens in the products available in the market. Though, there are various studies reported on sensing paraben electrochemically, the use of interfacing materials are restricted to silica and metal oxide based materials [2][3]. Here, we have reported the sensing of paraben and its derivatives (methyl paraben, ethyl paraben and propyl paraben, etc.) using mesoporous carbon (MPC) as interface. The preparation of MPC has been performed through hard templated carbonization reaction technique and subjected to various textural & structural characterization using field emission scanning electron microscopy (FE-SEM), filed emission transmission electron microscopy (FE-TEM), powder X-ray diffractometry (XRD), fourier transform infrared spectroscopy (FT-IR) and nitrogen physisorption isothermal analysis (BET & BJH). The pristine MPC was then assembled on bare glassy carbon electrode (GCE) for the detection of paraben and its derivatives. The electrochemical behavior was investigated by cyclic voltammetry (CV), linear sweep voltammetry (LSV), differential pulse voltammetry (DPV) and amperometric techniques. The optimization experiments like effect of scan rate, pH, concentration, repeatability, reproducibility, selectivity and stability were studied on the particular modified GCE/MPC for paraben detection. The real time measurements of the modification were further utilized for commercially available cosmetic samples.

References:
Synthesis of Novel Three-dimensional ZnO Blind-Holed Hexagonal Rods

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Zinc Oxide (ZnO) is a wide band gap (3.37 eV) semiconductor. It is used in many fields like optoelectronic devices, gas sensors, solar cells etc. Metal oxide sensors have been a topic of interest due to their size, shape, and structure-dependent properties [1]. Microwave-assisted synthesis of metal oxides, hydroxides, semiconductors have been in use largely these days [2]. Semiconductors show structure and shape dependent properties. Treatment by microwave irradiation helps in obtaining various kind of nanostructures with different shapes and sizes. Here, a simple synthesis route for obtaining ZnO blind-holed hexagonal rods is reported. Zinc acetate is mixed with urea and distilled water in appropriate proportions followed by ultra-sonication for a while and subsequently exposed to microwave radiation for various time intervals. The product obtained is then extracted and dried at mild temperature in a hot air oven, while the decant liquid is further reduced with sodium hydroxide (NaOH) for complete reduction. The product obtained is then analyzed by X-Ray Diffraction to confirm ZnO phase formation. Field Emission Scanning Electron Microscopic analysis confirmed formation of different sizes and shapes of blind-holed hexagonal rods for different time intervals. The rods have an outer dimension of about 500 nm and an inner dimension of about 250-350 nm with a wall thickness of about 150 nm rendering these structures unique; the inner hollow provides a nano-sized cavity, the inner hexagonal walls have sheet structures while outer hexagonal walls provide six outer surfaces for interfacial reactions. The length of these structures runs into 2-3 microns. Radiation time interval seems to have an influence on the surface smoothness of outer surface and depth of the blind-holed rods. This aspect is being investigated in detail by further characterizing samples for their physical and morphological properties along with testing in potential gas sensing applications.

References:
Nanoparticles Assisted Synthesis of Europium Doped Calcium Silicate Phosphor: A Novel Approach to Make Single Phased Single Emitting Centre Based Phosphor for Warm White LED Applications

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A novel yellow emitting luminescence material of silica nanoparticles assisted Ca₂SiO₄: Eu²⁺ phosphors and conventional silica assisted Ca₂SiO₄: Eu²⁺ phosphors are made through high temperature wet-solid phase reaction technique. The studies of morphology, crystal phase and photoluminescence of silica nanoparticles assisted Ca₂SiO₄: Eu²⁺ phosphors and conventional silica assisted Ca₂SiO₄: Eu²⁺ phosphors are characterized and compared the efficiencies. All the prepared phosphors mimic the crystal phase of undoped Ca₂SiO₄ which confirm that the introduction of dopant-Eu²⁺ did not affect the crystal phase of Ca₂SiO₄. The photoluminescent studies of synthesized phosphor show a maximum intensity peak at 365 nm covering the range of 200 to 450 nm. This shows the ability of this material to use under wide spectrum of light especially NUV (~400 nm) and blue LEDs (~450 nm). The emission under 365 nm of excitation shows a broad range (430-650 nm) of the visible spectrum leading to the greenish yellow colour. Concentration quenching and application performance such as thermal studies were elucidated with the help of ocean optics spectrophotometer. The results show that this phosphor could be excellent candidates for the application of NUV and blue excited W-LEDs.

References:
Development of Surfactant-Stabilized Nanosuspension of Canagliflozin to Improve Solubility and Permeability of BCS class IV Drug

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Canagliflozin (CGF) is a sodium-glucose co-transporter-2 inhibitor, which prevents reabsorption of glucose in kidneys and used for treatment of type-2 diabetes in doses of 100-300 mg once daily [1]. It exhibits 65% oral bioavailability with half-life of 10 hours. The major limitation of CGF is its poor aqueous solubility and permeability (BCS class-IV). The present work focuses on development of nanosuspension for enhancing the solubility and permeability of the drug. The nanosuspension is prepared by Nanoprecipitation method with CGF: Eudragit polymer (EE100) at 1:05, 1:1 and 1:1.5 ratios using different surfactants from 1-2% w/v concentrations. The formulation with optimum ratio of drug: polymer and surfactant was selected based on particle size distribution, zeta potential, entrapment efficiency and in vitro drug dissolution studies using different media such as distilled water (pH-7), 0.1N HCl (pH-1.2) and phosphate buffer (pH-7.4).

Poloxamer containing nanosuspension showed monodisperse nanoparticles (PDI <0.2) with maximum entrapment efficiency (96-100%). The nanosuspension prepared using poloxamer as surfactant exhibited average particle size in the range of 90-120 nm with zeta potential ranging between +7 mV and +12 mV. The nanosuspensions demonstrated enhanced drug dissolution in distilled water, 0.1 N HCl pH 1.2 and phosphate buffer pH 7.4 media (58-80% at 8 hours) compared to pure drug (16-26%). The selected formulation is subjected to nanoparticles characterization studies such as scanning electron microscopy, drug polymer interactions by FTIR and DSC, in vitro drug permeation study using Franz diffusion cell, and in vitro cytotoxicity studies by MTT assay. The developed nanosuspension could be utilized to improve the solubility, permeability, stability and thereby enhance the bioavailability of the BCS class IV drug.

References:
Dual layer cathode with Molybdenum trioxide as a polysulfide shielding layer for high energy density room temperature sodium sulfur battery

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Battery systems based on the chemistry of sodium and sulfur are considered to meet the future demand of large-scale energy storage system because it can balance the cost as well as performance. Traditional sodium sulfur battery is being operated at a high temperature of above 300° C because they employ solid ceramic electrolyte which conducts Na\(^+\) ions at a higher temperature. This arises the problem of safety and low specific capacity. So, a stable room temperature sodium sulfur battery (Na-S) with high theoretical energy density of 1274 W h kg\(^{-1}\) will be a promising and an efficient storage device for large scale energy storage application [1]. The major obstacle is that sodium is more reactive to aprotic electrolytes and forms less stable solid electrolyte interface layer. Also, the larger size of sodium ions compared to lithium ions causes slow reaction kinetics at the cathode and huge volume expansion (260% for Na, 80% for Li). This results in low utilization of active material, high rate of capacity fading and low coulombic efficiency which limits its commercial application. To mitigate these problems the polar polysulfides are trapped using polar metal oxides by chemical confinement. Molybdenum trioxide helps to provide strong chemical interaction with polysulfide and prevents shuttling effect. Different techniques like galvanostatic charge discharge; cyclic voltammetry and impedance spectroscopy techniques were employed to study the electrochemical performance of sodium sulfur battery. MoO\(_3\) as a trapping layer helps to achieve a high specific capacity of 1000 mAh g\(^{-1}\) at 100 mA g\(^{-1}\) with a stable cyclic stability. Importantly, the specific capacity is higher than that obtained for high temperature molten type sodium sulfur battery and thus this study provides a new approach for preventing sulfur dissolution in room temperature sodium sulfur battery.

References:

P 035

To Develop Ph-Sensitive Carrier for Drug Delivery in Acute Myeloid Leukemia (AML)

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The conventional therapy for AML includes: induction of remission and post-remission treatment. The initial phase of the treatment administers high doses of the chemotherapeutic drug that slows the growth and proliferation of cancer cells. These high doses have adverse side effects. This research is aimed at increasing the therapeutic benefit, while minimizing side effects by employing biodegradable nanoparticles. A novel polyketal co-polymer will be used for this purpose. These classes of acid responsive polymers are less explored in the context of drug delivery. The ketal linkage in the polymer is pH cleavable which enables its endosomal escape. These aliphatic polyketals degrade into neutral products thus preventing inflammatory reactions. The Copolymer was synthesized with 1,4-Cyclohexanediol, 1,5-Pentanediol, 1,4-Butanediol with p-toluene sulfonic acid as catalyst and 2,2-Dimethoxypropane as initiator. The synthesised polymer was characterized using 1HNMR, FTIR, TGA. This was followed by the synthesis of polymeric nanoparticles by emulsion technique and their characterization. The encapsulation of the therapeutic agent was also carried out by emulsion technique. The pH responsiveness of the polymer was tested in vitro at pH 7 and pH 4.5 buffered solutions using membrane dialysis method. The in vitro studies to investigate the therapeutic efficacy of the developed system were performed and assessed cell toxicity and internalization.

References:

P 036

Stimuli Responsive Gelatin-Glutaraldehyde (GG) Construct For Cardiac Tissue Engineering

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According to the American Heart Association Statistics, cardiovascular diseases cause the highest risk of death in the world. Currently, there are limited treatment options available for myocardial infarction (MI) and subsequent congestive heart failure. Cardiac tissue engineering is the field of attraction due to the insufficient number of heart donors and the limited regenerative ability of the heart. The main objective of
the study is to fabricate stimuli-responsive glutaraldehyde crosslinked gelatin construct for cardiac regeneration. To give adequate mechanical strength and to mimic the geometry of the extracellular matrix, glutaraldehyde crosslinked gelatin films will be stacked to form a 3D construct. Multiwalled carbon nanotubes (MWCNTs) will be dispersed in the films to stimulate the cardiomyocytes seeded on the scaffold. The MWCNTs will help in aligning the cells in the direction of the stimulus and also can increase the electrical coupling. In vitro evaluation was done for the scaffolds and studied for viability, adhesion, and proliferation.

References:

Acknowledgement:
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P 037

**Evaluation Of Anti-Biofilm Efficacy Of ZnO-Nano Rods (ZnO-NRs)**

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**Background:** In present day healthcare, enormous demand of catheters has resulted owing to its ease in administering fluids, medication therapies and nutrition to patients admitted in intensive care units. (1). However, due to the hydrophobicity of the surface material of catheters, it results into protein adsorption and cell adhesion. Catheters (the current investigation is based on a Central Venous Catheters) are therefore prone to complications, such as colonization by microbial biofilms, associated infections, and thrombosis. Microbial Biofilms display high tolerance toward the immune system and various antimicrobials and are thus difficult to eradicate. Moreover, biofilms on the surfaces of central venous catheters are potential sources of bloodstream infection, a leading cause of healthcare-associated infection in critically ill patients. Here, in the present study we have evaluated the potential of ZnO-NRs as potential coating material on surfaces of central venous catheters against biofilms formed by clinically relevant strains (*E. coli, P. aeruginosa, S. aureus and K. pneumonia*).

**Methods:** ZnO-NRs were prepared by mechanical-assisted thermal decomposition method process (6). Morphology and Structural properties of ZnO-NRs were characterized by TEM, SEM, FTIR, XRD methods. Antibiofilm assays were carried out as described earlier (5). Briefly, bacteria were grown in enrichment media for 24 hrs in 96 well round bottom flasks. Biofilm biomass was determined by crystal violet staining (George O’Toole Protocol, 7). ZnO-NRs were added to the test wells along with the bacterial culture to inhibit the probable adhesion to the well walls. Bacterial culture without ZnO-NRs were treated as controls.

**Results:** ZnO-NRs are potential coating materials as they inhibit the biofilm formations investigated in vitro conditions.
P 038

A Novel Ionic Conducting Biodegradable Polymeric Scaffold For Peripheral Nerve Regeneration

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Abnormalities in the structural orientation of peripheral nerves lead to biochemical and electrical imbalances, poor movement and coordination resulting in impairment of functional organs. Conventional treatments strategies are successful for small sized injuries but in the case of large size injuries (greater than 6 mm) are not very successful. Use of nerve allografts or xenografts possesses several disadvantages like immune rejection, infections, etc. Use of biodegradable and nonbiodegradable prosthesis also have the risk of rejection leading to the immediate removal of implant. In this study, ionic conducting polymeric hydrogel scaffolds were developed, characterized and evaluated for its toxicity studies in vitro. Alginate/polyvinyl alcohol blended hydrogels were prepared using ionic liquid (Choline acetate) and cross linked using calcium chloride and characterized for its morphology, functional group analysis, thermal behaviour, viscoelasticity, ionic conductivity, swelling property, gelation analysis using Scanning Electron Microscopy, Fourier Transform Infra Red Spectroscopy, Differential Scanning Calorimetry, rheometer, two probe technique, gravimetric technique and tube inversion method respectively. The scaffolds were also evaluated for its cellular viability for 24 h using MTS assay. The developed scaffold exhibited porous morphology, excellent homogeneity of the blend, enhanced ionic conductivity and visco elastic property.

References:
Comparative Study on the Effects of Biological and Chemical Synthesized Zinc Oxide Nanoparticle in Nile Tilapia (*Oreochromis niloticus*)

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The long-term effects of biological and chemical synthesized zinc oxide nanoparticle on oxidative stress, histology and genotoxicity in Nile tilapia are investigated. Synthesis of zinc oxide nanoparticle was based on co-precipitation method described by Singh et al. Starting materials used for chemical synthesis were zinc acetate dihydrate (Zn (CH\(_3\))\(_2\)COO)\(_2\) \(\cdot\) 2H\(_2\)O) and sodium hydroxide (NaOH). Zinc oxide nanoparticle was biologically synthesized using *Leucas aspera* aqueous extract and oxyresveratrol. From the 1mg/ml stock solution of both nanoparticle suspensions, 1ml, 5ml and 10ml of suspension were sprayed on commercial fish feed, mixed in a vortex mixer and dried. Nanoparticles were characterized for understanding various physico-chemical features by UV-vis spectroscopy analysis, XRD, FTIR, SEM and TEM. Antibacterial activity of both type of nanoparticles were determined by agar well diffusion method against *Aeromonas hydrophila* and *Streptococcus agalactiae*. Nile tilapia was fed for 30 days with three doses of both types of nanoparticle sprayed feed. After 30 days, liver and gills were collected to understand oxidative stress and also for evaluating histopathological alterations. Blood was collected to assess the damage in DNA by comet assay. Accumulation of nanoparticle in tissues are determined by ICP analysis. The preliminary results suggest that biologically synthesized zinc oxide nanoparticle has highest antibacterial activity against *S. agalactiae*, whereas chemically synthesized zinc oxide nanoparticle has highest antibacterial activity against *A. hydrophila*. Also, the antioxidant activity evaluated by DPPH assay and reducing power assay revealed that biologically synthesized zinc oxide nanoparticle exhibited greater antioxidant activity than chemically synthesized zinc oxide nanoparticle. Levels of antioxidant enzymes like catalase, superoxide dismutase, glutathione peroxidase and glutathione reductase were determined in gills and liver. The results suggest that high dose of biologically synthesized zinc oxide nanoparticle could enhance the level of antioxidant enzymes in liver and gill tissues compared with control and chemically synthesized nanoparticle.

References:

Fe-Containing Oxides as Conversion-Type Negative Electrode Model Systems for Lithium-Ion Battery

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Lithium-ion batteries are most promising power sources for portable electronic devices due to their high energy density. To exploit lithium-ion batteries to their maximum applications, innovative electrode materials should be developed, and existing materials should be improved. In a lithium-ion battery, negative electrode materials are required in excess amount (with respect to the specific capacity) in comparison with the positive electrode materials. Hence, it is important to reduce the amount of negative electrode so as to reduce the cell size and further the production cost [1]. At present, the widely used negative electrode material is graphite. Graphite has a limited specific capacity of 372 mAh g\(^{-1}\)[1]. Moreover, it suffers from safety issues. Due to the lower working voltage of graphite, the lithium plating can occur on the electrode surface which could lead to a thermal runaway. Hence, intense research on alternative negative electrode materials are going on worldwide to hunt for alternate materials with higher specific capacity as well as better safety characteristics.

Conversion reaction-based transition metal oxides are promising candidates as anodes for lithium-ion batteries because of their high theoretical capacities [2]. Among these materials, Iron oxides, especially Fe\(_3\)O\(_4\) is considered as one of the most promising anodes due to its high capacity, toxicity, low cost, natural abundance and high electronic conductivity. In this work, Fe\(_3\)O\(_4\) is synthesized by a one pot co-precipitation method. Additionally, conductive polymer coated Fe\(_3\)O\(_4\) was also synthesized. The polymer coated Fe\(_3\)O\(_4\) is found to be beneficial with respect to its electrochemical performance in comparison with its bare analogue. The phase purity, particle size as well as elemental analysis studies were conducted using X-ray diffraction, Scanning electron microscopy as well as Energy-dispersive X-ray spectroscopy (EDX), respectively. The electrochemical characterization was performed using cyclic voltammetry and galvanostatic cycling techniques and will be discussed in the poster.

References:

Synthesis of Layered MoS$_2$ Thin Films by Chemical Vapor Deposition

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2D materials are a unique class of materials in which in-plane atomic bonding is much stronger than that along out of plane. Among different TMDs MoS$_2$ is studied extensively due to its intrinsic large bandgap. Flexibility to control MoS$_2$ layers makes it a complementary candidate to zero bandgap graphene. MoS$_2$ flakes from mechanically exfoliated single layer MoS$_2$ has shown excellent on off ratio and high mobilities and the logic gates could also be made using them, making it a versatile compound. Practical application of MoS$_2$ requires the fabrication of MoS$_2$ thin films with controlled layer thickness [1]. Large-scale synthesis of layered MoS$_2$ thin films with controlled layer thickness opens a pathway for their integration into practical systems. Chemical Vapor Deposition (CVD), which gives high throughput, is therefore an important technique for the growth of MoS$_2$ atomic layers [2].

In this work MoS$_2$ was prepared by chemical vapor deposition technique using MoO$_3$ and sulphur powder as the starting material. The reaction was carried out on quartz substrate at different temperatures (550 to 750 °C with a step size of 50 °C) in argon atmosphere. X-ray diffraction studies revealed the formation of crystalline MoS$_2$ with diffraction peaks corresponding to 2H- MoS$_2$. Raman Spectra and PL spectra conforms the formation of few-layered MoS$_2$. Raman spectra also revealed that when the temperature was increased to 700 °C and more the layered structure transformed into bulk. Therefore, the number of layers in the MoS$_2$ thin films synthesized by CVD method was influenced by growth temperature. Thus, by optimizing the growth parameters, large area monolayered MoS$_2$ can be synthesized.

References

Large-Scale Low-Cost Nano-Plasmonic Array Fabrication

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Plasmonics is an important part of the field of nano-photonics, which realizes the confinement of the electromagnetic field over the dimension smaller wavelength of light. It is based on the interaction between electromagnetic radiation and the free electrons in metals at the interface or in small metallic nanostructures. This interaction leads to enhanced optical near field at sub-wavelength dimensions. This enhancement has
led to a large number of proposals to use these structures for near field-based sensing applications. Technologically, these efforts are marred by the high cost of fabrication of these nanostructures, which typically requires expensive techniques such as electron beam lithography.

In the present work, we demonstrate the fabrication of large scale plasmonic nanoparticle array using colloidal lithography technique. Colloidal lithography technique is based on the usage of the colloidal particles as a mask for etching and deposition. In our work we utilize a convective self-assembly approach for the deposition of a monolayer of micro particles on a centimeter scale over a photoresist. This monolayer acts as mask in a subsequent dry etching process. The different etching rates of photoresist and the microparticle monolayer leads to the formation of periodic nanopatterns with deterministic sizes and shapes. Subsequently we deposit plasmonic materials on top of these nanostructures and characterize the resonances which match well with our full wave simulations.

We will discuss optimized fabrication protocols of these large area nanostructures and our results on using them for enhancing the sensitivity of poisonous gas detection.

P 043

Cytotoxic Activity of Phytofabricated CeO$_2$ Nanostructures

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Nanotechnology is a science that helps us to manipulate matter at the molecular level so that devices with novel chemical, physical and biological properties can be created. Nanoscale devices differ from the conventional methods of diagnosing and treating diseases, and present certain advantages over them. The extremely small size enables the nanoscale devices to readily interact with bioreceptors on both the surface and inside cells. Having a large surface area, the nanoparticles can readily be attached to drugs, proteins, targeting moieties and diagnosing agents, making them useful in medicine [1]. Cerium oxide nanoparticles (CeO$_2$ NPs) are considered favorable in nanotechnology based on some remarkable biological properties. The growing demands for CeO$_2$ NPs are met by the synthesis through physical and chemical routes. However, disadvantages associated with physical and chemical methods have directed the current nanoparticle research towards biological methods. Hence, biosynthetic method of nanoparticle is cost effective and environmentally friendly [2].

The present study focuses on the green synthesis of CeO$_2$ NPs using aqueous extract of Syzygium cumini leaf extract as the bioreductant. A pale yellow colored powder indicates the formation of cerium oxide nanoparticles. The characterizations of synthesized nanoparticles are done by using various techniques such as X-ray Diffraction spectroscopy, Transmission electron microscopy and UV-visible absorption spectroscopy. TEM analysis reveals the morphology and size of nanoparticles with an average particle size of approximately 5.8nm. The XRD analysis illustrates the crystalline nature of as synthesized nanoparticles. The enhanced cytotoxic activity of the as prepared nanoceria has been determined on normal fibroblast cell lines, which suggests their possible applications in biomedical fields.

References


P 044

Synthesis and Characterization of SnS$_2$ Nanostructures by Wet Chemical Routes

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Two-dimensional layered metal dichalcogenides (LMDs) materials including molybdenum disulfide (MoS$_2$), tungsten disulfide (WS$_2$) and black phosphorus have attracted a huge of interests in the last decade due to their excellent electronic, optical, mechanical and thermal properties. The basic building block of TMDCs consists of a hexagonally ordered plane of transition metal atoms sandwiched between two hexagonally ordered planes of chalcogen atoms, together referred to as monolayer. The unique physical properties of semiconducting TMDCs are most relevant in electronic, optoelectronic, and sensing device applications. Tin disulfide (SnS$_2$) is an emerging n-type indirect bandgap semiconductor material with a tunable band gap. It has a layered sandwich structure, where two adjacent layers of S–Sn–S are interacted with each other by weak Van der Waals forces. Moreover, its components Sn and S are earth abundant and environment friendly elements. SnS$_2$ is a promising candidate for applications in solar cell, lithium battery and optoelectronic devices. Light-absorbing capabilities in the visible and short-wavelength near-infrared regions enable SnS$_2$ to work as promising sensitizers for wide band gap semiconductors or visible light-driven photocatalysts. Here we synthesised SnS$_2$ nanostructures using tin chloride and thioacetamide via co-precipitation and hydrothermal methods. The structural, optical and morphological properties of the SnS$_2$ nanostructures synthesised by two methods were compared and studied. The effect of temperature and duration of growth of hydrothermally synthesised SnS$_2$ nanoparticles were also studied.

P 045

Hydrogen generation with solar light induced water splitting using 600 keV N$^{2+}$ ion beam irradiated BiVO$_4$ photoanodes

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The requirement of primary energy source is fulfilled by the combustion of fossil fuels which is also related to emission of green house gases. Hydrogen generation by using photoelectrochemical (PEC) water splitting route is one of the most promising methods for solar to chemical energy conversion and for the use of hydrogen as future fuel. Use of low energy ion beam can be a effective way to alters materials properties [1-2].

Present work is focused on studying BiVO$_4$ thin films irradiated with 600 keV Ar$^{2+}$ ion for phot electrochemical water splitting. All the samples were characterized by XRD, XPS, SEM, EDX, UV-Visible spectroscopy. The influence of ion irradiation on BiVO$_4$ thin films for photoelectrochemical
performance has been studied by current voltage characteristics, Nyquist plots, Mott-Schottky analysis and efficiency measurements. Maximum photocurrent density was obtained at lowest of $2 \times 10^{15}$ fluence. The results will be discussed in detail.

References:


P 046

An Extensive Research Survey on Organic Transistor Based Complementary Inverters

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Over the past five decades, no other semiconductor device has had such huge influence on technological progress as the field effect transistor. The development of this device is a driving force in solid state science. For decades, semiconductor science has been focussing on silicon-based devices [1-2]. Silicon chip production is complex and expensive. Because of this alternative materials like organic semiconductors have gained special attention in recent years. They can be easily deposited over large flexible substrates [3,4].

One among the important applications of OTFTs is the complementary inverter circuit. The face off in the complementary circuits is choosing p-type and n-type organic thin film transistors (OTFTs) that match in performance. Also, OTFTs lack in suitable conductive material that enhance the device performance. The operating characteristics of OTFTs are governed by the boundary conditions imposed by the device structure such as interfaces and contacts instead of the properties of the semiconductor material. Therefore, the performance of OTFTs is often limited. The search of materials for n channel and p channel transistors is a major area of research [4-6]. Various dimensional parameters, materials and performance of different TFTs used in the inverter circuits are discussed. Also, to find the gaps in the current research some of the recent research surveyed. Following the current state of the art in the research of organic complementary inverters is given. Finally, the paper is ended-up with a conclusion and futuristic scope of the research survey.

References:

Influence of Au nanoparticles on Photoelectrochemical Performance of Metal Oxide Semiconductors

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Hydrogen generation via photoelectrochemical method has been emerged as one of the most promising ways that can be used at commercial scale in the near future. To design efficient electrode for PEC water splitting, research has been carried out to meet the benchmark set for its commercialization, but results are still far from our reach. Introduction of plasmonic nanoparticles exhibiting SPR (Surface Plasmon Resonance) and their transfer of energy to semiconductor material by PRET (Plasmon Resonance Energy Transfer) and HET (Hot Electron Transfer) in semiconductor materials is influencing the researchers to use these noble metal nanoparticles to enhance the photoelectrochemical performance. Role of plasmonic Au nanoparticles towards increased photoelectrochemical response was investigated on metal oxides viz. Fe₂O₃, TiO₂ and BiVO₄/Fe₂O₃ heterojunction by authors [1-2]. The results and mechanism will be discussed in detail.

References:

Polyhedral Oligomeric Silsequioxane as nanocarrier for drug delivery application in Cancer treatment

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Cancer is a complicated disease for which finding a cure is a present challenge. Most of the treatments employed to kill cancer cells work by causing cellular DNA damage which may also affect healthy cells along with cancerous cells. So, there are lots of side effects due to treatment procedures. To overcome such controversies smart nano intervention paves a beest solution in current scenario. Nanoparticles are gaining lot of attention due to its high surface area, drug loading ability and high specificity. It can be modified with polymers and bioactive molecules to achieve efficient and specific targeting. Polyhedral oligomeric silsesquioxane (POSS) is an organic-inorganic (RSiO₁.₅)₈ hybrid material which consists of a Si-O-inorganic core surrounded by tunable organic moieties [1]. It is highly symmetrical, cage like structures, possible to add functional groups, both organic and inorganic in precision. POSS has been synthesized and modified through simple hydrolysis process. The product has been characterized using SEM, FT-IR, ¹H NMR and ¹³C NMR. It has been developed into cross-linked nanostructure by cross-linking the POSS caged structures using thiol linkages [2]. Gold nanoparticles have been introduced in the cross-linked POSS using thiol terminals [4]. The combination of photo-thermal and targeted drug delivery possess to give the best cancer treatment. Cell viability studies of synthesized nanostructured materials show the biocompatible nature [3]. So, the biocompatible POSS based polymer cross-linked nanomaterial can be utilized for efficient cancer treatment.

References:


P 049

Chemically Active Boron Rich Nanosheets: An Avenue to Realize Borophene-Graphene Hybrids In Solution
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Two-dimensional boron has been garnering remarkable interest, following the experimental synthesis of borophenes in the last few years [1]. Metal borides are suitable starting materials towards exfoliative synthesis of boron based nanosheets, owing to their layered constitution - graphenic planes of boron sandwiched between hexagonal layers of metal atoms [2].

We report that nanosheets synthesized by the chemical exfoliation of magnesium diboride, comprising of chemically modified boron planes, exhibit a reducing action. This chemically active nature is demonstrated by the ability to reduce many inorganic and organic molecules in aqueous solution. In addition, this unique property has been utilized for the spontaneous reduction of gold salt and the subsequent formation of gold nanoparticle decorated nanosheets. We also show the potential of these nanosheets to reduce aqueous graphene oxide dispersions and form reduced graphene oxide-boron based nanosheet hybrids. This is the first report on interfacing boron planes with graphene, that too in an aqueous solution. The chemically modified boron based nanosheets derived from layered metal borides, hence hold excellent prospect in acting as templates towards forming mixed dimensional heterostructures.

There is a surging interest in combining 2D materials with other nano dimensional materials to create heterostructures, which synergise the constituent properties. Our work suggests that a wide range of boron based nano hybrids can be easily designed owing to the ability of these nanosheets to act as active templates.

References:

P 050

Superparamagnetic Polymeric Nanoplatform For Combined Anticancer Therapies & MR Imaging
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Cancer is a one of the deadliest diseases that imposes a big challenge for modern medicines to develop a strategy for effective cancer treatment. Among the various conventional therapies, chemotherapy is largely used in the cancer treatment. However, chemotherapy could fail due to (i) multidrug resistance express by cancer cells and (ii) multiple side effects produce by large dose of chemotherapeutic drugs (CHDs).
Recently, superparamagnetic iron oxide nanoparticles (SPIONs) are extensively investigated for cancer diagnostics and therapeutics. SPIONs along with CHDs encapsulated multifunctional polymeric nanoplatforms are potential cutting-edge tool in cancer theranostics research as a result of their applicability in multimodal anticancer therapies with their simultaneous monitoring through MRI imaging. Herein, we have developed superparamagnetic polymeric nanoplatform (SPNPTs) by using SPIONs, CHDs (Cur) and biodegradable polymer (PLGA/TPGS) for multimodal anticancer therapies based on the combined effect of thermotherapy (using magnetic fluid hyperthermia (MFH)) and chemotherapy (using CHDs) [1, 2].

Initially, 10 nm size of oleic acid (OA)/oleylamine (OM) functionalized hydrophobic SPIONs with are synthesized by thermal decomposition method. Then, a series of empty SPNPTs (without SPIONs and CHDs), SPIONs encapsulated SPNPTs (without CHDs), and SPIONs along with CHDs encapsulated SPNPTs samples are prepared and then optimized based on their hydrodynamic size (Ds) and encapsulation efficiency (EE% of SPIONs/drugs). Physiochemical properties of the optimized SPNPTs samples are characterized by using several basic techniques such as DLS, TGA/DSC, AFM, FESEM and TEM. SPNPTs samples are further characterized by SQUID and magnetic hyperthermia equipment to determine their magnetic properties and calorimetric heating efficiencies (in terms of SAR/ILP values), respectively. Finally, the optimized SPNPTs samples are investigated for CHDs based thermo-chemotherapy in Hepg2/HeLa cancer cell lines and their contrast properties are inspected through in vitro MRI. The results showed that formulated SPNPTs are very promising candidates for combined anticancer therapies & MR imaging.

References:


P 051

Investigations on “On-Growth Mechanism of Nanostructured Copper Oxide Thin Films” on Different Substrates

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The surface morphology of nanostructured thin film plays a decisive role in deciding the response of gas sensors. The surface texture of the substrates is one of the governing factors of the growth of thin films. In this context, the growth mechanism of nanostructured CuO thin films on different substrates has been investigated. The structural, morphological, optical, electrical and sensing studies have been investigated using X-ray Diffractometer (XRD), Field Emission Scanning Electron Microscope (FESEM), UV-Visible (UV-Vis) spectrophotometer, Fourier Transform Infrared (FTIR) spectrometer, Hall measurement system and Keithley electrometer. Structural studies confirmed the formation of CuO film with polycrystalline nature on alumina and silicon substrates and amorphous nature for the films deposited on glass and quartz.
substrates. The estimated band gap of the deposited film varied between 1.2-2.0 eV. The carrier concentration and mobility varied from 3x10^{11}-1.39x10^{16} cm^{-3} and 5.67 - 153 cm^{2}V^{-1}s^{-1} respectively. The sensing studies were carried out at the room temperature and CuO thin film deposited on quartz substrate showed a better selectivity towards acetaldehyde with a swift response and recovery times.

References:

P 052

In-situ investigation of interface structure and its magnetic properties as a function of temperature

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Major developments in the field of memory devices and opto-electronics are made possible only because of development of ultra-thin magnetic layers. Magnetic thin films, especially nanoscale structures, attract great attention both for their technological application and fundamental research. Magnetic properties exhibited by these films act as a mainframe for various technological advancements [1-3]. Engineering these properties by changing the parameters like thickness of the layers, annealing at different temperatures or changing the ordering of the multilayers makes them suitable for different application. This study is focused to analyze the variations caused by the surface/interface roughness of the films with respect to different temperatures.

Two different multilayers were prepared by magnetron sputtering technique with different Co layer thicknesses. Cr and Au were deposited as buffer layers. Cr is used to have better control over magnetic properties. The thickness of Co were 12 Å and 25 Å respectively in two different layers. High temperature measurements were carried out in UHV chamber with the temperature ranging from 0 °C to 420 °C. The films were characterized with X-ray Reflectivity (XRR), Magneto-optic Kerr Effect (MOKE) at various temperatures. Our results showed that the increase in temperature causes variation in r.m.s surface roughness. Coercive field decreases with increase in temperature continuously till 350 °C and suddenly increases at breaking temperature. Breaking temperature is the point where the inter-diffusion seems to occur. These observations reveal that interface quality of the films influences the magnetic properties.

Keywords: Magnetic multilayers, In-situ heating measurements, XRR, MOKE

References:
Li$_2$FeSiO$_4$/C Aerogel Cathode Materials for Lithium-Ion Battery Applications

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Worldwide energy demand and shortcomings of the energy generation from fossil fuels like limited availability, polluting the atmosphere and associated global warming, health hazards urges the research community to look for alternate clean and green energy resources. The lithium-ion battery is one of the alternatives which stored the energy from intermittent energy resources and used effectively for the portable electronic devices and electric vehicles. To improve the energy and power density of lithium-ion battery surface area and porosity of the electrode material should be improved. Aerogels are highly porous materials with high surface area, and hence the proposed work is aiming to prepare Li$_2$FeSiO$_4$/C composite aerogel cathode materials for lithium-ion battery applications.

The aerogels are prepared using acid catalyst assisted Sol-gel process. The precursor chemicals are anlar grade tetraethylorthosilicate (TEOS) (99.99% purity), ethylene glycol, sucrose, and ethanol. The required quantity of TEOS is mixed with ethanol and distilled water under continuous stirring. 1 ml of 0.1N HNO$_3$ is added to the above solution as a catalyst for the hydrolysis reaction under stirring for 30 minutes. The required lithium nitrate, iron nitrates are dissolved in ethanol and added to the main solution. 30% of sucrose based on weight ratio is added as a carbon source to the solution. The 1:1 mole ratio of ethylene glycol is added as a stabilizing agent. The solution is kept under stirring for 3 hrs. Then the solution is taken into a hot air oven and kept at 50 °C for six days to transform sol to a gel. The prepared gel along with ethanol is taken in Parr make high-temperature high-pressure autoclave. Initially, 10 bar nitrogen is purged into the vessel, and the temperature is gradually heated to 255 °C, and the pressure reached to 90 bar. The temperature and pressure are maintained for 1 hr. After one hour, ethanol vapor is released from the vessel by maintaining the temperature at 255 °C. The nitrogen gas is purged to make the vessel to 20 bar. The temperature increases to 300 °C, and the aerogel is kept for two hours. The obtained aerogel is used for TG-DSC and FTIR measurements. The aerogel is calcined at 600 and 700 °C under N$_2$ flow for carbonization. The carbonized Li$_2$FeSiO$_4$/C aerogels are characterized using XRD, FTIR and FE-SEM measurements. The electrode is prepared by mixing the active material with carbon black, and sodium alginate binder with distilled water as a solvent and the slurry is coated over aluminum foil, and the cyclic voltammetry measurements were analyzed at different scan rates. The battery fabricated with Li$_2$FeSiO$_4$/C cathode material showed better performance at different current rates. The detailed results will be discussed.
Nanofluid Stabilized Electrolytes for Reduced Graphene Oxide

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Supercapacitors are attractive energy storage devices, which store energy by two distinct mechanisms, namely, adsorption/desorption of charges at the electrode/electrolyte interface and Faradaic reactions [1,2]. Carbonaceous materials predominantly store charges by the formation of electric double layer and hence exhibit good rate performance and excellent cycling stability [3]. Among various carbonaceous materials, graphene is very attractive for supercapacitor applications due to its high electrical and thermal conductivity, excellent mechanical strength and high theoretical surface area (2675 m²g⁻¹) [4]. However, preparation of single-layered graphene in large scale is very difficult and hence few-layered graphene is prepared by chemical exfoliation method, namely, Hummer’s method. Thus, prepared few-layered graphene is referred as reduced graphene oxide (RGO) [5]. Due to the intermolecular physical forces of attraction acting between the graphene sheets, the reported values of capacitance and energy density for RGO is less than the theoretical value of single-layered graphene [6]. Herein, the energy density of RGO is increased by enhancing the capacitive storage and also by expanding the potential window of operation using metal oxide-based nanofluid electrolytes. Addition of small amount of SiO₂ and ZnO nanoparticles into the native electrolyte (0.1 M KOH) not only widens the potential window of operation from 1 V into 1.2 V but also enhances the specific capacitance from 82 F g⁻¹ to 174 and 124 F g⁻¹, respectively). Accordingly, the energy density of RGO increases from 11.5 Wh kg⁻¹ to 34.5, 24.5 Wh kg⁻¹. In addition, nanofluid electrolytes are found to be stable over 30 days and RGO exhibits stable cycle-life over 1000 cycles in nanofluid electrolyte. Asymmetric supercapacitor assembled using RGO exhibits higher specific capacitance, better rate retention and longer cycle-life in nanofluid electrolyte than native electrolyte.

Reference:
P 055

Synthesis of Mesoporous Silica Nanoparticles Decorated with Pyridine Based Imines

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The present investigation is in search of an effective and novel solution for the treatment of infectious diseases by using ‘NANOBULLETS’ capable of destruction of bacterial cell wall, thus increasing the antimicrobial effectiveness. Mesoporous silica nanoparticles were synthesized by solvo-thermal method which are chemically and thermally stable nanomaterials with well-defined morphology and porosity. The synthesized imine based silica nanoparticles were subjected to different characterization techniques like UV-Visible spectroscopy, FT-IR, powder X-ray diffraction (P-XRD), scanning electron microscope (SEM), energy dispersive X-ray spectroscopy (EDS) and BET analyzer. The technique involves development of ‘NANOBULLETS’ by formulation of imine based nano-silica with biocompatible rose oil. Nanobullets showed good antibacterial activity against methicillin-resistant Staphylococcus aureus (MRSA) with comparison to Streptomycin. The nanobullets interferes the adherence of MRSA to surface indicating an anti-biofilm characteristic nature which is confirmed by SEM studies for the first time. And also nanobullets shows protecting and destabilization of azo compound 2,2’-Azobis(2-amidinopropane) dihydrochloride (AAPH) in erythrocyte membrane. Therefore, the synthesized nanobullets established biocidal performance against MRSA with biocompatibility in nature and underlined the role of this strategy in control of public burden caused by MRSA. MSPN’s with large surface area and pore volume can serve as efficient carriers for various therapeutic agents. These positive results open up very promising expectations for their potential application in new infection therapies.

Keywords: Mesoporous silica nanoparticles (MSNP’s), Imines, Biocompatibility, Rose oil.

P 056

Optical, Electrical and Morphological Properties of Down Converting Indium Doped Ceria Nanoparticle

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Cerium oxide is one of the extensively studied oxides among the various lanthanide oxides due to its profound mechanical strength, high oxygen storage capacity, great conductivity, good optical properties, redox performances, large thermal stability, ease to create of active sites and oxygen vacancies on the surfaces and most importantly ease and cost effective synthesis. In this present research we illustrate the synthesis and characterization of Nano crystalline Indium doped ceria nanoparticles by solution combustion synthesis (SCS) using cerous nitrate as a source of metal precursor and indium nitrate as a dopant precursor using Glycine as fuel. The prepared nanoparticles where subjected for different characterization techniques
to evaluate their structural, electrical, spectral and morphological characters. The phase study of prepared indium doped ceria reveals that the indium was successfully substituted into the fluorite lattice without any distortion. The effect of indium doping on structural and morphological change were analyzed by Scanning Electron Microscope. The optical activity was analyzed by UV visible spectroscopy which resulted in down conversion on doping indium with ceria. Furthermore, the AC and DC electrical behavior was investigated by LCR meter and IV characterization technique.

**Keywords:** Nano Ceria, Indium oxide, down conversion, UV-visible spectra.

**P 057**

Development of Nanosensor Integrated IoT for Monitoring Paddy Godowns

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Wastage of food grains during storage has been a major concern in India and statistics on food wastage is alarming that 62,000 tons of food grains were wasted during 2016-17. Technology intervention is imperative to continuously monitor food grains stored in godowns for providing early warning system to avoid wastage and effective distribution. In this scenario, headspace analysis of food grains using chemiresistive type gas sensor has been considered as one of the promising solutions for the detection of biomarkers or volatiles indicating the spoilage levels of food grains. Alcoholic vapours were identified as primary biomarkers for paddy spoilage level assessment [1], [2]. Hence, chemiresistive type nanosensor integrated Internet of Things (IoT) network has been developed for online monitoring of food grains and in particular, paddy grains stored in silos. Sensor nodes have been designed using ATmega 328P microprocessor, nanosensor and DHT 11. Cloud storage was adapted for collecting and storing data from IoT network. Further, a lightweight decision-making algorithm was implemented on Raspberry Pi 3 based cluster head node to assess the spoilage level of paddy. The output from head node is stored in the online database and the same is intimated through mobile platform. Dispatch of paddy bags for distribution can be made based on the recommendation from early warning system. The performance of the IoT network was compared with the expert results for validation.

**References:**


Nanofertilizers Aided With Systematic Delivery Mechanism For Enhancement Of Nutrient Use Efficiency And Crop Quality.

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As the availability of agricultural land and water resources in India is dwindling swiftly due to rapid urbanization, the farmers countrywide are imposed with great challenge to grow more than sufficient food from the same piece of land to satisfy the hunger of the ever increasing population. In order to reach their targeted yield, farmers adopt with excess application of mineral fertilizers which in turn is leading to substantial reduction of nutrient use efficiency, severe fall in soil productivity, green house gas emission due to nitrogenous fertilizers, cadmium contamination in soil due to single super phosphate, pollution of soil and groundwater. To overcome these environmental sustainability and the production challenges nutrient management must be done with precision usage of fertilizers. In recent years, development and application of specially formulated nanofertilizers have emerged out as a novel approach to increase the efficacy of nutrient use. The size diminution of nanoparticles results into increased surface area to volume ratio which allows exposure of more surface atoms leading to improved chemical reactivity and also the physical property compared to the bulk material.

These particles exhibit higher sorption capacity and controlled-release phenomena to targeted sites. Nutrient can be encapsulated within nano-materials such as inside nanotubes or nanoporous material, coated with a protective polymer film, or formulated as particles or emulsions of nanoscale dimensions. Since, plant roots and leaves have nano and micropores, therefore nanomaterials with small dimensions and large surface areas could augment the interaction with plant surfaces leading to improved uptake of nutrients. Research studies have reported that nanofertilizers based on carbon walls, metal and metal oxide, Polymer nano-composite formulation enhance seed germination, photosynthetic activity, carbohydrate and protein synthesis, nutrient use efficiency, regulates nitrogen metabolism, alleviate abiotic stresses in crops, simultaneously improve soil physico-chemical and microbial health along with maintaining environmental sustainability.
Formulation Development and Optimization of Hepatocyte Targeted Primaquine Loaded Nanostructured Lipid Carriers using Box-Behnken Design

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**Introduction:** Malaria is a complex parasitic infection caused by *Plasmodium* species. According to the WHO malaria report 2017, India alone contributed 76% of total 216 million cases of Malaria reported in 91 countries. In *P. vivax* and *P. ovale* induced malaria, hypnozoites harbour in liver and skillfully remain dormant in the hepatocytes resulting in relapse of Malaria which could be fatal. Asialoglycoprotein receptors (ASGPR) are primarily expressed on hepatocytes which can be exploited for targeting and internalization of drug Primaquine (PQ) which is the only available drug to treat liver stage Malaria.

**Objective** of ongoing project is to fabricate, characterize and evaluate hepatocyte targeted carbohydrate anchored lipid nanocarriers (NLCs) of model anti-malarial drug that act on pre-erythrocyte phase of *Plasmodium* parasite life cycle.

**Methodology:** Selection of targeting ligand for hepatocyte targeting was done by molecular docking studies using Maestro Schrodinger software 2014-2. Palmitoylated arabinogalactan [PAG] was synthesized using palmitoyl chloride and arabinogalactan after optimizing the reaction conditions and was characterized by TLC, FTIR, $^1$H NMR and $^{13}$C NMR spectroscopy. PQ was selected as model drug and a UV spectroscopic and HPLC method was developed and validated. Solid lipids, liquid lipids and surfactants were screened for their solubility of PQ. PQ loaded NLC dispersions were prepared by melt homogenization technique using high pressure homogenizer (HPH) and probe sonication (PS) techniques using Box Behnken experiment design to get the optimized formulation. The optimized NLCs were evaluated for particle size, polydispersity index, zeta potential, drug loading and percent entrapment efficiency.

**Results and discussion:** The docking studies for targeting ligands like Lauroylated Pullulan, Lauroylated Arabinogalactan, Palmitoylated Pullulan and PAG revealed that PAG bind to the ASGPR receptor in a fashion similar to Arabinogalactan (AG) molecules. PAG revealed good docking score and hence was selected as targeting ligand. The FTIR spectra of synthesized PAG showed two prominent bands at 1746.26 cm$^{-1}$ and 1160.94 cm$^{-1}$ and 2852.2 cm$^{-1}$ and 1466.6 cm$^{-1}$ characteristic of ester groups and palmitoyl chains respectively. The results of FTIR were further confirmed by $^1$H NMR and $^{13}$C NMR spectroscopy. NMR confirmed the intact nature of carbohydrate backbone of AG and the carboxyl group (C16) of ester bond between palmitoyl chloride and hydroxyl grup of AG. PQ diphosphate was converted to PQ base by base catalysed reaction and was characterized by FTIR and UV spectroscopy. PQ base showed maximum solubility in oleic acid and Precirol ATO 5, hence were selected as liquid lipid and solid lipid respectively. Tween 20 was selected as the surfactant since it exhibited least solubility for PQ. Plackett Burman design was used to select the factors for process optimization for PS and HPH method. A three-factor, three-level Box–Behnken design was used to optimize the independent variables, lipid: drug ratio, solid lipid: liquid lipid ratio and surfactant concentration for PS method. A four-factor, three level design was used to optimize the independent variables, surfactant concentration, lipid to drug ratio, solid lipid to liquid lipid ratio and number of homogenization cycles for HPH method. Different batches were prepared and evaluated for responses, particle size, zeta potential, drug loading and percent entrapment efficiency. Response surface plots and perturbation plots were constructed to study the effect of factors on responses. The optimized formulation prepared by probe sonication technique containing 3.5 % surfactant concentration, solid lipid : liquid lipid ratio of 3.3 and lipid to drug ratio of 32 gave particle size of 181.68 nm, -21 mV zeta potential,
0.16 PDI, 2.73 % drug loading and 64 % entrapment efficiency. The optimized formulation prepared by HPH technique containing 3 % surfactant concentration, solid lipid: liquid lipid ratio of 1.5 and lipid to drug ratio of 21 particle size of 145.68 nm, -34 mV zeta potential, 0.25 PDI, 3.4 % drug loading and 79 % entrapment efficiency. Observed values for responses were found to be closer to the predicted values by the DESIGN EXPERT software thus validating the optimization method.

**Conclusion:** Thus, within the scope of experimental design the hepatocyte targeted carbohydrate anchored nanostructured lipid carriers can be developed for treating pre-erythrocytic phase of parasite life cycle. Further evaluation in suitable cell lines, toxicity studies, in vitro and in vivo anti-malarial efficacy studies and pharmacokinetic studies will be carried out.

**References:**


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**P 060**

**Controlling the Sugar Translocation Across A Bacterial Polysaccharide Transporter**

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CymA is the outer membrane protein from the bacteria *Klebsiella oxytoca*, which is selective for cyclic and linear oligosaccharides. The structure of CymA has already been solved using X-ray crystallography technique which revealed a unique asymmetrical binding sites for cyclic oligosaccharides. This is due to the asymmetrical charge distribution between extracellular and periplasmic side, where extracellular side shows more binding affinity for substrates when compared to the periplasmic region. However, the crystal structure does not mimic the natural physiological membrane environment. Here, in our work we investigate the single channel properties of CymA pore in a real natural mimetic condition by analyzing the conductance, ion selectivity and gating properties of the pore. We tried to resolve the dynamics of sugar translocation by studying the ion current blockage and release events, at a single molecule level.

**References:**

An Approach for Decontamination of Wastewater Using CuO Nanoparticles Synthesized by Chemical Route Method and Study of Its Characterization

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By this study, it will investigate an approach for decontaminating of wastewater especially the removal of heavy metals from waste water. For this approach, a simple and cost-effective chemical route method was used in the synthesis of CuO nanoparticles and it was aided by the chemical co-precipitation method. Copper chloride (CuCl2) and copper nitrate (Cu (NO3)2) are used as the precursor for this chemical route. The synthesized nanoparticles were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and Fourier transforms infrared spectroscopy (FTIR). XRD is used for knowing the size, purity, and crystallinity of the CuO nanoparticle. FT-IR is used to verify the different functional group of the CuO NP, whereas FESEM is used to understand the surface morphology and elementary composition. The size of the nanoparticle can be confirmed from the Debye Scherer’s formula. The synthesized nanoparticle will be in the monoclinic phase. The copper oxide with monoclinic structure has unique physical and chemical properties. Simultaneously, the various parameters were studied for wastewater treatment, such as nanoparticle concentration, pH, contact time, the temperature of wastewater.

Keyword – Co-precipitation, FTIR, SEM, XRD, Decontamination, Temperature, pH

References:
Nanostructured materials modified cotton textile substrates could be a versatile and cost effective solution for fabricating protective fabric, which can be used to filter UV rays as well as detect toxic substances present in living / working ambient. In the present work, cotton fabrics were surface modified with tungsten oxide using pad-dry-cure method for the development of flexible gas / chemical sensor and UV radiation blocking fabrics. Structural, morphological, thermal and wettability characteristics of the surface modified fabrics were investigated using X-ray Diffractometer, Field Emission Scanning Electron Microscope, Differential Scanning Calorimeter, Thermogravimetric Analyzer and Goniometer. Further, Ultraviolet Protection Factor (UPF) of the tungsten modified fabrics was measured using an in-vitro method following the AATCC 183:2004 standard employing UV transmittance analyzer. The UPF of WO₃ modified fabric was estimated to be 145, which is excellent protective clothing according to Ultra-violet Protection Factor Standard for fabrics. Also, the gas sensing characteristics of WO₃ modified fabrics revealed the selective response towards ammonia at room temperature. Hence, nanostructured WO₃ modified multi-functional cotton textile can be used as a wearable protective fabric.

Reference:


P 063

Nanoparticle Incorporated Inorganic Phase Change Material For Solar Thermal Energy Storage

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Thermal energy storage system (TES), which uses PCM as an energy storage media offers high energy storage density. However, PCMs suffer from low thermal conductivity which greatly influences its thermal performance by decreasing the charging and discharge rate. The present work aims to increasing the thermal conductivity of sodium nitrate by the addition of carbon nanotubes (MWCNT). Accordingly, a novel preparation method for CNT dispersed nanocomposite was adopted. A 44.3% enhancement in solid phase thermal conductivity was observed for 1 wt.% CNT-sodium nitrate composite. The SEM images revealed that the CNT’s aspect ratio was preserved and homogeneous dispersion of CNT was found in the base material contributing to pronounced augmentation in thermal conductivity.

References:


P 064

Role of passive diffusion and active process in internalisation and externalisation of biodegradable nanoparticles in cells

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Biodegradable nanoparticles (NPs) do not have nanoparticle induced toxicity while do have been reported to have sustained release property. As of now there are very few studies on internalisation and extrusion process of biodegradable nanoparticles in different cancer cell lines. PLGA polymer was used for synthesis of fluorescent nanoparticles by solvent evaporation method. Characterisation of size and zeta potential was done by “Dynamic light scattering technique” using “Zetasizer” instrument by Malvern.

Nanoparticles were used for uptake studies on Hela, SiHa and LN229 cancer cell lines. Uptake and extrusion study was done at 37°C and 4°C without metabolic inhibitor and at 37°C with metabolic inhibitors (Sodium Azide 10 mM and 2-Deoxyglucose 50 mM) to stop active transport for internalisation.
and extrusion. After normalisation of fluorescence in different nanoparticles by fluorimetry, uptake was studied on the images taken by **Fluorescent microscopy**. Data was analysed by **Image J software**.

Post exposure of 234 nm fluorescent PLGA nanoparticles concentration in cancer cell lines HeLa SiHa and LN229 cancer cell lines as compared to 37°C without inhibitor shows significant rise in cell lines treated at 37°C with metabolic inhibitor (Na Azide and 2-Deoxyglucose) while at 4°C the concentration of nanoparticles were found to be significantly less. Results were found to be consistent in all three cell lines. Higher intensity in cells treated with metabolic inhibitor suggests involvement of active process in their extrusion from the cell. Persistence of significant uptake of hydrophobic biodegradable nanoparticles in HeLa, SiHa and LN229 cell lines even at 4°C suggests that diffusion may be a significant component in their uptake mechanism.

**P 065**

**Calcium Doped ZnO Nanofibers as Exhale Breath Sensor**

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Medical diagnostics can be revolutionized by chemiresistive type nanosensors based exhale breath analysis, which can rapidly detect and continuously monitor the ailments in human beings. In the present work, calcium (Ca) doped zinc oxide (ZnO) nanofibers based chemiresistive type gas/chemical sensor has been fabricated using electrospinning technique. The structural, morphological and optical features of Ca-doped ZnO nanofibers were investigated using X-ray diffractometer, Scanning Electron Microscope, Fourier Transform Infrared (FT-IR) spectrometer, and UV-vis spectrophotometer. Further, the sensing responses of Ca-doped ZnO nanofibers towards noticeable disease biomarkers like ammonia, acetone, acetaldehyde, ethanol, methanol and toluene were studied. The figure of merits of the developed sensor have been reported.

**References:**

P 066

Design and Development of Ni-rGO Nanocomposites Interfaced Non-Enzymatic Electrochemical Sensor for the Detection of Profenofos in Ground Water

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Extensive usage of pesticides in the farm fields leads to accretion of its residues in soil and plants, which result in the contamination of groundwater [1]. Profenofos (PFF) an organophosphate insecticide is widely used in the fields of cotton, potato, soya bean as pest repellent. It has the ability to inhibit the active sites of acetylcholinesterase in many of the living organisms when the level of exposure exceeds 0.03mg/kg (ADI as per WHO) [2]. Herein, we design and develop a highly selective and sensitive electrochemical sensor to detect and quantify PFF in groundwater with the detection limit much lesser than the ADI limit. One dimensional Nickel-reduced graphene oxide (Ni-rGO) nanocomposites were prepared via electrospinning technique and the same has been used to modify the glassy carbon electrode (Ni-rGO/GCE). The fabricated Ni-rGO/GCE electrode was used to detect PFF employing cyclic voltammogram and the redox peak was observed at 292 mV. The fabricated electrode could detect ultralow levels of PFF by amperometric technique in the linear range of 20-100 nM with the sensitivity and detection limit of 0.0116µA.µM and 11.5 nM respectively.

References:
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P 067

Prevention of Agglomeration by Gamma Ray Irradiation on Silver Nanoparticles

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Colloidal silver nanoparticles are prepared by biosynthesis using medicinal plants like Osimum Sanctum (Krisha Thulsi) and AdhaThodaVasica (Adalodakkam) leaf extracts. The formation and stability of silver nano particles in the colloidal solutions are monitored using UV-Visible absorption spectra. Suitable dosage of gamma rays are irradiated to the sample to prevent the aggregation of silver nanoparticles. Various optical constants like refractive index, band gap energy and dielectric constants of the medium with respect to given photon energy is also calculated. Transverse electron microscopic image of silver nano colloid
shows the agglomeration of polycrystallites to form spherical nano particles before irradiation and shows a chain free individual nano crystallines after the irradiation. Structural studies can explain both the polychain pattern and Face Centered Cubic (FCC) nature of nano silver.

References:

P 068

Microwave Assisted Synthesis of Cobalt Oxide Nanoparticles as Room Temperature Formaldehyde Sensor

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Formaldehyde exposure in industries has become a major threat to workers as it results in adverse health effects such as myeloid leukaemia once it exceeds the human permissible limits. In this context, the present work is aimed at developing room temperature operated cost-effective chemiresistive based formaldehyde sensor. Towards this, cobalt oxide nanoparticles were synthesized using microwave method by varying the concentration of oxidant (hydrochloric acid) from 1 to 5 mL. Formation of agglomerated nanosphere morphology was observed and there was no significant change in the morphology as a function of increasing HCl concentration. Structural analysis revealed the formation of Co$_3$O$_4$ with face cantered cubic lattice and enhanced crystallinity was observed on increasing HCl concentration. Peak absorption wavelength was observed in the range of 400-410 nm for all the samples. The Co$_3$O$_4$ sample synthesized at 2 mL of HCl showed maximum sensing response of 505 towards 100 ppm of formaldehyde with the response and recovery times of 140 and 71 s respectively.

References:
Electrical and Thermal Properties of Graphene Doped Indium Sulphide Thin Films

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Indium sulphide is a nontoxic n-type semiconductor belongs to III-VI family\cite{ref1}. It is one of the important materials in optoelectronic devices and solar cells\cite{ref2}, whose properties could be tailored by doping with graphene, the most stable two dimensional carbon based material\cite{ref3}. The properties of any composite materials could be altered by doping with graphene due to its unique structural and optoelectronic properties\cite{ref4}. Here, we report the synthesis of graphene doped indium sulphide thin film by a two step process. First, pure indium sulphide samples are coated on glass substrates by a chemical bath deposition and then doping of graphene in these films is done by spin coating followed by annealing. Characterizations of as-synthesized films are carried out using XRD, EDAX, Raman, Photoluminescence, Electrical and Thermal measurements.

The XRD patterns of as-synthesized indium sulphide thin film shows that it is crystallized in tetragonal structure with strongest diffraction peak corresponding to (109) plane which is in good agreement with ICDD card no. 00-025-0390. An additional peak is observed in the XRD spectra of doped film that corresponds to the plane (002) of reduced graphene oxide. From the EDAX, the presence of indium, sulphur and carbon in doped samples are observed. The appearance of peaks corresponding to D and G bands in the Raman Spectra of the doped film confirms the existence of the graphene in the as-synthesized samples. From the I-V characteristics, it is observed that the resistance of the doped film decreases as compared to pure sample. The Thermogravimetric (TG) analysis reveals that the thermal stability of graphene doped thin film is greater than that of pure film. From these analyses, it is confirmed that graphene could be successfully doped in indium sulphide thin films by this process. Also, the doped samples showed better improvements in its electrical and thermal properties.

References:

On the Phase Formation and Properties of Copper-oxide Thin Films towards Low Cost Solar Cells

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The present work provides a detailed investigation on how Copper-Oxygen bonding configuration varies with the plasma processing parameters. The Copper-Oxygen bonding configuration was altered by varying the RF power and substrate temperature. We studied the combined effect of both RF power and substrate temperature on the Cu-O bonding configuration, which in turn affects the optical and electrical properties, which are essential to understand before the device fabrication. Films were deposited with 40, 60 and 80 Watts of RF power at the different growth temperatures such as RT (room temperature), 200°C and 400°C. Even the RT deposited films were found to be exhibiting the crystalline nature to the maximum extent. Three phases of copper oxide i.e CuO, Cu₂O₃ and Cu₂O has been observed. Films deposited at 80W are leaning towards Cu₂O phase, whereas films deposited with 40W is close to CuO phase. Also observed is the bandgap variation from 1.8 to 2.3eV during CuO to Cu₂O phase transformation. Similarly, resistivity is also showing an increasing trend as we go from CuO-to-Cu₂O₃-to-Cu₂O. Carrier concentration is decreasing with increasing substrate temperature and sputtering power.

References:
Confinement of Nickel Single-Atoms in Nanoporous Carbon: A Pyrolysis of Covalent Imine Polymer Method to Achieve Selective and Stable N-Arylation Catalysts

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Atomically dispersed catalysts with mono-nuclear metal complexes or single metal atoms anchored on supports, referred to as single-atom catalysts (SACs), [1] have recently emerged as promising new heterogeneous catalysts, especially in the organic transformations. Owing to high surface area, high electrical conductivity (facilitated electron transfer) and tunable active anchor groups carbon materials have been adopted to disperse single atoms. [2, 3] Further, doping of N atoms into the support was proved as an effective method to disperse the metal atoms. [4] Herein, we have employed Ni ions incorporated covalent imine polymer as template to fabricate Ni SACs dispersed in the N-doped nanoporous carbon (Ni@N-NPC) by pyrolysis. While the functionalization of the carbon with nitrogen facilitates interaction with the Ni precursor, it further enables to control of dispersion of the generated Ni SAC during the thermal treatment at 1073 K. The Ni@N-NPC catalyst shows high performance towards aryl–amine coupling reactions and the use of carbon matrix to entrap Ni SACs results in structurally stable catalytic sites, which makes them recyclable without any loss in activity.

References:

Implications of Breath Sensor in Disease Diagnosis

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Malignancy is the second deadliest disease in the planet as per the record of World Health Organisation. In the midst of all diseases, lung malignant growth scores the most noteworthy rate as far as mortality. Towards this, a cost effective non-invasive metal oxide semiconductor based vapour sensor has been developed to detect acetaldehyde, which is the prominent biomarker for lung cancer via exhaled breath. In the present work undoped and tungsten-doped ZnO thin films were fabricated using Successive Ionic Layer Adsorption and Reaction (SILAR) method and characterization studies were carried out using X-ray Diffraction (XRD), Field Emission Scanning Electron Microscope (FE-SEM), Energy Dispersive X-Ray Spectrometer
(EDAX), Fourier Transform Infrared (FTIR) Spectrometer, UV-Vis-spectrophotometer, Electrochemical Impedance Analyzer and Hall measurement system. From XRD analysis the estimated crystallite size was in the range of 19-43 nm and exhibited hexagonal wurtzite structure with preferred orientation along (002) plane. The grain size and optical band gap were increased with an increase in dopant concentration. FTIR spectra were observed in the range of 4000-400 cm\(^{-1}\) and Zn-O stretching was observed at 430 cm\(^{-1}\). Vapor sensing studies of 0.01 M of tungsten-doped ZnO sample showed the maximum response of 385 towards 100 ppm of acetaldehyde with the response and recovery times of 46 and 52 s respectively.

References:


P 073

Preparation and characterization of flavonoid encapsulated liposomal carrier system against cerebral ischemia

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Cerebral stroke arises due to blockage of the blood vessels in the brain leading to oxygen deficiency thereby arresting brain functions and resulting in death or permanent impairment. After removal of blockage, reperfusion injury increases the brain damage [1]. The main challenge in delivering a drug to brain is crossing the blood brain barrier. This can be overcome by using a nanocarrier system for drug delivery. Liposome is a spherical lipid bilayer vesicle which has the capability to encapsulate hydrophilic drug in the core and both hydrophobic and amphiphilic drug in the hydrophobic lipid layer. PEGylation helps to increase the stealth property and the surface can be incorporated with targeting moiety to increase the accumulation of drug in the disease site [2]. Due to these advantages liposomes were chosen as a carrier system for delivering the neuroprotective drug rutin and prepared using thin film hydration method. Ratio of drug and lipid composition was optimized to obtain better encapsulation efficiency. The prepared carrier was characterized using field emission transmission electron microscopy, FTIR and DSC. MTS assay was performed to check cytocomatpability of carrier system. With the help of in transdifferentiated C6 cells, the antioxidant effect of drug loaded carrier system was evaluated using glutathione (GSH) assay. We believe that this carrier system is suitable for protecting brain from reperfusion injury. In future, incorporation of diagnostic agent in to the carrier can extend its application to a multi-functional theranostic entity for treating cerebral stroke.
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References


P 074

Bacteriocin Composite with Au/Ag Nanoparticles against Multidrug Resistant Pathogens: A Review

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Worldwide, multidrug resistance among pathogenic microbes consider as growing global problem endangers public health care challenges of the 21st century. The overuse and abuse of antibiotics affects the natural evolutionary processes of bacteria that led to this crisis [1]. At present, there is search for alternative strategies that promote the elimination of such a resistant microbial strains from the environment is become an utmost importance. Recently, research novel classes of molecules, such as engineered antibodies, antibiotic enhancers, siderophore conjugates, engineered phages, photo-switchable antibiotics, and genome editing facilitated by the CRISPR/Cas system, are laid road map to facilitate the development of new generation antimicrobial therapies [2]. Further bioinformatic tools recognized in transforming research and development efforts to discover novel antibiotic drugs. The exploration of bionanomaterials as new antimicrobial introduces a new paradigm for biomedical applications. For example, silver and gold are traditionally used as bacteriocidal and bacteriostatic purposes [3]. This concept attracts the researchers to fabricate Ag/Au nanoparticles to address multidrug resistance in pathogenic microbes. In future, Ag/Au nanoparticles composite with bacteriocin would also be developed to multidrug resistant microbes.

Keywords: Multidrug resistance bacteria, AuNPs, AgNPs, Nanoparticles, Bacteriocin

Reference:


P 075

Self-Cooling By Fe\textsubscript{3}O\textsubscript{4}-Kerosene Ferrofluid In A Square Loop Under The Influence Of Magnetic Field

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This paper reports the synthesis of Fe\textsubscript{3}O\textsubscript{4}-kerosene based ferrofluid and demonstrating a practical design of self-cooling system employing ferrofluid. This system uses heat from heat source and a permanent magnet to maintain the fluid flow in a square loop that transfers heat to heat sink. The system is self-regulating and requires no power or pump for flowing the fluid. The ferrofluid comes in vicinity of heat source, fluid heats up and rises, as a part of thermal energy is converted into kinetic energy. In the presence of external magnetic field, a driving force is produced that enhance the fluid flow and consequently, heat transfers from heat source to heat sink at a faster rate. The performance of device on various parameters like volume fraction of nanoparticles, temperature of heat source and strength of magnetic field is also discussed. The device is efficient, reliable and easy to maintain.

P 076

Spray Dried Nano-Particulate System of Dolutegravir using Biopolymer: Production, Characterization and Release Study

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Spray drying is a simple and easily scale-up technique widely used in the food and pharmaceutical industries, in which the drug can be encapsulated inside the polymer, for the controlled delivery of the drug. Biopolymers are widely used in drug delivery systems due to their biodegradability, biocompatibility and low toxicity. Levan is an exopolysaccharide composed of fructans linked by β-(2-6) glycosidic bonds obtained from both plants and microorganisms. In medicine, levan is used as a plasma substitute and prolongator of drug activity. Dolutegravir (DTG) is a recently approved Integrase Strand Transfer Inhibitor (ISTI) for the treatment of HIV type-1 infection and is poorly soluble in water (95 mg/L). With this framework, the current research involves the production of levan and development of DTG nanoparticle using levan (LDTG\textsubscript{n}) by spray drying technique as dissolution enhancement approach. The physiochemical properties of LDTG\textsubscript{n} such as particle size (195 – 329 nm), surface morphology (SEM) revealed the nanoparticles are in spherical and smooth surfaced. The predominant molecular peaks present in dolutegravir and levan was also found in LDTG\textsubscript{n} with mild shift, which confirmed the presence of drug and their interaction established by FTIR analysis. The X-ray diffraction and thermal analysis results showed that the LDTG\textsubscript{n} has undergone a solid state transition from crystalline to amorphous due to the encapsulation by the polymer. The LDTG\textsubscript{n} showed 60.93% of the drug release in 24 h in distilled water whereas the pure drug showed only 50% release at the same time. The size reduction to nanometer range...
and the solid state transition help in the dissolution enhancement of DTG. Thus, the developed nanoparticle could be considered as an effective alternative to improve the dissolution of DTG.

References:

P 077

Argentum Metal Ion Substituted AlSiO$_4$-20 Synthesis, Spectroscopic Analysis And Its Green Catalytic Reduction Of Carbon Dioxide To Control And Prevent Global Warming

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The conversion of carbon dioxide is more important due to global warming [1]. Mesoporous material has wide range of application in all fields [2]. New type of nanoporous solid acid catalyst is synthesized from inexpensive method and its structural formation is confirmed by various spectroscopic techniques. This study describes the decomposition of CO$_2$ using newly designed catalytic reactor packed with AlSiO$_4$-20 based nanoporous solid acid catalyst. Fine powdered Ag-AlSiO$_4$-20 catalyst is packed on U-shaped catalytic reactor to decompose CO$_2$. The efficiency of CO$_2$ decomposition is studied at various conditions such as temperature, CO$_2$ concentration, catalyst dosage and time on stream. Argentum metal ion incorporated AlSiO$_4$-20 exhibits a prominent CO$_2$ conversion at low temerature (70 °C). Most encouragingly, a maximum decomposition rate of 62 % is obtained for Ag-AlSiO$_4$-20. CO selectivity is up to 64 % and O$_2$ selectivity is 35 %. The improved decomposition rate and product selectivity may be attributed mainly to the stronger acid sites and pore size.

Key words: Ag-AlSiO$_4$-20, nanoporous solid acid catalyst, CO$_2$ decomposition

References:
P 078

**Optimized Synthesis of Single Phase Tin Sulphide Quantum Dots for Enhanced Photocatalytic Applications**

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Tin Sulphide (SnS) quantum dots have shown their advantages in multifunctional applications like solar cells [1], gas sensing and opto-electronic devices due to their extremely smaller in particle size and facile solution based synthesis processes. In the present work, the phase pure, uniform SnS quantum dots were synthesized by using simple chemical reduction method. The structural studies obtained from the XRD and high-resolution TEM with SAED analysis confirmed the presence of formation of single phase SnS with orthorhombic crystal structure which was further confirmed by Raman spectroscopy. The spherical morphology of the particles having the size of 10 nm was inferred from the field-emission SEM analysis confirms the synthesis of quantum dots. The elemental observation obtained from EDAX spectra confirms the presence of Sn and S. The optical characteristics of the SnS quantum dots were obtained using UV-vis-NIR absorption spectroscopy and Photoluminescence spectroscopy. The photo-catalytic properties of SnS quantum dots were studied using standard methylene blue dye under the visible light irradiation source. After 80 minutes of irradiation, which proves that the prepared SnS quantum dot act as efficient photocatalytic material for the reduction of methylene blue dye without any reducing agents or scavengers [2]. Enhanced photo-catalytic properties of SnS quantum dots over the bulk can be used commercially for multifunctional applications to increase the performance of the devices.

References:


P 079

**Influence of PVA Templates on Synthesis of Interconnected and Long-Winded Electrospun V$_2$O$_5$ Nanowires – Acetone Sensor**

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Detection of food borne pathogens in ready-to-eat products is a highly challenging task. Aroma evolving from food items is one of the biomarkers to differentiate spoiled food items from fresh one. In this regard, V$_2$O$_5$ nanowires based vapour sensor were successfully prepared via electrospinning techniques. The
precursor solution of ammonium meta vanadate with varying PVA molecular weight (14,000 g/mol; 1,15,000 g/mol; 1,60,000 g/mol) was used to synthesize V_2O_5 nanowires labelled as NC1, NC2, NC3. The as-deposited fibers were calcinated at 500°C for 2 h to remove PVA template. The structural, morphological, chemical, electrical and sensing characteristics of V_2O_5 nanowires were investigated. X-ray diffractometer (XRD) pattern confirmed the formation of polycrystalline nature with orthorhombic structure of V_2O_5 nanowires. Field Emission Scanning Electron Microscope (FE-SEM) image revealed the formation of highly interconnected, and long-winded nanowires with the average diameter of 120, 70 and 97 nm for NC1, NC2 and NC3 respectively. The peaks observed at 1019 cm\(^{-1}\), 831 cm\(^{-1}\) and 594 cm\(^{-1}\) of FTIR spectra of V_2O_5 nanowires revealed the formation of V=O & V-O-V bands with complete polymer evaporation. Mobility of V_2O_5 nanowires were measured using Hall measurement system and was found to be 253, 33 and 99 cm\(^2\)V\(^{-1}\)s\(^{-1}\). V_2O_5 nanowires (NC1) were highly selective towards acetone with a response of 97 towards 100 ppm at ambient atmosphere. The response and recovery times were observed to be 41 and 20 s respectively towards 100 ppm of acetone.

References:

P 080

**Development and Evaluation of Amorphous-Solid Nano-Adsorbates**

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The purpose of the present study was to improve the oral bioavailability of telmisartan via formulating amorphous solid Nano-adsorbates (ASNAs) based delivery system[1]. The amorphous-solid nano-adsorbrates consists of amorphous solid dispersion adsorbed to the high surface material. This adsorption rises to the significant increases in the surface area of the particles and leads to the higher dissolution rate of the drug. The ASNAs facilitates the dissolution rate enhancement by the modulation of solid-state along with the particle size reduction[2]. The ASNAs of telmisartan were prepared by spray drying a solution containing drug, additives and adsorbent and subjected to interaction pattern (FTIR), solid-state characterization (PLM, DSC, PXRD), surface morphology (SEM), solubility, dissolution, and pharmacokinetic studies. The FTIR analysis notifies a possible interaction among components, solid-state characterization revealed an amorphous state, surface morphology explicitly showed the adsorption of solid dispersion particles on the surface of adsorbent. In addition, TEM studies revealed the presence of amorphous nanoparticles after dispersing ASNAs in water. The ASNAs particles showed significant improvement in the solubility and dissolution profile of telmisartan. After an oral administration (Sprague Dawley rats) of ASNAs C\(_{\text{max}}\) and AUC values of telmisartan increased about 3.4 and 2.69-fold respectively, while t\(_{\text{max}}\) was shortened. Thus, ASNAs approach might be a potential approach to improve the oral bioavailability of poorly soluble drugs.
References:


P 081

Highly Efficient and Sustainable Carbon Supported Pd-Y as Oxygen Reduction Reaction catalyst for Polymer Electrolyte Fuel Cells

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Polymer electrolyte membrane fuel cells (PEMFCs) have more attention in industries and electric vehicles due to its high efficiency, quick start-up, high power density and low emission of pollution. In PEMFCs, Pt based metal, alloy, metal-metal oxide catalysts have been investigated extensively as electrocatalysts for low temperature fuel cells, due to its high catalytic activity, stability in fuel cell operating condition and acidic-resistant property. The elevated price and limited resources of Pt hinders the large-scale applications. Hence development of alternative catalyst, without compromising the catalyst effect is a challenge for researchers. Pd has very similar properties like Pt due to same group in the periodic table, same fcc crystal structure and similar atomic size. In addition, palladium is fifty times more abundant on the earth than Pt [1, 2]. Hence Pd and its alloys could be a good substitute and have attracted greater attention as non-Pt catalyst.

In this work carbon supported Pd-Y catalysts in varying atomic ratios of Pd to Y, namely 1 : 1, 2 : 1 and 3:1 were synthesized and evaluated by the polarization studies in fuel cell mode with hydrogen as a fuel and oxygen as an oxidant. Physical and electrochemical characterizations of the prepared catalyst were investigated and also stability of the catalyst was evaluated.

References:


Sustained Release Polymeric Nanoparticles of Valaciclovir for Improved Antiviral Therapy

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Valaciclovir is a L-valine ester prodrug of Aciclovir, a synthetic purine nucleotide analog which inhibits the viral DNA replication and commonly used in the treatment of Herpes Simplex virus, Varicella Zoster virus and Cytomegalo virus infections [1]. The half life of Valaciclovir is less than 30 minutes with oral bioavailability of 55% only at higher dose, which necessitates frequent dosing that leads to adverse effects. Our work focuses to overcome the limitations of conventional dosage forms through a novel sustained release therapy by utilizing nanotechnology based drug delivery approach.

Polymeric nanoparticles of Valaciclovir was prepared by emulsion solvent evaporation method [2] with Eudragit RS 100 polymer at 1:1, 1:3 and 1:5 ratio using Pluronic F127 as surfactant at 0.25%, 0.5% and 1% w/v concentrations to obtain nine formulations. The optimum formulation was selected based on entrapment efficiency, particle size, zeta potential and sustained in vitro drug release profile in phosphate buffer (pH 7.4) dissolution medium.

Nanoparticles containing drug: polymer ratio of 1:3 with 0.5% surfactant showed average particle size of 97.3 nm in monodisperse nature with maximum drug entrapment efficiency of 57.14±7% and zeta potential is +6.93 mV. The FTIR analysis showed mild interaction between the drug and polymer. The XRD spectrum confirmed the change of crystalline pure drug into amorphous or semi crystalline nature in the polymeric nanoparticles. In vitro drug release profile showed the sustained release pattern with maximum of 61% release at the end of 8 hours. The optimized formulation could be used to achieve prolonged antiviral efficacy with reduced dose and dosing frequency, as convenient once-daily administration.

References:

Anticancer Drug Loading Into Protein-Nanostructure Conjugates- A Biophysical Study

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Protein-nanostructure conjugates have emerged as a powerful tool for biomedical applications, specifically for targeted drug delivery. It has proved that the protein-nanostructure conjugates have better
biocompatibility, stability, bioavailability, and the possible surface modification that enables enhancement of its efficacy. In the present investigation, α-lactalbumin (ALA) / β-lactoglobulin (BLG) – gold nanoparticle conjugates were established as anticancer drug carrier. Both proteins ALA and BLG were purified from buffalo milk using chemical precipitation and size exclusion chromatography. The purity of proteins was confirmed by SDS PAGE. The chemically synthesized and citrate stabilized gold nanoparticles (~29.0 nm) have been used for the development of drug carrier. The ALA/BLG - gold nanoparticles (GNPs) conjugates were systematically characterized using biophysical tools viz. UV-visible, fluorescence, FTIR and CD spectroscopy, dynamic light scattering. The binding characteristics of anticancer drugs (Curcumin, Docetaxel and Gemcitabine) with ALA/BLG-gold particle conjugates were studied and found to better stability, biocompatible, enhanced half life etc. This study confirmed that ALA and BLG-gold NPs conjugates could effectively be used for anticancer drug carrier in targeted therapy.

P 084

Design and Development Of Metal-Organic Framework Based Materials For Gas Sensing Applications

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Gas sensors provide a real time feedback to our surrounding containing different amount of gases that are hazardous to human health. Metal-Organic Frameworks (MOFs) reveal great promise for the development of sensors for hazardous gases due to high tunability, high selectivity and sensitivity by variation of pore dimension and chemical composition.

We assembled a Co-imidazole framework (ZIF-67) over traditional metal oxide gas sensor-SnO$_2$ to realize a new class of material for chemiresistive sensing of CO$_2$. The nanostructure of SnO$_2$@ZIF-67 was established using PXRD, TEM, and SEM analysis. Unlike SnO$_2$, which showed an ambiguous low response, the SnO$_2$@ZIF-67 exhibited a stable and strong response owing to synergistic effects (such as electronic structure changes) arising from the hybrid nanostructure. At the TLV limit (5000 ppm) of CO$_2$, the SnO$_2$@ZIF-67 sensor showed a response of 16.5±2.1% at 205 °C, one of the best values reported for a SnO$_2$-based sensor.

On the other hand, by tuning the predesigned linkers with specific interacting functional groups can increase their affinity to the analyte gas and bring detectable changes in the resistance of the MOFs. Pore surface functionalization of a MOF with an amine moiety has turned an innocent MOF into a chemiresistive sensor for acidic gases. The Zr-NH$_2$-benzenedicarboxylate MOF (NH$_2$-UiO-66) proved to perform as an efficient and stable chemiresistive sensor for SO$_2$, NO$_2$ and CO$_2$ at low concentrations and an operating temperature of 150 °C. The detection limit of SO$_2$ was found to be 1 ppm.

References:


Detection of Acetic Acid using Electrospun PVA/GO Nanofibers

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Consumption of bacterial contaminated food items causes foodborne illnesses in humans. Foodborne pathogens such as *Salmonella*, *Staphylococcus* and *Acetobacter* releases toxic volatile compounds during contamination of food items. Among which, acetic acid is one of the major volatiles evolving from these bacteria. In this context, developing chemiresistive sensor for detecting acetic acid is imperative and hence the present work dealt with the fabrication of acetic acid sensor employing polyvinyl alcohol (PVA)/graphene oxide (GO) nanofibers as sensing element prepared using electrospinning technique. GO was synthesized using modified Hummers method and utilized for making composites with 10 wt.% of PVA in concentration of 0.02, 0.2, and 0.4 g. Formation of GO was confirmed from the XRD peak observed at $2\theta = 14.5^\circ$. On the other hand, PVA exhibits characteristic diffraction peak at $2\theta = 19.5^\circ$. For the PVA/GO nanofibers prepared at three different proportions, the predominant plane was observed at $2\theta = 19.5^\circ$ confirmed the intercalation of carbon and oxygen atoms in the PVA matrix due to the interaction of hydrogen bonding between GO and PVA. Morphological analysis revealed the formation of nanofibers with average diameters of 255, 167 and 188 nm respectively for 0.02, 0.2, and 0.4 g of GO in 10 wt.% of PVA. The mobility of PVA/GO nanofibers was increased from 51–66 cm$^2$ V$^{-1}$s$^{-1}$ on increasing the concentration of GO from 0.02 to 0.4 g in PVA. This increased mobility could be attributed to the conducting nature of PVA and band overlapping properties of GO. The PVA/GO nanocomposite prepared at 0.2 g of GO in 10 wt.% PVA showed a selective response of 193 towards 100 ppm of acetic acid at room temperature with response and recovery times of 29 and 26 s respectively. Thus, the sensor can be potentially deployed for detecting acetic acid in food items.

References:


Micro-magnetic study of spin wave propagation: In Air-gaps magnonic waveguides and Bicomponent magnonic waveguides for transmission signal devices

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Abstract: Analysing the spin wave (SW) propagation in 1-D magnonic waveguides is composed of M and N stripes are studied through micro-magnetic simulation (OOMMF). In the present work, we proposed the two magnonic waveguides (i) Airgaps magnonic waveguides (AMWs) and (ii) Bicomponent magnonic waveguides (BMWs) as displayed in Fig. (1). In AMWs, the air-gaps medleyed with the N Stripes and M are made up of soft ferromagnetic materials. In BMWs, the two different magnetic properties materials used in both M and N (Instead of airgaps). The AMWs exhibited the narrow transmitted bands (~ 3-7 GHz) due to the inhomogeneous demagnetization field of air-gaps. The BMWs explore the wide transmitted bands (~11 to 40 GHz) due to exchange interaction at interfaces of different magnetic properties of constituent materials. This work paves way to design the narrow and wide transmission signal devices based on information carrying SWs on these MWs which is highly useful in microwave communication systems.

Keywords: Exchange spin waves, Demagnetization field, Exchange field, Transmission bands and Forbidden bands.

References:
Fabrication of Screen-Printed Carbon Electrodes on Plastic, Paper and Textile Substrates for Electrochemical Biosensing Applications

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Screen-printed electrodes (SPEs) are widely used in the field of electrochemical biosensors, especially in the area of food, healthcare and environmental applications. In this context, optimized microband screen printed carbon electrodes (SPCEs) on different substrates like Whatman paper, overhead projection (OHP) sheet and cotton textile were fabricated. Carbon ink was used to print working and counter electrodes and Ag/AgCl ink was used to print the reference electrode. The optimized length, width and thickness of these electrodes are reported. To obtain the single electron transfer rate, the fabricated SPCEs were pretreated with thermal, electrochemical pre-anodization and oxygen plasma processes. Surface morphologies of the pretreated SPCEs were observed using scanning electron microscope and the respective electrochemical performances of SPCEs were analyzed using cyclic voltammetry technique with K₃(FeCN₆) electrolyte. A reversible CV response with single electron transfer rate was achieved for the SPCE fabricated on OHP substrate. Thus, optimized SPECs-OHP was used to detect 1 mM of uric acid and ascorbic acid with acceptable repeatability and reproducibility.

References:


Unassisted Water Splitting by Nanostructured Partially Crystalline N-Doped Metal Oxide


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Nanostructured partially crystalline nitrogen doped Metal Oxide thin films were fabricated on ITO by sol gel spin coating method. The comparison study were made with nanostructured highly crystalline pure metal oxide (HCPMO) using XRD, HR-TEM, UV-Visible, FE-SEM, Raman spectroscopy, XPS, ESR, and
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Photoelectrochemical (PEC) study. Amorphous compound shows high charge storage capacity which was confirmed by cyclic voltammetry technique. Nanostructured PCN-DMO shows applied bias photo to current conversion efficiency of 17.8 % at zero bias versus SCE.

References:

P 089

Two-Dimensional Electron Gas at the Interface of Strong Spin Orbit Coupled Perovskite Oxides

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Transition metal oxides have gained interest in the past few years because of their prospective applications and implementation in the emerging field of spintronics. The discovery of two dimensional electron gas (2DEG) at the interface of two oxide band insulators SrTiO3 and LaAlO3 and possibility of realization of Rashba type spin splitting in such oxide heterointerfaces have spurred tremendous amount of research in contemporary condensed matter physics and drew attention towards this class of materials for spintronics based devices. Observation of novel phenomena like giant magnetoresistance, superconductivity and anomalous Hall effect etc. in these oxides made them the most suitable candidates for such applications.

Among the perovskite family, KTaO3 has drawn considerable interest not only because it has shown interesting physical properties but also because this material has a very high spin orbit coupling that makes it a possible candidate for "Rashba systems". Strong spin orbit coupling and possible "Rashba effect" makes it a good candidate for spin-electric applications. We have realized two dimensional electron gas at the polar-polar interface of a mott-insulator-LaVO3 and KTaO3. Thickness dependent transport measurements show the heterostructure is conducting above a minimum thickness of 4 monolayers of LaVO3. The heterointerface is free from oxygen vacancies and has a typical charge carrier density of the order of 1014 cm-2. The highest mobility found in our case is 604 cm2V-1s-1 at 1.8 K for 40 monolayers thick sample. We have also performed magneto-transport measurements on our heterostructure by applying magnetic field in plane of the applied current. Observation of planar Hall effect and anisotropic magnetoresistance in this configuration shows the presence of strong spin-orbit coupling in the system. A theoretical analysis of the magneto-transport data based on the Rashba Hamiltonian is being carried out.
P 090

Chemically Designed Nanoparticle for Prevention of Neurodegenerative Diseases

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Deposition of amyloid protein aggregates in different organs like brain, pancreatic cell, cornea etc. are linked to several detrimental human diseases. Alzheimer’s, Parkinson’s, Huntington’s, Diabetes Type II, cataract are few common examples of such protein aggregation derived diseases. Till now there is no therapy or permanent cure of such diseases. Recent works show that various natural products, peptides, chelators, modulators of oxidation can inhibit protein aggregation. But their performance is poor due to low chemical stability, weak interaction with amyloid protein, poor bioavailability and inefficiency to cross blood-brain barrier. Here we have synthesized a series of designed nanoparticles using antiamyloidogenic biomolecules to mimic molecular chaperones that prevent protein aggregation in our body. We have found that these nanochaperones are $10^2$-$10^5$ times more efficient in inhibiting protein fibrillation and reduce amyloid derived neurotoxicity. Some of the designed nanoforms can clear amyloid aggregates from cell by upregulating the perturbed autophagy of Huntington’s cell. Mechanistic details have shown that nanoform offers stronger binding with amyloid protein, high cellular uptake via endocytosis, modulates autophagy mediated clearance pathway and enhances bioavailability of antiamyloidogenic biomolecules. In conclusion presented approach can be extended for the development of new nanomedicine to combat protein aggregation derived diseases.

References:

P 091

Facile and Blue Fluorescence Carbon Nanoparticles from Pith of Tapioca (Manihot esculenta) Stem: Fe (III) and pH Detection Applications

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Modern day research has given importance to carbon nanostructures because the currently used chemical synthesis is not an eco-friendly approach. This poses to be a challenge to the scientific community. Now, green synthesis from bio-precursors has been preferred as it is pollution free, biocompatible, and efficient.
The present work focuses on the extraction of carbon nanoforms from the pith of Tapioca (Manihot esculenta) stem in a simple, cost effective strategy. Pith is the non-edible part of tapioca, which is the main agricultural crop in Kerala. Its luminescence response is taken as a probe for elemental detection.

Hydrothermal carbonization method was performed at 210°C for 12 hrs. XRD patterns indicated the amorphous nature of the particles with an average particle size of 22.4 nm observed using HRTEM. XPS and FTIR revealed the surface moieties and elemental compositions on the formed nanospheres such as –C=O, C-O-C and –OH groups. These nanoparticles have strong optical absorption in the UV region at 217 and 280 nm. The quantum yield value was found to be 19.2%, which is much higher than the reported values for the particles extracted from watermelon, papaya, rose-heart radish etc [1]. These nanoparticles were found to be very sensitive to Fe (III) ions, which act as quenching agents. The detection limit for Fe (III) ions was 30.01µM. The detection limit variation at different pH values for carbon nanoparticles solution was studied in detail.

Reference

P 092

Biocompatible Benzodioxane Coupled Piperazine Moiety Decorated Chitosan Silver Nanoparticles (Bcp*C@AgNps) As Anti-Biofilm Agent against Methicillin-Resistant Staphylococcus Aureus (MRSA)

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Nanoparticle research has facilitated a number of applications using specifically designed nanoparticles (NPs). The purpose of this investigation was to synthesize a benzodioxane coupled piperazine moiety decorated chitosan silver nanoparticles (Bcp*C@AgNPs) against epidemic methicillin-resistant Staphylococcus aureus (MRSA) from the perspective of the NPs as efficient antibacterial and anti-biofilm candidate. The synthesized Bcp*C@AgNPs had spherical shape, 34.2 nm in size, positive and mono dispersive in nature. It showed antibacterial activity against MRSA having 80 µg/mL (10.21±0.03 ZOI) minimum inhibitory concentration (MIC) with respect to reference bacteria 80 µg/mL (9.17±0.01 ZOI), compared to streptomycin 10 µg (10.34±0.05 ZOI). The Bcp*C@AgNPs interferes the adherence of MRSA to surface indicating an anti-biofilm characteristic nature which is confirmed by confocal laser microscopic studies for the first time. And also, Bcp*C@AgNPs shows protecting and destabilization of azo compound 2,2'-Azobis(2-amidinopropane) dihydrochloride (AAPH) in erythrocyte membrane, the involvement of NPs as a protective agent for biomolecules such as DNA and protein followed by treatment with AAPH was confirmed. The inhibition of cellular damage and leakage of cellular inflammatory agents were confirmed by AFM, SEM, SDS-PAGE, LDH and PLA2 enzyme inhibition by in vitro studies. Also, the docking study of Bcp showed excellent score for PLA2 and DNA gyrase. This in silico study confirmed the achieved efficacy of Bcp, with less toxicity against normal PMBCs in vitro and in vivo studies. Therefore, the synthesized Bcp*C@AgNPs established for biocidal performance against MRSA with biocompatibility in nature and underlined the role of this novel NPs in control of public burden caused by
MRSA. This present investigation highlights the biocidal performance of Bcp*C@AgNPs with bacteria-killing and anti-biofilm characteristics covers the interesting targets for clinical trials in future for therapeutic applications.

**Keywords:** Biofilm; Biocompatibility; Piperazine, silver nanoparticle.

P 093

**Room Temperature n-butanol Sensing Characteristics of Hydrothermal Synthesized Molybdenum Oxide Nanobelts**

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Molybdenum oxide nanobelts were synthesized using hydrothermal technique. Transformation of $\beta$-Mo$_{9}O_{26}$ to orthorhombic $\alpha$-MoO$_3$ was observed when it was calcined at 450°C for 5 h. Preferential plane orientations of (223) and (060) were observed for $\beta$-Mo$_{9}O_{26}$ and $\alpha$-MoO$_3$ respectively. Due to the weak van der Walls forces exerted in [010] direction, crystallites tend to orient along (060) plane with {010} facet in stable $\alpha$-MoO$_3$. Morphological analysis revealed the formation of irregular nanorods and nanobelts like morphology for $\beta$-Mo$_{9}O_{26}$ and $\alpha$-MoO$_3$ respectively. Stoichiometric ratio of Mo/O was observed to be 2.59 from the surface analysis. Defect profiles related to 5+ and 6+ coordinated Mo along with oxygen vacancies were observed from the PL spectra. Activation energy of $\alpha$-MoO$_3$ nanobelts was observed to be 0.137 eV along with grain and grain boundary resistances of 4.7 x10$^2$ and 3.14 x 10$^4$Ω respectively. Presence of M=O terminal oxygen in $\alpha$-MoO$_3$ was observed from the functional group analysis. Nanobelts showed maximum sensing response of 75 towards 50 ppm of n-butanol at room temperature with linear detection range of 1-100 ppm. Response and recovery times were found to be 17 and 10 s towards 1 ppm of n-butanol. Influence of relative humidity on n-butanol sensing response were also investigated and reported.

**References:**


Nanotechnology Enabled Oral Drug Delivery System of a Bisphosphonate for the Treatment of Osteoporosis

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Oral delivery of bisphosphonates is always a challenging task to scientist. As they have very low oral bioavailability and thus limiting their use for oral therapy. They are considered to be the highly effective medicines in comparison to other treatment option because they possess phosphate moiety which makes them inherent molecules for the targeted therapy for osteoporosis. They are considered as a carrier molecule for various anticancer drugs as reported earlier. Drugs like zoledronic acid, pamidronic acid are very potent and effective but they are available as IV infusion only, because too rapid injection of bisphosphonate can leads to complex formation with calcium in blood. Thus slow infusion is given which takes at least 15 minutes. The present era of nanotechnology and nanomedicines can counter this problem. Higher surface area and their low particle size make them important. Several nanocarriers are available which can increase the bioavailability like liposomes, niosomes, solid/lipid nanoparticles (SLN), nano lipid carrier (NLC), polymeric nanoparticles like chitosan nanoparticles, PLGA nanoparticles, and micelles. Studies say that nanoparticles can enhance the oral bioavailability upto 80-90%. The major challenge in oral delivery is to enhance the solubility and permeability. Nanoparticles are capable to increase the both solubility as well as permeability of the oral formulations. Thus, we decided to prepare oral formulation of bisphonate.

**Keywords:** Osteoporosis; Oral Delivery: Bisphosphonates; Nanocarriers

**References:**


Targeted Pegylated Mesoporous Silica Nanoparticles Reduce the Toxicity of Doxorubicin and Inhibit the Tumor Growth In Animal Model Of Breast Cancer

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The chemotherapeutic drug doxorubicin (Dox) is used to treat different types of cancers. The Dox caused a lot of side effects especially cardiotoxicity depend on the dosage. Mesoporous silica nanoparticles (MSN) were prepared by sol-gel method and dox loaded into the pores of the MSN. The dox loaded MSN were coated with polyethylene glycol and further attached with targeting moieties such as folic acid and hyaluronic acid. TEM images revealed that average size of MSN were 100 nm and size increased to 120 nm after coating of PEG over the surface of the MSN. In vitro cytotoxicity showed that dox exhibited a higher cytotoxicity than dox loaded nanoparticles. Preclinical antitumor study in 4T1 orthotopic xenograft model showed that all nanoparticle formulations inhibit tumor growth to a significant level. The survival curve showed that all mice treated with dox died on fourth day of treatment, control and MSN-NH$_2$ died on eighth day of treatment, all nanoparticle formulations were alive up to 25 days even after the treatment. Hence, we propose that targeted pegylated mesoporous silica nanoparticles can be used as the carrier to deliver the doxorubicin to breast cancer patients to avoid the side effects.

Development of Hybrid vector for treating Acute Myeloid Leukemia

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Treating cancer is certainly a challenging one because of its complexity; therefore single therapeutic approach is insufficient to suppress the growth and proliferation of cancer cells. Recent years have focused on developing carriers for combinational therapy. Our study explores pH responsive polymeric carrier to co-deliver a cytotoxic gene and a cytotoxic drug to treat acute myeloid leukemia (AML). We have developed an aliphatic polymer with ketal linkage to deliver Adeno associated virus (AAV) carrying a transgene and cytarabine to myeloid leukemic cells. Despite viruses being a widely preferred vector due to their superior transduction efficacy, they are limited by their immunogenicity. The polymeric carrier not
only delivers the therapeutic agents but also could shield the AAV from the neutralizing antibodies present in the systemic circulation. PCADK (Poly (cyclohexane-1,4-diyiacetone dimethylene ketal) was synthesized by step growth polymerization and characterized. Emulsion technique was adopted to synthesize nanoparticles and were characterized for size and other physiochemical properties. The entry mechanism of the developed polymeric nanoparticles was studied using chemical inhibitors. Various method of coating AAV to PCADK has been explored. The hybrid vector was tested for its transduction efficiency and therapeutic efficacy on U937 cells. The developed hybrid vector could be an efficient strategy for therapy of acute myeloid leukemia.

References:


P 097

Spray Dried Nanoparticles of Dolutegravir - an Anti-HIV drug for dissolution enhancement


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A crucial global health threat termed as Acquired Immunodeficiency Syndrome (AIDS) is one of the lethal diseases. The world is still amidst the pandemic with 39 million infected patients, among which 2.08 million are living in India. Oral antiretroviral therapy with specific drug regimen is highly preferred for treatment of HIV infections. However, oral absorption is often limited due to poor solubility of drugs, which affects its bioavailability. To overcome this limitation, nanotechnology-based drug delivery have been demonstrated with substantial improvement in the solubility and bioavailability of poorly soluble drugs. The present study aims to enhance the dissolution of Dolutegravir (DTG, an integrase inhibitor) through nanoparticles using spray drying technology. The drug solution was spray dried using ultrasonic nozzle, with inlet and outlet temperatures of 120°C and 60°C, respectively. The spray dried nanoparticles (DTGn) evaluated for its physicochemical properties resulted in particle size <500 nm, zeta potential -15.8 mV and spherical surface morphology (FE-SEM). The solid-state transition, chemical interactions and thermal stability were characterized by XRD, FT-IR and TGA-DSC, respectively. The in vitro drug release study was carried out by dialysis membrane method and cytotoxicity was studied in vero cell lines by MTT assay. The DTGn showed 100% drug release in distilled water at end of 24 hours, compared to the pure drug, which showed only 50% release in the same time. The XRD and DSC analysis of DTGn have revealed its amorphous nature, which is ascribed for its enhanced dissolution rate. The DTG and DTGn were found to be non-toxic in vero cell lines up to concentration of 100 µg/ml. The CC50 value of DTG and DTGn was found to be 217µg/ml and 132 µg/ml, respectively. Hence, the developed nanoparticles formulation could be considered as a successful alternative dosage form to enhance dissolution of Dolutegravir.

Keywords: Dolutegravir, nanotechnology, dissolution, solubility
Catalytic Activity of Graphene Oxide Surface Coated V$_2$O$_5$ Nanorods in the Conversion of Glucose to Gluconic Acid

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Diabetes is one of the most commonly seen metabolic disorders in the present era. Glucose is considered as the predominant biomarker for hyperglycemia [1]. There has been extensive research focused on developing methods for the measurement of glucose in various matrices such as blood, urine, and saliva [2]. With this background, a non-enzymatic electrochemical sensor has been developed to detect glucose in human plasma samples. Towards this, graphene oxide (GO) was electrochemically exfoliated and coated on vanadium pentoxide (V$_2$O$_5$) prepared through solution combustion process. Graphene oxide surface coated vanadium pentoxide (GO@V$_2$O$_5$) nanoparticles were synthesized via ultrasonication and used as interface material in the glucose sensor. Structural properties of the GO@V$_2$O$_5$ nano-interface were analyzed using X-ray diffractometer (XRD). Raman spectra distinguished the formation of GO@V$_2$O$_5$. X-ray photoelectron spectroscopy (XPS) confirmed the surface coating of GO on V$_2$O$_5$. Gold (Au) working electrode was modified using GO@V$_2$O$_5$ and chitosan. Cyclic voltammetry and amperometry studies were carried out to study the electrocatalytic nature of nanoscales like GO@V$_2$O$_5$ modified working electrode towards the detection of glucose. GO@V$_2$O$_5$ had more oxygen vacancies and lattice oxygen and hence it promoted absorption of glucose, which is the rate determining step. Decrease in pH value confirmed the formation of gluconic acid. GO@V$_2$O$_5$ based non-enzymatic glucose sensor is capable to overcome interferents. Further, the developed sensor exhibited sensitivity of 10.97 µA mM$^{-1}$ with a stability for 30 days (87%) and was employed to detect glucose levels in human blood plasma.

References:


Effect of charge compensator on crystal phase and optical properties of Eu$^{3+/2+}$ activated Ba$_2$SiO$_4$ phosphor

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In this work, Eu$^{3+}$ doped Ba$_2$SiO$_4$ phosphor were prepared via conventional wet phase reaction technique. There are several research works that elucidate the enhanced luminescence efficiency by altering the crystal phase. As charge imbalance in the crystal lead to the low quantum yield, flux materials have been introduced to attain the crystals with no defects. The different concentrations of sodium fluoride (NaF) were introduced as flux to the phosphor to balance the charge of the crystal and to get the crystal with no charges. The introduction of flux materials may enhance the luminescence properties of phosphor materials as it was concluded that change in flux concentration plays a vital role in crystal purity. The crystal phase and photoluminescence property of the synthesized phosphor were studied using powder X-ray diffractometer (XRD) and photoluminescence spectroscopy (PL), respectively. The photoluminescence emission spectra were measured at 450 nm of excitation wavelength. Since the results show the enhanced photoluminescence properties of NaF treated phosphors, it can be further utilized for constructing warm white emitting diodes.

References:

A pathological Hallmark of Alzheimer’s Disease (AD) is the significant deposition of amyloid beta (Aβ) plaques in the brain [1]. Several studies were reported to inhibit the Aβ fibrillation using nanoparticles, nanoclusters and bioconjugate nanomaterials for Alzheimer’s treatment [2]. In recent years, natural compound (phytochemicals) have been largely used to study and identified as promising agents for the prevention and treatment of neurodegenerative diseases including AD [3]. Gold nanoparticle, with different size and shapes enable their multifunctional properties used in biomedical applications. Gold nanoparticle with appropriate surface conjugates with higher affinity has been studied and acknowledge the interaction between Bio-Nano interfaces [4]. The surface covering or anchoring conjugates will play a major role in vitro and in vivo. Herein, we reported Epigallocatechin gallate (EGCG) stabilized gold nanoparticle (AuNps) were synthesised as a Aβ inhibitor. The synthesised EGCG-AuNps Characterized using UV-Vis Spectroscopy, DLS, XRD, SEM (EDAX) and TEM (SAED) and the biocompatibility were studied by using MTT and scratch assay. The synthesised EGCG-AuNps inhibiting Aβ aggregation, dissociation Aβ fibrils which lead to prevent plaque formation, which confirmed using Thioflavin T-assay and TEM studies. Thus, this work provides new insights into the synthesised AuNps as functional therapeutic agent for AD.

References:


P 101

**Effect of zeta potential on PLGA biodegradable nanoparticle internalization and extrusion in cancer cells**

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Biodegradable nanoparticles are found to be more efficient as drug delivery system because of sustained release and biocompatibility with different tissue systems. Efforts have been made to understand uptake pathways as well as retention of nanoparticles. Studies are yet to be done to understand whether variation in zeta potential of PLGA nanoparticles affect nanoparticles internalization and extrusion in cancer cell lines. The nanoparticles were prepared using solvent evaporation method; PLGA Polymer was dissolved in an organic solvent followed by addition Cy3.5 fluorescent dye. For preparation of positively and negatively charged nanoparticles CTAB and SDS added to polymer fluorophore solution respectively. Following sonication and differential centrifugation, Size and zeta potential of nanoparticle was determined by “Zetasizer” instrument. Equal no. of nanoparticles incubated into the cells and concentration of NPs was seen in cancer cell lines by Fluorescent microscopy after 30’of incubation. Data was analysed by Image J software. In another set of experiment, cells were exposed to metabolic inhibitor [ NaN$_3$+2DG] for 15’ followed by incubation of differently charged NPs in the cells for 30’ at two different condition (4°C without metabolic inhibitor and 37°C with/without metabolic inhibitor). Similarly, data was analysed by Image J software. In cancer cell lines it is found that PLGA_CTAB nanoparticle showed highest MFI followed by PLGA_SDS and PLGA alone NPs. In all three type of differently charged nanoparticle it is found that MFI is maximum at 37°C with metabolic inhibitor than without inhibitor followed by without inhibitor at 4°C. Among differently charged nanoparticle PLGA_CTAB showed highest MFI than PLGA_SDS and PLGA NPs. There was increased internalisation of PLGA_CTAB NPs in cell lines compared to PLGA and PLGA_SDS NPs depending on their zeta potential Since there was significant uptake in 4°C with all three NPs, a role of diffusion in nanoparticle uptake can’t be ruled out. Increased retention of nanoparticle with metabolic inhibitor at 37°C in all three NPs open up the question of active extrusion of nanoparticle after internalization.

P 102

**Controllable Synthesis of Functionalized Phosphorene Quantum Dots for Efficient Oxygen Evolution Electro catalysis**

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Wide interest in exfoliated 2D layered materials such as graphene [1] and transition metal dichalcogenides (TMDs) motivated scientists to explore similar layered materials and, phosphorene, a layered counterpart of black phosphorous, has attracted lot of attention in recent times. The high air sensitivity and chemical reactivity of mono/few-layered phosphorene remain a big challenge in its synthesis and further applications. But recent studies explored phosphorene as a potential candidate for electrocatalytic oxygen evolution reaction (OER) [2]. However, controllable synthesis of mono/few-layered phosphorene nanostructures with a large number of electrocatalytically active sites and exposed surface area is important to achieve
significant enhancement in OER activity. Herein, a novel strategy for controlled synthesis and in situ surface functionalization of phosphorene quantum dots (PQDs) using a single-step electrochemical exfoliation process is demonstrated [3]. Phosphorene quantum dots functionalized with nitrogen-containing groups show promising potential as technologically viable OER electrodes for water-splitting devices.

References:

P 103

Optical response of Eu$^{2+}$ doped Sr$_2$SiO$_4$ Phosphor synthesized by solid state reaction method

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Sr$_2$SiO$_4$:Eu$^{2+}$ phosphor was prepared by High-temperature Solid state reaction method Under N$_2$ atmosphere. The material was characterized by powder X-ray diffraction (XRD), FTIR and SEM. The average crystallite sizes could be calculated by Scherer’s formula which is order up to 45-85nm range and the crystal structure of the prepared phosphor has a monoclinic structure.

From scanning electron microscopy (SEM), agglomerations of particles were observed due to the high temperature synthesis process and Fourier transmission infrared spectroscopy (FTIR) confirms Non-existence of water elements in Sr$_2$SiO$_4$:Eu$^{2+}$ phosphor. The photoluminescence and afterglow behavior of these phosphors are reported. The luminescence of Sr$_2$SiO$_4$:Eu$^{2+}$ consists of two broad bands, peaked at 492 nm (blue-green) and 568 nm (yellow-orange), which originate from two luminescence centers, related to Eu$^{2+}$ in ten-coordinated Si and nine-coordinated Si sites.

Keywords: Sr$_2$SiO$_4$:Eu$^{2+}$, XRD, FTIR , SEM, Photoluminescence
P 104

TiO$_2$/Aqua-Glycol-Ag$^+$ Nanofluid Based PCM for Rapid Cooling of Milk

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Rapid cooling of a perishable commodity like milk below the safe temperature of microbial growth and chemical worsening plays vital role in preserving quality, shelf-life and safety of not only milk but the milk products derived out of it. In a country like India, where milk production is highest in the world [1], but procurement, collection, chilling, processing and distribution chain at different junctures are reasonably associated with unorganized, scattered and small to marginal scale dairy farmers, which ultimately deters the suave cold chain expedition as practiced in the developed nations. Thus, in order to bridge the stubborn breach between demand and supply of electricity in Indian villages and meet the cooling demand for quality and safety by upholding the temperature of milk at various stages within safe limit, enhanced cold energy carrying phase change material (PCM) based on Aqua-Glycol-Ag$^+$ dispersed with food grade TiO$_2$ nanoparticles were engineered and tested from the point of production of milk for immediate charging and discharge of cooling energy to check the microbial as well as chemical deteriorations. The studied were conducted under laboratory and field purlieus at small, marginal and individual dairy farmer level to chill and maintain fresh raw milk temperature from the drawing temperature (37 °C) to below critical limit (10 °C). The experimental outcomes of milk chilling from constrained melting of the PCM encapsulated in a stainless-steel module revealed a rapid temperature drop which significantly looked-after the qualities standards of milk at par the FSSAI standards [2]. The PCM engineered could be indorsed in other dairy/food cold chain applications for rapid energy storage and discharge to maintain quality, safety and save energy.

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P 105

Detecting Cyclic Oligosaccharides Through A Hetero-Oligomeric Nanopore In Real Time.

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Nanopore technology is used for the single molecule sensing of different analytes using different types of membrane proteins. The major challenge in achieving this is the faster translocation of analytes through the pore. Controlled interaction of analytes through the protein pores is important for their efficient detection and identification. In this work we describe a novel approach to control the interaction of cyclic
oligosaccharides across a hetero-oligomeric nanopore in single molecule electrical sensing. The model system we used in our study was a hetero-oligomeric biological nanopore from *Nocardia farcinica*, with two different types of subunits. The unique geometry of the porin makes it a better candidate to study complex biopolymers such as nucleic acids and complex polysaccharides. Because of the asymmetrical shape and charge distribution of the pore we can study the possibilities of protein sequencing and post translational modifications.

References:

P 106

**Controlled Pesticide Delivery: An Application of Nanotechnology**

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The presence of pesticides in water, soil, and air has raised concerns for the protection of the environment, in particular protection of drinking water quality. Production and uses of pesticides must be strongly controlled to minimize the health and environmental problems. An important way to achieve this aim is the design of formulations which combine an optimum of bioactivity with a minimum amount of pesticides. Controlled pesticide release systems are used on farmlands by selecting a suitable and timely administration route to precisely regulate the target pest. The principal advantage of controlled-release formulations is that they allow much less pesticide to be used for the same period of activity. The development of nano-based pesticide formulation aims at precise release of necessary and sufficient amounts of their active ingredients in responding to environmental triggers and biological demands through controlled release mechanisms.

Though a lot of work has been done for the controlled drug delivery, not much work has yet been done in the controlled delivery of pesticides especially when using polysaccharides. In this study, we took a problem to demonstrate which type of nanocarrier for pesticide delivery would be viable among organic or hybrid nanoparticles. Herein, we worked on the synthesis of hybrid nanomaterials and organic nanomaterials as controlled release formulations and compared the encapsulation efficiency and loading efficiency of pesticide. This study revealed that which is the viable method for better encapsulation and sustained release among the various polysaccharides.

References:
Synthesis of Carbon dots (C. dots) from Jeera and its application as Cr (VI) sensor and bioimaging agent

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The invention of highly fluorescent nanoparticles obtained from natural sources acting optical probes has helped the scientific community to overcome the limitations of organic dye and other synthetic fluorophores used for the same purpose for decades. In the recent past, Carbon dots (C. dots) are gaining attention within the carbon nanomaterial family. They are swiftly replacing the conventional semiconductor nanoparticles (Q-dots) which have raised serious health and environmental concerns because of the presence of heavy metals in it (1). C.dots are spherical, oxygenous, carbon nanoparticles with size below 10 nm. C. dots akin to Q. dots shows all the lucrative properties like high emission quantum yields, size-tuneable emission, chemical and physical stability, narrow spectral bands, and possibility of surface modification for a specific sensing application etc. It is generally observed that to enable C. dots to be used for some definite task, it has to be bound with various specific organic, polymeric or biological groups via covalent bonds, hydrogen bonds or electrostatic interactions, thereby making the capped C. dots selective for certain areas like specific sensing, drug delivery and so on. Herein, we first synthesised photo stable, aqueous soluble C. dots from Jeera which is a natural carbon source using one pot hydrothermal methodology for the synthesis. The fabrication of cystamine-C. dots (Cys-C.dot) system using EDC/NHS coupling chemistry were carried out and the above system was successfully used for the selective sensing of Cr (VI). The above system was also used for the bioimaging of MCF-7 cells.

References


Conducting LaVO$_3$/SrTiO$_3$ Interface: Is Cationic Stoichiometry Mandatory?

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The origin of the conductivity at the interface of two insulating perovskite oxides has always been a matter of discussion [1-2]. The conductivity generated at the interface of insulating LaVO$_3$ (LVO) and SrTiO$_3$ (STO) had been explained in terms of polar catastrophe [3]. In this study, thin films of LVO have been grown on (001) STO substrate by pulsed laser deposition technique. Cation stoichiometry of grown LVO films has been tuned by changing the laser fluence of the ablating excimer laser. We demonstrate a small variation in cationic stoichiometry has a dramatic effect on the conductivity of the interface. Conducting states appear for La-deficient films, whereas stoichiometric and La-rich films show insulating behavior. Furthermore, we demonstrate that cation non-stoichiometry of La-deficient LVO film has negligible effect on both carrier density and mobility of the charge carriers.

References:


functionalized MWCNT with methacrylic acid (functional monomer) and ethylene glycol dimethacrylate (crosslinking agent) with a thermal polymerization technique. Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction technique (XRD), and Transmission electron microscopy (TEM) were used to characterize the composite structure, morphology and determine the grafted MIPs quantities in the composite. Properties like adsorption dynamics, specific binding and selective recognition capacity were evaluated. The resulting MWCNT-MIP demonstrated favorable selectivity, good stability and a higher adsorption capacity for the template molecule compared to products created by bulk polymerization. For comparison, blank polymer (MWCNT-NIP) was prepared by the same procedure, only without using the template molecule in the polymerization process. To get an insight into the role of MWCNTs on chiral recognition, L-PABE imprinted and non-imprinted polymer without MWCNTs were also prepared.

**Key Words:** Molecular imprinting; Nanotubes; Enantiomer recognition; L-PABE

**References:**


**P 110**

**Electrodeposited Doped Bismuth Vanadate towards Augmenting the Performance of a PEC System for Hydrogen Generation**

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Human dependency on energy is continuously increasing with the growing population and sources to fulfill this energy demand is depleting fastly. Therefore, there is an urgent need to search an alternative energy source which is clean, renewable, cost effective and efficient. Among the available renewable energy sources, hydrogen generation from Photoelectrochemical (PEC) water splitting comes out to be the best method. Ideal semiconductor with low band gap (2.2 eV), long stability of charge carriers and power conversion efficiency are desired goal of research.

Bismuth Vanadate is attracting attention lately in PEC studies due to low band gap (2.4 eV), appropriate band edges alignment, absorption in visible region and stability in neutral medium but it suffers from poor charge transport and electron-hole recombination. The present study is an attempt to increase the efficiency of Ni doped BiVO₄ prepared by electrodeposition method first time on conductive glass substrate. Characterizations of the prepared thin films were done by X-ray Diffractometry, UV-visible spectroscopy, Raman Microscope, Scanning Electron Microscopy and Energy Dispersive X-ray spectroscopy. PEC studies revealed that 1.5% Ni doped BiVO₄ (N3) sample exhibit higher photocurrent Density (6.73 mA cm⁻²)
Detection of Asparagine Levels in Leukemic Cells and Monitoring the Cell Proliferation with an Enzyme Modified Using Carbon Black Biosensor

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L-asparagine (Asn) is an essential amino acid required for protein synthesis and is utilized by cancer cells for growth and proliferation. It is considered an important biomarker of leukemic cells in humans. Acute Lymphoblastic Leukemia (ALL) is responsible for the rapid mortality rate in children worldwide. Asparagine released by cancerous cells leads to faster proliferation rates and tumor growth. In recent decades, research towards determination and quantification of asparagine release as a diagnostic tool for Leukemia has accelerated. Among all the traditional techniques used to detect Asn, electrochemical biosensor methods using carbon nanomaterials have garnered attention in recent years. In this work, we have utilized amino acid oxidase (AAO) enzyme as a stand-alone redox mediator, to detect and quantify asparagine release in normal and leukemic cells, through electron transfer behavior by electrochemical sensing without any other supporting interference from other amino acids. Here, we demonstrate the design and development of asparagine (Asn) sensor using immobilized (AAO) on carbon black (CB) modified electrode on the glassy carbon electrode (GCE). The modified electrode utilized for selective electrochemical sensing of Asn is at -0.4 V vs Ag/AgCl in pH 7 PBS. The sensitivity, linear range and the detection limit of the modified electrode was calculated to be 1.4 µA/µM/cm², 25-950 µM and 0.6 µM respectively. The selectivity of the modified electrode was investigated with other amino acids. The CB/AAO was evaluated by adding ASN to monitor leukemic cells and its proliferation real time.

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Comparative Experimental and Theoretical Study to Explore the Atomic Origin of Superlative Catalytic Activity for Porous Au-Ag Nano-alloy: Is It Au\textsuperscript{0}/Ag\textsuperscript{0} or Au\textsuperscript{0}/Ag\textsuperscript{+}?  

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Bimetallic Au-Ag hollow nanoprism (HNPr) with variable effective surface area, atomic composition (Au:Ag) and clear distinction between central porous region and crystalline periphery are synthesized through a modified seed mediated growth followed by sacrificial galvanic replacement method. The creation of porous central cavity is due to the accumulation of kirkendall voids which appears owing to the different rates of mass diffusion between Au and Ag. The crystalline facets of each HNPr are characterized by X-ray Diffraction (XRD) and Selected area diffraction (SAED) pattern from HRTEM where as Au:Ag composition was examined through Inductively coupled plasma - optical emission spectrometry (ICP-OES), X-ray photoelectron spectroscopy (XPS) and Energy Dispersive X-Ray Analysis (EDAX) techniques. It was observed that the hole-induced distortion from prism to disk shape generates increased number of numerous low coordinated crystal defects like multiple twin boundary (MTB), grain boundary (GB), steps, kinks, edges and terraces on crystalline nanodisk surface along with different dislocation-based porous cavity region. Numerous crystal defects along with extended d-orbital spacing of respective crystal disorders in the central cavity region of HNPrs control their adsorption efficiency for different redox reactions. Among different HNPrs, the HNPr\textsubscript{250} possess high density of grain boundary and extensive porous central cavity along with a preferable Au:Ag ratio to form porous ligaments and thereby acts as the superior electro-catalyst towards the oxidation of Uric Acid (UA). Electrochemical impedance spectroscopy (EIS), differential pulse voltammetry (DPV) and squarewave voltammetry (SWV) measurements show that the HNPr\textsubscript{250} modified glassy carbon electrode accelerates the kinetics of the UA oxidation up to 57.33 times than the bare glassy carbon electrode which allow us to detect the UA in picomolmar (pM) range. Experimental observations have been supported by DFT calculation to approximate the effective Au-Au displacement with suitable percentage of Ag in different HNPrs.

Fabrication of multi walled carbon nanotube impregnated carbon black nanocomposite interface for selective sensing of endocrine disruptor-Bisphenol A  

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Bisphenol A is a major component for epoxy resins, commercially used plastic containers, food packaging materials, and carbonless billing papers. Bisphenol A has been reclassified as a Class II – reproductive toxin...
due to its effects on various receptors pertaining to hormones, predominantly oestrogen, with recent studies that show its effect on thyroid receptors, androgen receptors and peroxisome receptors. The effect of BPA has been attributed to be both hormonal and epigenetic. These reasons make the detection of BPA very essential in perennial commodities and human metabolites. For the first time, nanostructured CB-CNT nanocomposite was prepared by simple mixing CB and CNT using ethanol as a solvent. The composite was prepared under various ratios of CB to CNT and the most effective ratio was optimised to be 2:0.25. The nanocomposite was systematically characterized by various techniques. The electron microscopy techniques like SEM and TEM revealed images showing CNTs impregnated into spherical CB particles. UV-visible and FT-IR techniques confirmed strong interaction between CB and CNTs. The electrocatalytic oxidation of BPA on CB-CNT/GCE was evaluated with respect to that of CB/GCE and CNT/GCE by cyclic voltammetry. An excellent synergistic electrocatalytic effect occurred between the CB and CNT. Effect of concentration of BPA, scan rate and influence of pH for the oxidation of BPA on CB-CNT/GCE (carbon black-carbon nanotube/glassy carbon electrode) were optimized. Differential pulse voltammetry (DPV) was chosen to be the detection method of the sensor with a limit of detection of 0.415 µM and a current sensitivity of 1.85 µA µM$^{-1}$ cm$^{-2}$. The sensor showed a linear response in the range of 0.2 – 200 µM. The fabricated sensor showed exceptional selectivity to BPA in the presence of a high concentration of some likely interference. The sensor showed great promise for sensitive and quantitative detection of BPA in commercially available water bottles.

References:


P 114

**Influence of pH on Nanostructured Copper Oxide Thin Films via Successive Ionic Layer Adsorption and Reaction (SILAR) Technique**

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Nanostructured copper oxide thin films were deposited using SILAR technique by varying pH values of cationic solution from 9 to 11 in the interval of pH=1. Structural analysis disclosed the formation of polycrystalline natured orthorhombic crystal structure of Cu$_6$O for pH= 9 and 10. Further increasing the pH to 11, formation of stable monoclinic CuO phase was observed and this transformation could be accredited to the higher concentration gradient of NH$_3$ ions in converging all the Cu and O atoms. Formation of aggregated spherical nanoparticles was observed for pH 9 and it gets transformed to tiny nano-worms like morphology for pH 10 and 11 due to the dual role of NH$_3$ ions in pH stabilizing agent and growth deriving agent. Cu-O stretching mode was observed in the range of 400-600 cm$^{-1}$. Bandgap value of 1.41 eV was observed for pH 9 and it decreased to 1.35 eV for pH 10. Further increase in pH to 11, bandgap was increased to 1.50 eV. This increased bandgap at pH 11 could be due to Moss-Burstein shift. Carrier
concentration of $4.46 \times 10^{10}$ cm$^{-3}$ was observed for pH 9 and it was increased to $1.91 \times 10^{12}$ cm$^{-3}$ for pH 11 due to the cationic assimilation effect. In contrast, mobility of charge carriers was observed to be decreased on increasing the pH value. I-V characteristics of the prepared thin films at different pH levels revealed the Ohmic behaviour of p-type copper oxide thin films. Influence of grain and grain boundary resistances at different pH values on vapour sensing properties were investigated and reported.

References:

P 115

Preparation of Carbon Based WO$_3$ Nanowires Coated GCE for Effective Detection of Bisphenol – A

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Development of valuable materials from invaluable biowaste is an active area of current research interest. Particularly, developing country like India has taken enormous effort to convert the biomass into valuable products and in turn demonstrated for various critical applications. Specifically, development of carbon-based materials has received tremendous attention owing to their multifunctional properties. Certain biomaterials often serve as an inspiration for the preparation of new carbon materials. In this piece of study, we present a facile synthesis of a new bioinspired graphene oxide like Trigona Carbon Nano Petals (TCP) material using food wastes. The TCP was further decorated with tungsten trioxide WO$_3$ nanowires and demonstrated for electrochemical applications. To explain in detail, the prepared WO$_3$ decorated TCP was characterized by XRD, Raman spectroscopy and FESEM techniques. Bisphenol A [4, 4-(propane-2, 2-diyl) diphenol] (BPA) is one of the widely used industrial raw materials for the production of polycarbonate plastics, water bottles etc. So far, a greater attention has been paid to study the toxicity of BPA for its sustained release from polycarbonate flasks and water bottles. In order to alleviate toxicity, its determination even at negligible concentration through electrochemical sensor is suggested. It is in this background, a novel, sensitive and active sensor material is prepared by decorating the WO$_3$ nanowires on TCP and the resulting electrode material is coated on Glassy Carbon Electrode, hence obtained (TCP/WO$_3$/GCE). The sensing ability of this electrode was examined by determination of BPA through CV and DPV techniques. Thus, the proposed sensor could be advantageously employed for the determination of BPA in any other samples at low concentration.

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Photophysical Study of Pt (II) Complexes at Nanoclays as Supramolecular Scaffolds

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Pt(II) complexes have been exploited in bioimaging and for therapeutic applications. Solubility of such complexes in aqueous media is of great importance, and can be improved by structural modification of the complexes or by elegant supramolecular approaches. Supramolecular scaffolds of Pt(II) complexes formed with polymers or nanoclays are expected to stabilize triplet excitons by reducing vibrational relaxation and shielding from the environment.[1]

In this study, a water-dispersible and biocompatible nanoclay, Laponite®, was used as a transparent nanocarrier with a high aspect ratio.[2] Supramolecular inorganic hybrids were formed by adsorbing Pt(II) complexes at Laponite®. Pt(II) complexes constitute d⁸ coordination compounds having square planar geometries and possess a strong tendency to stack, leading to Pt-Pt interactions. To understand the tunability of the intermetallic interactions, we used Pt(II) complexes bearing different substituents on the tridentate NNN-type luminophores. Spectrally and time-resolved spectroscopy was used to study their photoluminescence. Interestingly, the adsorbed species showed bathochromic shifts in solution. Self-assembly of the Laponite® nanodiscs forcing intermetallic interactions explains these phenomena. Oxygen insensitivity is attributed to diffusional shielding from oxygen, which renders these arrays as potential bioimaging probes. In summary, the mutual influence of the molecular structure of Pt(II) complexes and Laponite® on their self-assembly in water was elucidated and finely tuned.

References:
Wearable Sensor for the Detection and Detoxification of Toxic Gases

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The surge in number and types of terrorist attacks in recent times is a major concern to mankind. Chemical warfare agents have been considered as the most dangerous weapons of mass destruction. In this scenario, it is imperative to develop wearable protective fabrics, which can detoxify the toxic gases released in the ambient in-turn save many lives. Development of surface modified textiles with functional materials could be a prominent solution for the detection and detoxification of poisonous gases. In this work, Metal Organic Frameworks (MOFs) modified cotton fabrics have been developed using chemical bath and electrospinning techniques towards the development of protective fabrics. Zirconium based MOF (UiO-66) was synthesized using solvothermal technique. Also, amine functionalized UiO-66 was synthesized to enhance the detection and detoxification performance. Structural, morphological, optical and gas sensing properties of UiO-66 and UiO-66-NH$_2$ MOFs were investigated using X-ray Diffractometer, Field Emission-Scanning Electron Microscope, UV-Vis Spectrophotometer, Fourier Transform Infrared Spectrometer and Keithley electrometer. The sensing and detoxification features of UiO-66 and UiO-66-NH$_2$ MOFs modified cotton fabrics were tested in the presence of ammonia and the results are reported.

References:

Anomalous electron transport in epitaxial NdNiO$_3$ films

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The origin of simultaneous electronic, structural and magnetic transitions in bulk rare-earth nickelates (RENiO$_3$) remains puzzling with multiple conflicting reports on the nature of these entangled phase transitions. Heterostructure engineering of these materials offers unique opportunity to decouple metal-insulator transition (MIT) from the magnetic transition. However, the evolution of underlying electronic properties across these decoupled transitions remains largely unexplored. In order to address this, we have measured Hall effect on a series of epitaxial NdNiO$_3$ films, spanning a variety of electronic and magnetic phases. We find that the MIT results in only partially gapped Fermi surface, whereas full insulating phase forms below the magnetic transition. In addition, we also find a systematic reduction of the Hall coefficient ($R_H$) in the metallic phase of these films with epitaxial strain and also a surprising transition to negative value at large compressive strain. Partially gapped weakly insulating, paramagnetic phase is reminiscence of pseudogap behavior of high $T_c$ cuprates. The precursor metallic phase, which undergoes transition to insulating phase is a non-Fermi liquid with the temperature exponent ($n$) of resistivity of 1, whereas the exponent increases to 4/3 in the non-insulating samples. Such nickelate phase diagram with sign-reversal of $R_H$, pseudo-gap phase and non-Fermi liquid behavior are intriguingly similar to high $T_c$ cuprates, giving important guideline to engineer unconventional superconductivity in oxide heterostructure.

Reference:

Impact of Annealing Temperature on Sol Gel Synthesized Barium Bismathate

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Oxide based topological insulating (TI) material Barium Bismathate was synthesized by a two step modified sol-gel technique. Prepared powder sample was annealed at different temperature for three hours and the impact of annealing temperature was studied. The effect of annealing temperature on the structural, morphological and optical characteristics were studied. Structural and morphological characterization were performed using X-ray diffractometer (XRD), Fourier Transform Infrared Spectrometer (FTIR) and Scanning Electron Microscope (SEM). XRD spectra of high temperature annealed samples shows better phase purity and crystallinity. PL and UV-Vis spectroscopic studies were used to characterize the optical properties and the band gap was estimated.
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P 120

Role of synthesis parameters of Magnetite Nanoparticles in Efficient Water molecule splitting for electricity generation

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Harmful greenhouse gas emission by fossil fuels and disposal issues of existing energy sources like solar cells, Li ion batteries, Ni-based batteries or electrochemical batteries have triggered great interest in alternative green, clean energy sources. Recently invented green energy source Hydroelectric cell (HEC) is picking pace in energy research. It will replace conventional energy generation techniques owing to its environment friendly, facile, economic and sustainable approach to generate electricity at room temperature using microliters of water [1]. Water dissociates into $\text{H}_3\text{O}^+$ and $\text{OH}^-$ ions on active unsaturated surface cations and oxygen vacancies of processed nanoporous metal oxides. Electrochemical redox couple reaction of dissociated ions with external Ag and Zn electrode generates emf in cell.

Magnetite nanoparticles were synthesized at solution temperature kept 100 °C by chemical co-precipitation method. Such a cell delivered 50 mA current and emf 0.775 V [2]. Change in synthesis parameters significantly affects the chemical and electrical properties of nanostructure. In present work, effect of variation in magnetite nanoparticle synthesis temperature on cell output performance has been investigated. Room temperature synthesis of magnetite nanoparticles in air as well as in inert conditions was done to ascertain the role of oxygen vacancies in water dissociation. Crystalline nature and surface microstructure along with pore size distribution have been studied by X-Ray Diffraction, SEM technique. Fine mesopores were uniformly distributed in magnetite nanoparticles. Grinded samples were pelletized into a 2.54 X 2.54 cm$^2$ pellet and Ag/Zn electroding were accordingly to fabricate HECs. Water molecules acted as fuel to generate 40 mA current and emf 0.75 V in magnetite HEC synthesized in air. While it only generated 12 mA current and 0.75 V in magnetite HEC synthesized in inert environment. High stoichiometric magnetite synthesized in inert conditions restricts the concentration of oxygen deficient shallow trap centers reducing active water adsorption sites.

References:


**P 121**

**Quantum Dot Sensitized Solar Cells employing Type-II CdSe-Cu₂Se Core-Shell systems**

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Core-shell quantum dots are functional nanomaterials in which ‘band engineering’ results in tailored properties that are quite different from their monocomponent counterparts. Since the position and the density of energy states in quantum confined semiconductor nanostructures are governed by the size and the dimensionality, the energy offsets in these materials can be controlled by a judicious control of the composition, size and shape of each component. The staggered alignment of the band edges at the material interface leads to the relative delocalization of electron and hole wave functions in different regions of the structure that benefits in improving the performance of solar cells based on them.

In this work, we discuss the fabrication of quantum dot sensitized solar cells using highly reproducible oleylamine capped CdSe-Cu₂Se type-II core-shell quantum dots prepared by organometallic high temperature synthesis procedure. The optical and structural properties of as synthesized core-shell quantum dots were investigated using UV-visible absorption spectroscopy, photoluminescence spectroscopy, X-ray photoelectron spectroscopy, energy dispersive X-ray spectroscopy, X-ray diffraction and high-resolution transmission electron microscopy. The pre-synthesized type-II QDs were deposited onto TiO₂ photoanode as an active layer. Cu₂S was used as the counter electrode, prepared using brass foil and polysulfide electrolyte as the electrolyte. With ZnS as the passivation layer, the solar cells showed an appreciable performance with a conversion efficiency of 1.8%.

**References:**


**P 122**

**Experimental Study of ZnO Nanoparticles Doped Paraffin Wax In A Shell And Tube Energy Storage Device**

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Phase Change Materials (PCM) can store the thermal energy as a latent heat over a nearly isothermal temperature range [1]. In the current experimental study, ZnO nanoparticles doped paraffin wax (organic PCM) was prepared with the ZnO concentration being 2, 4 and 10 wt.% using oleic acid as the dispersant. ZnO nanoparticles synthesized using Zinc nitrate hexahydrate was crystalline, non-spherical with characteristic dimension ranging between 50 to 100 nm. The composites were characterized using Differential Scanning Calorimetry and Transient Hot Wire technique. Astonishing 88% enhancement in
thermal conductivity was measured for the 4 wt.% composite. The energy storage capability of the material is further examined using a shell (heat transfer fluid) and tube (ZnO doped paraffin wax) energy storage device based on charging and discharging rate of PCM using water as a heat transfer fluid. Temperature variation at the tube centre filled with PCM were studied using an inexpensive K-type thermocouple temperature logger based on Arduino UNO[2].

References:


P 123

Building Synthetic Nanopores

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Ion channels are transmembrane proteins involved in important cellular processes. Notably, most of the Human ion channels possess α-helical conformation and thus targeting α-helical bundles have huge therapeutic applications. Though previous structural and functional studies provide basic understandings of α-helical ion channels, we remain relatively ignorant about their structure-function correlation. Studying A-helical ion channels in dynamic membrane environment remain nearly impossible due to their complex interaction with the membrane and hence require a model system to achieve that.

For that purpose, we fabricated a synthetic α-helical transmembrane pore derived from short synthetic peptides based on a pore forming protein PorACj expressed by Corynebacterium jeikeium. By high resolution single-channel electrical recording, we defined the structural and functional properties of the pore in a membrane mimetic environment. The peptide pore is ion-selective, functional, capable of conducting ions and binding blockers. Modulation of selectivity of this artificial pore makes it an excellent model system to study human ion channels. Our findings also have important therapeutic implications, including the development of personalized diagnostic methods and drug targeting studies.

References:

P 124

**Electrochemical Detection of Imidacloprid using Cu/rGO Composite Nanofiber Modified Glassy Carbon Electrode**

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Pesticides have been extensively used in the agricultural field to enhance the food yield. The irreplaceable impact by the pesticide usage is the degradation of useful microbes and toxic water ecosystem. Among several pesticides, Imidacloprid (IMD) has been widely in the fields of apple, corn, eggplant, potatoes, sunflower, wheat and sugar beet [1]. IMD is highly aerobic with an average half-life of 128 days in soil [2] and hence the inception of IMD has to be detected to minimize its adverse effects on the environment. Henceforth, we have developed a sensitive and rapid electrochemical sensor for the detection and quantification of IMD in soil samples. In this work, an IMD sensor was fabricated by modifying the glassy carbon working electrode with copper-reduced graphene oxide (Cu/rGO) nanocomposite, prepared by electrospinning technique. The redox reaction was observed at 0.181 V by cyclic voltammetry analysis and this has been considered as the fixed potential for amperometry studies. The amperometry study implies that the developed sensor exhibited a sensitivity of 0.325 µA µM$^{-1}$ with the limit of detection, limit of quantification and repeatability of 2.511 nM, 7.533 nM and 0.28% RSD respectively. Hence the fabricated sensor was successfully employed to quantify the levels of IMD below the WHO adequate daily intake limit of 0.06 mg/Kg bw/per day.

**References:**


P 125

**Reduced Graphene Oxide based Molecularly Imprinted Polymer Nanocomposite: A Smart Material for Selective Detection of Bisphenol A**

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Bisphenol A (BPA) is a main endocrine disrupting chemical (EDC) found in nature originating from polycarbonate plastic/epoxy pitches. It is presented to the earth through various procedures of industrial manufacture, industrial wastes, leaching from disposed of bisphenol A-based items viz. plastic jugs, toys, packages, papers and polluted waste water. Human consumption of this EDC leads to a variety of issues such as birth defects, infertility, obesity and prostate cancer. Thus, detection and removal of BPA from
industrial waste, soil, and drinking water are important for decreased human consumption. Out of different methodologies accounted for the efficient detection of BPA from contaminated water molecular imprinting is a broadly utilized strategy to accomplish selective molecular recognition in a composite by target molecule assisted assembly.\(^2\)

Here, we outline a \(\beta\)-cyclodextrin functionalized reduced graphene oxide-based molecular imprinted nanocomposite for particular electrochemical detection of BPA.\(^3\) The conducting property of reduced graphene oxide, effective recognition capacity of polymeric \(\beta\)-cyclodextrin and the electro-active phenolic groups of BPA make it responsible for selective electrochemical detection. Electrochemical detection was adopted in order to evaluate the rapid selective recognition ability of the prepared imprinted nanocomposite contrasted with non-imprinted towards specific EDC. Special emphasis was given on the BPA detection sensitivity below micromolar concentration as this is essential for World Health Organization (WHO) permissible limit. Moreover, inclusion of Fe\(_3\)O\(_4\) nanoparticles based molecular imprinted nanocomposite causes easy magnetic separation of BPA. In conclusion, molecular imprinted principle is used to introduce the specific recognition capacity of the nanomaterials with their integrated characteristics towards the selective detection/removal of target molecule in the presence of abundant non-targets in contaminated water, food and other materials.

References:


P 126

Non-enzymatic Nano-interfaced Electrochemical Sensor for the Detection of Banana Wilt

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Fusarium wilt of banana is a lethal fungal disease caused by \textit{Fusarium oxysporum f. sp. cubense} (Foc). It infests bananas extensively and limits the water uptake of the plants through the xylem vessels [1]. Fusaric acid - a toxin produced by \textit{Fusarium oxysporum} is known to stimulate the infection by inducing early senescence and retrogression of vascular tissues instigating necrosis [2]. It is quite a challenge to overcome the rapid infestation and bear the loss of harvest, therefore our ultimate aim is to detect the existence of the fungi even before its manifestation in the banana plant. In this study, an electrochemical sensor with gold (Au) nanointerface has been developed to detect fusaric acid in soil samples. The Au nanointerface was prepared using plant extract of \textit{Terminalia bellirica}. The preliminary confirmation of the instantaneously formed Au nanoparticles was performed using Ultraviolet-Visible Spectrophotometer. Fourier Transform
Infrared spectra confirmed the role of plant compounds in the formation of Au nanoparticles and the same was substantiated by Field Emission Scanning Electron Microscope image. Further, electrochemical studies were carried out with Au modified working electrode, Ag/AgCl saturated with 1 M KCl as reference electrode and platinum wire as counter electrode. Design parameters such as incubation time, pH of electrolyte, and scan rate were optimized for better performance of the biosensor. The sensing parameters such as sensitivity, selectivity, limit of detection and repeatability are reported.

References:

Nanometal Oxide Based Wood Preservatives- A New Strategy to Protect Non-durable Wood

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Nanoparticles are gaining acceptance in wood preservation and wood protection, due to its relatively small size, high reactivity. However, instability of the nanoparticles in liquid medium is a major constrain in preparing nanoparticle-based wood preservative formulations. In this work, stable dispersions of nano zinc oxide and nano copper (II) oxide were prepared in propylene glycol (PG) without adding any additional dispersant. Homogenization and ultrasonication was carried out to prevent agglomeration of particles. The dispersions were characterized using Dynamic light scattering (DLS), Scanning Electron Microscopy (SEM), UV-Visible absorption spectroscopy (UV- Vis). Rubber wood (Hevea brasiliensis) specimens impregnated with nanodispersions were studied for decay resistance, termite resistance, moisture adsorption and dimensional stability. 2.5% ZnO and CuO nanodispersions significantly prevented the growth of wood decaying fungi ie., brown-rot (Polyporus melia) and white-rot (Trametes hirsuta) as indicated by weight loss, FTIR and SEM analysis. 5% CuO nanodispersion treated specimens prolonged service life of treated rubber wood specimens to more than one year in high termite prone test site. Moisture adsorption was reduced, and dimensional stability was improved in ZnO and CuO PG dispersion treated specimens. Nano ZnO coated wood increased UV-resistance and provided high Photostability by reducing the phot yellowing initiated by UV radiations. Leaching of nanoparticles from treated wood was negligible compared to their bulk counter parts. The results of the study will help in developing a nano based wood preservative formulation with limited leaching and increased antifungal and anti-termite properties.
**P 128**

**Influence of Chelating Agents on the Growth of CeO$_2$ Nanoparticles Prepared Using Microwave Synthesis Technique – Gas Sensing Application**

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Cerium oxide (CeO$_2$) nanoparticles were synthesized using microwave technique at two different microwave powers of 300 and 450 W. The influence of two different concentrations (0.5 and 1 mM) of chelating agents such as polyvinyl pyrrolidine (PVP) and citric acid on the growth of CeO$_2$ nanoparticles were investigated. PVP derived CeO$_2$ nanoparticles showed polycrystalline in nature with face centred cubic crystal structure whereas the citric acid derived CeO$_2$ nanoparticles exhibited amorphous nature. Optical bandgaps of the CeO$_2$ nanoparticles derived from PVP and citric acid were found to be in the range of 5.5-6.2 eV, which is blue shifted from the band gap of bulk CeO$_2$ nanoparticles (3.1 eV). This drastic blue shifting in band gap value could be due to the influence of smaller crystalite size and defect states exhibited by CeO$_2$ nanoparticles. Morphological analysis of both the PVP and citric acid derived CeO$_2$ nanoparticles revealed the formation of irregular agglomerated nanoparticles. Formation of Ce–O stretching mode at 420.56 cm$^{-1}$ was observed through the functional group analysis. The vapour sensing properties of prepared nanoparticles were investigated towards 50 ppm of different VOCs like ammonia, formaldehyde, methanol, butanol and isopropanol by using custom made gas sensing chamber and Keithley electrometer.

**References:**


**P 129**

**Dielectric Properties of Magnesium Ferrite (MgFe$_2$O$_4$) Ceramics Synthesized Through Sol-gel Auto-combustion Method**

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Understanding structural, electrical, dielectric and magnetic properties of ferrite materials has been an area of intense research in the past decade. Ferrites were developed into commercially useful magnetic materials during the years 1933-1945 by Snoek [1] and his associates at the Philips Research Laboratories in The Netherlands [1-3]. In the last few decades, ferrites have become technologically important materials...
because of their unique properties. Among all ferrites, magnesium ferrite is a soft magnetic n-type semiconducting material, which finds number of applications in microwave devices, radio frequency coils, transformer cores, noise filters, antennas, sensors, heterogeneous catalysis and pigments [4-8].

In present study magnesium ferrite powder was synthesized via sol-gel auto combustion technique using DL-alanine fuel which yielded single phase powder in the as-burnt stage itself. The obtained as-burnt powder was annealed at 900 °C for 4 hrs to eliminate the residual carbon, nitrogen and hydrogen. Highly resistive MgFe$_2$O$_4$ ceramics are obtained by sintering at 1200 °C for 4 hours. Novo control impedance analyzer is used to investigate the frequency and temperature dependent dielectric properties and found to exhibit semiconducting behaviour.

References:

P 130

**Pd-TPMO: An Effective and Renewable Catalyst for Selective Hydrogenation and Cross-Coupling Reactions**

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Hybridization of inorganic and organic moieties on molecular to mesoscopic scales is a powerful tool for developing novel functionalized materials.\textsuperscript{1} Periodic mesoporous organosilicas (PMOs), an inorganic/organic hybrid materials, have taken considerable interest over the last decades owing to their broad applications including catalysis, sensors, etc.\textsuperscript{2,3} PMO as a catalyst support has innumerable advantages comprising of high surface area, large pore volume and tunable pore size which are beneficial to enhance the catalyst loading and to improve the dispersibility of active species, resulting in high catalytic performance.\textsuperscript{4}

Herein, we describe the synthesis of 2-thiazolone derived PMO (TPMO) and the palladium nanoparticles incorporated Pd-TPMOs. The TPMO and Pd-TPMO materials were characterized through several
techniques. The Pd-TPMO was found to be an effective and renewable catalyst for selective hydrogenation of organic substrates and for cross-coupling reactions to produce bi-aryl ketones and bi-aryl derivatives.

**Keywords:** Palladium, Periodic Mesoporous Organosilica (PMOs), Thiazoline

**References:**


**P 131**

**Zn Doped α-Fe₂O₃: Efficient Material For UV Driven Photocatalysis**

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Nanocrystalline Zn²⁺ ion doped hematite α-Fe₂O₃ with composition α-ZnₓFe₂₋ₓO₃ (x = 0, 0.02, 0.04, 0.06)] were synthesized via sol gel method to investigate the effect of divalent zinc ion doping on structural, optical and dielectric properties of α-Fe₂O₃. The as-prepared samples has been characterized by various analytical techniques such as X-ray diffraction (XRD), Fourier transform infrared (FTIR), Raman spectroscopy, UV-Vis spectroscopy and impedance analyzer. XRD pattern of synthesized samples indexed to trigonal-hexagonal R-3c space group of hematite with 10-30 nm crystallite size. Reduced band gap energy has been calculated using Tauc plot. Dielectric properties of pure and Zn doped α-Fe₂O₃ investigated at room temperature and found to be followed the same trend as that of crystallite size. Crystallite size increases with Zn ion concentration which is due to the doping of larger ionic size Zn²⁺ as compared to Fe ion. Photocatalytic properties of ZnₓFe₂₋ₓO₃ nanoparticles investigated for hazardous Rose Bengal dye and showing effective degradation efficiency in the presence of UV light. Hence, Zn²⁺ doped hematite can be considered as an efficient material for the potential application in the field of photocatalysis.
Correlation of Structural and Photocatalytic Properties of Erbium Ion Doped Cerium Oxide Nanoparticles

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CeO\textsubscript{2} has been used extensively as a catalyst along with many other valuable applications such as photocatalysis, three-way catalysis, oxygen storage devices, solid oxide fuel cells, spintronic devices, solar cell, biological and medical applications. In the present work, Er\textsuperscript{3+} ion doped cerium oxide nanoparticles of stoichiometric composition Ce\textsubscript{1-x}Er\textsubscript{x}O\textsubscript{2-δ} (x = 0, 0.02, 0.04, 0.06 & 0.08) were synthesized by facile sol-gel method and characterized by various analytical techniques. Er\textsuperscript{3+} ions substitution induces dislocation and deformity in lattice to develop defects in the crystalline network. XRD patterns confirmed the polycrystalline nature of these nanoparticles with no extra phase in accordance with JCPDF Card No. 34-0394. Raman spectroscopy revealed the formation of defects due to the reduction of ceria from Ce\textsuperscript{4+} to Ce\textsuperscript{3+} ionic state that corroborates well with the XRD results. Reduction of ionic state played an important role to generate oxygen vacancies in the lattice system. Photocatalytic performance of Rose Bengal (RB) dye was investigated under the influence of UV light by using as-synthesized samples as catalysts. It was observed that with an increase in doping concentration of Er in cerium oxide improved decolorization of RB dye. Results revealed that oxygen vacancies in the synthesized samples also played an important role to degrade the RB dye.

Keywords: CeO\textsubscript{2}; Sol-gel; Oxygen vacancies; Photocatalysis.

Synthesis and Characterization of Tween-80 Based Low-k Films

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Low dielectric constant (k) films are used as inter layer dielectric for wiring structure in nanoelectronics devices to reduce the interconnect delay, crosstalk noise and power consumption in ULSI circuits. The porous low-k films attracted more and more attention as it has lowest reported k value. Current paper reports the synthesis of Tween-80 based porous low-k films. To form coating solution, Tetraethyl orthosilicate is used as a source of Si, ethanol as solvent, HF acid catalyst and distilled water were mixed in appropriate proportion. The prepared sol is spin coated on pre-cleanned Si wafer. To introduce the voids in film matrix, the obtained films were annealed to remove Tween-80 from the film matrix. The formation of SiO\textsubscript{2} is confirmed using FTIR analysis. Further, surface properties are studied using AFM and FESEM analysis.

Keywords: Tween-80, FESEM, Low-k, dielectrics, Porogen
Formulation and Optimization of Green Tea Catechins Loaded Transfersomes by Box-Behnken Design for Aptness of Skin Cancer Chemoprevention

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Green Tea Catechins (GTC) are highly active against cancer, cardiovascular and neurological diseases due to abundant presence of Epigallocatechin gallate [1, 2]. With the development of biodegradable phospholipid and surfactant based nanovesicular system like transfersomes, enhanced skin permeation and cancer targeting could be achieved for GTC that would lead to novel approach for skin cancer chemoprevention. The aim of the present study is to standardize the green tea catechins extracted from green tea manufactured by Zaroni Green Tea (Sonitpur, Assam) and optimize the transfersomes formulations loaded with the extracted GTC by observing the effect process factors on the responses using Box-Behnken design. Extraction of GTC was done by Hot-water extraction method [3]. Standardization of the catechins extract was carried out using UV-VIS spectroscopy, IR-spectroscopy and HPTLC. Transfersomes were formulated by thin film hydration technique [4]. The effect of three independent factors, that is, soya lecithin as phospholipid, sodium cholate as surfactant and GTC was studied on four dependent responses, that is, effective diameter, polydispersity index (PDI), % entrapment efficiency and % drug loading. The optimized formulation showed similar response as the predicated values of particle size of 151.4 ± 1.9 nm, PDI of 0.326 ± 0.009, entrapment efficiency of 67.93 ± 0.09 % and drug loading of 10.17 ± 0.01% without any significant differences. The morphology optimized formulation was observed under TEM. The study showed successful loading of GTC extract in transfersomal nanoformulation for aptness for skin cancer chemoprevention.

Keywords: Transfersome, green tea catechins, drug delivery, Box-Behnken design, soylecithin.

References:
A Comparative study of piezoelectric polymer materials for Energy Harvesting Applications

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In recent years, due to technological advancements more number of modern portable tiny electronics are coming into existence in our day-to-day life and their energy requirements also very less in terms of few mW/µW. This act as a key point for many researchers to turn their heads towards energy harvesting techniques by interconnecting many branches of Science like basic Physics, Chemistry and Engineering Technology like Nanotechnology, Material Science, Electrical and Electronics, Wireless Communication Network and even Biomedical Science. The impact of energy harvesting techniques also plays a significant role in real time applications in various sectors like healthcare, Environmental gas sensing applications, Defence and Airforce Applications, Wearable electronics, infrastructure building Monitoring and security systems. Among various comparative investigations of different materials, piezoelectric polymer materials holds quite good due to its attractive features like biocompatibility, environmental friendly, flexibility, sustainability, pollution free and also electromechanical coupling in nature. This article discuss about the comparative analysis of various piezoelectric polymer materials like PDMS, PTFE, PI, PVDF which is suitable for self-generating applications based on their structure, thermal, mechanical electrical properties. Moreover, these active nano generators can able to harvest energy from variable environmental sources like solar, wind, thermal, workflow and mechanical vibrations.

Keywords: energy harvestors, piezoelectric, portable tiny electronics, polymer materials, mW/µW.

High Resilience Piezoresistive Carbon Nanotube-Polymer Nanocomposite Strain Sensor for Structural Health Monitoring Application

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In industries, structural health monitoring in a non-destructive method is a critical task to achieve. Any fault like corrosion, micro/macro cracks, ageing and heavy loading in industrial machines leads to a failure of machines and accidents. To overcome these issues, strain induced in the machines should be monitored continuously by deploying the array of strain sensors on the machine parts. The machine parts may undergo
different kinds of stresses like tensile, compressive and shear. Functioning of a sensor under all these circumstances demands high flexibility along with robustness. Polymer nanocomposite is one of the ideal solutions to fabricate such sensors. Researchers are exploring various novel high piezoresistive materials such as carbon nanotubes (CNTs), silicon nanowires and silicon carbides. The high electrical, thermal and mechanical properties of CNTs prompt one to use them as nanofillers in the polymer matrix to enhance the electromechanical properties of the polymer composites. However, the agglomeration of CNTs in the polymer matrix hinders the dispersion of nanofillers, which affects the electrical conductivity of the composite. Herein, we selectively functionalized the CNTs with suitable polymers so that CNTs can retain its property without any defects in the structure. The selective polymer functionalized CNT in the polyvinyl-difluoride (PVDF) matrix can be well dispersed with an electrical conductivity of 0.2 S cm$^{-1}$, which is 12 order increments when compared to the PVDF. The flexible thin films of PVDF-polymer functionalized CNTs have been prepared and their resistance and gauge factors have been investigated. In the percolation regime, the gauge factor of the flexible polymer functionalized CNTs based strain sensor is ~9, which is 4.5 times higher than commercially available strain sensors.

**P 137**

**Structural, Optical and Multiferroic Properties of (Cs, Th)-Co-Doped Bismuth Ferrite Nano Particles**

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Different dopant strategies are currently under investigation in order to make multifunctional materials. In this research work Thorium and Cesium doped bismuth ferrite nano particles were synthesized using the solution combustion synthesis method by taking tartaric acid and citric acid as a fuel respectively. Thorium (Th) and Cesium (Cs) substitution onto A site of the perovskite lattice and substitution is successfully confirmed by using different characterization techniques. Powder XRD, UV-Visible, FESEM and MFM are employed to establish the magnetic, optical, morphological and electrical properties of the prepared nano particles. XRD reveals that substitution of Th (+4) in the perovskite lattice does not damage original structure of parent material. The improved magnetic properties with Th substitution have been observed from MFM analysis and UV-Visible reflectance spectra showed a prominent red shift in the band gap and changes in the band structure of doped nano particles, Furthermore, Cs substitution on to A site of perovskite lattice provokes significant change in the crystal structure of the parent material from rhombohedral symmetry to the cubic symmetry which is confirmed by XRD diffraction which in turn enhances the multiferroic properties. The P-E curves confirm the ferro electric nature for all samples. The influence of A site Cs doping on the structure, dielectric and magnetic BiFeO$_3$ are investigated systematically. All the results indicate that co-doping of Cs, Th can effectively improve the magnetic and high frequency dielectric properties of the multiferroic bismuth ferrite compounds.

**Key word:** SCS method, BiFeO$_3$, Ferro electric properties, magnetic properties,
Nanostructured ZnO Thin Film for Frequency Selective Surface Application

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Rapid development of wireless communication technologies and deployment of electronic devices as a part of Internet of Things (IoT) network have significantly increased the adverse effects of electromagnetic radiations on living organisms. As per the World Health Organisation (WHO) and International Agency for Research on Cancer (IARC), exposure towards electromagnetic radiation is considered as carcinogenic to humans. So, it is essential to develop a multifunctional material platform for protecting ourselves from harmful radiations. Hence, this investigation is aimed at the development of RF attenuating material using nanostructured ZnO thin film. ZnO film was deposited on glass substrates using reactive DC magnetron sputtering. Structural, morphological, optical, electrical, sensing and electromagnetic interference (EMI) filtering properties of the deposited thin films were investigated. X-ray diffraction patterns confirmed the formation of ZnO thin film with hexagonal wurzite structure. FE-SEM image revealed the formation of nanospheres like morphology with an average grain size of 45 nm. EMI characteristics were investigated towards X-band region and the ZnO thin film showed attenuation of -35 dB at 8.62 GHz. Subsequently, gas/chemical sensing characteristics of ZnO thin film were investigated using custom-made gas testing chamber and it showed a selective response towards ammonia with a sensing response of 76 for 100 ppm at room temperature.

Reference:

Biocompatible NIR-responsive Polyaniline-based Nanomedicine for Highly Effective Targeted Photothermal Triple Negative Breast Cancer Therapy

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Nanotechnology is an evolving and imperative field in research area of biomedical application in this recent decades. Nanoparticles (NPs) have several advantages including, increase the tumor specific distribution
via the enhanced permeability and retention effect (EPR) [1]. Photothermal therapy (PTT), based on the principle of converting light energy into heat energy, can lead to tumor necrosis [2]. The photothermal agents are habitually prerequisite to have strong NIR absorbance (700-950 nm), high photothermal conversion efficiency and desired photo-stability [3]. Compared with traditional cancer therapies, such as surgery, radiotherapy, and chemotherapy, PTT is a targeted and noninvasive therapeutic intervention for specific biological targets when combined with light excitation and photoinduced heating nanoparticles and the nanomaterials geared towards the PTT application has gained increasing attention [4, 5].

Excellent biocompatible conducting polymers (CPs) with strong near infrared (NIR) absorption and great heat conversion efficiency has emerged as an innovative research field of photothermal cancer therapy (PTCT) agents for cancer treatment. An effectual strategy to design NIR absorbing CPs with good dispersibility be there imperative to accomplish excellent therapeutic effect. In this work, well dispersed CPs of polyaniline (PANi) synthesized with organic acids, citric acid (CA) and hyaluronic acid (HA) for doping as well as targeting ligand, respectively. They were characterized using by UV-vis, TEM, DLS, Zeta and FT-IR. The TEM image showed that the nanocomposite of CA-PANi and HA-PANi assemble to spherical in nanoshape. Furthermore, photothermal performance and conversion efficiency of CA-PANi NPs and HA-PANi NPs results demonstrated the both martials have good conversion efficiency and photostability. Besides, compared to CA-PANi, HA-PANi NPs have significant selectivity for photothermal tumor cell-killing under NIR-illumination, however excellent biocompatibility was observed without NIR to triple negative breast cancer (TNBC) cells. TNBC cells was treated with HA-PANi NPs+NIR illumination have the ability to destroy the TNBC cells selectivity, due to overexpression of CD44 on the surface. The NIR irradiation precedence to heating of HA-PANi NPs endocytosed and ablation of the cancer cells. Moreover, cell death was performed by FACS analysis results indicate HA-PANi NPs with NIR irradiation have very good photothermal effect to induce apoptosis in target TNBC cells.
P 140

Laser Ablation of Toluene- A Novel Method for The Synthesis of Graphene and Graphene Quantum Dots

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Graphene Quantum Dots (GQDs), which are zero-dimensional graphene particles with characteristics of both graphene and carbon dots have been successfully synthesised by laser ablation of toluene. Strongly fluorescent graphene quantum dots have generated enormous excitement due to their biocompatibility, large surface area, and nontoxicity. GQDs gain significant interest in recent years due to their potential for biomedical field owing to their distinctive and tunable photoluminescence properties, fascinating physicochemical properties, high photostability, and small size. In this work, we have synthesized GQDs in the range of 5-10 nm size that is decorated in the graphene layer. Because of the luminescent property, GQDs can serve as a paper strip sensor for detection of insulin. Further research in the field of drug delivery, LEDs and solar cells accelerate the development of new applications.

Keywords: laser ablation, graphene quantum dots, paper strip sensor

References:

P 141

Absorption of Aromatic Solvents and Swelling Characteristics of Carbon Black Filled Natural Rubber/Styrene Butadiene Rubber Blends

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Elastomeric materials with excellent solvent absorption properties are used in a wide variety of applications, including food and beverages packaging, automobile industries, various sealing products, and oil and gas fields. The flexible rubber chains are highly diffusive and allow easy penetration of solvent molecules through it. The flexibility of rubber chains is reduced by either cross-linking or blending. Information on
absorption of solvents by neat and filled rubbers and blends is limited even though it is very important in solvent resistant materials. Transport of aromatic solvents through unfilled and carbon black filled Natural rubber and Styrene Butadiene rubber and their blends has been studied. Our interest here is to study diffusion and transport of aromatic solvents as a function of unfilled and filled rubber and their blends with varying carbon black concentration and blend ratio. Solvent uptake, diffusion, sorption and permeation constants were calculated and compared for understanding mechanism of absorption and swelling in aromatic solvents. Mole percentage of uptake of solvents are less in filled rubber blends as compared to neat blends. The equilibrium solvent uptake and diffusion coefficient decreases with increase in natural rubber content. The synthetic elastomers show good absorption properties as compared to natural rubber

**Keywords:** Absorption, Transport Property, Natural Rubber, Styrene Butadiene Rubber, Carbon black, Rubber Blends.

**References:**


**P 142**

**Fluorescence kinetics of Sm$^{3+}$ doped alkali fluoroborate glasses for orange emission applications**

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Trivalent Samarium (Sm$^{3+}$) doped alkali fluoroborate glasses (KBZFB) have been prepared by melt quenching technique. The spectroscopic properties were investigated using photoluminescence and decay curve analysis. Under 401 nm excitation, Sm$^{3+}$ doped KBZFB glasses give intense orange emission (600 nm) of Sm$^{3+}$ ions corresponding to $^5G_{5/2} \rightarrow ^6H_{7/2}$transition. Various radiative properties like radiative transition probabilities, emission cross section were estimated using experimental branching ratio and life time. The emission intensities were characterized using CIE chromaticity diagram and the prepared glasses offer high purity intense orange emission which is useful for various photonic applications.
Tunable UV Photoluminescence in Polymer Nano Composite for UV-LED Application

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A low-cost polymer nanocomposite of carbon quantum dot in Poly (Vinylidene fluoride-Hexafluoropropylene) with very high photoluminescence in UV region is synthesized. The results suggest that synthesized fluoropolymer composite has several properties like strong photoluminescence, short lifetime, beta crystalline phase and very high thermal stability. This work investigates about the enhancement of UV emissive property of PVDF-HFP polymer when incorporating it with carbon quantum dot (CQD). PVDF-HFP is selected as host polymer due to its higher thermal stability, high resistance against UV degradation and self-extinguishing properties. The PVDF-HFP is a strong candidate for UV emitting polymer source due to the presence of CF₃ end functional groups. UV emission around 390nm here already been reported in polymer nanocomposites. Since it is near to the visible range, there is a requirement of polymer composites, with pure UV emission for specific applications like UV-LED. Presently most of the LEDs uses quantum dots such as CdTe, CdS, PbS etc and are highly toxic in nature. Therefore, the effective use of CQD reduces this risk and the composite is totally ecofriendly. This composite can be used as suitable UV-emission enhancer coating, an intermediate layer to enhance UV emission in UV-LEDs, fluoropolymer lens for LEDs and in imaging devices.

Core-shell Hybrid Multiferroics for Magnetic Data Storage Applications

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The coexistence and coupling between the ferromagnetic and phases properties show the way to the fascinating electric control of the magnetic properties. Hybrid multiferroic materials with core-shell structures, MgFe₂O₄@BaTiO₃ with magnetic core and ferroelectric shell possessing bifunctional properties were synthesized. The strong coupling between ferroelectric polarization and ferromagnetism at the core-shell interface of multiferroic compounds give rise to engineered functionalities. The interface effect on the strain transfer was observed to strongly influence the magneto-electric coupling and, the electric and magnetic properties of the system. In line with this understanding, we report the dielectric, magnetic, ferroelectric and magneto-electric coupling attributes of the core-shell system. Admirable dielectric properties, including a low dielectric loss tangent and high dielectric constant, were further observed in this material. The multiferroicity induced by excellent coupling amongst the ferroelectric and magnetostrictive...
phases at the core-shell interface unlocks wide prospects for device downscaling and information storage applications. Interestingly, the realization of a superparamagnetic multiferroic system has been a breakthrough and facilitates ultra-high-density magnetic data storage technologies. Evidence for spontaneous polarization and the ferroelectric trait exhibited by the multiferroic samples was revealed from the P-E hysteresis loop.

References:

P 145

Interface engineered NiFe$_2$O$_4$@BaTiO$_3$ core-shell nanostructure loaded PVDF nanofibers for high-end magnetoelectric and piezoelectric applications

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Strain mediated magnetoelectric effect in polymer magnetoelctrics have attracted the scientific community because of its excellent magnetoelectric coupling coefficient at room temperature, which is highly preferred in fast ultra-modern memory devices. In line with this, we developed flexible magnetoelastic 0-1 nanocomposites of nickel ferrite @ barium titanate core-shell nanostructure loaded PVDF nanofibers abbreviated as (NFO@BTO-PVDF). Aligned and random NFO@BTO nanoparticles embedded nanofibers were prepared by electrospinning method by varying the weight percentage of core-shell nanoparticles (5 and 10 wt.%) in polymer matrix. The ferroelectric β-phase of the nanofibers seems to be enhanced due to the synergistic effect of the core-shell structure and polymer matrix itself. Fiber diameter were also found to be increased after the addition of NFO@BTO nanostructures. A systematic study on the dielectric, ferroelectric, magnetoelectric, mechanical properties of the prepared composite fibers was carried out. All the above properties were found to be enhanced after the addition of core-shell nanoparticles. Apart from
these, a piezoelectric nanogenerator were fabricated using these composite nanofibers, which possess excellent piezoresponse, which in turn generates high open circuit voltage. The present composite systems with excellent dielectric, magnetoelectric and piezoelectric properties along with good flexibility will be a promising candidate for the fabrication of innovative flexible electronic devices.

References:


P 146

Synthesis And Characterization of Mesoporous Cobalt Oxide Nanocone Arrays

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Cobalt Oxide is a p-type metal oxide semiconductor and is a good candidate for applications in sensors, Li-ion batteries, catalysts, super capacitors etc. [1]. A two-step hydrothermal method was adopted to synthesize mesoporous cobalt oxide nano cone arrays. A pink precursor film obtained during the first stage of the hydrothermal route was annealed at 350°C to obtain velvet-black cobalt oxide film. The films were characterized using Thermo-gravimetric analysis (TGA), X-ray diffraction (XRD), Field emission scanning electron microscopy (FESEM), Transmission Electron Microscopy (TEM), Raman spectroscopy and BET analysis.

XRD pattern showed spinel structure of cobalt oxide films. The film thickness was found to be 15μm. The acicular structures have length in the range 1-2μm. From TEM image, it was found that each acicular structure in cobalt oxide film was made up of nano-crystals of cobalt oxide whereas each acicular structure in the precursor film was a single crystal. Raman peaks at 187, 461, 505 and 665 cm⁻¹ signifies the F₂g, E₂g, E₁g and A₁g modes of spinel Cobalt Oxide [2]. BET surface area analysis gave an average surface area of 17.968 m²/g. From pore size distribution curves, the film was found to be mesoporous in nature.

References:


Highly Lithium ion Conductive, Al$_2$O$_3$ Decorated Electrospun P(VDF-TrFE) Membranes for Lithium ion Battery Separator

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Electrospun battery separators have drawn considerable attention due to their high porosity, surface area, and electrochemical performance. In this work, a novel class of Al$_2$O$_3$ nanoparticles decorated Poly(vinylidene fluoride-trifluoroethylene) (P(VDF-TrFE)) membrane was fabricated by electrospinning technique. Both P(VDF-TrFE) and Al$_2$O$_3$ are well known for their excellent properties, like mechanical strength, piezoelectric nature, thermal stability etc, and the electrospun membrane is prepared by combining the excellence of these two materials. The physical properties of P(VDF-TrFE) and the influence of nanoparticles on the physical properties were evaluated by morphological, thermal, XRD and FT-IR analysis. SEM and TEM analysis show that the nanoparticles increases the fiber diameter and are located on the surface as well as the bulk of the fiber. XRD studies reveal that the nanoparticles are localized at the inter-planar spacing of the polymer chain. Melting temperature of P(VDF-TrFE) is increased by the addition of Al$_2$O$_3$ nanoparticles, and all the prepared membranes exhibit superior thermal and dimensional stability than Celgard 2320 separator. The potential applications of the prepared membrane were explored as a lithium-ion battery separator by characterizing their wettability, electrolyte uptake, % porosity, ionic conductivity and charge-discharge performance. High porosity (>80%) of electrospun P(VDF-TrFE) and Lewis acid-base character of Al$_2$O$_3$ nanoparticles help to improve the ionic conductivity from 4.0 to 5.8 mS/cm at room temperature and electrolyte uptake from 280 to 375 %. Finally, 2032 type coin cells (Li/Separator/LiFePO$_4$) were fabricated using P(VDF-TrFE) nanocomposites and the fabricated cell delivered a discharge capacity of 154 mAh/g, which is superior to Celgard 2320 separator (120 mAh/g). This work proves that Al$_2$O$_3$ incorporated electrospun P(VDF-TrFE) membrane is a promising candidate to act as lithium-ion battery separator.

Effect Of Various Capping Agents On The Properties Of Mn Doped ZnS Quantum Dots

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In this work the effect of capping agents on the structural and optical properties of Manganese doped ZnS Quantum Dots has been investigated. Mn doped ZnS Quantum Dots were prepared by simple, water based
chemical precipitation method using various capping agents – thiourea, thioglycollic acid and L-cysteine. The prepared Quantum Dots were characterized by various techniques like X-ray diffraction spectroscopy (XRD), Scanning electron microscopy (SEM), UV-vis. Spectroscopy, FT-IR spectroscopy, Diffuse reflectance spectroscopy (DRS) and Fluorescence spectroscopy (PL). The results revealed that the surface morphology, size, absorption band and band gap of the Mn doped ZnS Quantum Dots were varied by capping agents. As there is relationship between band gap and photo-catalytic activity, the latter was also varied with various capping agents. In the fluorescence study, the sensing of phthalate using thiourea capped quantum dots was investigated. The results revealed that the prepared quantum dots are effectively sensing phthalate with good selectivity and sensitivity. Hence the quantum dots are promising in the sensing of environmentally relevant compounds.

P 149

A Novel Application Of Green Silver Nanoparticles For Determination Of Heavy Metal Ions In Real Sample

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We report novel methods for the selective and sensitive detection of poisonous metal Hg (II) ion using silver nanoparticles. The plant extract a synthesis of silver nanoparticles (AgNPs), which is a greener way used in this study. Curcuma longa rhizome (Turmeric) is widely used in the Indian medicinal system for various ailments such as purifier, stomach ache, appetizer and tonic [1]. Curcumin has the ability to bind heavy metal ions through ligand-metal complexes [2]. Curcuma longa rhizome extract is prepared and mixed with 1mM AgNO₃ solution [3]. The reaction mixture kept in microwave oven and irradiated for few minutes. A dark yellow solution is obtained and exhibited surface plasmon resonance (SPR) peak at 421nm. The reaction conditions were optimized by applying suitable conditions.

The addition of Hg (II) ion at a concentration as low as 0.01μM induced aggregation of AgNPs resulting the colour change from dark yellow to white which could be easily seen by the naked eye. Curcuma longa-AgNPs and Hg(II) ion induced changes were characterized and detected by the support of various techniques including, UV-vis., XRD, FT-IR, TEM, EDX, DLS, fluorescence and electrochemical methods. The limit of detection for fluorescence and electrochemical methods are 0.5 and 6.5 nM. The selectivity of the proposed method was also evaluated by analysis of curcuma longa-AgNPs response upon addition of different metal ions such as Cd (II), Co (II), Cr (III), Cu (II), Mn (II), Ni (II), Pb (II) and Zn (II). The real sample collected from well water in flood affected areas in Kottayam district, Kerala. The real sample analysis was done by fluorescence and electrochemical techniques with good recovery values.

References:


High performance epoxy coatings for anticorrosive applications

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Over the last decade there is a growing attention in developing an excellent coating material with anticorrosive property. Protective coatings are recognized as a very efficient way to protect steel from corrosion. Epoxy composites exhibit good corrosion and chemical resistance however inherent brittle nature of the neat epoxy resin is the major limitation. Thus, extensive studies are conducted to toughen the brittle epoxy resin by adding thermoplastics, rubbers and nanofillers. Among the available nanofillers graphitic derivatives such as graphene oxide and graphene gain main attraction by virtue of its excellent combined properties.

In this work SiO$_2$-GO nanohybrids were successfully fabricated through two different so-gel based methods. The GO–SiO$_2$ nanohybrids were characterized by FT-IR, XPS, AFM, XRD, TGA and SEM then they are incorporated into the epoxy resin. Incorporation of SiO$_2$ particles into the epoxy coating notably enhanced its dispersion performance, barrier properties and corrosion resistance. Corrosion protection performance of SiO$_2$-GO/EP samples were measured using EIS analysis and Cathodic delamination test.

Keywords: Graphene Oxide, silica, Epoxy, nanohybrids, anticorrosion

References
Silica-Graphene Oxide Hybrid Filler Reinforced Rubber Nano Composites

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The branch of nanoscience has budded over the last twenty years, and the significance for nanotechnology will rise as shrinking come to be more important in regions, such as drug delivery, sensing, agriculture, tissue engineering, environmental and many other applications. This capability is the result of many developments in the past two decades of the 20th century.

Nanomaterials have been widely used in polymer matrix to improve mechanical, thermal, barrier, electronic and chemical properties. In rubber nanocomposites the dispersion of nanofillers and the interfacial adhesion between polymer and the filler influences the factual properties of the composites1. In the present work an analysis of hybrid effect of silica and Graphene Oxide was studied. Natural rubber was taken as the elastomer rubber matrix. The hybrid effect of silica and Graphene Oxide in natural rubber was studied mainly by the analysis of tensile strength, hardness testing and by rheological analysis of the nanocomposite. The tensile strength was measured by Tinus Olsen, Rheological Studies by Anton Paar Rheometer MCR3022-5. The results established that the hybrid filler is effective in increasing tensile properties. Also, the decline in the amount of carbon black in the nanocomposite can be a secondary benefit bearing in mind that the environmental and economic factors.

Keywords: Silica, Graphene Oxide, Rubber, Nanocomposites.

References
**P 152**

**Quasi spherical Hybrid Nanosystem with Potential anti cancer activity as Edible Coatings**

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Edible films and coatings improve the quality, safety, transportation, storage, and appearance of fresh and processed foods. The present study focuses on the fabrication of an edible coating made up of sesame oil, incorporated into polysaccharides that are a novel pharmaceutical formulation for fresh vegetables and fruits. We chose a water-soluble hydrocolloid like polysaccharide as it imparts better mechanical properties to edible films and coatings than do hydrophobic substances. The curcumin loaded hybrid nanosystems of dextran were characterized using TEM, DLS and FT-IR analysis. The blood compatibility, cytotoxicity, anti microbial activities and cell uptake studies were carried out using the hybrid nanosystems to ensure its non-toxicity, microbial contamination and potential anti-cancer activity. The synthesized nanoparticles exhibited quasi spherical morphology with an average size of 161.65±44.06 nm; the hybrid nanosystem also demonstrated high anti bacterial efficiency and less moisture absorbance due to the presence of sesame oil. The hybrid nanoparticles were found to be blood compatible and non-toxic. It was also observed that the curcumin loaded hybrid nanoparticles could effectively enter the nucleus of cancer cells and showed significant anti cancer activity at higher concentration, evident from the cytotoxicity assay. These edible coatings obtained from natural polymers can be utilized as excellent coating materials for fresh vegetables and fruits because of the low costs of the raw materials and the facile method of production.

**P 153**

**Optical response of Dy\(^{3+}\) doped Sr\(_3\)SiO\(_5\) Phosphor**

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Dy\(^{3+}\) doped Sr\(_3\)SiO\(_5\) phosphor was synthesized by solid reaction method. X ray diffraction (XRD) and Photo-luminescence (PL) analysis were used to characterize the phosphor. The starting materials were strontium carbonate (SrCO\(_3\)), Silicon dioxide (SiO\(_2\)) and Dysprosium oxide (Dy\(_2\)O\(_3\)) and small quantities of H\(_2\)BO\(_3\) were added. The formation of the phosphor powders occurs according to the following equations.

\[
3\text{SrCO}_3 + \text{SiO}_2 + \text{Dy}_2\text{O}_3 \rightarrow \text{Sr}_3\text{SiO}_5: \text{Dy}^{3+} + 3\text{CO}_2↑
\]

All the constituent material were homogenously mixed for 2 h heated subsequently at 1250°C for 3 h and Nitrogen cylinders was used to create reducing Nitrogen atmosphere. The XRD result shows that the synthesize phosphor was tetragonal structure, average crystalline size of Dy\(^{3+}\) doped Sr\(_3\)SiO\(_5\) phosphor was obtained 55 nm by Debye Scherrer’s formula.

**Keywords:** Sr\(_3\)SiO\(_5\):Dy\(^{3+}\), Solid State Reaction method, XRD, Photoluminescence.
P 154

Synthesis And Luminescent Properties Of Tb$^{3+}$ Doped Alkalifluoroborate Glasses

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In this work new and economical Tb$^{3+}$ activated alkali fluoroborate glasses were synthesized by conventional melt quenching technique. The luminescence properties have been studied via photoluminescence (PL) emission, excitation and decay curve analysis. The radiative parameters including radiative transition probabilities, total transition probability, fluorescence branching ratio and stimulated emission cross section were determined via a reverse calculation approach. The optimum dopant ion concentration to get maximum emission intensity seems to be 1 mol%. CIE coordinates of the samples were determined to reflect the true colour of luminescence and are found to be much closer to the commercial green phosphors. The study proves the prepared sample to be beneficial for various optoelectronic applications including lasers and w-LEDs.

P 155

Green Synthesis Of Silver Nanoparticles Using Aqueous Extract Of Vigna Pilosa Assisted By Microwave Irradiation

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Different physical, chemical and biological methods of synthesis of silver nanoparticles are available. Majority of these methods include the use of toxic chemicals and severe reaction conditions. Hence, the green biological method of synthesis of silver nanoparticles by the use of plant extracts, microorganisms, enzymes are gaining much importance in the present scenario. The green approach by the use of plant extract is a very safe, cost effective and non-toxic method for the silver nanoparticle synthesis. This green synthetic route causes less chemical toxicity and hence is environmentally benign. In the present study, the silver nanoparticles were synthesised using aqueous leaf extract of medicinal plant Vigna pilosa and silver nitrate solution with microwave assistance. The plant extract act as the reducing and capping agent. Microwave irradiation is a feasible method as it is effective, fast and it overcomes the short coming of time consumption in biological methods. The formation of the nanoparticles is confirmed by using Ultra Violet-visible spectroscopy, Fourier Transform Infrared spectroscopy, X-ray diffraction, High resolution transmission microscopy analysis. The green synthesised silver nanoparticles showed good catalytic and antibacterial activities.
Engineered Different Morphologies, Hybrid Structures of Molybdenum Disulphide and Their Characterizations

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An efficient approach for synthesis of, different morphological structures of Molybdenum disulphide like nanosheets, rods, flower-like microspheres, and nickel ferrite nanoparticles on MoS₂ composite has been developed. The MoS₂ samples were synthesized by simple hydrothermal method, and Nickel ferrite nanoparticles by sol gel method. The samples synthesized were characterized by X-Ray Diffraction (XRD), FE-SEM and Transmission electron microscope (TEM) and Dynamic Light Scattering (DLS).

From the XRD data which confirms the cubic phase of nickel ferrite and stable hexagonal state of MoS₂. FE-SEM images revealed different morphologies of MoS₂ like uniform flower-like microspheres, which are formed by several nanosheets gathering together like a flower like morphology and nanorods, it also reveals the thickness of MoS₂ nanosheets in the range of 10-15nm. From TEM images, particle size is determined in the range of 5 to 7 nm for nickel ferrite which is confirmed by DLS.

References:

Metal-MoS₂ Nano Hybrids Greenly prepared via Nanosecond Laser Ablation for SERS Applications

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MoS₂-based nano-hybrids finds extensive research interest for enhancing chemical catalytic performance, application of biochemical sensing etc. [1-4]. This work presents a novel green method to prepared Ag–MoS₂ nano-hybrids through the photo generated electrons of MoS₂ nano-sheets induced by using nanosecond laser pulses. Metal (Ag) nanoparticles (NPs) are reduced by capturing the photo generated
electrons of MoS$_2$, and in situ decorated on MoS$_2$ nanosheets, thus forming Ag–MoS$_2$ nano-hybrid. The proposed method does not need other chemical reagents, which commendably avoids the introduction of reagent byproducts to the reaction mixture, toxicity, and chemical or environmental contamination. TEM, Raman, and XPS characterizations depict the formation of Ag NPs on MoS$_2$ nanosheets, the doping effect of metal NPs on MoS$_2$, and the modification of MoS$_2$. The prepared Ag–MoS$_2$ hybrid material reveals excellent surface enhanced Raman scattering performance.

References:

P 158

Graphene oxide- Silica conjugate reinforced natural rubber latex system

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Carbon black is one of the main carbon associated fillers and is being used widely as a reinforcing filler in various rubbers because of its high reinforcing action. Also, carbon black incorporated rubbers have been in use for fabricating tyres for several decades. However, the amount of carbon black being used in tyre manufacturing is too high (very often more than 60 Phr) and this leads to environmental pollution and less fuel efficiency (due to high weight of the tyres). Additionally, the rolling resistance of carbon black filled rubber compounds is very high and traction is poor, and these aspects contribute adversely towards fuel efficiency and driving safety for automotives. To avoid the above-mentioned problems of poor fuel efficiency and driving safely, nano fillers based on silica are very much required for fabricating rubber composites for tyre engineering.

Graphene is a one-atom thick sheet of sp$^2$ bonded carbon atoms that are tightly packed in a honeycomb lattice$^1$. Graphene oxide (GO) was obtained through oxidation and exfoliation of graphite and was employed as a reinforcing nanofiller for natural rubber (NR)$^2$. Due to the polar nature in silica the filler-filler agglomeration is high. In order to avoid the self-aggregation of silica we propose self-assembled nanostructured core-shell architecture of functionalized silica and graphene oxide for reinforcement of natural rubber. Due to the difficulty of dispersing and exfoliating graphene in a rubber matrix, only recently have several studies emerged involving the preparation and characterization of graphene/NR nanocomposites. Stanier et al.$^3$ prepared GO/NR nanocomposites by simply performing latex mixing of NR latex and an aqueous dispersion of GO nanoplatelets, followed by casting in a Petri dish. Dong et al.$^4$ employed latex mixing, coagulation, and the two-roll mill mixing method to prepare GO/NR nanocomposites. The results showed that the nanocomposite showed a segregated “weblike” morphology.
The hybrid effect of silica and graphite in dispersing the nanofillers was studied mainly by the analysis of morphological analysis, tensile strength, rheological analysis etc.

**Keywords:** Graphene Oxide; Nanocomposites, Natural rubber

**References**


**P 159**

**Au@Ag core shell doped SiO2-TiO2-ZrO2 fiber optic sensor for Vitamin A detection**

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Surface plasmon resonance induced Au@Ag core-shell nanoparticles were embedded in SiO2-TiO2-ZrO2 ternary matrix for potential Vitamin A sensing applications and are reported for the first time. Ternary SiO2-TiO2-ZrO2 glasses were prepared through a non-hydrolytic sol-gel process and were incorporated with Au@Ag core-shell nanoparticles having an average size of 30 nm. The sensing capability and selectivity of the as prepared Au@Ag core-shell nanoparticles were studied using absorption spectroscopy and was established to have good selectivity over other biomolecules. The title specimen was coated on an optical fiber to reveal the practical application of such a sensor and analyzed its specificity towards vitamin A sensing using transmittance spectra. A nonlinear response towards vitamin A concentration ranging from 10-1000 µM was observed for the as prepared novel vitamin A sensor. An economical, low toxic and sensitive bio-sensor for vitamin A detection based on SPR mechanism is proposed in the current work.

**References**

P 160

Metal Free Modification On Ag₃VO₄ Photocatalyst For Augmented Sunlight Induced Water Remediation

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Clean water is a necessity in our daily life, while the access to safe drinking water became knotty than ever owing to recent floods. Recently, photocatalysts have been assessed to address the worsening clean water shortage. Herein, we demonstrate a sonochemical method for obtaining sulphur doped graphene oxide modified silver vanadate (sGO-Ag₃VO₄) nanocomposites as photocatalysts where the Ag₃VO₄ nanoparticles are dispersed on the sulfonated graphene oxide nano sheets. Modification by sGO is much desirable since it provides metal free, stable, eco-friendly and economic method to improvise photocatalytic action of Ag₃VO₄. The structural and optical properties of obtained nanocomposites were characterized by XRD, FTIR, UV-vis. DRS, PL, SEM and TEM analysis. Analysis revealed that the composite is star shaped and dispersed on sGO sheets promoting charge mobility and vanadate is present in α-Ag₃VO₄ form. Strong absorption span from 200-500 nm without much change in band gap (2.15 eV for composite) and a huge collapse in emission intensity was observed for composite relative to pure Ag₃VO₄ indicating enhanced charge mobilization effect of sulphur doping, thus reducing charge recombination and photo corrosion rather than band gap. The photocatalytic degradation performance of the composite towards organic pollutants was explored by using methylene blue (MB) as a model compound. The results showed that 1% sGO-Ag₃VO₄ nanocomposites could degrade ~99% of the dye within 30 min, under natural sunlight irradiation. Sulphur doping render sGO-Ag₃VO₄ with superior activity than sGO, Ag₃VO₄ and GO-Ag₃VO₄. With holes as the predominant active species in the system, the catalyst could bring about 99% degradation of textile dyes rhodamine B (RhB) while 50% for methyl orange (MO) and reactive red (RR) in 30 minutes. The present work highlights the competence of metal free modification to photocatalyst for wastewater treatment in real time application to degrade organic pollutants. The major contribution to the enhanced catalytic activity of our system is not from noticeable change in absorption profile, but from plentiful transportation and thus minimized recombination of charges resulted by the presence of largely conducting sGO sheet. The activity and stability of the composite are promising to extend application to degradation of other organic pollutants such as pesticides and deactivating bacterial strains from real water just by exposure to sunlight.

P 161

Nanostructured Hybrid Materials for Targeted Cancer Therapy

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Cancer is a major cause of death worldwide. Targeted or selective approaches used during cancer treatment determine the efficacy and outcome of the therapy. In order to enhance specificity and targeting and obtain
better treatment options for cancer, novel modalities are currently under development. Nanomedicine-aided cancer therapy shows enhanced specificity for cancer cells and minimal side-effects coupled with effective cancer destruction both *in vitro* and *in vivo*. This study presents the recent developments in targeted cancer therapy by using different nanostructured materials. It deals with the *in vitro* and *in vivo* tumor therapy applications of spherical gold nanoparticles, gold nanorods and nanoclusters. Also, we have studied the targeted drug delivery and gene delivery applications of Au-LDH nanohybrid materials. Also, this paper highlights the progress, challenges and opportunities in cancer nanomedicine and novel engineering approaches that capitalize on our growing understanding of tumour biology and nano–bio interactions to develop more effective nanotherapeutics for cancer patients.

**References:**


**P 162**

**Nanoparticles to prevent Endophytic contamination from tissue culture of *Scoparia dulcis* L**

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Nanotechnology is an emerging area of research which has a wide range of application including medicine and agriculture. Commonly nano-fertilizer and nano-pesticide are the major research area coming under nano-agriculture. However, nanoparticles are also having many applications in plant tissue culture. Major applications are in disinfection, plant regeneration and secondary metabolite production. Endophytes are the micro-organisms which are beneficial to plants. But in tissue culture it will affect the regeneration of healthy plants and yield [1]. So, it is necessary to eliminate the endophytic contamination [2]. However, it is a very difficult task. We have studied the capability of nanoparticles to prevent the endophyte contamination in *in-vitro* culture of *Scoparia dulcis* L.

**References**


P 163

Morphological, Mechanical and Biological Properties of Silver Nanoparticle Decorated Denture Base Polymer

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Aim: Biofilm formation and clinical fracture are the most common problems of poly(methylmethacrylate) (PMMA) based denture base materials. This study aimed to investigate the effect of incorporation of PMMA with silver nanoparticles (AgNPs) and evaluation of its mechanical and biologic performance.

Materials and Methods: PMMA were incorporated with 1, 2, 5 and 10wt% AgNPs. Various physiochemical characterizations were done using X-Ray Diffraction Fourier Transform Infrared Spectroscopy, Scanning Electron Microscopy, Transmission Electron Microscopy and Atomic Force Microscopy. Mechanical properties were statistically analysed using Post hoc Bonferroni test. Cytotoxic studies were done with MTT assay. Biofilm formation was checked against Candida albicans and Streptococcus mutans.

Results: Morphologic analysis revealed uniform distribution of nanoparticle in the matrix. The surface roughness was proportionate with the amount of nanoparticle added. Tensile strength, modulus of elasticity, flexural strength and flexural modulus were improved by the addition of up to 5 wt % of AgNPs with statistical significance. SEM micrographs revealed the fracture resistance of AgNPs by the reduction in the size and direction of cracks. The cytotoxic studies carried out on PMMA/AgNPs revealed good biocompatibility. The composite also showed reduction in the adherence of Streptococcus mutans and Candida albicans.

Conclusion: The results indicate that doping PMMA with AgNPs enhances the mechanical properties of the system. The good biocompatibility and anti-biofilm property revealed by this novel system is suitable for various prosthodontic applications such dentures, obturators, ocular prosthesis and cranial prosthesis.

References:


P 164

Electrospraying technique as a facile approach for the synthesis of porous TiO$_2$-ZrO$_2$-PMMA-Pluronic F127 composite microspheres for photocatalytic degradation of industrial dyes

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This work presents a novel and facile approach to fabricate sol-gel derived TiO$_2$-ZrO$_2$-Poly (methyl methacrylate)-Pluronic F127 composite microspheres directly using an electrospraying technique. The low concentration of polymers and optimization of various processing parameters such as flow rate, applied potential, tip to collector distance etc leads to the formation of microspheres with homogeneous morphology. Field emission scanning electron microscope (FESEM) images manifest the different morphologies of the organically modified binary metal oxide composite microspheres. Elemental mapping reveals the presence and distribution of various elements in the composite. The microspheres are found to have an average diameter of 25 μm. These novel spherical nanostructures may find applications in photocatalytic degradation of industrial dyes/effluents, drug delivery, filtration, cosmetics etc due to their large surface.

P 165

Magnetic Fe$_3$O$_4$ Based Nanohybrid As An Efficient Electrochemical Sensor And Photocatalyst

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Different nanohybrids are reported either as a good electrochemical sensor or as an efficient photocatalyst. Very few nanohybrids are only reported as having both electrochemical and photocatalytic activity. So here we develop a simple silver based ternary nanohybrid as a good electrochemical sensor and an efficient photocatalyst. The developed ternary nanohybrid can be used as a wonderful electrochemical sensor for determining the minute concentrations of different toxic organic pollutants, especially the phenolic isomers such as hydroquinone, catechol and quinone. Also, it is an efficient photocatalyst for the degradation studies of different toxic organic dyes. By using the voltammetric analysis, very minute concentrations of the toxic phenolic isomers can be effectively detected with this ternary nanohybrid. The simultaneous detection of these phenolic isomers can be easily analyzed using this sensor. The better degradation of different organic dyes such as methylene blue and pesticides such as methyl viologen can be easily done with this ternary sensor. The development of this silver based nanohybrid is via a simple heating method and the presence of Fe$_3$O$_4$ nano rods provides magnetic separation of the hybrid. A high limit of detection is obtained for the phenolic isomers with this electrochemical sensor. Better photodegradation occurs for dyes such as methylene blue and pesticides such as methyl viologen.

Keywords: Nanohybrid, Voltammetric sensor, Pesticides, Electrochemical sensor, Photocatalyst

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Synthesis of Nanoparticles by using Enzyme and Photons in Visible range of Electromagnetic Spectrum with different wavelength helps us to obtain Silver Nanoparticles of Monodispersed size and also with differentiate shape. As we all know Nanoparticles of significant size and shape show spectacular properties these particles may prove to play a crucial role in the field of Nanoscience and Nanotechnology. The Size and Shape of Nanoparticles were characterized with the help of several Biophysical Techniques like Nanophotometer, DLS (Dynamic light Scattering), XRD X-Ray Diffraction, Fluorescence Spectroscopy and TEM (Transmission Electron Microscopy). Hemolysis was conducted to check the toxicity of the Nanoparticles.

Use Of Lipid Nanoparticles For Effective Delivery Of siRNA Against Chikungunya Virus

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Chikungunya fever, a mosquito-borne disease which causes fever and strong joint pain in Humans, is a profound global threat because of its high rate of contagion and lack of antiviral interventions or vaccines to control CHIKV infection. We have previously reported efficacy of the siRNAs against ns1 and E2 genes of CHIKV both in vitro and in vivo [1]. The main challenge for siRNA therapy is that it is hampered by the barriers for siRNA to reach their intended targets in the cytoplasm and to exert their gene silencing activity. Therefore, there is an increasing demand for novel siRNA delivery systems to overcome these challenges [2]. Aim of this study was to investigate solid lipid nanoparticles (SLNs) for their suitability as a siRNA delivery system. SLNs were synthesized by a modified solvent emulsification method in order to study their potential to form complex with siRNA and to evaluate for their efficiency in inhibiting CHIKV growth in vitro. In SLN formulation we have also used stearylamine (SA) as cationic lipid and charge inducing agent, which is reported for its anti-parasitic and anti-cancer potential. There is also published evidence that Cationic liposomes containing SA have stronger inhibitory effects against infectious baculovirus (BV) and HSV-1 virions [3]. Hence, we have also investigated the antiviral activity of SA in in vitro system. The SLN was characterized for particle size, surface charge, and serum stability. The siRNA-SLN and SA were tested for cytotoxicity and antiviral activity was determined by foci forming unit assay and quantitative RT-PCR. The optimized siRSLN indicated 130 nm size and 2 mg SA sufficiently induced 39.2 mV surface charges for enhanced in vitro transfection. Gel electrophoresis indicated no unbound siRNA from complex indicating better complexation and stability up to 24 days. Treatment of SA at concentration of 25 and 50
µM showed significant reduction at 16 h and 24h post treatment. Studies of the effect of siRNA-SLN complex on CHIKV infection on Vero cells are in progress. These findings highlight the antiviral potential of SA against CHIKV infection.

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P 168

Nanocomposites (metal oxides) in the Effective Removal of Hexavalent Chromium – Waste Water Treatment Studies

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In the present investigation Induction Furnace (IF) steel slag-based nanocomposite is used for the removal of hexavalent chromium [Cr (VI)]. Cr (VI) causes carcinogenic diseases with environmental impacts in various aspects. Steel slag is calcined at 600°C which enhances the removal of Cr (VI). Chromium removal is studied by Di-Phenyl Carbazide (DPC) (C_{13}H_{14}N_{4}O) method using UV–vis Spectrophotometer. In acidic condition Cr (VI) forms pink colour with DPC and is analyzed at 540 nm. Cr (VI) removal is studied for various parameters such as pH, initial concentration of Cr (VI) solution, IF steel slag dosage and contact time. Elemental composition and surface morphology of IF steel slag is characterized using X-ray fluorescence (XRF) and scanning electron microscope (SEM) with respectively. Atomic absorption spectroscopy (AAS) is emphasized for the total chromium of pre- and post removal. Langmuir, and Freundlich isotherm models is also for the removal studies.

References:


P 169

Preparation and characterization of nanocomposites based on sodium alginate and TEMPO-oxidized nanocellulose

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With the aim of developing bio-nanocomposites using new natural biopolymers, nanocomposite films were prepared based on sodium alginate and kapok nanocellulose. The reinforcing capability of nanocellulose on the structural, morphological, visco-elastic and surface properties of alginate nanocomposite films were investigated by $^{13}$C-CPMAS NMR, XRD, SEM, AFM, DMA and IGC studies. In order to prepare high-performance bio-nanocomposites, the kapok nanofibrils (CNFs) were subjected to TEMPO-mediated oxidation and ultrasonication treatment. TEMPO-mediated oxidation treatment disintegrates the CNFs into small particles – cellulose nanocrystals (TOCNCS) – with carboxyl groups at the surface ( = 3.64). When incorporated in the alginate matrix the CNFs particles have the tendency to form surface aggregation ( = 2.37) causing distortion of the alginate network and creating heterogeneous films. Such films have high surface roughness ($S_a = 29.37 \text{ nm}$), have higher porosity ($D_p = 0.087 \text{ cm}^2/\text{min}$) and are structurally more vulnerable to heat. In the case of TOCNCS incorporation into the alginate, they present good dispersion and give rise to formation of a 3D network of interconnecting layers in the polymer matrix, which formsuniform ($D_p = 0.122 \text{ cm}^2/\text{min}$) and homogeneous films with smooth surface ($S_a = 16.83 \text{ nm}$). The ultrasonication treatment facilitated the dispersion of the nanocellulose particles within the alginate matrix, improving the interfacial interaction between the reinforcing phase and the matrix phase. The overall results show an excellent reinforcement potential of nanocellulose in an industrially and medically important biopolymer, sodium alginate, especially when TOCNCS and ultrasonication were used in the preparation of bio-nanocomposites.

P 170

Nano Nutraceutical Enriched Poultry Feed

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Nanotechnology is an emerging technology that has the potential to make revolutionized changes in agriculture and livestock sectors globally. The concept of nanotechnology was introduced to alter the particle size to nano meters. These nano sized particles possess specific structural and physiochemical properties and have the ability to transport various components under various environmental conditions. Nowadays nanoparticles are widely used in various sectors such as food and nutrition, drug delivery, vaccines preparations and textile industries, etc. In food sector, nanotechnology offers a number of new approaches for improving the quality of the food in all aspects. Many researchers are now looking for ways to use nanotechnology to design delivery mechanisms for nutrients, and to improve the efficiency of nutrient delivery from food. In animal nutrition, the nanotechnology is mainly used in preparation of feed. In this context, we have formulated a poultry feed with nano nutraceuticals as supplement.
Advancement in therapeutic strategies has significantly extended the average life of human being. Prevalence of chronic wound is high with the increase in the life of human being. It is one of the major causes of morbidity. Millions of people suffer from wounds annually. A variety of Wound care products are available globally. Among the wound dressings hydrogel dressings play a vital role in maintaining the moist environment conducive for healing. Moist environment permits the movement and proliferation of fibroblasts and enhances healing without pain. Hydrogel is suitable for necrotic and dry wounds. Increase in the incidents of accidents, emergency, burn wound and diabetic wound has driven the wound dressing market to research and invest on hydrogel dressings. The present study was focused to prepare a nano hydrogel with active components released slowly. The hydrogel was characterized and the results indicated the slow release of drugs.

Wound healing is a complex cascade of overlapping events that restore the lost tissue structure and function. In chronic wounds, the sequence of events is abated and it takes prolonged time to heal. Wound dressings are the structural and functional aid to protect the skin from external environment. Major expenses incurred in wound healing are associated with wound dressings. Many different formulations of wound dressings are available. The choice of the wound dressing is based on the severity of the wound. Burn wounds are most severe among other wounds as it damages the deeper tissues. Repeated application and removal of dressings causes trauma and pain to the patient. Spray dressings are advantageous that the action is instantaneous and does not require extensive application and removal. The present product was focused to deliver the bioactive agents in nano formulation for deeper penetration. Enhanced permeability and retention of nanomaterials are exploited to formulate a nano spray in the current study. The nanospray was characterized for its size and functional properties.
Foliar Nano Nutrigaint

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Micronutrient deficiency also called as Hidden hunger occurs due to deficiency of essential micronutrients and vitamins. It affects more than 2 billion people in the world [1]. India has achieved about four-fold enhancement in food grain production during green and post green revolution due to intensive agriculture practices. This results in depletion of native soil fertility and mining of soil nutrients. On comparing the nutrient profile of tomato of 2017 with that of 1937, 66-73 % reduction in thiamine, iron and zinc content was observed. It causes nutrient deficiency and disease in human [2]. To overcome the problem, the present work was focused on fortification of micronutrients in plants through nano foliar spray. The concentration of iron plants were increased significantly. The fortified plants was fed to rat. Blood profile of the animals attested the increase in Hb. To ascertain the effect on different plants and different climatic conditions, the study was extended to investigate the effect of nanofoliar on other plants like Lycopersicum esculentum, Solanum melongena, Oryza sativa, Cyamopsis tetragonoloba, Arachis hypogae in large scale under field trial. Thus, agronomic fortification of micronutrients in plants can solve hidden hunger in human and restore the skill and productivity of Youth of India.

References:

Investigation on Super Critically Dried Aerogel Films

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The low-k films were synthesized by using sol-gel based spin coating technique. The aerogel films were aged in solvent and then dried in CO2 super critical drying autoclave. Current work investigates the effect of various super critical drying temperatures on deposited aerogel low-k films. Formation of SiO2 in film matrix is confirmed using FTIR bonding analysis. The dielectric constant of aerogel films extracted from ellipsometry refractive index found to be decreased with increase in drying temperature from 25°C to 50°C. The porosity, density of the deposited aerogel films is calculated from measured refractive index. The porosity is observed to be increased for the films dried at higher temperatures. Further, surface properties were studied using AFM micrographs.

Keywords: Aerogel, Low-k, AFM, super critical drying
Development of Colorimetric Nano-Biosensor Strip for Detection of E. Coli O157:H7 And E. Coli

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The microbial hazards play a significant role in quality of all food products including seafood [1]. Conventional methods for detection of pathogenic bacteria employs enrichment (24h for Escherichia coli) in specific medium before plating and incubation for specified time interval [2]. Advanced detection techniques like polymerase chain reaction (PCR) is tedious, requires costly instruments and highly trained personnel [3]. There is a need to develop simple, rapid and cost-effective method to overcome these drawbacks. In this study, gold nanoparticle-based paper strip was developed for the detection of E. Coli O157:H7 and E. coli. Various parameters viz., enzyme, substrate, volume of nanoparticles, sonication and time interval for the detection of pathogen was optimized. Spiking study was carried out in sterile shrimp meat to detect target pathogen using colorimetric method and paper strips. In colorimetric assay, a clear distinct visible colour was observed within 9 and 12 h of enrichment with incubation of 15min and 2h at 37°C for spiked shrimp at 10^1 cfu/g for E. Coli O157:H7 and E. coli, respectively. Gold nanoparticle-based paper strip developed in the study produced distinct visible colour change for spiked samples (10^1 cfu/g) within 9 and 12 h of enrichment with incubation of 30 min and 2h at 37°C respectively, for E. Coli O157:H7 and E. coli. The developed nanoparticle-based paper strip can be used for the presence of pathogenic E. coli as first level screening in food samples.

References:

Electrochemical Exfoliation of Layered $\beta$-Co(OH)$_2$ Nanosheets for Improved Oxygen Evolution Electrocatalysis

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Water electrolysis is considered to be one of the green and efficient production methods for the hydrogen generation, especially when coupled with energy sources such as solar and wind. The overall efficiency of water electrolysis is hindered due to the high overpotential and sluggish reaction kinetics of oxygen evolution reaction (OER) in comparison with hydrogen evolution reaction (HER). The electrocatalysts play a crucial role in improving the performance of the electrochemical systems by reducing the activation barrier and increasing energy efficiency.\textsuperscript{1,2} Layered metal hydroxides (LMHs) have gained much attention due to their high electrochemical activity and stability towards OER. Thin nanosheets of metal hydroxides can have greater electrochemical activity because of the highest exposed surface area, high surface energy, and enhanced edge sites.\textsuperscript{3} We used a single-step electrochemical exfoliation method for synthesis of layered $\beta$-Co(OH)$_2$ nanosheets. The electrochemical exfoliation method is simple, efficient and cost-effective in comparison with various established synthesis routes. The electrochemical approach leads to cracking of $\beta$-Co(OH)$_2$ hexagonal flakes into ultrathin nanosheets with increased active edge sites that results in improved electrocatalytic activity towards OER with a low overpotential (1.62 V @ 10 mA cm$^{-2}$) and low Tafel slope (57 mV dec$^{-1}$).

References:

Fe-rGO Based Voltammetric Sensor to Detect Endosulfan in Water - A Non-Enzymatic Approach

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Application of pesticides becomes a part of agricultural procedure to increase the yield. Among pesticides endosulfan an organochlorate pesticide has been categorized as more hazardous and even banned in many countries. Unfortunately, the same pesticide is in use in India. In this context, Fe-rGO based non-enzymatic electrochemical sensor has been fabricated by modifying the platinum working electrode as employed to detect endosulfan in water. The synthesized Fe-rGO interface material was characterized for observing its structural, morphological, and the cyclic voltammetry studies were carried out to detect endosulfan in water and the oxidation potential was found to be at ‘-0.2 V’. Sensor characteristics like sensitivity, linear range, limit of detection, etc., have been reported. The detection limit is in the nanomolar range, which is well below than the ADI limit of WHO.