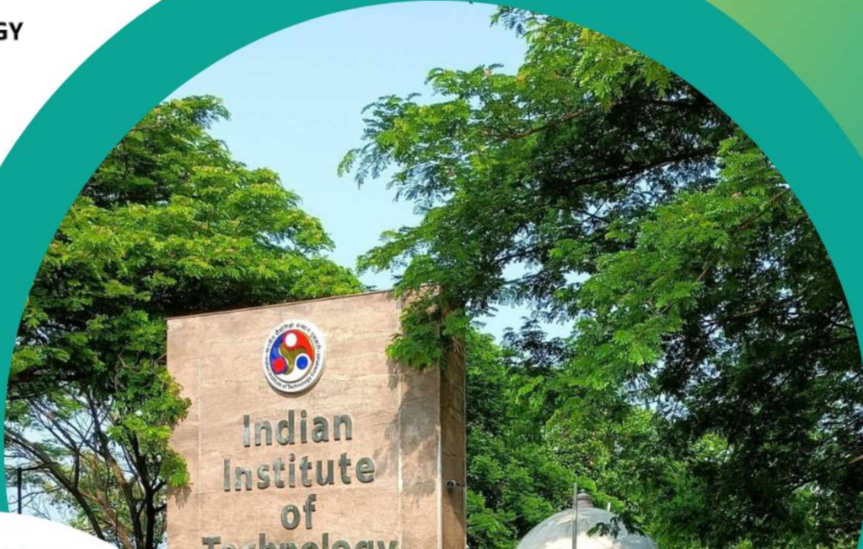
भारतीय प्रौद्योगिकी संस्थान गुवाहाटी
Indian Institute of Technology Guwahati

@iit-g
Centre for Nanotechnology

ABSTRACT BOOK

इलेक्ट्रॉनिकी एवं
सूचना प्रौद्योगिकी मंत्रालय
MINISTRY OF
ELECTRONICS AND
INFORMATION TECHNOLOGY
सत्यमेव जयते



ICANN 2023

8th International Conference on Advanced Nanomaterials and Nanotechnology

November 29 – December 1, 2023

Organized by Centre for Nanotechnology, IIT Guwahati

INCUBATE NURTURE ACCELERATE
BIONEST
IITG TIDF

ICMR
INDIAN COUNCIL OF MEDICAL RESEARCH
Serving the nation since 1911

INUP i2i

8th International Conference on Advanced Nanomaterials and Nanotechnology

ICANN 2023

November 29 to December 1, 2023

Organized by
Centre for Nanotechnology
Indian Institute of Technology Guwahati
Guwahati – 781039, Assam, India

Message from Prof. Rajeev Ahuja, Officiating Director, IIT Guwahati

भारतीय प्रौद्योगिकी संस्थान गुवाहाटी
INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
गुवाहाटी-781039, असम, भारत
Guwahati-781039, Assam, INDIA
दूरभाष/**Tele: +913612690401 / +913612582005**
ई - मेल / **Email: director@iitg.ac.in; rajeev.ahuja@iitg.ac.in**

प्रो. राजीव आहूजा
Prof. Rajeev Ahuja
कार्यवाहक निदेशक
Officiating Director

15 November 2023

MESSAGE

It is a matter of great pride and it gives me immense pleasure that the Centre for Nanotechnology at IIT Guwahati is organizing the flagship biennial event " 8th International Conference on Advanced Nanomaterials and Nanotechnology - ICANN 2023”. I take this opportunity to welcome all the dignitaries and participants to ICANN 2023. I am sure that our esteemed visitors would enjoy our beautiful campus in addition to the eventful scientific sessions. I am delighted to know that provides a common platform for eminent scientists, technologists, entrepreneurs, designers, policy makers, and young scholars from diverse disciplines across the globe to come together, discuss, and exchange ideas. It is commendable that the current version of ICANN has been successful in attracting over more than 400 participants including close to 55 eminent scientists, 10 doctors of international repute apart from directors/CEOs of a few flourishing start-ups.

A Conference of this nature would not only provide an excellent opportunity for the scientific community to disseminate of their latest ideas and exchange them with other bright minds, but also helps to make new colleagues and collaborations through networking. It is very heartening to note that the conference covers pretty broad themes that include healthcare, nanomaterials, nanoelectronics, quantum technologies, environment, energy, computation, point-of-care devices and their design, packaging technologies, semiconductors, sensors, micro/nano fluidics, photonics, translational research, and start-up & entrepreneurship.

I strongly believe that the conference will expand the intellect of young researchers across the nation while strengthening the scientific-base of the North-East region. I hope that the scientific community at IITG would be greatly benefitted by the new ideas, research interventions and potential collaborations likely to be generated during the event. Hearty congratulations to the organizers and warm wishes to all the participants. I do hope that the symposium will be a successful, eventful and memorable one.

(RAJEEV AHUJA)

Message from Prof. Akshai Kumar A. S, Head, Center for Nanotechnology, IIT Guwahati

Dr. Akshai Kumar A. S
Head, Center for Nanotechnology

भारतीय प्रौद्योगिकी संस्थान गुवाहाटी
गुवाहाटी - ७८१०३९, भारत Indian Institute of
Technology Guwahati
Guwahati - 781 039, India

Center for Nanotechnology

Message from the Head, Centre for Nanotechnology, IIT Guwahati

The Centre for Nanotechnology, IIT Guwahati is going to organize its flagship biennial international conference on **8th International Conference on Advanced Nanomaterials and Nanotechnology - ICANN 2023** from November 29 to December 1, 2023. The first edition of ICANN was organized in 2009 which was an instant success among researchers interested in nanoscience and nanotechnology. Over the years we have been conducting various editions of ICANN successfully and new themes have been included to keep abreast of the state-of-art. On behalf of the Centre for Nanotechnology, IIT Guwahati, it gives us great pleasure to warmly welcome you to the current edition, ICANN 2023, to be organized in our beautiful campus on the banks of the mighty river Brahmaputra. The scientific program will not only consist of plenary sessions and invited talks by eminent scientists across the globe but also oral and poster presentations by budding research scholars. Independent conclave by doctors and entrepreneurs on the current technological needs in the field of medicine, healthcare and agri-tech would add a new flavor to the already engaging conference with cross-talk across disciplines. Overall, ICANN 2023 will be a great platform to share our thoughts and exchange our scientific ideas.

To put a conference of this magnitude together is not a small task. To that end, I would like to acknowledge the contribution of the conference organizers and the student volunteers. The team will make your stay a memorable one during the conference. Lastly, I would like to thank all of the conference participants for their contributions towards making ICANN 2023 a grand success. I wish you all an engaging and productive conference participation. Look forward to see you all in this lush green 700 Acre campus at the early winter with a lot of sunshine but a temperate climate to discuss and deliberate science, technology, translation and research. Once again, I would like to take this opportunity to heartily welcome all the participants from across the globe to ICANN 2023. My best wishes for the conference and hope it will be a great success.

Sincerely,

Dr. Akshai Kumar Alape Seetharam
Head, Centre for Nanotechnology

Table of Contents

Bio-sketches and Abstracts of

- Plenary Speakers
- Keynote Speakers
- Invited Speakers
- Short Invited Speakers

Prof. Amitava Patra
Director and Senior Professor,
Institute of Nano Science and Technology (INST)
Mohali, India

Prof. Amitava Patra is currently the Director at the Institute of Nano Science and Technology (INST), Mohali, and a Senior Professor at the Indian Association for the Cultivation of Science. He was born in 1965 and received his Ph. D. (1993) from Jadavpur University, India. Prof. Amitava Patra is amongst the world's top 2% scientists in 2020-2021 with a global rank of 149 in Physical Chemistry (Ranking is based on C-score). In the 2023 Edition of our Ranking of Top Scientists in the field of Materials Science from Research.com, he ranked 4156 in the world and 37 in India. He is interested in learning the fundamental mechanisms for photo-initiated processes such as exciton dynamics, ultrafast carrier dynamics, electron transfer, and energy transfer of nanomaterials for solar energy conversion.

Prof. Amitava Patra has been elected as a Fellow of the Optical Society of America (OSA) and the Royal Society of Chemistry (FRSC). He is a Fellow of the Indian Academy of Sciences (FASc), India, and the National Academy of Sciences (FNASc) and Indian Chemical Society, India. He is the recipient of the Acharya J. C. Ghosh Memorial Award, National Prizes for Research in Chemical Spectroscopy and Molecular Structure, MRSI-ICSC Materials Science Annual Prize, C.N.R. Rao National Prize for Chemical Research, DAE-SRC Outstanding Investigator Award, A.V. Rama Rao Foundation Prize in Chemistry, AsiaNANO 2010 Award, CRSI Bronze Medal, Ramanujan Fellowship, MRSI Medal. He is the author or co-author of more than 266 scientific papers, 5 book chapters, and 2 Indian patents. He was an Advisory board member of Nanoscale, Journal of Physical Chemistry, ChemPhysChem, ChemNanoMat, and others. His research papers have been cited by more than 12850 peers (h-index= 61).

Ultrafast Carrier Dynamics of Nanomaterials to Manipulate Light Harvesting

Amitava Patra
School of Materials Sciences, Indian Association for the Cultivation of Science, Jadavpur,
Kolkata-700032, India
Institute of Nano Science and Technology, Knowledge City, Sector 81, Mohali 140306, India

Nanomaterials-based light-harvesting systems have been the research subject because they can generate exciton after photoexcitation. A deep understanding of hot carrier (HC) dynamics is crucial to improving the performance of optoelectronic devices by reducing thermalization losses. Here, we investigate the carrier dynamics, energy transfer, and charge carrier dynamics of 2D nanoplatelets, perovskite nanocrystals, and conjugated polymer nanoparticles.[1-6] Ultrafast spectroscopic investigations provide direct insight into the impacts of electron and hole transfer at the interface of hybrid materials for optoelectronic applications. The fundamental knowledge of these photophysical processes is crucial for developing efficient light-harvesting systems.

References

1. Simanta Kundu and Amitava Patra, Chem. Rev., 2017, 117, 712−757.
2. Anusri Medda, Avisek Dutta, Dipankar Bain, Manish Kumar Mohanta, Abir De Sarkar and Amitava Patra, J. Phys. Chem. C 2020, 124, 19793−19801
3. Kritiman Marjit, Goutam Ghosh, Srijon Ghosh, Sumanta Sain, Arnab Ghosh, and Amitava Patra**,** J. Phys. Chem. C 2021, 125, 12214−12223,
4. Srijon Ghosh, Bikash Jana, Arnab Ghosh, Dirk M. Guldi and Amitava Patra, J. Phys. Chem. Lett. 2021, 12, 3424−3430.
5. Goutam Ghosh, Kritiman Marjit, Srijon Ghosh, Arnab Ghosh, Raihan Ahammed, Abir De Sarkar and Amitava Patra, J. Phys. Chem. C 2021, 125, 5859−5869
6. Avisek Dutta, Anusri Medda, and Amitava Patra, J. Phys. Chem. C 2021, 125, 20−30.

Prof. S. Sampath
Professor, Department of Inorganic and Physical Chemistry
Indian Institute of Science
Bangalore, India

Prof. S. Sampath is a distinguished academician and researcher, currently holding the position of Professor in the Department of Inorganic and Physical Chemistry at the renowned Indian Institute of Science in Bangalore, India. With an illustrious career focused on Surfaces, Interfaces, and Materials Electrochemistry, Prof. Sampath's research is dedicated to unraveling the intricacies of interfacial properties involving novel materials and modified surfaces. Employing a multidisciplinary approach, his work combines spectroscopy, electrochemistry, and microscopy, with a particular emphasis on in-situ techniques such as electrochemical FTIR and Raman electrochemistry.

His research interests involve studies on various interfaces with relevance to electrochemical phenomena. Different classes of materials including layered chalcogenides such as MPX_3, MoSSe, MoSeTe type compounds; transition metal nitrides/carbides; self-assembled monolayers and Langmuir-Blodgett films; deep eutectics are of current interest to his group.

Notably, Prof. Sampath has been granted several US patents, including a low-cost electrochemical disposable sensor for measuring glycated hemoglobin, a composition of electrode material, and a process for the formation of metallic patterns on a semiconductor wafer substrate. His commitment to advancing electrochemistry is evident in his substantial body of work, which includes over 50 publications in high-impact journals.

Inorganic and Organic Nanostructures: Electrocatalysis, Sensors and Energy Storage

S Sampath
Department of Inorganic and Physical Chemistry
Indian Institute of Science, Bangalore

Fundamental as well as applied research involving electrochemical interfaces have gained considerable attention in the recent past especially due to enormous interest in energy conversion, storage, and sensors. Nanostructured- materials and organized assemblies have significantly contributed to this development. Our group has been working on various materials, both organic and inorganic, in this direction. These include transition metal nitrides, carbides, chalcogenides and thin films based on organic molecules. The present lecture will describe some of our efforts on these interesting systems for electrocatalysis, energy storage and solid-state devices. Using the fundamental knowledge, it is possible to further delve into applications based on energy storage, such as batteries, capacitors and fuel cells. The present lecture will discuss results from our group in the above-mentioned areas.

Prof. Rahul Banerjee
Professor, IISER-Kolkata, India

Prof. Rahul Banerjee received his PhD degree from University of Hyderabad, Hyderabad in 2006. After a postdoctoral work in UCLA (2006-2008), he joined CSIR-National Chemical Laboratory, Pune, India in 2008 as a Scientist. Prof. Rahul Banerjee is currently an Associate Professor at Indian Institute of Science Education and Research (IISER) Kolkata. His research interests include the study of structural chemistry with the flavor of chemical synthesis to design new porous materials. His work represents an important blend of fundamental as well as applied research, as these materials might selectively capture and store hydrogen and carbon dioxide as a reservoir. Apart from the gas storage application, his group was further able to utilize the ordered pores of COFs for gas and liquid separation application, by making the first COF membranes. Exceptional features of these porous covalent organic frameworks drew the attention of the public sector giant, Gas Authority of India Limited [GAIL], who has funded the "Phase-1 and Phase 2" to demonstrate the proof of concept for developing materials for onboard methane storage applications. The 'Phase -2' objective is linked to the commercial feasibility of the onboard methane storage applications. Such collaboration/initiative is exemplary. An academic institution [IISER Kolkata] and a Government of India undertaking company [GAIL] have decided to participate in translational research to develop unique technology. Currently Rahul Banerjee's research group is working with TATA Steel to develop a process to make porous covalent organic frameworks with exceptional chemical stability for CO2 capture. This concept is being considered globally as a breakthrough in porous material research. Prof. Rahul Banerjee has published over 170 publications and 24 patents applications from CSIR-National Chemical Laboratory and Indian Institute of Science Education and Research (IISER) Kolkata on various porous framework materials since 2010. His current h-index is 84. Prof. Banerjee is an editorial board member and associate editor of the Journal of the American Chemical Society.

Porous Covalent Organic Framework Nanotubes (CONTS): Reticular Chemistry in One-dimension

Rahul Banerjee
Department of Chemical Sciences, Indian Institute of Science Education and Research (IISER) Kolkata,
Mohanpur Campus, Mohanpur 741 246, India
e-mail: r.banerjee@iiserkol.ac.in

Despite significant advancements in nanotubular architectures with well-defined lengths and diameters, the synthesis of purely covalent bonded organic nanotubes has remained elusive. This study presents a new design strategy and its execution for synthesizing purely covalent bonded porous organic nanotubes. We achieved this by combining carefully designed organic building blocks using dynamic covalent chemistry, resulting in one-dimensional covalent organic nanotubes (CONTs). Our one-pot synthetic approach differentiates itself from conventional random polymer synthesis, as our focus was on creating a porous single-walled nanotube with an atomically precise periodic structure. The reversible Schiff base bond formation reaction provides error correction and selectively favors the formation of an ordered porous covalent 1D tubular framework over a random polymeric structure. Additionally, covalent bonds' high strength and stability in the synthesized CONTs contribute to their unprecedented chemical and thermal stability. These extended nanotubes, reaching several microns in length with sub-nanometer diameter, exhibit porosity up to 321 m^2/g. In addition to the synthesis, we extensively investigated the morphological evolution of CONTs. Time-dependent electron microscopic studies confirm the transformation from isolated tubular morphologies to intertwined structures.

Prof. Gautam Biswas
Professor, IIT Kanpur, India

Gautam Biswas is a distinguished professor and is the former director of Indian Institute of Technology Guwahati (2013 – 2019). A faculty member of the Mechanical Engineering Department at IIT Kanpur, he served the Institute in various capacities including the Dean of Academic Affairs.Prof Gautam Biswas is a Fellow of the all three major science academies of India, such as, the Indian National Science Academy (INSA, New Delhi),[3] the Indian Academy of Sciences (IAS, Bangalore) and the National Academy of Sciences India (NASI, Allahabad). He is a Fellow of the Indian National Academy of Engineering (INAE) and Institution of Engineers (IEI). He was the occupant of the position of GD and VM Mehta Endowed Chair Professor of Mechanical Engineering at the Indian Institute of Technology Kanpur. A Fellow of the American Society of Mechanical Engineers (ASME), Prof Biswas is the author of more than 150 scientific publications and guided many PhD theses. In the year 2011, he was awarded the esteemed J C Bose National Fellowship by the Department of Science and Technology, Government of India.

Metastatic potency of cancer cell lines and drug delivery using Microfluidics

G. Biswas[1]
[1] Indian Institute of Technology Kanpur, Kanpur – 208016

Scientists and oncologists have not been able to resolve the mystery of metastatic cancer, which causes high mortality worldwide. A population of small, loosely bound clusters of cancer cells deriving from the primary tumour sites, also known as circulating tumour cells (CTCs), are able to stray away from the aggregate cluster through motion in the bloodstream or the lymphatic system, causing metastasis. In order to understand the challenges of metastasis, a microchannel of 35 μm diameter, constricted to 7 μm over a distance of 200 μm in a total length of 3 mm, was designed and fabricated using a mask aligner made of polydimethylsiloxane (PDMS) to mimic in vivo capillaries. A thin glass cover-slide was mounted on top to monitor the motion of single or aggregated malignant HeLa cells (size 17–30 μm) microscopically through the constricted microchannel at a constant flow rate of 30 μl/h. Quantitative deconvolution of high-speed videography of a single cell of 30 μm revealed cellular deformation while passing through constriction, having elongation index, average transit velocity and entry time of 2.67, 18 mm/s and 5.1 ms, respectively. Morphological analysis of live and apoptotic cells by dual staining with Acridine Orange/ Ethidium Bromide demonstrated retention of a significant viable cell population after exit through the constriction and a viability index of 50% was quantified by dye exclusion assay. The cumulative data for microfluidic parameters, morphology and relevant metastatic MMP2 gene expression efficiency measured by real-time polymerase chain reaction revealed retention of virulence potency that could possibly cause metastasis (Nath et al., 2018). While the epithelial-to-mesenchymal transition (EMT) is known to be an important factor in cancer spread, how the converted cells travel through the blood vessels and undergo reverse transition (mesenchymal-to-epithelial, MET) at the secondary sites has hitherto not been completely understood. The microfluidics-based interdisciplinary research initiatives (Nath et al., 2019), in which the speaker was a member, were successful to understand how the MDA-MB-468 cells lose their EMT phenotype and revert back to epithelial format through a process termed MET. The conclusive part of the study, we discuss the following aspect. Protein-bound paclitaxel has been developed clinically as one of the most successful chemotherapy drugs for the treatment of a wide variety of cancers. However, these medications, due to their nanoscale properties, may often induce capillary blocking while migrating through minute blood vessels. Considering the detrimental impact of this restriction, we investigated the transport of protein bound paclitaxel, Paclicad, in a 7 μm microchannel mimicking the identical mechanical confinement of the blood capillaries (Prasad et al., 2022). 6-Thioguanine (6-TG) is a well-known drug. The conjugation of 6-TG to BSA stabilized gold nanocluster (AuNC@BSA-TG) through a "One-pot" synthesis approach offers enhanced therapeutic benefit compared to free 6-TG. The therapeutic action of AuNC@BSA-TG is due to synergistic oxidative stress amplification and chemotherapy, mediated by the incorporation of released 6-TG into DNA ultimately leading to apoptotic cell death (Jaiswal et al., 2023). Extensive studies on this concept are being conducted by an actve group, led by Dr. Chanda.

References:

[1] B. Nath, A. Raza, V. Sethi, A. Dalal, S. S. Ghosh and G. Biswas, Scientific Reports, Vol. 8, pp. 17357-1 – 17357-10, (2018)
[2] B. Nath, A. P. Bidkar, V. Kumar, A. Dalal, M. K. Jolly, S. S. Ghosh and G. Biswas, Journal of Clinical Medicine, Vol. 8, pp 1194-1 – 1194-15, (2019)
[3] N. K. Prasad, R. Shome, G. Biswas, S. S. Ghosh, Langmuir, Vol. 38, pp. 2014−2025, (2022).
[4] N. Jaiswal, N. Mahata, G. Biswas and N. Chanda, Journal of Drug Delivery Science and Technology (communicated), 2023.

Prof. Egbert Zojer
Professor, Institute of Solid-State Physics, NAWI Graz, Graz University of Technology, Graz, Austria

Egbert Zojer received his Ph.D. in Physics (1999) from the Graz University of Technology, where after his habilitation he was appointed Associate Professor in 2002. On leave from Graz, he worked with Jean-Luc Brédas at the University of Arizona and at the Georgia Institute of Technology (2002-2005). In 2023 he was appointed full professor of Physics in Graz. He has been dealing with topics like optical and electron spectroscopy, organic devices, materials modelling, and in recent years focused on employing quantum-mechanical simulations to further the understanding of hybrid interfaces, porous framework materials, and heat-transport processes.

The Electrostatic Design of Materials and Interfaces

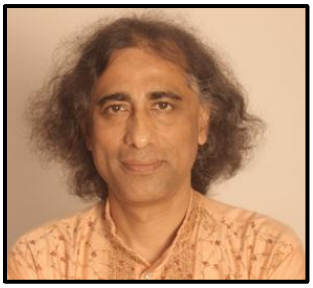
Collective electrostatic effects arise from the periodic assembly of polar entities. They enable the tuning of the electronic properties of, for example, electrode interfaces or of the inner surfaces of porous materials. A common approach for controlling injection barriers at interfaces between metal electrodes and organic semiconductors is the use of polar self-assembled monolayers (SAMs). In this context, a particularly promising strategy is to embed the dipoles within the backbones of the SAM-forming molecules.[2,3,4] Employing such embedded-dipole SAMs not only decouples work-function tuning from semiconductor growth, but also allows generating a variety of fundamental insights of how polar layers modify interface properties:[1,4] One can, for example, show that core-level spectroscopy not only provides information on the chemical environment of certain atoms, but also serves as a tool for probing the local electrostatic situation at a surface.[5] By tuning the interfacial level alignment, embedded dipoles can also change contact resistances in organic transistors by several orders of magnitude.[6]

Besides controlling interface properties in 2D, the inclusion of embedded dipole linkers has considerable potential for electrostatically designing the electronic properties of 3D extended materials classes: for example, it could be used for inducing potential gradients[7,8] or complex energy landscapes[9] in porous materials like metal-organic frameworks. Moreover, simulations suggest that exploiting the collective action of polar substituents in the pore walls of covalent framework materials (COFs) allows tuning the electrostatic energy within their pores[10] with the potential of massively impacting the application of COFs in batteries or as catalysts. In combination with post-synthetic modifications of the substituents it should also be possible to realize complex potential variations along COF pores.

References:

1 E. Zojer et al., Adv. Mater. Interfaces 2019, 1900581;
2 T. Abu-Husein et al., Adv. Funct. Mater. 2015, 25, 3943;
3 O. M. Cabarcos et al. J. Phys. Chem. C 2017, 121, 15815.;
4 E. Zojer et al. Acc. Chem. Res. 2022, 55, 13, 1857;
5 T. Taucher et al., J. Phys. Chem. C 2016, 120, 3428;
6 A. Petritz et al., Adv. Funct. Mater. 2018, 28, 1804462.;
7 G. Nascimbeni, et al. Nanomaterials 2020, 10, 2420;
8 A. Nefedov et al., Adv. Mater. 2021, 33, 2103287;
9 V. Obersteiner, Adv. Mater. 2017, 1700888;
10 E. Zojer, Nano Lett. 2023, 23, 8, 3558–3564

Prof. Arun Chattopadhyay
Professor, Dept. of Chemistry & Centre for Nanotechnology
Indian Institute of Technology Guwahati, Assam, India



Dr. Arun Chattopadhyay is a professor of Chemistry at the Indian Institute of Technology Guwahati. He is also associated with the Centre for Nanotechnology. He obtained his M. Sc. in Chemistry from the Indian Institute of Technology Kanpur and PhD in Chemical Physics from Columbia University. He then went on to pursue postdoctoral work at Stanford University. His students are interested in pursuing research in nanoscale science and technology.

Hypermolecular Chemistry in 2D Nano

Arun Chattopadhyay*
Department of Chemistry and Centre for Nanotechnology
Indian Institute of Technology Guwahati, Guwahati 781039; India.
https://iitg.ac.in/arun/

It has been well-established that molecules form assembly through supramolecular interactions. What happens if in two-dimensions (2D) molecular crystals further assemble in non-conventional ways to form moiré superlattices? In that respect, our recent findings suggest that surfaces of molecular crystals have distinct properties.[1]

Recent results also from the laboratory suggest that ligand-stabilized copper atomic clusters react with Zn^{2+} ions leading to the formation of 2D crystalline films with hexagonal lattice structures. Under suitable reaction conditions these 2D films further assemble to form twisted super lattices.[2-3] The hexagonal lattices are twisted at angles as low as 1° and as high as 30°. Each arrangement leads to distinct optical property of the superlattices. The interactions between the lattices could be termed as hypermolecular interactions. Results also suggest that assembly of organic molecules could potentially lead to such formation of moiré superlattices. For example, when tryptophan in water is heated at 80 °C under constant stirring, 2D moiré superlattices with fluorescence in the visible are formed.[4]

On a separate note, we will also report on our latest findings that evaporation of a sessile droplet containing gold nanoparticles leads to coffee-ring deposition through a phase transition.[5]

References

1. Molecular Cooperativity in the Intense Raman Scattering on the Surface of an Organic Molecular Microcrystal. Arin Bhakat and Arun Chattopadhyay. Adv. Optical Mater. (**2023**), DOI: 10.1002/adom.202301776.
2. Moiré superlattices of two-dimensional copper nanocluster assemblies with tuneable twin emissions from hierarchical components leading to white light emission. Priya Das and Arun Chattopadhyay. J. Mater. Chem. C (**2023**), DOI: 10.1039/D3TC02193A.
3. Enhanced Chemical Stability in the Twisted Dodecagonal Stacking of Two-Dimensional Copper Nanocluster Assemblies. Priya Das and Arun Chattopadhyay. J. Phys. Chem. Lett. (**2022**), DOI: 10.1021/acs.jpclett.2c02300.
4. Tryptophan Molecular Moiré Superlattices with Visible Fluorescence. Ujjala Dey and Arun Chattopadhyay. (**2023**) https://doi.org/10.26434/chemrxiv-2023-3ds8h.
5. Single Phase Transition Leads to the Nanoparticle Deposition in an Evaporating Sessile Droplet. Sujay Paul and Arun Chattopadhyay. J. Phys. Chem. C. (**2023**), DOI: 10.1021/acs.jpcc.3c06029.

Prof. Andreas Terfort
Professor, Goethe-University
Frankfurt, Germany

Andreas Terfort studied chemistry in Göttingen and Regensburg (PhD: 1994). After a post-doc stay with George M. Whitesides, he returned to Hamburg, Germany in 1996 to pursue his Habilitation (2003). Following a series of (locum) professorships in Bochum, Frankfurt and Marburg, he finally was appointed as full professor at the Goethe-University of Frankfurt in 2008. His research aims at understanding the fundamentals of surface phenomena for the development of surfaces with pre-determined ('designed') properties, such as bio-compatibility, disinfection, corrosion inhibition, or sensing.

Fluorine Atoms as Key Feature for Functional Nanolayers

Andreas Terfort[1]*
[1] Goethe-University Frankfurt, Department of Chemistry, Institute of Inorganic and Analytical Chemistry,
Max-von-Laue Straße 7, 60438 Frankfurt am Main (Germany)
aterfort@chemie.uni-frankfurt.de

Due to the extreme electronegativity of fluorine, basically all its bonds with other atoms are highly polarized. If these bonds are not arranged in a symmetrical manner, the resulting molecules typically bear high dipole moments, which is exploited e.g. in liquid crystals, where the orientation of the molecular assemblies can be manipulated by outer electrical fields. An inversion of this can be attained by the orientated assembly of such dipolar molecules, which then induce an outer electrical field. An excellent means for the stable assembly of molecules are self-assembled monolayers (SAMs), in which the molecules are chemically bound to solid surfaces, resulting in defined orientations and packing densities. It has been demonstrated that the induced fields permit the optimization of charge carrier transfer through the ubiquitous interfaces in organic electronic devices.

In this talk, we will present a series of *p*-oligophenyl thiolates, which bear either a single fluorine atom or highly fluorinated moieties (CF_3, SF_5) as head groups, resulting in the formation of highly polarized SAMs on gold surfaces. The head groups do not only influence the attainable electrical fields, but also the packing of the molecules and other parameters. In view of the application in organic electronics, we also studied the charge transfer properties as a function of molecular length (corresponding to SAM thickness) and, certainly, head group identity.

Our experiments on the effect of transversal dipole moments in SAMs led to the question of the effect of longitudinal dipole moments, for which no SAM system has been reported yet. The recently established all-*cis*-hexafluorocyclohexane with its extraordinarily high dipole-dipole interactions in the condensed state opened the opportunity to explore these effects. After introduction of thiol-terminated alkylchains with odd (11) and even (12) number of CH_2 groups, we were able to generate well-defined SAMs with surprising properties.

References

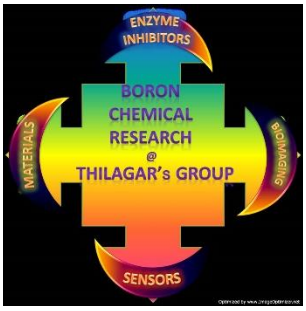
[1] Liu, Y. B.; Katzbach, S.; Asyuda, A.; Das, S.; Terfort, A.; Zharnikov, M. *Phys. Chem. Chem. Phys.* **2022**, *24*, 27693-27704.

[2] Liu, Y.; Zeplichal, M.; Katzbach, S.; Wiesner, A.; Das, S; Terfort, A.; Zharnikov, M. *Nano Res.* **2023**, *16*, 7991−8002.

[3] Fischer, C.; Das, S.; Zhang, Q.; Liu, Y.; Weinhardt, L.; O'Hagan, D.; Zharnikov, M.; Terfort, A. *Nano Res.* **2023***, 16*, 11030−11041.

Dr. Pakkirisamy Thilagar
Professor
Department of Inorganic & Physical chemistry,
Indian Institute of Science
Bangalore, India

P. Thilagar obtained his B.Sc. from Tagore Arts College and his M.Sc. from Pondicherry Central University. He received his Ph.D. in 2007 working with Prof. V. Chandrasekhar at the Indian Institute of Technology Kanpur (IIT-K) and has postdoctoral experience from working at the University of Rutgers with Prof. Frieder Jakle. In 2009, he joined the Indian Institute of Science as a faculty member in the Department of Inorganic and Physical Chemistry. In 2009 he was elected as a Young Associate of the Indian Academy of Sciences and was the recipient of the CRSI (Chemical Research Society of India) BRONZE medal in Chemistry (2017). He served on the Editorial Advisory Board of Organometallics (2016-2022) journal published by the American Chemical Society. He also serves in the International Editorial Board of Aggregates and Chemphotochem, the journals published by the Wiley vch. He served as guest editor for the special issues on "Main-Group Molecules to Materials" in the Journal of Organometallic Chemistry. He has also served as guest editor for the special issues on "Recent Advances in Stimuli-responsive Photoluminescence Switching of Purely Organic Compounds" in the Journal Frontiers in Chemistry. He has written book chapters on boron compounds. Also, He has written popular articles on boron chemistry for the general science audience. His research work has received international media attention and has been featured in Science Translational Medicine Chemical News, Chemical Engineering News, and Atlas of Science. He has been serving as a member of several institutes and national-level committees in different capacities. His current research interests concentrate on the development and possible applications of various classes of boron-containing luminescent dyes and the medicinal aspects of boron-containing peptides.

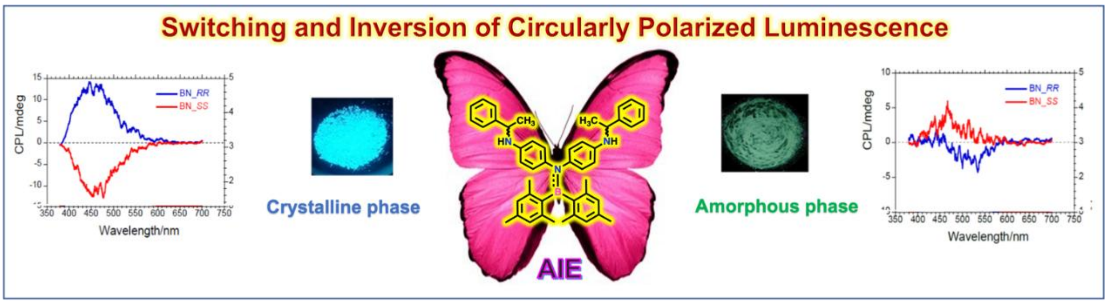


Chiral BN/CC Isosteric AIEgens: Circularly Polarized Luminescence Switching and Stimuli-Induced Phase Change Materials

Thilagar P
[a]Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore-560012, India.; Email: thilagar@iisc.ac.in

Substituting isoelectronic B–N units for C=C units in π-conjugated systems produce novel materials with structural similarities to all-carbon frameworks but fundamentally altered electronic and optical properties. Further, the co-occurrence of excited states with different symmetry (π-π* and n-π*) should facilitate effective spin-orbit coupling and enhance ISC and RISC processes (El-Sayed, 1963). Though BN/CC isosterism has been known for several decades, this concept has not been demonstrated. By exploiting the BN/CC isosterism (Front Chem. 2020) and topochemistry our group has developed highly sought-after deep-blue delayed fluorescent materials (*Angew.Chem.Int.Ed.* **2018**). We have also developed a new strategy for the rational design and construction of novel materials by replacing the carbon-carbon double bond in tetraarylethylene systems with an isoelectronic boron-nitrogen unit (*J. Mater. Chem. C*, **2016).** For the first time, this approach led to the identification of the intriguing aggregation-induced emission enhancement (AIEE) and mechanoluminescence properties of *tetra*-arylaminoboranes (TAAB) (*Organometallics*, **2017** and *J. Mater. Chem. C*, 2017). We adopted a similar strategy to develop multifunctional molecular materials showing triboluminescence (TL) and temperature sensing (Chem. Commun., **2017**). As part of the ongoing program, we studied the crystalline phase-dependent chiral photoluminescence switching in amino boranes with chiral pendents (**BN-RR**, **BN-SS,** and **BN-MR**). Enantiomerically pure amino boranes BN-RR and BN-SS show strong luminescence than the racemic compound **BN-MR**.

Interestingly, a rare event of mechanical pressure-induced color switching and inversion of CPL was observed. Detailed steady-state, time-resolved optical studies, together with microscopic and computational studies, unveil that the chiral ordering in solid-state plays a vital role in controlling their optical properties. This is the first example of B-N-based chiral AIEgens showing considerably high ϕF, glum, and switchable CPL features to our knowledge (*Org. Lett.* 2023., *Chem.Eur.J*. **2023**, *Adv. Optical Mater.***2023**., *Chem Science*, **2022**). We will also discuss the preliminary results of studies on phosphoramide-based chiral AIEgens.



Dr. Dipankar Choudhury
Ansys Fellow, Ansys Inc.

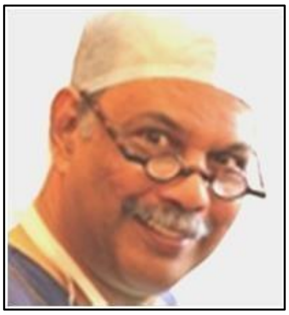
Dr. Dipankar Choudhury, Ansys Fellow, leads advanced technology and exploratory R&D in several areas at Ansys Inc. In addition, he leads Ansys's Academic Program which includes coordinating collaborative research and education partnership programs with Academia centered around engineering simulation. Prior to taking this role, Dipankar was responsible for Ansys Inc.'s technical directions in the Fluids Business Unit. Dipankar obtained his BE in Mechanical Engineering at BITS Pilani and his Ph.D. in Computational Fluid Dynamics and Heat Transfer from the University of Minnesota. After his graduation, he held engineering and product management positions at Creare Inc. and Fluent Inc. where he was part of the founding group and the Chief Technology Officer. He is a member of the ASME, AIAA and the ASEE and has technical publications in journals, conference proceedings, and trade magazines. Dr. Choudhury is an adjunct faculty at the University of Notre Dame and an invited lecturer at leading institutions worldwide.

The Impact of Physics-based Simulation Methods in Industry and Academia

Digital transformation continues to pervade every industry - automotive, aerospace, electronics, logistics, and manufacturing, to name a few. Concurrently, digital technologies are increasingly being used in colleges and universities in support of research and as an aid for in-person/remote learning where laboratory experiments, design projects, and physical prototyping are being complemented by software-based experiential learning. The main breakthroughs have been in achieving an unprecedented level of usability, fidelity, and performance of these software tools via several key technological advances. The impact of these advances in modeling and simulation technologies and their applications is also being felt in diverse fields such as design, high-tech, materials science, sustainability, energy and biomedical engineering, medicine, and healthcare.

The first part of this presentation will provide an overview of the underpinnings of physics-based simulation software, while touching on current practices and emerging trends in areas such as Numerical Methods, High-Performance Computing, and Machine Learning. The second part of the talk will focus on new initiatives and applications in the areas highlighted earlier in this abstract while addressing the important question of modeling and simulation in academic research and education.

Dr. Paul C. Salins
Sr. Vice President, Narayana Health - Mazumdar Shaw Medical Centre



Prof. Salins is an acclaimed authority in Cranio-Maxillofacial and reconstructive Surgery, known for developing orthomorphic surgery techniques for correction of facial deformities, innovations in skull base access and reconstructive surgery. Dr. Salins work on systems approach to drug discovery to arrest or reverse lifestyle and ageing related Chronic diseases early, during its continuum has led to a genre of "interceptive therapeutics". Composite Interceptive Medical Science Laboratories, (CIMED) is a startup that he founded that works in this domain. In the area of computation Professor. Salins terms his work "predictability before knowability! creating intuitive AI/machine learning systems for analysis of large, complex data clusters and adaptive systems as the foundation for pattern-based topologic analytics and inverse kinematics. Professor. Salins has a passion for Art and architecture, Classical music and Opera, literature, and the study of its impact on creativit

Future of Medical Science and Emergence of Technology Lead Healthcare

Medical Science has transformed healthcare enabling prevention and management of many diseases. Indeed, developments in genetics, molecular biology and biological sciences continues to provide insights into the fundamental processes of health and disease. However, continued threat of pandemics, the epidemiological shift from communicable to non-communicable chronic diseases and the failure of current model of healthcare to provide accessible and affordable universal healthcare demands fresh perspectives and novel solutions. The enormous progress in engineering sciences and AI/ML now enables us to explore possibilities beyond conventional medical science-based strategies towards a new genre of technology led solutions.

The lecture will outline the development of medical profession, it's sovereign jurisdiction over healthcare. The changing landscape of engagement between medicine and technology will be briefly discussed and the 4 key domains of change mediated by technology that will fashion the shape of future healthcare.

1. Technology will shift the current "disease centric- clinic/hospital - Physician dependent healthcare" towards a "wellness centric - personal/community focused -surveillance/prediction-based system of "Health-Enablement".
2. The rigid medical super-specialty boundaries that currently fragment medical care will be effaced by technology enabling seamless optimized access to medical care.
3. The current dominance of allopathic medical practice over global healthcare will make way for a technology enabled "Unified-Integrated Healthcare" combing modern medicine with the holistic value embedded in Ayurveda and other traditional systems of medicines.
4. The new lead role of engineering sciences leading to shared jurisdiction of healthcare with Medical science will cause the formation of a composite specialty of "Healthcare Engineering".

Leadership in such a future healthcare cannot be achieved by merely juxtaposing a medical center with a center of excellence in engineering but demands assiduous development of an eclectic ecosystem purposed to establish a common vocabulary of eclectic thinking and ideation alloying engineering and medical sciences.

IIT Guwahati as a leader in fostering research and technology development makes it an ideal ecosystem for establishing such an endeavor.

Dr. Raksh Vir Jasra
Senior Vice President (R&D), Reliance Industries limited, India

Dr. Jasra Phd, from IIT, Delhi has published more than 325 Research articles in National and International journals, and 10 Chapters in books. He has total 314 Granted Patents including 68 US patents, 148 Indian patents and 900 confidential technical reports during his stay in Reliance and IPCL. Developed 66 chemical processes; 27 implemented in Industry; 27 demonstrated up to pilot plant and 12 developed at lab scale. Listed in top 2% Scientist in the field of physical chemistry in the World list as per Stanford University, USA research in 2021 & 2022. Google Scholar Citation Index = 13000; h- index =58; i10-index = 214; He is President Catalysis Society of India. He has also Guided 29 Ph.D. students and has delivered 192 invited talks in National and International forums.

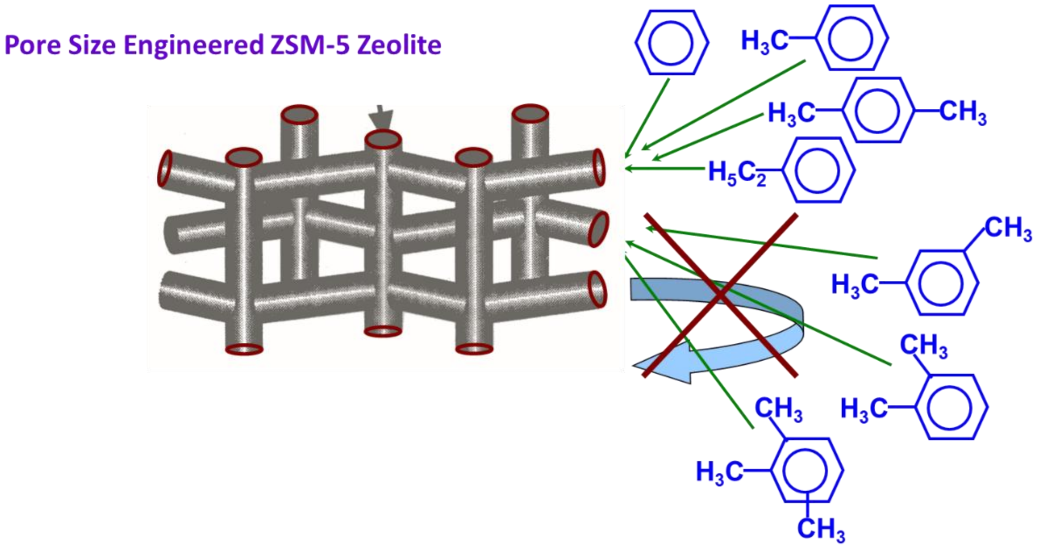
Recipient of following awards and recognition:

- Finalist for Hydrocarbon Processing award, 2022 and for Gulf Energy Excellence Award, 2023 in the category Lifetime Achievement.
- Fellow, Indian National Science Academy, 2019.
- Fellow, Indian National Academy of Engineering, 2008.
- Life time achievement award 2021 of Indian Chemical Society.
- Fellow, Gujarat Science Academy, 2015.
- Kullor Memorial lecture at Chemical Engineering department, IISc., Bangalore, 2012.
- Vasvik Award for outstanding contribution in Chemical Science and Technology, 2011
- Prof. S K Bhattacharya Eminent Scientist Award of Catalysis Society of India for the year, 2008.
- Prof. K.G. Naik Gold medal award for the year 2006 for outstanding contributions in applied chemical research, The M.S. University of Baroda
- Bronze medal for significant contributions to research in chemistry, Chemical Research Society of India (CRSI), 2007.
- Professor B.D. Tilak visiting fellowship, University of Mumbai, Institute of Chemical Technology, Mumbai, 2006-07.
- UPL distinguished speaker award of IIChE at ChemCon, 2008

Pore Engineered Nano porous Zeolites as Commercial Adsorbents and Catalysts

Raksh Vir Jasra,
R&D Centre, Reliance Industries Limited, Vadodara Manufacturing Division, Vadodara, Gujarat, India

Zeolites due to their high crystallinity, varied surface functionalities, molecular sized pore dimensions and high thermal and hydrothermal stability provide a very strong portfolio of heterogenous industrial catalysts for chemical industry. Zeolites have been conventionally been used as catalysts in a wide variety of industrial processes, especially in oil refining and petrochemistry. Their application has extended to fine chemicals and even in biomass conversion to value added products in recent times. Present talk will briefly discuss industrial catalytic application of zeolites.



Zeolites due to their unique structural features are outstandingly shape- and size-selective materials. With the slight changes in zeolites like change of extra framework cation or pore-aperture control significantly influence molecular recognition by zeolites which makes them super selective adsorbents/catalysts. Present talk will discuss about some of the adsorbents and catalysts developed and commercialized at Reliance industry using pore-engineering technique.

Dr. Satadal Saha,
Founder & Director, JSV Innovations Pvt. Ltd., India

Dr. Satadal Saha MS (Gold medalist), FRCS (Eng.) started his professional career as a General Surgeon, after completing his PG education in Calcutta and higher training in the UK. On his return to India, with his doctor friends he established four affordable yet financially sustainable hospitals in different districts in West Bengal flagship hospital being "Westbank Hospital" in Howrah. End-2010, in a significant shift, he began to focus on 'What causes so much disease that he was happy to treat over last 15 years and create shareholders wealth'; till he understood that the 'dog's tail could not be straightened', more hospitals, by themselves, is not the answer to India's massive health inequity. Over next 4 years, he worked with by virtue of working with International Finance Corporation (member of World Bank Group) as a consultant and large global Private Equity groups, which involved extensive traveling in resource-poor emerging economies. Through experiential learning gained from this, he developed a 3T model that will potentially address the chasm of income and health inequity between rural and urban populations. The model would be based on the triad of task-shifting from doctors to trained community health workers, further empowered by a combination of technologies, decision-support software and frugal diagnostics.

Over last nine years, his organisations, JSV Innovations Pvt. Ltd. and Foundation for Innovations in Health, have established a scale and proved consolidated sustainability, both being keys to long-term future of any enterprise. Today, the initiative, in some form or other, is to be found across seven states in India – West Bengal, Assam, Jharkhand, Madhya Pradesh, Gujarat and Maharashtra.

Dr. Saha has been a Professor at IIT Kharagpur till 2021; he is now an honorary visiting professor at the Centre for Nanotechnology at IIT Guwahati. He is also the Consultant for the upcoming Assam Advanced Healthcare Innovation Institute (AAHII) – a state-of-the-art integrated R&D facility for healthtech, along with PG medical education and 500-bed super-speciality hospital. During this academic pursuit, he has contributed to development of two large R&D centres in IIT Kgp and Guwahati for inter-disciplinary translational innovation of frugal health technologies that will find mass market adoption. The fundamental faith that drives his organisation is that convergence of physical sciences to life-sciences, democratisation of education and technology, marrying technology and science to social ethnography and anthropology has the answer to the immoral health inequity in India and the world where even today, 100 mn people have to choose between medicine and food every day.

People are dying every day. It is the collective responsibility of all of us to find an answer.

Addressing Multi-Dimensional Poverty – The Technology Way

A major bane to development of an equitable society is 'Multi-dimensional Poverty' (MDP) affecting nearly 50% of the world's population. MDP is an interplay between three equally weighted factors – health, education and living standards (poverty, environment, housing and other infrastructure being the determinants of 'living standard').

Historically, MDP has been viewed through the lens of social scientists and economists. In our presentation, we present an alternate view – how technology & its diffusion into communities can induce sustainable changes that result in more resilient communities, the key to societal and national development. Of course, it is not at the exclusion of important roles economics, sociology and geo-politics play.

We will discuss how technology and process have been integrated, how community members have been encouraged to comprehend the values it brings to their lives for a life-changing experience, how different micro business models have converged into a single sustainable eco-system, and finally, how a design-with-user approach and inculcating community ownership have led to scalable, replicable, language and location-agnostic enterprises for improving access to data-driven frugal tech-enabled health and increased livelihood opportunities.

Two of the most important elements which we will examine are the more nuanced version of 'design ethnography' – both for technology innovation and cultural integration. We will challenge the long-held dominant logic thinking of how the poor are unwilling and unable to pay, how communities with low level of formal education are resistant to adoption of technology. We will show the best symphony is created when technology integrates with their lives and enhances access to health and income.

We will tell stories of how a few thousand youth from disenfranchised background with low formal education embraced fit-for-purpose technologies, built a business model around them and delivered healthcare to the community members. We do not say the story is over; it has just begun. Technology is the answer to mitigating all three elements (health, education, living standards) of MDP in a sustainable manner, in the spirit of democracy and inclusion.

Prof. Suhrit Ghosh
Professor, School of Applied and Interdisciplinary Sciences
IACS, Kolkata, India

Suhrit Ghosh was born in 1976 in India. After completion of the undergraduate education (Chemistry major) in the Presidency College (now University), Kolkata, he was admitted in the integrated PhD program (Chemical Science) at IISc, Bangalore in 1997. He received the MS degree (Chemistry) in 2000 and continued for PhD till 2005 under the supervision of Professor S. Ramakrishnan. Then he moved to the group of Professor S. Thayumanavan at the University of Massachusetts, Amherst, USA, for postdoctoral studies (2005-2007). Subsequently he worked as a Humboldt postdoctoral fellow (2007-2008) with Professor Frank Würthner at the University of Würzburg, Germany. In 2008 he joined IACS, Kolkata, India, as an Assistant Professor where he currently holds the position of a Senior Professor in the School of Applied and Interdisciplinary Sciences. Research interest of his group includes supramolecular polymerization of donor-acceptor π-systems, H-bonding driven assembly of amphiphilic π-systems/ macromolecules and biologically relevant stimuli responsive aggregation of amphiphilic polymers (polydisulfides, polyurethanes). Thirteen students have already completed PhD under his supervision from IACS, Kolkata.

Awards and Honours:

- CNR Rao National Prize for Chemical Research by CRSI (2023)
- Fellow, Indian Academy of Sciences (2022)
- Featured in the book "*75 Under 50: Scientists Shaping Today's India*", DST (2022)
- Polymer Chemistry Pioneering Investigator 2021 (*Polymer Chemistry*, RSC)
- Member, Editorial Advisory Board of the journal *Macromolecules* (since 2021)
- Bronze Medal, CRSI (2018)
- K. Kishore Memorial Award, Society of Polymer Science, India (2016)
- SwarnaJayanti Fellowship (Chemical Science), DST, Government of India (2016)
- B. M. Birla Science Prize in Chemistry (2014)
- Associate: Indian Academy of Sciences, India (2009-2012)

Chain-folding Regulated Hierarchical Assembly of Amphiphilic Polymers and Functional Materials

Suhrit Ghosh
Senior Professor, School of Applied and Interdisciplinary Science, Indian Association for the Cultivation of Science, Kolkata, India-700032
Email: psusg2@iacs.res.in

Despite a rapid growth in cationic host defence peptide (CHDP)-mimicking synthetic polymers, the importance of the secondary structure of such synthetic systems, similar to CHDPs, has not been understood well in context of bacterial membrane perturbation. Recently we have investigated a series of cationic amphiphilic alternating polyurethanes (PUs) for antibacterial activity with specific focus on the effect of the chain-folding on the antibacterial activity. Some of them contain linear flexible hydrocarbons (F-PUs), while others contain cyclic rigid hydrocarbons (R-PUs) in the segmented polymer backbone. F-PUs exhibit intra-chain H-bonding driven pleated structure, followed by hierarchical assembly, producing cationic polymersome in water. In sharp contrast, R-PUs, deprived of the chain-folding possibility due to the rigid linker, exhibit immiscibility-driven aggregation producing spherical nanoparticles. F-PUs exhibit exemplary antibacterial activity with exceptionally low minimum inhibitory concentration (MIC), while R-PUs do not show even moderate activity.1 Beyond planktonic bacteria, F-PUs also exhibit extraordinary biofilm eradication efficiency. Likewise, we have recently shown sulfated F-PUs show excellent antiviral activity while their rigid analogues fail to exhibit any antiviral effects.2 Similar foldable PUs with pendant naphthalene-diimide (NDI) moiety in hydrocarbon solvent show pleated structure with the NDI units organized at the periphery.3 In presence of pyrene (Py), NDI-Py charge transfer interaction promotes formation of elongated nanotubular structure with stable room-temperature ferroelectricity4 and highly promising piezoresponse. This presentation will focus on the chain-folding regulated self-assembly of different polyurethane derivatives in water or hydrocarbon and implications in applications such as antibacterial/ antiviral material or organic optoelectronics.

References:

1. Barman, R.; Ray, D. S.; Aswal V. K.; Ghosh, S. Polym. Chem. 2022, 13, 4384.
2. Nag, A.; Banerjee, K. J.; Barman, R.; Kar, J.; Sarkar, D. P.; Jana, S. S.; Ghosh, S. J. Am. Chem. Soc. 2023, 145, 579.
3. T. Mondal, T. Sakurai, S. Yoneda, S. Seki and S. Ghosh, Macromolecules 2015, 48, 879.
4. Mukherjee, A.; Barman, S.; Ghosh, A.; Datta, A.; Datta, A.; Ghosh, S. Angew. Chem. Int. Ed. 2022, e202203817.

Prof. Devasish Chowdhury
Professor, Division of Physical Sciences
Institute of Advanced Study in Science and Technology (IASST)
Guwahati, Assam, India

Professor Devasish Chowdhury, affiliated with the Institute of Advanced Study in Science and Technology (IASST) in the Division of Physical Sciences, is a distinguished researcher specializing in Polymer Nanocomposites, Surface Self-Assembly, and Atomic Force Microscope Mediated Nanolithography. As the head of the Material Nanochemistry Laboratory (MNL), his work encompasses a wide range of nanomaterials, aiming for the systematic bottom-up fabrication of nanoscale electronic devices. Prof. Chowdhury holds an M.Sc. from Delhi University (1998) and a Ph.D. from IIT Guwahati (2004). He further enriched his expertise through a post-doc at the Weizmann Institute of Science, Israel (2004-2007)

Functional Biopolymer Nanocomposite Materials for Food Packaging Applications

Devasish Chowdhury
Material Nanochemistry Laboratory, Physical Sciences Division, Institute of Advanced Study in Science and Technology, Paschim Boragaon, Garchuk, Guwahati-781035, India.
E-mail: devasish@iasst.gov.in

The development of bio-polymeric materials is exceedingly gaining importance as a potential material for the replacement of petroleum-based material. Polysaccharide based biopolymers are the emerging material to replace petroleum-based material. They have an excellent film-forming property and are extensively used for the formation of polymeric films. However, biopolymers are highly sensitive to moisture, restricting their industrial application. Various strategies such as composite formation, blending, cross-linking, hydrogel formation etc., have been employed to overcome such drawbacks. Packaging is necessary for conserving and protecting food from deteriorating agents such as physical, chemical, microbiological, or other risks that could compromise its quality or safety. Biopolymer are potential material that are non-toxic, biodegradable, low-cost, and environmentally friendly material for use as packaging material. Therefore, with the rapid advancement and development of technology, the focus has shifted towards the fabrication of smart and active packaging materials to detect and report food quality in a real-time fashion. Such smart and active packaging systems respond to signals while interacting with the food-packaging environment. So, in this talk I discuss our work on fabrication of crosslinked guar gum-chitosan composite film without using any plasticizer fabricated via the solution casting method. The fabricated biopolymer composite film demonstrated superior properties like high stability in water, good mechanical properties etc. The crosslinked guar gum-chitosan composite film also shows a high contact angle and low water vapour permeability when compared with the film of chitosan. We introduced functionality in the bio-polymeric material to make it into a smart material. In this regard, we fabricated guar gum- sodium alginate blending with glucose-glycerol carbon dots nanocomposite film can be used to detect relative humidity. The fabricated nanocomposite film was an excellent smart sensor based on the fluorescence 'on-off' mechanisms against humidity. The practical feasibility of the biocomposite developed film was tested in real conditions by placing a piece of bread with high humidity conditions wrapped with the developed nanocomposite film. It was observed that under such conditions, marked quenching of fluorescence was observed and hence detection of humidity was possible. Other properties that can be introduced in biopolymer nanocomposite is antimicrobial property. Hence, such biopolymer films can be used as smart packaging material.

References

1. Sazzadur Rahman, Devasish Chowdhury, International Journal of Biological Macromolecules, 2022, 216, 571–582
2. Sazzadur Rahman, Achyut Konwar, Gitanjali Majumdar and Devasish Chowdhury, Carbohydrate Polymer Technologies and Applications, 2021, 2, 100158.

Prof. Saravanan Pichiah
Head, Environmental Nanotechnology Laboratory
Department of Environmental Science and Engineering,
Indian Institute of Technology (ISM) Dhanbad, Jharkhand

Dr. Saravanan Pichiah, currently serving as the Head of the Environmental Nanotechnology Laboratory at the Department of Environmental Science and Engineering, Indian Institute of Technology (ISM) Dhanbad, Jharkhand, stands as a distinguished academician and researcher in the realm of environmental nanotechnology. Holding a Ph.D. in Chemical Engineering from the Indian Institute of Technology Guwahati, he has traversed through a remarkable academic journey, including positions such as Senior Lecturer at the University of Malaya, Malaysia, and Assistant Professor at esteemed institutions in Poland and India.

Dr. Pichiah's academic prowess is evident in his extensive publication record, comprising 116 articles with an average impact factor of 6.5 and 13 book chapters. His intellectual contributions extend to a filed intellectual property, showcasing his innovative approach to research. Beyond his scholarly achievements, Dr. Pichiah has played a pivotal role in shaping research environments, having established state-of-the-art analytical facilities for environmental engineering at both the University of Malaya and IIT (ISM). His commitment to fostering the next generation of researchers is underscored by successful mentorship, having advised one Post Doc, 11 Ph.D. candidates, and 2 M.S. (Research) students.

Dr. Pichiah's impact extends beyond academia, with his leadership in sponsored projects securing research funding amounting to INR 23 million. Recognized for his outstanding contributions, he has received prestigious awards, including the "One Belt One Road" Innovative Talent Exchange Foreign Expert Program in 2021. Notably, he is a Fellow of the Royal Society of Chemistry and holds the title of Chartered Engineer. His commitment to fostering innovation is further exemplified by winning two Gold medals in the 2017 Innovation Competition held in Malaysia. Actively engaged in the global scientific community, Dr. Pichiah is affiliated with esteemed societies such as the American Institute of Chemical Engineers (AIChE) and the Indian Institute of Chemical Engineers (IIChe), showcasing his dedication to advancing knowledge and collaboration in the field.

Solar Driven Potable Water Purification System

Saravanan Pichiah[1]
[1]Environmental Nanotechnology Laboratory, Department of Environmental Science and Engineering,
Indian Institute of Technology (ISM) Dhanbad- 826004, Jharkhand, India

The full sanitation model is not adopted in most rural and suburban areas of the country. This inadequate drinking water treatment has been the root cause of most waterborne diseases a major cause that claims the lives of many infants of our country. Pollutants produced by anthropogenic activity are easily carried by runoff and exist in significant concentrations, making them unsuitable for human and livestock consumption. These reservoirs are also the main source of drinking water for most settlements. The formation of United Nation Sustainable Development Goals (SDG) had highlighted this problem, as UNSDGs 6 deals with clean water and sanitation. This has promoted many purification systems over a period, comprising processes like filtration, ion exchange, adsorption and membrane or combination of these. However, most of them are incapable either economically or technically to meet the need. Therefore, it is important to develop affordable and sustainable portable cleaning systems that can meet the needs of these communities. Hence, this research aimed to achieve the stated hypotheses in the concept of sustainability. The prototype of the achieved water purifier is shown in Fig.1

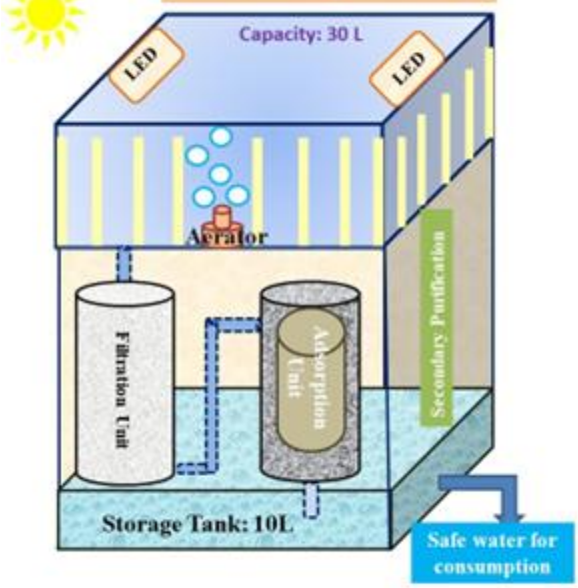


Fig.1. Illustration showing the prototype of water purifier

Dr. Mohit Tyagi,
Scientific Officer E,
Department of Atomic Energy
Bhabha Atomic Research Centre
Mumbai, India

Dr. Mohit Tyagi joined Crystal Technology Section, Bhabha Atomic Research Centre in 2005. He completed his M.Sc. Physics from CCS University Meerut, Ph.D. from HBNI, Mumbai and Post-Doc from University of Tennessee, USA. He visited Kyungpook National University in 2019 as a Brainpool fellow. He is working on the growth and characterization of single crystal scintillators for nuclear radiation detection. He has published about 75 research papers in refereed journals and 6 patents on novel radiation detection devices. He is a recipient of 'DAE Group Achievement- 2013', 'DAE Young Applied Scientist -2014', 'IACG Young Crystal Grower-2015', 'Nucleonix best researcher -2015', 'Indian Physical Society Young Physicist-2016', DAE SSPS Young Achiever Award 2017, 'NASI Young Scientist -2017', DAE Scientific & Technical Excellence Award 2020, etc." He is Young Associate of Maharashtra Science Academy and Member of Indian Young Academy of Science".

Synthesis and Characterization of Scintillating Material-Nano to Bulk

Mohit Tyagi
Crystal Technology Section, Technical Physics Division Bhabha Atomic Research Centre, Trombay, Mumbai-85

The quest of finding new scintillating materials is continuously increasing due to various applications related to the nuclear radiation detection in current and advanced technologies. This ongoing increment in demands has urgent need of finding novel scintillating materials, having required and improved performance characteristics. Further, the advancement in material synthesis and purity refinement techniques along with the state of art sensors and data acquisition systems have provided another dimension in this field. However, the discovery of alternative materials and the improvement of existing scintillators' performances require a systematic and integrated multidisciplinary approach. In this talk, along with the general view of selecting an appropriate scintillator for a particular application and a systematic approach, including first principles study of oxide and halide scintillators, for adequately addressing various issues in the development of advanced scintillators will be presented with a few examples. The detailed characterizations required for the nano-composite to single crystals will be discussed. The development of few novel devices based on phoswich detectors will be also presented.

Dr. M. S. Santosh

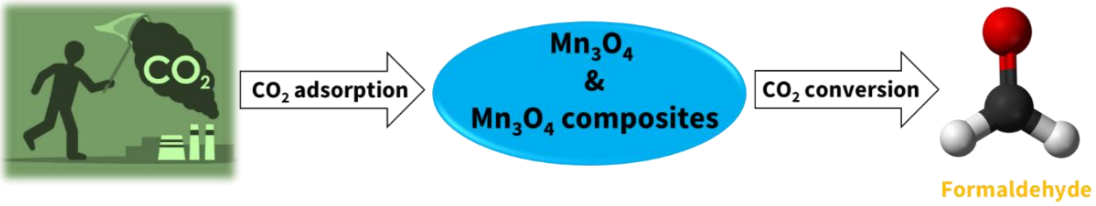
Senior Scientist,
Coal and Mineral Processing Division,
CSIR – Central Institute of Mining and Fuel Research (CIMFR)
Dhanbad, Jharkhand, India

Dr. M. S. Santosh is an experienced Researcher, TEDx Speaker, Educator and Master Trainer with a demonstrated history of working in the academic, research and startup sectors. With over 90 publications, his research interests are in the areas of Clean Energy Technologies, Wastewater Treatment and Energy Storage and has collaborations spanning different countries and continents. He has successfully completed projects funded by National and International Funding Agencies, including the European Union. He had successes under various bilateral and multilateral programs involving USA, France, Russia, Belarus, Sweden, Singapore, Egypt and Vietnam. With his novel technologies, he is consulting a few industries as well. He is a recipient of several national and international awards such as the INSA Summer Research Fellowship, DST Young Scientist Award, BIRAC-SRISTI Innovation Award, BRICS Young Scientist Award, Commonwealth & Hungarian Fellowships, Global Shaper Award, Swedish Institute's Guest Scholarship, IUPAC's Junior Researcher Award. He is a member of the Indian National Young Academy of Sciences (INYAS), National Academy of Sciences (NASI) and a Fellow of the Royal Society of Chemistry. He is also a Visiting Scientist to CSIR, South Africa and NUST, Russia.

CO_2 Capture and Conversion by Structurally Tailored Mn_3O_4 and its Nitrogen Rich g-C_3N_4 Composites

M. S. Santosh
Coal to Hydrogen Energy for Sustainable Solutions (CHESS) Division,
CSIR - Central Institute of Mining and Fuel Research (CIMFR), Digwadih Campus, PO: FRI, Dhanbad - 828108, Jharkhand. Email: santoshms@cimfr.nic.in

Understanding the structural features of solid metal oxides towards CO_2 adsorption and photocatalytic conversion is crucial in carbon capture, utilization, and storage (CCUS).1 Thus, the design and controlled synthesis of metal oxide-based materials are pivotal in mitigating global energy and environmental challenges 2,3. In this work, we have synthesized 2D and 3D configurations of Mn_3O_4 by a controlled synthesis using a deep eutectic solvent as the reaction medium. The solvothermal and precipitation approaches have been employed with varying reaction conditions. The synthesized materials exhibit a tetragonal phase of Mn_3O_4, and flakes (2D), flakes/peanuts (2D/3D) to peanuts shaped (3D) morphology with an increase in the reaction time in solvothermal process, while the precipitation approach resulted in only flakes (2D). Additionally, nitrogen-rich g-C_3N_4 and Mn_3O_4/nitrogen-rich g-C3N4 heterostructures have also been synthesized to assess their efficiency in CO_2 adsorption and conversion. The 2D Mn_3O_4 displayed high adsorption capacity for CO_2 as of 4.62 cc.g^{-1}, and it decreased to ~0.75 cc.g^{-1} with changes in the morphology to 2D-assembled 3D peanut shaped structures. Interestingly, it was observed that an increase in the reaction time led to a decrease in the surface area, attributed to the self-assembly of 2D sheets of Mn_3O_4. In contrast, the CO2 adsorption properties of nitrogen-rich g-C_3N_4/Mn_3O_4 composites prepared using in-situ precipitation and solvothermal method (12 h) showed adsorption capacities of 12.3 cc. g^{-1} and 3.5 cc. g^{-1}, respectively. Further, CO_2 reduction to formaldehyde through heterogeneous photocatalysis was carried out in 10 mL of aqueous solution at pH 7 using Mn_3O_4 and nitrogen-rich g-C_3N_4/Mn_3O_4 composites as catalysts and a yield of 135 µmol and 145 µmol, of HCHO were obtained, respectively.



Scheme. Schematic illustration of CO_2 adsorption and conversion using Mn_3O_4 and Mn_3O_4 composites

References

1. Senftle et. al., Acc. Chem. Res. 2017, 50, 472-475.
2. Mutch et. al., J. Am. Chem. Soc. 2018, 140, 4736-4742.
3. Kumar et. al., Green Chemistry 2020, 22, 1650-1661.

Prof. Shabana Khan
Associate Professor, Department of Chemistry
Indian Institute of Science Education and Research (IISER)
Pune, India

Shabana Khan completed her Ph.D. at the Indian Institute of Technology, Delhi, in 2008 with Prof. Jai Deo Singh, followed by postdoctoral work at the University of Göttingen with Deutscher Akademischer Austausch Dienst (DAAD) fellowship in the group of Prof. H. W. Roesky. Followed by this, she did her second postdoc with Dr. Manuel Alcarazo at the Max Planck Institute for Coal Research. She was appointed as an assistant professor at the Indian Institute of Science Education and Research, Pune, India (IISER Pune) in 2013 and is currently working as an associate professor. Her research interest includes the synthesis and application of compounds with low-valent main group elements, especially silicon, germanium, and tin. She was awarded the "POWER fellowship" from the Science & Engineering Research Board of India and "Alexander von Humboldt Fellowship" for the experienced researcher. She served as an editorial advisory board member of *Organometallics*. She is presently associated with the *Inorganic Chemistry*, *European Journal of Inorganic Chemistry* (EJIC) and *Chemistry- An Asian Journal* as an international advisory board member and *Organometallics* as a Topic Editor.

Cyclic (Alkyl)(Amino)Carbene Stabilized Gold Nanoparticles: Synthesis and Catalytic Application

Shabana Khan*
shabana@iiserpune.ac.in
Indian Institute of Science Education and Research Pune (IISER Pune), India.

Recent years have witnessed tremendous growth in the field of N-heterocyclic carbene (NHC) capped metal nanoparticles due to their interesting σ-donating properties. The NHC functionalized AuNPs is a milestone discovery from the main group chemistry perspectives. It has already been established that NHC-capped metal nanoparticles (MNPs) can be utilized as heterogeneous catalysts for the electrochemical reduction of CO_2 to CO, CH_4, and HCOO-, and the activity of the catalysts is controlled by the electronic properties of NHCs on the surface. Seeing the vast development of imidazoline-based NHCs on gold surfaces, we envisioned using CAAC on the surface of the AuNPs, which possess better σ-donation and π-acceptor properties (Figure 1). Hence, CAAC was anticipated to perform better than the reported ligands as it has already been proven an excellent ligand for the stabilization of several unusual compounds due to its electron-rich nature. Herein, I will discuss the synthesis of extremely electron-rich cyclic(alkyl)(amino)carbene (CAAC) stabilized gold nanoparticles (AuNPs) and their utilization for the selective electrochemical reduction of CO_2.

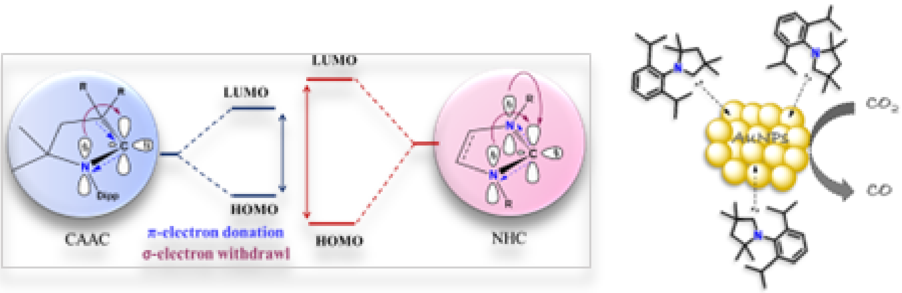


Figure 1. Graphical representation of the electronic properties of NHC and CAAC, and CAAC on the surface of AuNPs.

Keywords:
Cyclic Alkyl Amino Carbene, Catalysis, Electrocatalysis, CO_2 Reduction, Gold Nanoparticles

Dr. Rajendra S. Dhaka
Associate Professor
Department of Physics
Indian Institute of Technology Delhi

Rajendra S. Dhaka is currently working as an Associate Professor at the physics department of Indian Institute of Technology Delhi, and Chairperson of the Indian National Young Academy of Science (INYAS). He has received M.Sc. and Ph. D. degrees in Physics from University of Rajasthan Jaipur, and UGC-DAE CSR Indore, respectively. He worked as postdoctoral research fellow at Max Planck Institute for Microstructure Physics, Halle, Germany and at the Ames Laboratory, US DOE, Iowa State University, Ames, USA. He then spent more than a year at Paul Scherrer Institut-Swiss Light Source, Villigen, Switzerland as scientific collaborator. In early 2014, he joined at the physics department of IIT Delhi and involved in teaching, research, and administrative duties. His research interests are in magnetic materials, complex oxides, quantum materials and sodium-ion batteries. He authored around 110 refereed journal papers having >3050 citations and 30 h-index.

Dr. Dhaka is recipient of various awards and fellowships: INSA Medal for Young Scientist 2015 in Physics, DAE Young Achiever Award (YAA)-2018, Satya Murthy Memorial Award in Physics for young scientists-2020 by Indian Physics Association, "Veena Arora early career Faculty research award-2020" at IIT Delhi, SERB Early Career Research Award-2016, DAE Young Scientist Research Award (YSRA)-2015, Young Faculty Incentive Fellowship, at IIT Delhi (2014), Indo-Australia Early and Mid-career Researchers (EMCR) Fellowship-2017, INSA-DFG Fellowship-2019, under International Exchange of Scientists Programme. He is life member of the National Academy of Sciences India (NASI), Materials Research Society of India (MRSI), Neutron Scattering Society of India (NSSI), and Indian Physics Association.

More details can be found at: http://web.iitd.ac.in/~rsdhaka/

Electrochemical Performance of Sodium-ion Batteries for Energy Storage Applications

Rajendra S. Dhaka
Department of Physics,
Indian Institute Technology Delhi, Hauz Khas, New Delhi-110016, India
rsdhaka@physics.iitd.ac.in

In recent years, energy storage devices especially rechargeable batteries have become part of our daily life in portable electronic devices like mobiles, laptops as well as being used at large scale in electrical vehicles (EV), etc. Among various types of batteries, the only commercially established and feasible technology is based on Li-ion intercalation, mainly due to the advantage of its high energy density, good rate kinetics and light weight. However, the main concern comes from the limited availability and uneven distribution of Li in the earth crust. This motivates researchers to search for alternative avenue, and the Na-ion batteries are one of the potential candidates particularly for grid level storage due to its low cost and abundance on the globe, and therefore extensive research has been started in this field over past few years [1]. In this direction, it is vital to find suitable and high-performance electrode materials. However, there are many challenges due the larger size of the Na-ion as compared to the Li. Therefore, constant efforts are going on to search new electrode materials (negative as well as positive) for improving the electrochemistry. We have developed few cathode and anode materials and tested their electrochemical performance to understand the diffusion kinetics, stability, rate capability and coulombic efficiency in sodium ion batteries [2-5]. In the talk, I will cover basic of battery chemistry and need of development of cost-effective batteries.

Also, I will present some of our recent electrochemical results on sodium-ion batteries.

[1] S. K. Sapra, J. Pati, P. K. Dwivedi, Suddhasatwa Basu, J.-K. Chang, and R. S. Dhaka*, WIREs Energy and Environment 10, e400 (2021). Invited review article

[2] J. Pati, Hari Raj, S. K. Sapra, Anita Dhaka, A. K. Bera, S. M. Yusuf, and R. S. Dhaka*, Journal of Materials Chemistry A 10, 15460 (2022).

[3] P. K. Dwivedi, Simran K. Sapra, Jayashree Pati, and R. S. Dhaka*, ACS Applied Energy Materials 4, 8076 (2021).

[4] Priya Mudgal, Himani Arora, J. Pati, Manish K. Singh, M. Khetri, and R. S. Dhaka* PINSA, (2022) https://rdcu.be/cUFit

[5] M. K. Singh, J. Pati, D. Seth, J. Prasad, M. Agrawal, M. Ali Haider, J.-K. Chang, & R. S. Dhaka* Chemical Engineering Journal 454, 140140 (2023).

We acknowledge the DST-IIT Delhi Energy Storage Platform on Batteries" (project no. DST/TMD/MECSP/2K17/07) and SERB-DST core research grant (file no.: CRG/2020/003436.

Dr. Ramendra Sundar Dey
Scientist-D,
Institute of Nano Science and Technology
Mohali, India

Dr. Ramendra Sundar Dey is a Scientist at Institute of Nano Science and Technology, Mohali, India. Prior, he was a Hans Christian Ørsted postdoc fellow at Technical University of Denmark (DTU), Denmark. He received Ph.D. in Chemistry at 2013 from Indian Institute of Technology (IIT) Kharagpur, India. He is involved in research in the field of electrochemistry of nanomaterials. His current research is focused on the architecture and engineering of nanomaterials for electrochemical ammonia synthesis and advanced energy storage technology. He has been honored with a number of prestigious National and International recognitions, like, *INSPIRE Faculty Award* at 2015, *Journal of Materials Chemistry aand Nanoscale Emerging Investigator* by RSC and ACS Applied Energy Materials Early Career Energy Scientists 2022. He has been awarded as *Associate Fellow of Indian National Science Academy (INSA)* 2023, *Associates of Indian Academic of Science* (I.A.Sc.), Bengaluru and member of Indian National Young Academy of Sciences (INYAS). Recently, he has received Emergent Materials Scientist (EMS) award 2023 by IIT Roorkee

Electrochemical Nitrogen Fixation for Sustainable Ammonia Synthesis

Ramendra Sundar Dey
Institute of Nano Science and Technology, Sector-81, Mohali-140306, Punjab, India.
Email: rsdey@inst.ac.in

The over-consumption of the non-renewable energy sources tend the world-wide research to incline towards development of sustainable approaches to with-stand the global energy demand. In this scenario, the vital question of the hour is; ammonia was a saviour once to meet the global food scarcity, so can it save the world again? Although to meet the practical demands of ammonia, the century-old Haber Bosch process is the sole option, but it deviates from the goal to a carbon neutral society. The electrochemical ammonia synthesis from dinitrogen reduction reaction (NRR) thus has been an emerging hotspot in the academia as well as industries owing to the ever-growing demands of green ammonia. With a pledge of the "Net-Zero", different nations have been setting up ammonia plants with a target of few million tons of ammonia production in the coming two-three years. This calls for the electrochemical approach and we have thus keenly focused to work on different cell component including suitable electrocatalyst materials to achieve a significant ammonia production by nitrogen reduction reaction (NRR) in aqueous electrolytes.

Acknowledgement

R.S.D. acknowledges DST SERB (CRG/2020/005683) funding agencies for financial support.

References.

1. Biswas, A.; Kapse, S.; Ghosh, B.; Thapa, R.; Dey, R. S.* ***PNAS***, **2022**, 119, 33, e2204638119.
2. Biswas, A.; Nandi, S.; Kamboj, N.; Pan, J.; Bhowmik, A.; Dey, R. S.* ***ACS Nano***, **2021**, 15, 20364.
3. Bhardwaj S., Das S. K., Biswas, A.; Kapse, S.; Thapa, R.; Dey, R. S.* ***Chemical Science***, 2023, 14, 8936.
4. Biswas, A.; Kapse, S.; Thapa, R.; Dey, R. S.* ***Nano-Micro Letters***, **2022**, 14, 1-17.

Dr. P. Gopinath Ph.D., FRSC., FRSB.,

Professor,
Head, Centre for Nanotechnology
Department of Biosciences and Bioengineering,
Associate Dean of Academic Affairs -Admission (Former)
Indian Institute of Technology Roorkee,
Roorkee -247 667, Uttarakhand, India.

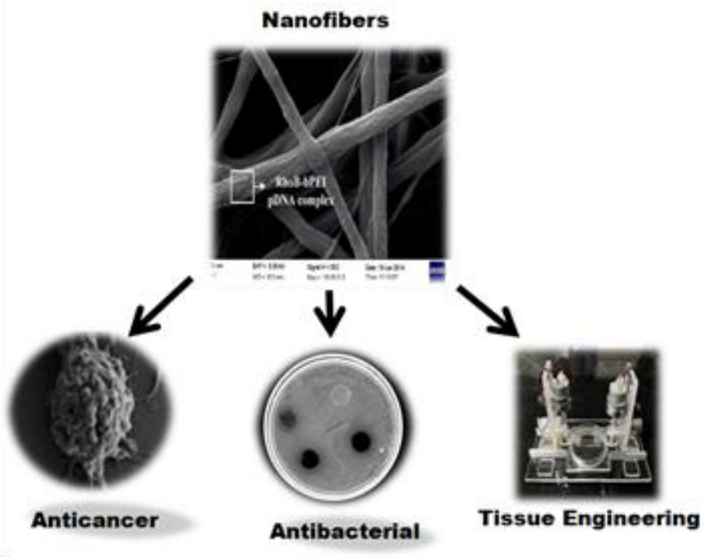
Dr. Gopinath is a Professor in the Department of Biosciences and Bioengineering at Indian Institute of Technology (IIT) Roorkee, India. Currently, he is the Head of the Centre for Nanotechnology, IIT Roorkee. He received his B.Sc. degree in Microbiology and M.Sc. degree in Biotechnology from Bharathidasan University, India. He earned his Ph.D. in Biotechnology from the Indian Institute of Technology Guwahati, India. He did his postdoctoral research at the University of Rochester Medical Center, New York, USA. His research group in the nanobiotechnology laboratory at IIT Roorkee is working on developing various nanomaterials for Biomedical applications. At present, he has more than 150 research publications in the area of nanobiotechnology in high-impact factor journals. He has filed 25 patents and done one technology transfer. He has also published eight books and 15 book chapters. He has been a reviewer & editorial board member for many international journals. His research work has been well cited with **total citations of more than 7000** (h index 46; i10 index 116) till date. He has completed 15 sponsored research projects so far and currently working on 5 projects sponsored by various funding agencies like DBT, DST, ICMR etc. Further, he has received several prestigious awards such as "Yogmaya Devi Award in Biomedical Sciences", "ILSI-India Young Scientist Award 2021", "AMI-Alembic Award-2020", "ICMR-prize for Biomedical Research-2019", "Shri. Om Prakash Sharma Award for a Young Scientist 2019 for outstanding contributions in Biomedical Research", "G.D. Naidu award for young scientist for the Year 2018", "Prof.H.S. Srivastava Foundation young scientist award". His credentials are very much impressive and outstanding. Based on his contribution at IIT Roorkee, he received the prestigious "Institute research fellowship for Outstanding Young faculty 2017", IIT Roorkee. His research group developed nanofiber-based scaffold and device for tissue engineering applications. For this work, his team received the **"BIRAC-SRISTI-Gandhian Young Technological Innovation (GYTI-2019) award"** from Shri. M. Venkaiah Naidu, Honorable Vice president of India. Dr. Gopinath also received the prestigious **Virendra Nath Malti Mital Award 2018** for this work. He is a Fellow of Royal Society of Chemistry (FRSC), United Kingdom, Fellow of Royal Society of Biology (FRSB), United Kingdom and Fellow of the Academy of Sciences, Chennai. He is the Co-founder and Director of the start-up company " Super Good Nano Pvt. Ltd." His start-up company received the best startup Award under health care division in the Startup Expo 2022 held at IIT Roorkee.

Development of Nanofibers for Biomedical Applications

Dr. P. Gopinath
Department of Biosciences and Bioengineering
Head- Centre for Nanotechnology
Indian Institute of Technology Roorkee
Roorkee 247667, Uttarakhand, India.
E-mail: gopi@bt.iitr.ac.in

Nanofibers have gained profound application in tissue engineering, wound healing and anticancer therapy. In the recent past, anticancer drug-loaded nanofibers have been sought extensively as post-operative implants to prevent cancer recurrence and metastasis. In this quest, although numerous nanofiber-based drug delivery systems have been realized, they unfortunately remain largely ineffective due to certain disadvantages. One such drawback is their incompetence to attain a controlled and sustained drug release profile which could also be effectively tuned to meet personalised medications of diverse patients. Thus, to overcome these drawbacks, we have developed differentially cross-linkable polymeric nanofibers to deliver various therapeutic agents for anticancer and wound dressing applications. Apart from this, we have also developed novel nanofibrous scaffolds to overcome the drawback associated with the existing scaffolds for tissue engineering applications.

Keywords: Nanofibers; Cancer Therapy; Wound Healing; Tissue Engineering



Nanofibers for biomedical applications

Dr. Pooja Devi
Principal Scientist, Materials Science and Sensor Applications (MSSA)
Central Scientific Instruments Organisation – CSIO
Chandigarh, India

Dr Pooja is working as a principal scientist at CSIR-Central Scientific Instruments Organisation. Her major research contributions are in Applied materials design for green hydrogen production, water/air pollutants degradation, and water pollutants monitoring, wherein she is developing the synthesis of catalytic materials as well as addressing their scalability challenges for commercial applications. Her research expertise spans a range of functional materials, including carbon nanostructure, 2D materials (MXenes, TMDs), metallic nanostructures and semiconductor oxides.

She has published around 84 research papers in high-impact journals, 6 peer reviewed conference proceedings, edited 07 books as lead editor, and published 25 book chapters. She has also filed 03 patents, 02 design registration, 02 copyright/trademarks and developed 04 technologies, 02 of which are transferred to the industries. She is also a recipient of several prestigious awards and fellowships including CSIR-Raman Research Fellowship to Visit Prof. Yury Gogotsi, USA; Nano Alumni Award, IIT Roorkee, NASI Young Scientist Platinum Jubilee Award (2021), IEI Young Engineer Award, INAE Young Engineer Award (2020), SERB Women Excellence Award (2020), Young Associateship of Indian Academy of Science (2019- 22), Haryana Yuva Vigyan Ratan Award (2019), Young Scientist Award (2019) from Indian Science Congress Association, IUSSTF Water Advanced Research and Innovation (WARI) fellowship (2017), Canadian Commonwealth Fellowship (2010), etc. She is also a young associate/member of major national academies of the country including INAE, IASc, and NASI. She is currently serving as a core committee member of the Indian Young National Academy of Science (INYAS), INSA, New Delhi. She has also represented India in BRICS Young Scientist Conclave and Shanghai Cooperation Organisation (SCO) Young Scientist Conclave. She has been recently listed under Eminent 125 women in Science by CII Compendium released by PSA (2022) and has been listed consecutively for three years in the list of Top 2% Researchers globally database, compiled by Stanford University in Association with Elsevier based on research publications, 2022.

Unravelling High-Order MXenes for Hydrogen Evolution Reaction

Pooja Devi
CSIR-Central Scientific Instruments Organisation, Chandigarh, India

The quest for efficient and sustainable hydrogen evolution reaction (HER) catalysts has spurred intense research efforts in recent years. Among the burgeoning family of 2D materials, MXenes have emerged as promising candidates. In particular, high-order MXenes, characterized by their layered structures and tunable surface terminations, have gained prominence for their potential in enhancing HER performance. This talk will provide an insightful overview of the current state of research focused on unraveling the catalytic prowess of high-order MXenes for HER with our recent findings on 413 and 514 MXenes. The talk will delve into the synthesis techniques, structural properties, and unique surface chemistries that define high-order MXenes. Furthermore, we examine the mechanistic intricacies of HER on high-order MXenes, shedding light on the crucial roles played by intercalated ions, and electrochemical kinetics. Recent experimental studies are presented, offering valuable insights into the design principles for tailoring high-order MXenes for improved performance. In conclusion, we discuss the future prospects and challenges associated with harnessing high order MXenes for practical HER applications, emphasizing the need for scalability, long-term stability, and integration into energy conversion technologies.

Keywords: MXenes, Electrocatalyst, Hydrogen, Ion Exchange, Water Splitting.

Prof. Sukhendu Mandal
Professor, IISER Thiruvananthapuram, India

Sukhendu received his Doctoral degree from the Solid State and Structural Chemistry Unit, Indian Institute of Science Bangalore, India in 2007, and was a post-doctoral research scholar at The Pennsylvania State University, USA during 2008-2012. He joined the Indian Institute of Science Education and Research Thiruvananthapuram (IISER TVM), Kerala, India in 2012 as an Assistant Professor in the Department of Chemistry and then promoted to Associate professor in 2017. Recently, he was promoted to the Professor position. His primary research interest is on atom-precise metal nanoclusters and metal-organic frameworks to explore their photo-physical and chemical properties with an emphasis on energy and environment. He has published more than 100 papers in international peer-reviewed journals and contributed to 5 book chapters. He is the recipient of the CRSI Bronze medal in 2021 and was recently inducted as a Fellow of the Royal Society of Chemistry through the leader in the Field. He has been elected as an Advisory Board member of the Journal of Chemical Science, ACS Sustainable Chemistry and Engineering and Inorganic Chemistry.

Structural Design in Atomically Precise Silver and Copper Nanoclusters

Sukhendu Mandal
[a]School of Chemistry, Indian Institute of Science Education and Research Thiruvananthapuram,
Thiruvananthapuram, Kerala, India-695551
Email: sukhendu@iisertvm.ac.in

Atomically precise metal nanoclusters (NCs), a new class of materials are composed of tens to hundreds of metal atoms in the core and possess unique structures, high stability, and attractive properties. Built on the significant success of Au NCs, Ag and Cu NCs have recently received increasing attention. Synthesis and structural elucidation of these NCs are challenging because the zero-valent oxidation states of Ag and Cu are very reactive and prone to oxidization.[1] We have designed a new strategy to synthesize Ag and Cu NCs and then correlated their structure-property relationship. Here, we will discuss the following: (a) A new Ag-S NC $[Ag_{50}S_{13}(S^tBu)_{20}][CF_3COO]_4$ with its unique hcp Ag_{14} kernel and Ag_{36} Keplerian shell-based structural architecture and its photoresponsivity;[2] (b) Ag_{12}-based two-dimensional cluster-assembled materials and their optoelectronic properties;[3] (c) Presence of unique structural geometry in Cu_{18} and Cu_{29}-based NCs (Figure 1).[4]

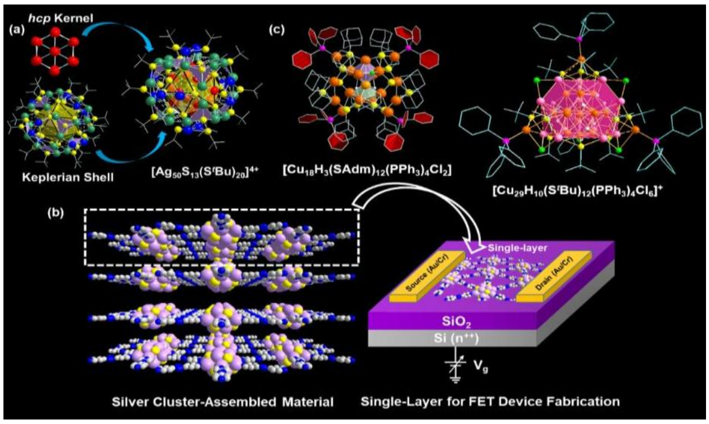


Figure 1. Structural illustration of the newly synthesized atom-precise Ag and Cu NCs.

References:

(1) Yang, J.; Jin, R. *ACS Mater. Lett.* **2019**, *1*, 482-489.

(2) Biswas, S.; Das, A. K.; Reber, A. C.; Biswas, S.; Bhandary, S.; Kamble, V. B.; Khanna. S. N.; Mandal, S. *Nano Lett.* **2022**, *22*, 3721-3727.

(3) Das, A. K.; Biswas, S.; Kayal, A.; Reber, A. C.; Bhandary, S.; Chopra, D.; Mitra, J.; Khanna, S. N.; Mandal, S. *Nano Lett.* **2023**. (Just accepted)

(4) Das, A. K.; Biswas, S.; Wani, V. S.; Nair, A. S.; Pathak, B.; Mandal, S. *Chem. Sci.* **2022,** *13*, 7616-7625.

Prof. Kolleboyina Jayaramulu
Assistant Professor, IIT Jammu, India

Kolleboyina Jayaramulu (Ram) is an Assistant Professor in the Department of Chemistry Indian Institute of Technology Jammu, India. He earned a Ph.D. in Materials Chemistry at Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India. His scholarly pursuits have been further enriched by international experiences, having been honored with an Alexander von Humboldt Postdoctoral Fellowship in Germany, as well as an ICMS Postdoctoral Fellowship. Ram is indeed a distinguished member of the prestigious Indian National Young Academy of Sciences (INYAS) (2023–2027). His research expertise is in the design and development of the structure–property relationship of hybrid (2D) porous materials for industrially relevant conditions.

Hybrid Two-dimensional Porous Materials

Kolleboyina Jayaramulu
Hybrid Porous Materials Lab, Department of Chemistry, Indian Institute of Technology Jammu, Jammu & Kashmir, 181221, India
Email: jayaramulu.kolleboyina@iitjammu.ac.in

Metal-Organic frameworks are crystalline materials that comprise metallic clusters and organic ligands with great potential for a diverse range of applications, including but not limited to gas separation and storage, electrocatalysis, water purification, batteries, and supercapacitors. However, their poor conductivity, inaccessible pores, and limited stability hinder their maximum utilization. To overcome these challenges, one solution to this problem is to integrate MOFs with two-dimensional (2D) layer materials to create emerging multifunctional hybrid two-dimensional porous materials. In my presentation, I will discuss our work in integrating 2D materials to create hybrid materials with improved electro and physicochemical properties, broadening their potential applications

Keywords: Coordination Polymers, Energy, Environment, Hybrids, Two-dimensional Materials

Prof. Chockalingam S
Assistant Professor, Department of Biotechnology, NIT Warangal

Dr. Chockalingam joined NIT Warangal as an Assistant Professor in the Department of Biotechnology in 2019. He earned his Ph.D. from the Department of Biosciences and Bioengineering (formerly Department of Biotechnology), IIT Guwahati under the supervision of Prof. Siddhartha Sankar Ghosh. His thesis work is related to the Role of Macrophage Colony Stimulating Factor in Drug Resistance. He was a postdoctoral research fellow with Dr. Karim Malik at the School of Cellular and Molecular Medicine, University of Bristol, UK where he studied the signaling pathways mediated by LGR5 in neuroblastoma. He then joined the lab of Dr. P. Gopinath at the Department of Biotechnology, IIT Roorkee where his research work involved studying the signaling pathways mediated by Cx43 gene. His current research interests include cancer biology, cancer cell signaling and nanobiotechnology.

Academic profile:

1. Ph.D. (Biotechnology): Indian Institute of Technology Guwahati (2008-2014).
2. B. Tech (Industrial Biotechnology)- Government College of Technology Coimbatore, Anna University (2004-2008).

Positions Held:

1. Assistant Professor, Department of Biotechnology, NIT Warangal.
2. Post-Doctoral Fellow, Department of Biotechnology, IIT Roorkee
3. Research Assistant, School of Cellular and Molecular Medicine, University of Bristol, United Kingdom.

Development of Nanoparticle-Based Drug Delivery System to Target ALK Signaling Pathway in Neuroblastoma

S Chockalingam*, Kajal Sandhu, Sreya Prasannakumar
Department of Biotechnology, NIT Warangal
Email: chocks@nitw.ac.in

Neuroblastoma (NB) is a diverse solid tumor primarily affecting infants. Two of the major causative factors of NB are alterations in a receptor tyrosine kinase- ALK (Anaplastic lymphoma kinase) and a transcription factor MYCN. ALK's enigmatic behaviour in NB prompted us to explore for hitherto unknown signaling molecules that can interact with ALK and alter its function in NB. Using various network analysis tools like KEGG, GeneMANIA, and STRING, we found Rspondins (Rspos) to be a potential interacting partner for ALK. Rspondins are a family of growth factors that act as a ligand for various other receptors including LGRs/RNF43/ZNRF3/Syndecan-4 etc. To confirm ALK-Rspo interaction, we conducted protein-protein molecular docking and molecular dynamics simulation to find the stability and persistent binding of the ALK-Rspo complexes. Docked structures were selected based on good cluster size and binding orientation. The results from MD simulation studies confirmed the stable conformation of complexes supported by data from analysis of other parameters like RMSD, RMSF, SASA and radius of gyration.

Parallelly, our exploration extended to the use of nanoparticles in targeting the signaling molecules in NB cells. In this study, we propose a novel therapeutic method for drug delivery using iron oxide ferrogel microbeads fabricated using green synthesized Fe_2O_3 and Fe_3O_4 nanoparticles from *Hibiscus rosa-sinensis* flower and leaf extracts. Drug used for this purpose is clotrimazole (CTZ) which is conventionally an anti-fungal drug but known to inhibit hexokinase, PI3K pathway, and VEGF-mediated signaling pathways. Clotrimazole was encapsulated inside the synthesised iron oxide ferrogel microbeads, and the release of the drug was efficiently controlled using an external magnetic field, enabling targeted and precise delivery. We are currently investigating the potential of clotrimazole to inhibit the ALK-mediated signaling pathway in NB. This research not only contributes to the development of a promising drug delivery system but also highlights the sustainable utilization of natural resources for synthesizing nanoparticles, promoting a greener and more eco-conscious approach to the utilization of nanotechnology in biopharmaceutical applications.

Keywords: Neuroblastoma, Anaplastic lymphoma kinase, Rspondins, clotrimazole (CTZ), ferrogel microbeads.

Prof. Nonappa
Associate Professor at the Faculty of Engineering and Natural Sciences at Tampere University, Finland.

Nonappa is an Associate Professor at the Faculty of Engineering and Natural Sciences at Tampere University, Finland. He received his Ph.D. from the Department of Organic Chemistry, Indian Institute of Science, Bangalore, India. He conducted his postdoctoral research at the University of Jyväskylä and Aalto University, Finland. His research interests include precision nanomaterials, bio-based optics, *in vitro* cancer models, and cryogenic transmission electron microscopy.

Novel Breast Cancer Models: Bridging Preclinical-Clinical Boundaries

Nonappa (e-mail: nonappa@tuni.fi)
Faculty of Engineering and Natural Sciences, Tampere University, FI-33720, Finland.

Breast cancer is the most frequently diagnosed cancer type and is one of the leading causes of cancer-related deaths among women. According to the latest (Global Cancer Observatory report, breast cancer is the most common cancer type in 159 out of 185 countries, with ~12% contributing to the total cancer incidence in 2020. Multiple molecular subtypes, heterogeneity, and complexity make breast cancer challenging to diagnose, treat, and obtain the desired therapeutic outcome. Two-thirds of breast cancers express the luminal estrogen receptor-positive (ERα+) phenotype that is initially responsive to antihormonal therapies, but drug resistance emerges. Furthermore, the ERα+ phenotype is unstable in cultured cells for reasons not fully understood. Recently, we have developed a novel patientderived breast cancer tissue explant culture (PDEC) model based on more than 1000 patient samples cultured in 3D hydrogel matrices (**Figure 1**). I will present how the chemical and mechanobiological cues affect breast tissue hormonal signaling and enable new therapeutic interventions. Finally, I will show our recent demonstration of 3D ex vivo models to control the phenotypic and genotypic plasticity in highly aggressive triple-negative breast cancer (TNBC).

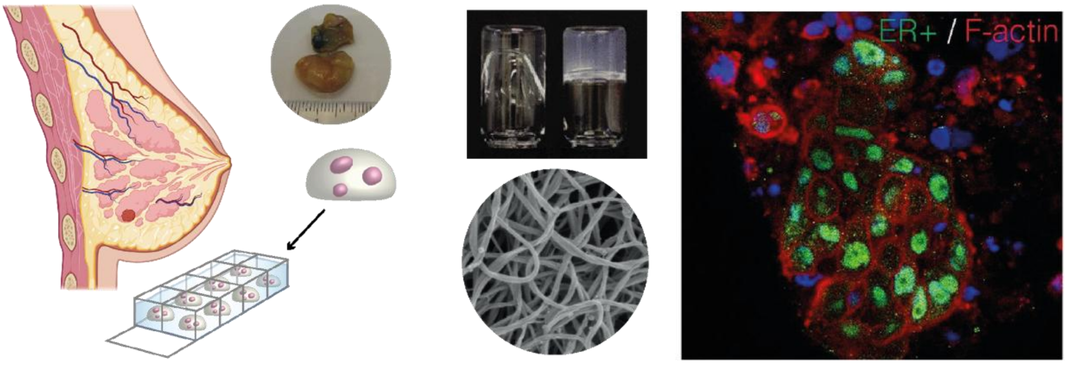
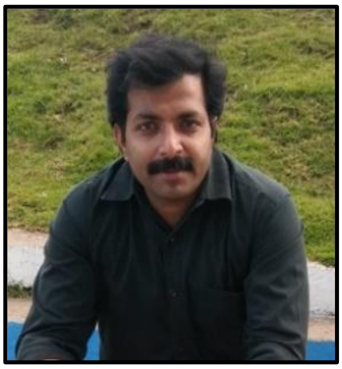


Figure 1. An overview of the *ex vivo* PDEC culture system, hydrogel matrix, and a representative image showing ER+ phenotype

References

1. H. Sung, J. Ferlay, R. L. Siegel, M. Laversanne, I. Soerjomataram, A. Jemal and F. Bray, *Ca-Cancer J. Clin.*, **2021**, 71, 209.
2. B. Firatligil-Yildirir, O. Yalcin-Ozuysal and Nonappa, *Nanoscale Adv.* **2023**, 5, 2375.
3. P. Munne, L. Martikainen, I. Räty, K. Bertula, Nonappa et al. *Nat. Commun.* **2021**, 12, 6967.
4. M. Heilala, A. Lehtonen, O. Arasalo, A. Peura, J. Pokki, O. Ikkala, Nonappa, et al. *Adv. Healthcare* Mater. **2023**,12, 2301137.

Prof. Mahesh Hariharan
Professor, IISER Thiruvananthapuram, India



Mahesh Hariharan is a Professor at School of Chemistry, IISER Thiruvananthapuram. After completing doctoral research (2002-2007) from CSIR-NIIST India with Dr. D. Ramaiah, Dr. Hariharan carried out postdoctoral research (2007–2009) with Prof. F. D. Lewis at Northwestern University. His research efforts focus on understanding the interaction of light with biomolecules, crystalline and twisted organic materials. Prof. Hariharan is an elected fellow of the Indian Academy of Sciences. Prof. Hariharan is the recipient of the Chemical Research Society of India Bronze Medal (2020), Japanese Photochemistry Association Lectureship Award for Asian and Oceanian Photochemist Sponsored by Eikohsha (2020), Distinguished Lectureship Award from the Chemical Society of Japan (2017) and the Asian and Oceanian Photochemistry Association Young Scientist Prize (2014). Prof. Hariharan has featured in the young chemists/scientists issue in ChemComm (2017), Chemistry A European Journal (2018) and The Journal of Physical Chemistry (2019).

Greek Cross (+) Aggregate

Mahesh Hariharan
School of Chemistry, IISER Thiruvananthapuram
Maruthamala P.O., Vithura, Kerala 695551, INDIA
E-mail: mahesh@iisertvm.ac.in

The independent discovery of dye aggregate by Jelley and Scheibe marked the beginning of a spectacular development in the field of aggregate photophysics.[1] Subsequent research warranted an exceptional model for defining the exciton interactions in aggregates, proposed by Kasha and Davydov independently, which was later modified by incorporating the short- range excitonic coupling.[2,3] Apart from the well-studied H- and J-aggregate, achieving the orthogonally cross-stacked assembly possessing null excitonic interactions remained elusive. The first crystalline evidence for the chromophoric Greek cross (+) assembly exhibiting monomer-like optical properties was reported in 2018 (Figure 1).[4] The emergent photophysical properties of the crafted Greek cross (+) architectures were explored using both experimental and computational techniques for understanding the aggregate properties beyond Kasha's model.[5,6] The manifestation of selective hole transfer coupling in the edge-to-edge arranged Greek cross (+) perylenediimide (PDI) dimer resulted in ultrafast dissociation of null exciton and evolution of the charge-separated state in a polar solvent, providing a way forward in the fundamental understanding of null aggregates.[7]

Prof. Kaushik Ghosh
Professor, Institute of Nano Science and Technology, India

Dr. Kaushik Ghosh did his PhD from Meijo University Japan in the year of 2010 from Prof. Sumio Iijima & Prof. Yoshinori Ando's group which are considered to be the birth place of Carbon Nanotube. He had worked on Semiconductor device and CMOS process flow in Nanyang Technological University, Singapore as Research Fellow for 5 years. He had joined in INST, Mohali in the year of 2014. He has published more than 66 peer reviewed international journals, one book and two book chapters. He has H-index of 27. He has developed 10K Class Cleanroom facility known as Nano-Carbon-Fab-Lab in INST, Mohali. His research group is currently focused on the following topics:

- Nanostructured materials for PEC (Photo-Electro-Chemical) and Alternate-PEC water splitting
- Bifunctional catalyst for electrochemical water splitting
- Nano-hybrid materials for energy storage
- Piezo-electric Sensor
- Industrial waste management

Dr Kaushik Ghosh has produced two Doctorate thesis, ten Master thesis and ten research intern thesis. He is currently guiding eight PhD students in his group as supervisor and co-supervising two PhD students jointly with other faculty/institutes.

Porous Carbon Template Decorated with MOF-Driven Bimetallic Phosphide: A suitable Heterostructure for the Production of Uninterrupted Green Hydrogen via Renewable Energy Storage Device

Mohd Afshan, Mansi Pahuja, and Kaushik Ghosh* Institute of Nano Science & Technology, Knowledge City, Sector-81, SAS Nagar,140306, Mohali, Punjab, India *Corresponding Author email: kaushik@inst.ac.in

Water splitting via an uninterrupted electrochemical process through hybrid energy storage devices to generate continuous hydrogen is an economic and green approach to resolve the looming energy and environmental crisis towards the constant supply of hydrogen fuel in fuel cell driven automobile sector. The rational design of bifunctional multicomponent electroactive materials with seamless interfaces having robust stability, facile scalability, and low-cost; is a grand challenge to store the renewable energy and facilitating the continuous production of hydrogen by water electrolysis. The synthesis of dual-function MOF driven bimetallic phosphide is reported here for elucidating their utilization as positive and negative electrodes in electrochemical energy storage devices as well as has been explored their applicability towards overall water splitting. The high surface area MOF driven Bimetallic phosphides (ZnP2@CoP) on top of the 3-Dimentional CNT-carbon cloth matrix has been synthesized by one-step hydrothermal method followed by high temperature phosphorization. The as prepared positive electrode exhibited excellent specific capacitances/capacity of 1600 F g^{-1}/800 C g^{-1} at lower current density of 1 A g^{-1}. The corresponding hybrid supercapacitor assembly reveals an energy density of 83.03 Wh kg^{-1} at a power density of 749.9 W kg^{-1} in addition to a retention rate of 92% after 20K cycles. Simultaneously, it has been demonstrated that the electrocatalytic performance of this material with overpotentials of 90 mV for the HER and 204 mV for the OER at a current density of 10 and 20 mA cm^{-2}, respectively under alkaline electrocatalyzer. Undoubtedly, the catalyst is capable enough for overall water splitting at a low cell voltage of 1.53 V at 10 mA cm^{-2} with a faradic efficiency and STH efficiency of 98.81% and 9.94%, respectively. Density functional theory show that the considerable theoretical capacitance enhancement in ZnP2@CoP results from increasing of density of states (DOS) close to the Fermi level as compared to its monometallic counterpart. In addition, the real phase demonstration of the overall water-splitting where the electrocatalyzer is connected with a series of hybrid supercapacitor devices powered up by the 6V standard silicon solar panel. This prototype technology demonstrates an alternate transformation of solar energy to uninterrupted green H2 production using a hybrid energy storage supercapacitor. This work unveils a smart approach for the development of a highly stable electrode material or electrocatalyst towards the realistic drive of renewable energy storage for the continuous production of green hydrogen.

Keywords: CNTs, bimetallic phosphide (ZnP2@CoP), Hybrid Supercapacitor, Hydrogen evolution reaction (HER), Oxygen evolution reaction (OER), Uninterrupted hydrogen evolution.

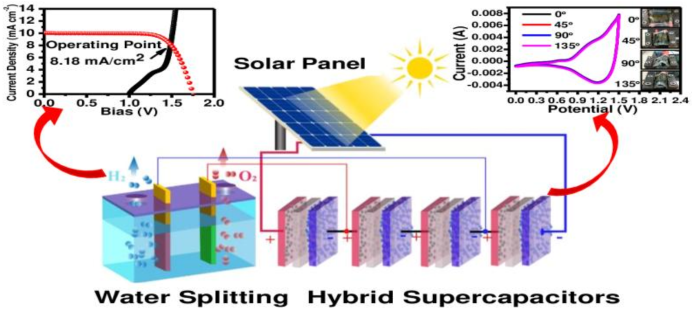


Figure: Integrated assembly of water-electrolyser and solar driven Hybrid supercapacitors devices connected in series to produce uninterrupted hydrogen

Dr. H. S. S. Ramakrishna Matte
Scientist-D, Centre for Nano and Soft Matter Sciences, India

H. S. S. Ramakrishna Matte currently working as a Scientist-D at Centre for Nano and Soft Matter Sciences. He obtained his B.Sc from Government College, Rajahmundry in 2006 and MS, PhD in Chemical Sciences in 2009 and 2013, respectively, under the guidance of Prof. C. N. R. Rao, FRS from the Jawaharlal Nehru Centre for Advanced Scientific Research, working on various aspects of nanomaterials. He did his Postdoc at Northwestern University, USA from 2013-2015 under the guidance of Prof. Mark. C. Hersam and Prof. Tobin. J. Marks in the area of organic solar cells. Later he moved to Prof. Nobert Koch's group at Humboldt University-Berlin to work on doping of organic semiconductors. His current research interests are Printed Electronics, Low-Dimensional Materials, Electrochemical energy storage devices and Organic Photovoltaics. Dr. Matte has published more than 60 research articles in reputed international journals and having 6 patents (granted/applied) to his credit. He has got more than 8300 citations with h-index of 30. He is a member of two prestigious academies of India namely INYAS-INSA and NASI, Associate Fellow-Andhra Pradesh Academy of Sciences, Silver medal from CRS, and also recipient of SRTF grant from French embassy India.

Solution Processing of Low-dimensional Materials and their Applications

H S S Ramakrishna Matte
Centre for Nano and Soft Matter Science, Bengaluru – 562162, India

Low-dimensional Materials like graphene, transition metal dichalcogenides, h-BN, transition metal oxides and layered double hydroxides possess the potential for applications across various fields. Liquid phase exfoliation of these layered crystals enables the solution processing of dispersions of mono- and few-layers, and provides a scalable viable alternative to other physical and chemical routes. The quality of the dispersions and their applicability are dependent on the exfoliation and stabilization of the exfoliated material by the solvent, often chosen on the basis of Hansen solubility parameters (HSP). In this work, the factors at play in liquid phase exfoliation besides HSP are explored via various experimental methods, in order to further enhance the versatility of the process by providing a deeper insight. By considering molecular aspects of the solvents, highly concentrated nanosheet dispersions were obtained in a low boiling point solvent. I will also discuss about experimental determination of the HSP of layered materials. I will be concluding my talk by discussing some of our recent efforts in exfoliating non-layered materials and applications of the 2D dispersions in various fields like flexible electronics, energy storage/conversion devices and electrochemical biosensors.

References

1. P. Chithaiah, Ramesh Chandra Sahoo, Jun Ho Seok, Sang Uck Lee, Matte, H. S. S. R, C.N.R. Rao, ACS Appl. Mater. Inter., 2023, Accepted.
2. Kenneth Lobo, Vijaya Kumar Gangaiah, Chandraraj Alex, Neena S. John, Matte, H. S. S. R., Chem. Euro. J., 2023, e202301596
3. Vishwanathan, Matte, H. S. S. R. Chem Comm, 2023, 59, 9263-9266
4. Ramesh Chandra Sahoo, Sreejesh Moolayadukkam, Jun Ho Seok, Sang Uck Lee, Matte, H. S. S. R., J. Mater, Chem. A, 2023, 13, 7142-7151
5. Savithri Vishwanathan, Sreejesh Moolayadukkam, Vijaya Kumar Gangaiah, Matte, H. S. S. R., ACS Applied Energy Materials, 2023, 6, 2022-2030
6. Kenneth Lobo, Rohit Thakur, S. Krishna Prasad, Matte, H. S. S. R., J. Mater. Chem. C, 2022, 10, 18326-18335
7. Ramesh Chandra Sahoo, Haijiao Lu, Dimple Garg, Zongyou Yin, Matte, H. S. S. R., Carbon, 2022, 192, 101-108.
8. P Sahoo, B Gupta, R C Sahoo, K Vankayala, Matte, H. S. S. R., Chem. Eur. J., 2021, 27, 11326
9. K Lobo, V. K. Gangaiah H. Priya, Matte, H. S. S. R., iScience, 2022, 25, 104120
10. K. Lobo, P. Sahoo, R. Kurapati, V. Patil, A. Pandit, Matte, H. S. S. R., Chem. Eur. J., 2021, 27, 7434-7443.
11. C. Sathiskumar, L. Meesala, P Kumar, B. R. Rao, N. S. John, Matte, H. S. S. R., Sus., Ener. Fuels, 2021, 5, 1406-1414.
12. S. Moolayadukkam, S. Thomas, R. C. Sahoo, C. H. Lee, S. U. Lee, Matte, H S. S. R., ACS Appl. Mater. Inter., 2020, 12, 6193-6204.
13. K. Lobo, S. Trivedi and Matte, H. S. S. R., Nanoscale 2019, 11, 10746-10755.
14. B. Gupta, Matte, H. S. S. R., ACS Appl. Electron. Mater. 2019, 1, 2130-2139.

* Presenting author: matte@cens.res.in

Dr. Siva Rama Krishna Vanjari
IIT Hyderabad, India

Prof. Siva Rama Krishna Vanjari aka Siva Vanjari completed his Ph. D from Indian Institute of Science, Bangalore in 2012 and is working as a faculty in Electrical Engineering, IIT Hyderabad ever since. His primary interests include but not limited to, Electrochemical Sensors, Biosensors and MEMS. He has a good number of publications in those areas. He is one of the key members in the national initiative of promotion of start ups in the area of Fabless Chip Design. He is one of the founding members of Fabless Chip Design Incubator (FabCI).

Flexible Miniaturized Functional Devices based on Silk Fibroin

Dr. Siva Rama Krishna Vanjari
IIT Hyderabad, India

The first thing that comes to mind when one thinks of silk is sarees. Without any iota doubt it can be stated that silk is present in every Indian household more or less. The lesser known fact is that silk is biocompatible and has been in use in several biomedical applications. The even lesser known fact is that silk possesses several exquisite properties. It can be made transparent. It can be moulded into different forms with each and every form having a unique application. The fact that is seldom explored is its piezoelectric nature, optical transparency, triboelectric effect of silk films for device applications. The talk focuses on these aspects. The material development, characterization and their usage in devices is elucidated in detail.

Prof. Abir Ghosh
Professor, IIT (BHU) Varanasi, India

Dr Abir Ghosh is currently an Assistant Professor at the Department of Chemical Engineering & Technology, IIT (BHU) Varanasi. He has completed his PhD from IIT Kanpur and worked as a Postdoctoral Research Associate in the Electrochemical Science and Engineering (ESE) group at Imperial College of London. His areas of expertise are complex fluids, thin films, microfluidics, electrokinetics, Li-ion batteries, and Supercapacitors. He has 15 publications in internationally reputed journals such as the Journal of Fluid Mechanics, Journal of Colloid and Interface Science, Soft Matter, Physics of Fluids, Journal of the Electrochemical Society, Physical Review Fluids, Nanoscale, ACS Applied Materials and Interfaces, ACS Energy Letters among others. He received the Best Poster Award in 2016 at the *3rd Indo-German workshop – Advances in Materials, Reactions & Separation Processes*. He was one of the Panel Members of the '*Collaborative / Cross-disciplinary Working*' session at the November 2019 Conference and Review Meeting of The Faraday Institution, UK (https://faraday.ac.uk/nov-2019-presentations) and also delivered an invited talk. Two of his research papers were selected as feature articles in the reputed '*Physics of Fluids*' journal. More details of his profile can be found at the given link: https://iitbhu.ac.in/dept/che/people/abirche.

Decoding Positive Electrode and Electrode-Electrolyte Interface Degradations: Insights for Next-generation Batteries

The expansion of Li-ion batteries from portable electronics to large-scale transport (electrical aircraft and vehicles) and energy storage applications has made understanding the mechanisms responsible for battery degradation increasingly important. The literature on this multifaceted topic has grown considerably; this talk aims to distil current knowledge into a succinct form to understand battery degradation. I will focus on the degradation of Ni-rich positive electrodes (PEs) like NMC811, which are currently in focus because of their high specific energies. Subsequently, I will emphasize the importance of kinetically stable electrode-electrolyte interfaces in the design of solid-state Batteries (SSBs). The lifetime of the Ni-rich PEs is shortened by faster capacity fading, impedance rise, and loss of active material than other incumbent chemistries. The theoretical understanding behind the PE degradation mechanisms has remained uncovered. We have developed a continuum-scale shrinking core degradation model for NMC811 that undergoes a structural reorganisation involving oxygen loss and the formation of a disordered (spinel or rock-salt structure) passivation layer (PL). The model considers [O] released from the bulk-PL interface and reaction kinetics of the same control reaction rate. Li-entrapment and growth of the PL engender capacity fade. Two limiting cases – '*diffusion and reaction dominated*', manifest with the variation in the relative rates of [O]-diffusion and [O]-release and the thickness of the PL. To reveal the effect of the electrode-electrolyte interface, we have considered a model prototype of such interfaces under the application of an external electric field. A confined system of thin solid viscoelastic polymeric film and deformable porous layer under the application of an external electric field is explored with the help of General Linear Stability Analysis (GLSA). The modified Kelvin-Voigt-Darcy-Brinkman model is used to represent the polymer flow through the porous media. The theoretical analysis unveils the conditions for the inception of the interfacial instabilities. These instabilities can be controlled meticulously by tuning the Darcy and electrical Rayleigh Numbers, which going to be the critical parameter in designing next-generation solid-state batteries.

Prof. Amit Jaiswal
Professor, IIT Mandi, India

Dr. Amit Jaiswal earned his B.Tech. degree in Biotechnology from Heritage Institute of Technology Kolkata in 2008, followed by an M.Tech. in Biotechnology from IIT Guwahati in 2010. He pursued his doctoral studies at the Centre for Nanotechnology, IIT Guwahati, and successfully obtained his Ph.D. degree in 2013. After completing his Ph.D., he conducted post-doctoral research at Washington University in St. Louis, USA, and Technion – Israel Institute of Technology, Haifa. In 2014, Dr. Jaiswal joined IIT Mandi as an assistant professor and currently holds the position of Associate Professor in the School of Biosciences and Bioengineering, IIT Mandi. He is also holding the position of the Associate Dean Research at IIT Mandi. His research focuses on the field of nano-biotechnology. In recognition of his research contributions, he was honored with the Department of Atomic Energy (DAE) Young Scientist Research Award in 2017 and the MAHE Young Scientist Award in 2018. He is also an Associate of the Indian Academy of Sciences. Dr. Jaiswal's research achievements were further acknowledged with the Indian National Science Academy (INSA) medal for young scientists, and his team received the Gandhian Young Technological Innovation Award (GYTI) 2021 appreciation award. He has authored about 50 peer-reviewed journal articles and contributed to 5 book chapters.

Webpage: www.theajlab.com
Email: j.amit@iitmandi.ac.in
Google Scholar Link: https://scholar.google.co.in/citations?user=SxIMTwIAAAAJ&hl=en

Anisotropic Plasmonic Nanostructures for Sensing and Therapeutic Applications

Amit Jaiswal
School of Biosciences and Bioengineering, Indian Institute of Technology Mandi, Kamand, Mandi,
Himachal Pradesh, India. Pincode: 175075
Email: j.amit@iitmandi.ac.in, Webpage: www.thajlab.com

Plasmonic nanostructures based on noble metals, like gold and silver has contributed significantly towards the area sensing and biomedical applications. These materials exhibit unique size and shape dependent optical properties at the nanoscale, enabling precise control over light-matter interactions leading to applications in various fields. Herein, we will discuss about the synthesis and applications of anisotropic plasmonic nanostructures, particularly in the field of SERS based sensing and photothermal therapy. The first part of the talk will provide a comprehensive overview of the fundamental principles underlying the shape and size dependent localized surface plasmon resonance (LSPR) phenomenon of plasmonic nanoparticles. In the second part, we will delve into the diverse applications of noble metal-based plasmonic nanostructures, with a specific focus on photothermal therapy. By utilizing the strong light absorption properties of plasmonic nanostructures, photothermal therapy can be achieved, where targeted heating of tumor cells occurs upon exposure to near-infrared light. This non-invasive technique shows great potential for cancer treatment. Plasmonic nanostructures can also provide highly sensitive SERS substrates for the detection of trace analytes and for bioimaging. By enhancing the Raman signals of reporter molecules plasmonic nanostructures enables imaging and sensing. The applications of anisotropic metal structures for SERS-based sensing will also be discussed.

References:

1. Prem Singh, TA König, **Amit Jaiswal**, NIR-active plasmonic gold nanocapsules synthesized using thermally induced seed twinning for surface-enhanced Raman scattering applications. ***ACS Applied Materials & Interfaces*** (2018) 10(45):39380-90.
2. . Prem Singh, Prakash Haloi, Khushal Singh, Shounak Roy, Ankita Sarkar, B. Siva Lokesh, Rajat Choudhary, Chandrasen Mohite, Saurabh Chawla, V. Badireenath Konkimalla, Pallab Sanpui and **Amit Jaiswal**, Palladium Nanocapsules for Photothermal Therapy in the NIR II Biological Window, ***ACS Applied Materials & Interfaces*** (2023) 15, 33, 39081–39098.
3. Prem Singh, Koustav Kundu, Sezer Seçkin, Keshav Bhardwaj, Tobias A.F. König and **Amit Jaiswal**, The Rise of Structurally Anisotropic Plasmonic Janus Gold Nanostars, ***Chemistry - A European Journal*** (2023), e202302100.

Prof. Nikhil R. Jana
Sr. Professor, School of Materials Science, ICAS, India

Professor Nikhil R. Jana received his PhD in chemistry from Indian Institute of Technology-Kharagpur in 1994. He was a postdoctoral fellow at University of South Carolina (1999-2001) with Professor Catherine J. Murphy and at University of Arkansas (2003) with Professor Xiaogang Peng.

He moved to Singapore in 2004 and worked as a Scientist at the Institute of Bioengineering and Nanotechnology, until he returned to India in 2008 and began his independent research carrier at Indian Association for the Cultivation of Science (IACS). He is currently Sr. Professor at School of Materials Science at IACS.

His laboratory focuses on chemical synthesis of colloidal nanobioconjugate and their application as bioimaging nanoprobe and for prevention/curing of neurodegenerative diseases. He has authored or co-authored about 200 peer-reviewed articles and 3 books on basic and applied science, with a primary focus on tuning of nanoparticle surface chemistry toward various biomedical applications.

Controlling Cellular Processes by Designed Nanoparticle

Nikhil R. Jana
School of Materials Science, Indian Association for the Cultivation of Science, Kolkata-700032
Email: camnrj@iacs.res.in

In past few decades there is significant advancement in biomedical applications of various nanoparticles. Current challenges include designing nanoparticle that can readily cross the cell membrane, target different subcellular compartments and control intracellular processes. We design colloidal nanoparticle/nanobioconjugate of 10-50 nm size and use them to control various cellular processes.1-4 We found that cellular uptake and intracellular function of nanoparticle can be controlled by appropriate chemical design. We show that nanoparticle can be designed for energy independent direct cell translocation (without endocytosis) or preferential lipid raft/caveola-mediated endocytosis as compared to conventional clathrin-mediated endocytosis. Adapting these principles we design nanoprobes that can readily enter into cell, label different subcellular compartments, inhibit intracellular protein aggregation and clear toxic amyloid aggregates via upregulated autophagy. The talk will focus on property of our designed nanoprobes along with various application potentials.

Reference:

1) Jana, N. R. Colloidal Nanoparticles: Functionalization for Biomedical Applications, CRC Press, 2019.
2) Debnath, K.; Pal, S.; Jana, N. R. Acc. Chem. Res. 2021, 54, 2916-2927.
3) Dolai, J.; Mandal, K.; Jana, N. R. ACS Appl. Nano Mater. 2021, 4, 6471-6496.
4) Debnath, K.; Sarkar, A. K.; Jana, Nihar R.; Jana, Nikhil R. Acc. Mater. Res. 2022, 3, 54-66.

Prof. Pankaj Barah
Professor, Tezpur University, India

Dr. Pankaj Barah is an Assistant Professor and holds the prestigious DBT- Ramalingaswami Re-entry Fellowship in the Department of Molecular Biology and Biotechnology at Tezpur University. Dr. Barah is currently a member of the national core committee of the Indian National Young Academy of Sciences (INSA-INYAS).

He earned his M.Sc. degree in Bioinformatics from the University of Madras and completed his Ph.D. in Computational Systems Biology at the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. Dr. Barah's career journey has taken him to diverse corners of the globe. Notably, he worked as a Bioinformatics scientist in the division of Theoretical Bioinformatics at the German Cancer Research Center (DKFZ) in Heidelberg, Germany, from 2015 to 2017. During this period, he contributed significantly to the International Cancer Genome Consortium (ICGC) and the Heidelberg Center for Personalized Oncology (HIPO) projects. He received research experience in esteemed institutes across Europe, including Norway, Denmark, England (Sanger Institute Cambridge, John Innes Centre Norwich), Belgium, Netherlands, Italy, Austria, Portugal, Germany, and France.

Dr. Barah's expertise encompasses a wide range of fields, including systems medicine, bioinformatics, Big data analysis and integration, Machine Learning, Next Generation Sequencing (NGS), metabolomics, and proteomics. He has authored 35 journal articles, edited two books, written five book chapters, and contributed to numerous popular science articles. Currently, he is dedicated to researching rare cancer types that are prevalent in Northeast India using OMICs and systems biology approaches. In recognition of his outstanding contributions to science and research, Dr. Barah has received eight national and eleven international awards and fellowships.

Integrative OMICs and Systems Biology Approach to Gallbladder Cancer Biomarker Discovery

Pankaj Barah
Department of Molecular Biology and Biotechnology, Tezpur University, Napaam, Sonitpur, Assam - 784028, India

Gallbladder cancer (GBC) is an extremely aggressive malignancy often detected in advanced stages, characterized by rapid progression and a significant mortality rate. The advanced disease stage limits the effectiveness of systemic chemotherapy, leaving predominantly palliative care as the primary option. Moreover, more than 75% of GBC patients have gallstones (cholelithiasis), but we still lack a clear understanding of how these gallstones transition to malignancy. This cancer is notably prevalent in North and North Eastern (NE) India, with a two-fold higher incidence in women. This presentation will offer a glimpse into our ongoing research efforts, employing a comprehensive multi-omics strategy to reveal the intricate molecular signatures at the systems level that drive the pathogenesis of GBC. By harnessing big data and advanced machine learning techniques, our goal is to identify diagnostic, prognostic, and therapeutic biomarkers. The outcomes of our research have the potential to shed light on the complex mechanisms underlying GBC pathogenesis and improve its clinical management.

Prof. Dr. Sebastian C. Peter
Professor, New Chemistry Unit & School of Advanced Materials
Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore

Dr. Sebastian C. Peter received his MSc (2000) from St. Thomas College, Thrissur, Calicut University and MTech (2002) from Cochin University of Science and Technology. He received his Ph. D. in chemistry from the University of Münster, Germany (2006). He was a post-doctoral fellow at Max Plank Institute for Chemical Physics of Solids, Dresden, Germany (2006-07) and Northwestern University, USA (2007-10). Dr. Peter joined as a faculty fellow at New Chemistry Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore in 2010. His broad research interests include the development of solid-state inorganic materials for various applications ranging fuel cell, CO2 reduction and in condensed matter physics. He has more than 210 peer reviewed publications and five patents. He was invited and attended around 100 national and international conferences. He is the recipient of Young Investigator awards from ACS (2013), RSC (2017) and IOP (2016). He was awarded Ramanujan fellowship (2010), MRSI medal (2016), SwarnaJayanti Fellowship in the category of Chemical Science (2018) and CRSI medal (2020), SMC Medal (2022) and IAAM fellow (2022). He is a member of American Chemical Society, Royal Society of Chemistry, ASM international, Chemical Research Society of India, Material Research Society of India, International Union of Crystallography, Indian National Young Academy of Science and Society for Material Chemistry of India.

He is the founder and director of the start-up “Breathe Applied Sciences Pvt Ltd” and entered into the final round of the NRG-COSIA XPRIZE 20 million USD prize on waste CO2 utilization. His team is the only one team in final round of the competition earning half a million USD as milestone prize. Breathe Applied Sciences Pvt Ltd has been selected as one of the best 100 start-ups by Karnataka state Government in 2017 through ELEVATE-100. CleanEquity, Monaco (2019) selected CO2 reduction technology as the second best in the global level. In 2021, Technology Development Board of the DST awarded National Technology Award for this development. In Dec 2021, his start-up has been selected as the winner of the KPMG ENRich21 on the theme The Global Corporation: preparing for the Low-Carbon World. He also received National Prize on CO2 reduction and green hydrogen production instituted by CNR Rao foundation and ETU of JNCASR in 2022. Dr. Peter is also featured in the “75 under 50: Scientists Shaping Today's India” by the DST and selected for J C Bose Diamond Jubilee Lecture Award by IAAM. In 2023, Dr. Peter led Breathe to win the competition MaterialsNext 4.0 hosted by Tata Steel. Dr. Peter Received Research Partnerships and Industry Translation Medal from Chirantan Rasayan Sanstha and Materials Science Annual Prize from MRSI in 2023.

Materials and Methodologies in Carbon Recycling for Sustainable Energy and Net Zero Target

Two most imminent scientific and technological problems that mankind is facing now are energy and climate. The energy production and utilization in modern society is mostly based on the combustion of carbonaceous fuels like coal, petroleum and natural gas the combustion of which produces CO_2, which alters earth's carbon cycle. 30 billion of tons of CO_2 per year get emitted globally as waste from the carbonaceous fuel burning and industrial sector, which if converted to valuable chemicals have the potential to change the economy of the world. We, in our lab, are trying to address both issues and are keen upon translating our innovative technologies from the lab to the industrial and commercial scale. In this talk, I will discuss about our recent discoveries of materials based on intermetallics, chalcogenides, oxides, organic-inorganic hybrids, etc as efficient catalysts for the conversion of CO_2 to chemicals/fuels. [1-15] We are capturing CO_2 from industrial flue stream and converting it to value added chemicals/fuels such as methanol, CO, methane, dimethyl ether, C2-C5 & C5-C11 gasoline hydrocarbons. Catalyst design is at the heart of all these technologies, and we have developed customized catalyst systems for targeted product conversions as per the need of different industries. Development of these catalyst via various methods, the driving force behind the enhancement in activity and the mechanistic pathways will be explained with the support of various in-situ (DRIFTS, IR, XAFS), ex-situ (XPS, XRD, IR, XAFS) and theoretical (DFT calculation) studies. The talk also will cover the industrial viability of these catalysts.

References

[1] Paul, R. Das, N. Das, S. Chakraborty, C-W. Pao, Q-T. Trinh, G. T. K. K. Gunassoriya, J. Mondal, Angew. Chem. Int. Edn. 2023, DOI: https://doi.org/10.1002/anie.202311304.

[2] S. Mohata, R. Das, K. Koner, S. Chakraborty, Y. Ogaeri, Y. Nishiyama, S. C. Peter, R. Banerjee, J. Am. Chem. Soc. 2023, https://doi.org/10.1021/jacs.3c08688.

[3] R. Das, R. Das, B. Ray, C. P. Vinod, S. C. Peter, Energy & Environ. Sci. 2022, 15, 1967-1976.

[4] R. Das, R. Paul, A. Parui, A. Shrotri, C. Atzori, K. A. Lomachenko, K. A.; Singh, J. Mondal, S. C. Peter, J. Am. Chem. Soc. 2023, 145, 422-435.

[5] S. Chakraborty, R. Das, K. Das, A. K. Singh, D. Bagchi, C. P. Vinod, S. C. Peter, Angew. Chem. Int. Edn. 2023, 62, e202216613.

[6] K. Das, R. Das, M. Riyaz, A. Parui, D. Bagchi, A. K. Singh, A. K. Singh, C. P. Vinod, S. C. Peter, Adv. Mater. 2023, 35, 2205994.

[7] D. Bagchi, J. Raj, A. K. Singh, A. Cherevotan, S. Roy, K. S. Manoj, C. P. Vinod, S. C. Peter, Adv. Mater. 2022, 34, 2109426.

[8] D. Bagchi, S. Sarkar, A. K. Singh, C. P. Vinod, S. C. Peter, ACS Nano 2022, 16, 6185–6196.

[9] S. Sarkar, J. Raj, D. Bagchi, A. Cherevotan, C. P. Vinod, S. C. Peter, EES Catalysis, 2022, 1, 162-170.

[10] D. Goud, S. R. Churipard, D. Bagchi, A. K. Singh, M. Riyaz, C. P. Vinod, S. C. Peter, ACS Catal. 2022, 12, 11118–11128.

[11] A. Cherevotan, B. Ray, A. Yadav, D. Bagchi, A. K. Singh, M. Riyaz, S. R. Churipard, V. Naral, K. Kaur, U. K. Gautam, C. P. Vinod, S. C. Peter, J. Mater. Chem. A 2022, 10, 18354-18362.

[12] A. Cherevotan, B. Ray, S. R. Churipard, K. Kaur, U. K. Gautam, C. P. Vinod, S. C. Peter, Appl. Catal. B, 2022, 317, 121692.

[13] R. Das, S. Sarkar, R. Kumar, S. D. Ramarao, A. Cherevotan, M. Jasil, C. P. Vinod, A. K. Singh, S. C. Peter, ACS Catal., 2022, 12, 687-697.

[14] A. Cherevotan, J. Raj, L. Dheer, S. Roy, S. Sarkar, R. Das, C. P. Vinod, S. Xu, P. Wells, U. V. Waghmare, S. C. Peter, ACS Energy Lett., 2021, 6, 509-516.

[15] R. Das, S. Chakraborty, S. C. Peter, ACS Energy Lett., 2021, 6, 3270–3274.

Prof. Gagan Kumar
Department of Physics, IIT Guwahati

Prof. Gagan Kumar is a distinguished professor currently serving at the Indian Institute of Technology Guwahati (IITG). Dr. Kumar earned his Ph.D. from the Indian Institute of Technology, Delhi, and further enriched his academic journey with post-doctoral research experiences at the University of Maryland, USA, and the University of Utah, USA.

Joinning IITG in 2013 as an Assistant Professor, Dr. Kumar has made significant contricutions to the field of tetrahertz plasmonic, metamaterials and waveguide devices. His expertise and research interests span a wide range of cutting-edge areas, making him a prominent figure in the academic community.

Terahertz Photonics

The field of terahertz photonics has grown rapidly owing to its immense potential in developing next-generation devices and components [1]. In view of the increasing demand for high-speed communication and bandwidth, the development of photonic components at terahertz frequencies is crucial. The advent of artificially designed materials, known as metamaterials, has given a new dimension to the development of terahertz photonic components. In my talk, I shall discuss the basics of terahertz frequencies, their generation, detection, and the building of terahertz photonic components using metamaterials for applications in 6G or beyond. Recently, we have fabricated several metasurfaces in the clean room ambience of IIT Guwahati with the motive to demonstrate terahertz photonic components resulting in polarisation conversion, slow light phenomena, logic gate operations, and electromagnetically induced transparency [2, 3]. The talk will cover the process technology involved in the fabrication of photonic devices and their characterization using terahertz spectroscopy. Recent research results through theory, numerical simulations, and experiments conducted in the terahertz photonics lab of IIT Guwahati will also be discussed.

References

[1]. Masayoshi Tonouchi, Cutting-edge terahertz technology. Nature Photonics volume 1, 97 (2007.

[2]. A. Bhattacharya, R. Sarkar, and G. Kumar, Toroidal electromagnetically induced transparency based meta-surfaces and its applications, iScience 25(1), 103708 (2022).

[3]. R Sarkar, A Bhattacharya, A Punjal, SS Prabhu, G Kumar, Broadband terahertz polarization conversion using a planar toroidal metamaterial, Journal of Applied Physics 132 (18), 183103 (2022).

Prof. Dibyendu Das
Professor, Department of Chemical Sciences
IISER Kolkata

Dibyendu Das is an Associate Professor at the Department of Chemical Sciences of IISER Kolkata, West Bengal, India. He obtained his Ph. D. at Indian Association for the Cultivation of Science (IACS), India and postdoctoral training from Emory University, USA. His research group is interested in emerging field of systems chemistry, chemical evolution and peptide nanotechnology.

Awards and Distinctions

1. Awarded CRSI Bronze Medal for the year 2023.
2. Featured in "75 under 50 scientists shaping today's India" compendium. On National Science Day, Honorable Minister of State for the Ministry of Science &Technology, Dr Jitendra Singh released this coffee table book published by Vigyan Prasar. The book mentions the profiles of 75 scientists under the age of 50 shaping today’s India.
3. Awarded Swarnajayanti Fellowship in Chemical Science 2020, DST, Govt of India. (https://dst.gov.in/swarna-jayanti-fellow-develop-intelligent-materials-taking-inspiration-living-matter).
4. Article featured in the virtual issue of the JACS Early Career Investigators as an outstanding work published in 2020.
5. Awarded Indian Peptide Society-Young Scientist Award (IPS-YSA) for excellence in Peptide Research for the year 2021.
6. Awarded CRSI Young Investigator Award 2021 at 27th CRSI National Symposium in Chemistry organized by IISER Kolkata
7. Early Career Advisory Board of ACS Chemical Reviews 2020-2021.
8. Selected as an Associate of the Indian Academy of Sciences (IASc) 2019.
9. Advisory Board of Materials Horizons, 2021.
10. International Advisory Board (IAB) of AsianJOC, 2021 onwards.
11. Awarded INSPIRE Faculty Fellowship from DST, Govt. of India.
12. Articles Featured in the Emerging Investigator Issue Chemical Society Reviews 2022 and Chemical Communications 2020.

Adaptive Life Inspired Nanomaterials via Systems Chemistry

There remain critical gaps in our understanding of the emergence of functional biopolymers in the origins of Earth's biosphere. Extant proteins, evolved over millions of years, carry out an impressive array of responsibilities, from catalysis and molecular recognition to motility and compartmentalization. One of the major goals of our lab is to investigate the possible origins of advanced enzymatic functions from folds of short peptide based paracrystalline phases.[1-2] Further, we are excited about understanding the non-equilibrium structures of living systems. I will show our recent discoveries of simple chemical systems that can be substrate-driven to access higher energy self-assembled states, just as seen in natural microtubules. Further, I will attempt to sketch our aims of developing self-assembled autonomous materials that can show temporal control of functions.[3-7]

Keywords: short peptide; non-equilibrium; self-assembly; autonomous materials; microtubules.

References

1. B. Sarkhel, A. Chatterjee and D. Das*. J. Am. Chem. Soc. 2020 142 4098-4103.
2. S.P. Afrose, C. Mahato, P. Sharma, L. Roy, and D. Das*. J. Am. Chem. Soc. 2022, 144, 673-678.
3. S. Pal, A. Reja, S. Bal, B. Tikader and D. Das* Angew. Chem. Int. Ed. 2022, e202111857.
4. S. Bal, C. Ghosh, P. Parvin and D.Das* Nano Lett. 2023(ASAP:10.1021/acs.nanolett.3c03135).
5. S. Goswami, A. Reja, S. Pal, A. Singh, and D. Das *. J. Am. Chem. Soc. 2022 144, 42, 19248–19252
6. A. Reja, S. Pal, K. Mahato, B. Saha, M. D. Piane, G.M. Pavan, and D. Das* J. Am. Chem. Soc. 2023, 145, 38, 21114–21121
7. C. Ghosh, S. Ghosh, A. Chatterjee, P. Bera, D. Mampallil, P. Ghosh and D. Das Nat. Commun. 2023 14, 5903

Prof. Kusum K Bania
Professor, Department of Chemical Sciences
Tezpur University, India

Prof. Kusum K. Bania studied chemistry and obtained M.Sc. from Gauhati University in 2005. He did his Ph.D. from Tezpur University. Dr. Bania did his postdoctoral research from RMIT University, Melbourne Australia and University College London, UK. Currently his research interest is heterogeneous catalysis, fine chemical synthesis, and fuel cells. He is a recipient of Indo-Australia Early Mid-Career Research Fellowship by INSA, Govt. of India. He was conferred with prestigious JN Baruah Memorial Award by CSIR-NEIST, Jorhat, Assam. He is a member of American Chemical Society, Life member of CRSI and MRSI.

Research Interests:

- Catalysis
- Fine Chemical Synthesis
- Fuel Cells

Awards and Honours:

- Indo-Australia Early Mid-Career Research Fellowship by INSA, Govt. of India
- American Chemical Society Membership Award
- JN Baruah Memorial Award

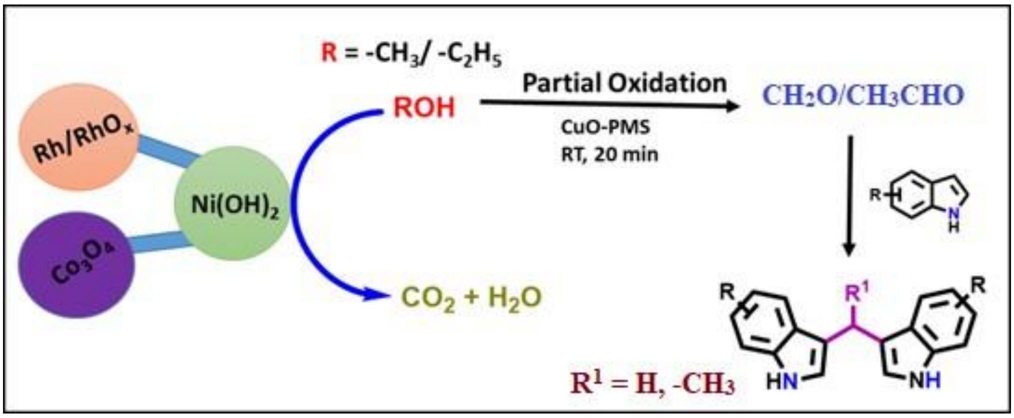
Positions Held:

- Assistant professor at Tezpur university from 2009-2021
- Associate Professor at Tezpur University from 2021-2023
- Currently working as Professor at Tezpur University

.

Nanocatalysts for Utilization for C1 and C2 Alcohols in Clean Energy Production and Fine Chemical Synthesis

In the current apprehension about environmental pollution and climate change, methanol and ethanol appeared to be important sources of fuel in the development of alcohol fuel cell (AFC). In concern with these, few nonmaterials are designed that can find application as anode materials in AFC. The $Ni(OH)_2$ nano tubules decorated in Co_3O_4 represented a high current density of ~4.2 Amg^{-1} at an onset potential of ~1.4 V vs. RHE in MOR [1]. At the same time, Rh-Ni hybrid catalyst in zeolite-carbon matrix exhibited significant activity in both methanol and ethanol oxidation reactions (MOR/EOR) [2]. Apart from the applicability of these C1 and C2 in AFC, nanocatalysts are synthesized that can promote the partial decomposition of these alcohols and facilitates the replacement of volatile formaldehyde (HCHO) and acetaldehyde (CH_3CHO) in different organic synthesis reactions. In this context, bulk CuO nanocatalyst was found to do the in-situ oxidation of methanol and ethanol by activating peroxy-monosulfate which further underwent the condensation with indole to yield 3,3'-bis(indolyl)methanes [3].



Keywords: Copper oxide, Ethanol, Methanol, Nickel hydroxide

References

[1] *ACS Applied Energy Materials*, 5(10):12651-12662, 2022.

[2] *ACS Applied Energy Materials*, 5(5):6118-6128, 2022.

[3] *Green Chemistry*, 25(9):3443-3448, 2023.

Prof. Dipyaman Ganguly

Principal Scientist & Professor, CSIR- Indian Institute of Chemical Biology, Kolkata, India

Dipyaman Ganguly is a physician-scientist and human immunologist with major research interests in role of dendritic cells in autoreactive inflammation and role of mechanosensing in human immune cells. He did his MBBS from Medical College, Kolkata (2001), PhD in Biotechnology from CSIR-Indian Institute of Chemical Biology, Kolkata (2006) and PhD in Immunology from UT MD Anderson Cancer Center, Houston, USA (2010). After postdoctoral stint in Columbia University, New York City, USA, he started his laboratory in CSIR-IICB in 2013. He is a recipient of NASI-Scopus Young Scientist Award in Medicine (2017), Swarnajayanti Fellowship from Dept. of Science and Technology (2017), National Bioscience Award from Dept. of Biotechnology (2018), CDRI Award (2018), Merck Young Scientist Award (2019) and Shanti Swarup Bhatnagar Award in Medical Sciences (2022).

Physical Cues for Immune Regulation: Piezo1 Mechanosensors

Myriad immune cells work with each other following evolutionarily emerged division of labour to achieve protective immunity in the body. Immune regulation involves different cell-intrinsic and extrinsic cues that control specific immunocellular function. The regulatory cues are mostly deciphered to be mediated by biochemical mechanisms involving various interacting biomolecules expressed by the immune cells. However, immune cells do experience different physical cues as well, while performing their key functions in the body, be it antigen recognition by T cell receptors, immune cell migration or phagocytic mechanisms. Thus, it is imperative that biomolecules expressed by immune cells and having the ability to sense such physical cues may play crucial role in immune regulation. Piezo1 ion channel was discovered to be a mechanosensing membrane protein that can sense plasma membrane tension and respond by calcium influx into the cells. Our group was first to report a regulatory mechanism in human T cells wherein Piezo1 activation play a crucial role in optimising T cell activation. Following this, other groups have found important role of Piezo1 mechanosesning in the function of dendritic cells and macrophages. We have also shown that during chemotactic migration of human T cells Piezo1 take part in the outside-in signaling by sensing physical cues. In a more recent work, we find that Piezo1 deployment can regulate endosomal trafficking in a subset of dendritic cells. Thus, exploring Piezo1 mechanosensing in immune cells opens up a very new avenue of research to enrich our understanding about how physical cues experienced by different immune cells may regulate the immune response. Apart from elucidating fundamental immune mechanisms, these insights may prove to be very important in translational endeavours targeting immune cells.

Prof. Ritu Gupta

Professor, Department of Chemistry, IIT Delhi, India

Dr. Ritu Gupta did her bachelor's from Miranda House and completed her MS-Ph.D. dual degree at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) in Bangalore in November 2013, under the guidance of Professor Giridhar U. Kulkarni. Following her doctoral studies, she conducted postdoctoral research with Prof. Timothy S. Fisher at Purdue University's Birck Nanotechnology Centre in the USA.

In 2015, she joined IIT Jodhpur as an Assistant Professor, becoming the youngest faculty member in the department. She served as an Associate Professor in the Department of Chemistry at the Indian Institute of Technology Jodhpur until June 2023. Currently, she holds the position of Associate Professor at Department of Chemistry, IIT Delhi.

Her research group focuses on advancing scalable synthesis methods and developing functional nanomaterials for use in devices, particularly in the fabrication of sensors for environmental monitoring and healthcare applications. She also works on developing electrocatalytic materials for electrochromic and energy storage applications. She has received several awards and recognitions. INSA Young Scientist Medal 2020, NASI-Platinum Jubilee Award 2021 and IAS Associateship 2021, Institute Young Researcher Award-2021 from IIT Jodhpur and Women Excellence Award-2021, SERB, India.

Tin Oxide-Based Nanomaterials for Environmental Gas/VOC Sensing

[1]Advanced Materials and Devices Laboratory, Department of Chemistry
Indian Institute of Technology Delhi, Delhi-110016, India
[2]Department of Chemistry, Indian Institute of Technology Jodhpur, Jodhpur, Rajasthan-342037, India

Extensive usage of toxic, flammable, and explosive gases/Volatile Organic Compounds (VOCs) in industry induces tremendous environmental pollution, leading to a threat to living organisms. Therefore, there is a requirement for continuous monitoring of VOCs/gases using cost-effective, highly selective, sensitive, environmentally stable sensors. So, our work focuses on different approaches to modify the SnO_2 for developing low-temperature operable humidity-tolerant VOC/gas sensors. In the SnO_2-rGO nanohybrid device identified through a combinatorial approach, optimum morphology and structure along with the intrinsic Sn-C bond exhibited a significant response of ~3 to a low concentration of 80 ppm NO_2 at room temperature operation and fluctuating humidity.[1] We synthesized Sn-SnO2 as a sensing material with unique mesoporous nano-spherical morphology, providing a high specific surface area for selective and sensitive detection of xylene at room temperature with humidity tolerant characteristics.[2] In another study, we carefully tuned the pH conditions of the precursor solution for optimized size, crystallinity, and porosity of SnO_2 nanosheets for excellent ammonia detection in simulated diseased breath.[3] The optimized substitutional fluorine doping in SnO_2 film results in high conductivity, hydrophobicity, transparency, reduction in oxygen defects, and excellent electrochemical stability. Consequently, the fabricated F-SnO_2 sensor showed a humidity-resistant nature with the highest response of 52% towards triethylamine at a relatively low operating temperature.[4] Thus, the gas and VOC sensors developed in our laboratory can be deployed for real-time sensing after miniaturization and integration with the AIoT platform.

References:

(1) Verma, M.; Bahuguna, G.; Shukla, S.; Gupta, R.* ACS Appl. Nano Mater. 2022, 5 (12), 19053–19061.

(2) Verma, M.; Bahuguna, G.; Saharan, A.; Gaur, S.; Haick, H.; Gupta, R.* ACS Appl. Mater. Interfaces 2023, 15 (4), 5512–5520.

(3) Verma, M.; Bahuguna, G.; Singh, S.; Haick, H.; Gupta, R.* Porous SnO2 Nanosheets for Room Temperature and Humidity Tolerant Ammonia Sensing. 2023 (In review).

(4) Bahuguna, G.#; Verma, M.#; Gupta, R.* J. Mater. Chem. A 2021, 9 (35), 19965–19974.

Dr. Prashant Kumar,
Chief Scientific Officer, Karakinos Healthcare Research Director, Karkinos Foundation

Dr. Prashant Kumar brings along with him vast expertise & accomplishments in the field of Cancer Biology and has done extensive research to enhance the translational merits of cancer research. He had established multiple collaborations, and attracted several grants funding from both national and international sources. He is a recipient of many prestigious awards and industry recognitions that include Ramanujan Fellowship awarded by the Department of Science and Technology (DST), Government of India, National Award for Excellence in Academic Clinical Research from the Indian Society for Clinical Research (ISCR) to name a few. The illustrious work experience of Dr. Kumar spans across various prestigious institutions/organizations such as Indian Institute of Science (IISc), Bangalore, Max Planck Institute for Infection Biology, Department of Molecular Biology, Berlin, Germany, Department of Cancer Biology, University of Massachusetts (UMASS) Medical School, Worcester, USA, Institute of Molecular and Cell Biology (IMCB), A-STAR Singapore and his entrepreneurial venture Institute of Bioinformatics (IOB) at Bengaluru..Dr. Kumar worked in several path-breaking research initiatives that includes establishing a novel mouse model of malignant breast cancers, establishment of a culture method to assess circulating tumor cells (CTCs) from breast cancers, implementation of cutting-edge technologies in genomics, proteomics to investigate biomarkers and therapeutic targets and his efforts to accelerated discovery in the advancement towards cancer vaccines, precision medicine, molecular diagnostics, bioengineering, and artificial intelligence to name a few. Another major contribution he made in the area of bladder cancer, where his discovery of a biomarker panel for the early diagnosis of bladder cancer was pursued by industry to commercialize it for routine clinical use. This is an important achievement in the clinical community of urologists since, as still today, there are no reliable biomarkers for bladder cancer, which includes the two FDA-approved diagnostic kits. He serves on the Editorial Board of Frontiers in Cell and Developmental Biology, Annals of Research in Oncology and Cancer Molecular Targets and Therapeutics, Frontiers in Oncology and Frontiers in Pharmacology; and, on the scientific advisory committee of various Industry and private organizations. Dr. Kumar received his Ph.D. in 2009 from the Max Planck Institute for Infection Biology, Department of Molecular Biology, Berlin, Germany. Did his postdoctoral work in the laboratory of Prof. Karl Simin at the Department of Cancer Biology, University of Massachusetts (UMASS) Medical School, Worcester, USA. To further advance his research stint, he joined Prof. Jean-Paul Thiery, a world renowned authority in the area of EMT (Epithelial-Mesenchymal Transition) at the Institute of Molecular and Cell Biology (IMCB), A-STAR Singapore.

Advancements in Precision Oncology: Transforming Cancer Care Through Multi-Omics Approaches

Advancements in precision medicine are at the forefront of a paradigm shift in cancer care, fundamentally transforming the way we understand and treat cancer. This approach harnesses the power of genomics, targeted therapies, and cutting-edge technologies to provide individualized treatment plans for cancer patients. By studying genetic, molecular, and cellular characteristics of the patient's cancer, the clinicians and scientists can make more informed decisions that are individualized. Large-scale studies such as The Cancer Genome Atlas (TCGA) and the International Cancer Genome Consortium (ICGC) have played pivotal roles in advancing the field of precision medicine. These initiatives have provided resources for comprehensively characterizing the genetic and molecular landscapes of various cancers. Through the collaborative efforts of researchers worldwide, these studies have identified countless genetic mutations, structural variations, and expression patterns specific to different cancer types, leading to a deeper understanding of the disease. This wealth of genomic information has not only facilitated the discovery of new therapeutic targets but has also allowed for the development of more accurate diagnostic tools and personalized treatment strategies. As a result, patients can benefit from more precise and effective interventions, minimizing the trial-and-error approach of traditional cancer treatments and significantly improving the chances of successful outcomes. Large-scale studies like TCGA and ICGC have laid the foundation for the transformation of cancer care through the lens of precision medicine. These studies have identified countless genetic mutations, structural variations, and gene expression signatures for each cancer type, leading to a deeper understanding of intra and intertumoral heterogeneity prevalent within cancers and has shed light on population specific genetic changes. Moreover, several of these alterations serve as important diagnostic, prognostic, and potential therapeutic targets. Discoveries like BCR-ABL in CML, EGFR mutations and ALK rearrangement in lung cancer, HER2 amplification and BRCA mutations in breast cancer have radically transformed the management of these cancers and paved the way for establishment of NGS as a routinely employed diagnostic technique. At Karkinos, we harness the power of state-of-the-art sequencing technologies to employ comprehensive genomic profiling (CGP), whole genome sequencing (WGS), whole exome sequencing (WES), and a suite of cutting-edge molecular techniques. Our aim is to gain profound insights into pan-cancer prognostic markers and therapeutic targets. Through innovative methods like liquid biopsy, we continuously monitor disease burden in our cancer patients. While we maintain a comprehensive focus across various cancer types, including breast, lung, glioma, colorectal, cervical and gallbladder, our research extends beyond conventional boundaries. The application of multi-omics approaches in our in-depth studies of these cancers, pushing the boundaries of knowledge in the quest for more effective treatments and improved patient outcomes.

Prof. Dinesh Shetty

Professor, Department of Chemistry, College of Arts and Science, Khalifa University, Abu Dhabi, UAE

Dr. Dinesh Shetty is an Assistant Professor of Chemistry in the College of Arts and Science, Khalifa University since fall-2019. He holds Ph.D. in chemistry from Seoul National University (SNU), South Korea. From 2011 to 2013, he was a postdoctoral fellow at Winship Cancer Institute, Emory University, USA, and later moved back to South Korea in the year 2013 where he was a research fellow in the group of Professor Kimoon Kim at the Center for Self-assembly and Complexity, Institute for Basic Science, POSTECH. In 2016, he moved to New York University Abu Dhabi as a research scientist. He is a trained chemist with experience in multidisciplinary research areas including material science, porous materials, renewable energy, water purification, supramolecular chemistry, and biomedical science. He is the author over 60 peer-reviewed journal papers, 32 conference papers, 20 invited talks, and 6 patents with an h-index of 29.

He received Young Investigator Award from the Korean Society of Nuclear Medicine and the Best Researcher Award from the Korean Cancer Research Foundation. He is the recipient of the US National Academy of Science Arab-American Frontiers seed grant and ERASMUS grant. His research accomplishments are recognized as one of the future leaders in the field and his author profile was recently introduced by Angewandte Chemistry International Edition, a flagship chemistry journal. He delivered research talks in multiple countries and is currently an active member of the Royal Society of Chemistry under the Future Leaders in the Filed category. In his free time, he writes poems and newspaper column articles and also podcasts his thoughts. His research interest is focused on the development of multifunctional materials for various applications including energy, water purification, and biomedical applications.

A list of publications can be found at:
Google Scholar:
https://scholar.google.com/citations?hl=en&user=QVgucAQAAAAJ&view_op=list_works&sortby=pubdate

Focus on Energy & Environmental Applications: Can Framework Materials Listen to Your Tunes?

Porous framework materials such as covalent organic frameworks (COFs) and conjugate metal organic frameworks (c-MOFs) have gained significant attention in the scientific community for a wide array of applications because of their attractive physical and chemical properties.[1,2] However, the functional tunability of these frameworks, which is highly important for many critical applications, is generally limited to the strategic selection of molecular building blocks.[3] In this regard, a simple method to tune the physiochemical properties of COFs/c-MOFs in their macroscopic architecture (powder or membrane) is fundamentally attractive and highly useful for technology transfer. Recently, we have successfully adapted multiple strategies to synthesize either powder or the free-standing membranes of COFs/c-MOFs and introduced a novel pre- synthetically controlled framework growth strategy to tune the properties.[3-6] We have explored these tunable materials for water purification, CO_2 conversion, and energy storage.[7-10] Notably, the results obtained by these novel materials are significantly superior to those from most materials reported previously. Our materials' high efficiency and ease of implementation demonstrate the advantages of our findings and bode well for the development of framework-based materials for energy and environmental applications. I will discuss material design, synthesis, and their application outcome during the talk.

Keywords: porous materials; covalent organic frameworks; c-MOFs; water purification; photocatalysis

References

[1] Matsumoto, M., Valentino, L., Stiehl, G. M., Balch, H. B., Corcos, A. R., Wang, F., Ralph, D. C., Mariñas, B. J., Dichtel, W. R. *Chem*, **2018**, *4*, 308–317.

[2] Mohammed, A. K. **Shetty, D.*,** *Environ. Sci.: Water Res. Technol.* **2021***, 7,* 1895–1927.

[3] Mohammed, A. K., Alkhoori, A. A., Addicoat, M. A., Varghese, S., Othman, I., Jaoude, M. A., Polychronopoulou, K., Baias, M., Haija, M. A., **Shetty, D.*** *Angew. Chem. Int. Ed.* **2022**, https://doi.org/10.1002/ange.202200905

[4] Garai, B., **Shetty, D***., Skorjanc, T., Gandara, F., Naleem, N., Varghese, S., Sharma, S. K., Baias, M., Jagannathan, R., Olson, M. A., Kirmizialtin, S., Trabolsi, A.*, *J. Am. Chem. Soc.*, **2021**, 143, 3407-3415.

[5] Mohammed, A. K.; Raya, J.; Pandikassala, A.; Addicoat, M. A.; Gaber, S.; Aslam, M.; Ali, L.; Kurungot, S.; **Shetty, D.*** *Angew. Chem. Int. Ed.*, **2023**, e202304313

[6] Mohammed, A.K.; Pena-Sánchez, P.; Pandikassala, A.; Gaber, S.; AlKhoori, A.A.; Skorjanc, T.; Polychronopoulou, K.; Kurungot, S.; Gándara, F. **Shetty, D.*** *Chem. Commun.,* **2023**, *59*, 2608-2611

[7] Skorjanc, T., **Shetty, D***., Mahmoud, M., Gandara, F., Jose, M., Mohamed, A., Boutros, S., Areez, M., Shehayeb, E., Sharabati, C., Raya, J., Gardonio, S., Hmadeh, M., Kaafarani, B.*, Trabolsi, A*. *ACS Appl. Mater. Interfaces,* **2021**, *14*, 1, 2015–2022

[8] Skorjanc, T., Kamal, K. M., Alkoori, A., Mali, G., Mohammed, A. K., Asfari, Z., Polychronopoulou, K., Likozar, B., Trabolsi, A*., **Shetty, D*.** *ACS Appl. Mater. Interfaces*, **2022,** *14,* 30796–30801.

[9] Skorjanc, T.; **Shetty, D.*;** Gandara, F.; Pascal, S.; Naleem, N.; Abubakar, S.; Ali, L.; Mohammed, A. K.; Raya, J.;Kirmizialtin, S., Siri, O.; Trabolsi, A.* *ACS Appl. Mater. Interfaces*, **2022**, *14*, 34, 39293–39298

[10] Mohammed, A. K.; Ali, J. K.; Kuzhimully, M. S.; Addicoat, M. A.; Varghese, S.; Baias, M.; Alhseinat, E.*; **Shetty, D.*** *Chem. Eng. J.*, **2023**, *466*, 143234

Prof. Uttam Manna
Professor, Department of Chemistry & Centre for Nanotechnology
Indian Institute of Technology Guwahati, Assam, India

Uttam Manna, Fellow of Royal Society of Chemistry (FRSC), is currently an associate professor at Department of Chemistry—and also affiliated with Centre for Nanotechnology and Jyoti and Bhupat Mehta School of Health Sciences and Technology in Indian Institute of Technology, Guwahati (IITG). He completed his Integrated PhD from IISc Bangalore in 2011. He pursued his post-doctoral research from University of Wisconsin-Madison, USA. He is recognized as an emerging investigator by Journal of Materials Chemistry A (2018), Chemical Communications (2020), Nanoscale (2021) and Chemical Society Reviews (2022). In 2023, Chemical Communications journal also recognized him as a pioneering investigator. He received the CRSI Bronze Medal for the year 2023. He is also a recipient of the Humboldt Research Fellowship for Experienced Researchers in 2021.

His research team is interested in designing functional and durable coatings embedded with bio-inspired wettability through the strategic association of robust and facile chemical approaches for energy, environment and health related different applications—including efficient oil/water separation, improving performance of water splitting, self-cleaning, chemical sensing, programmed release of small molecule, anticounterfeiting, no-loss liquid transport, strain sensing, joule heating etc.

https://uttammannaiitg.wixsite.com/polymericlab

Influence of Air-Bubble Adhesion on Hydrogen Evolution Reaction

Uttam Manna*
Department of Chemistry, Centre for Nanotechnology and Jyoti and Bhupat Mehta School of Health Science and Technology
Indian Institute of Technology Guwahati Email: umanna@iitg.ac.in

The nature-inspired wettabilities that either extremely repelled or allowed effortless sliding of different liquids (oil/water) in air or underwater are with immense potential for various prospective applications.[1-9] In common practice, essential chemistry and appropriate topography that conferred the special liquid wettabilities were mostly and generally achieved by associating delicate chemistry. Eventually, the synthesized materials suffered from poor durability issues. In the literature, very few designs are capable of providing durable bio-inspired wettability—but fabrication processes remain generally complex. In this invited talk I will discuss on the principle of designing durable liquid wettability[1-8] and will discuss the influence of air-bubble adhesion on electrochemical hydrogen evolution reaction (HER).[9] The produced hydrogen gas bubbles often adhered to the electrode surface and blocked the active catalytic site. While different catalysts are developed to improve the catalytic performance of HER, the design of a durable and universal approach for minimizing the force of nucleated hydrogen gas-bubble adhesion to prevent blockage of electrocatalytic sites because of bubbles-adhesion is unprecedented. Generally, buoyancy should outweigh the capillary force to remove nucleated bubbles, which means these forces ratio, Eötvös number $Eo > 1$. I will discuss a design of chemically reactive multilayer coating on an electrode to chemically modulate the adhesion force of nucleated gas-bubble on the electrode. A dual modified coating on Ni-foam provided a non-adhesive superaerophobicity with nucleated bubble adhesion force of 4.6 ± 0.3 μN and displayed superior HER performance with lower overpotential (333 to 250 mV) at 100 mA cm^{-2} with respect to bare Ni-foam. The chemically-modulated low bubble-adhesion facilitates the early removal of nucleated tiny hydrogen gas bubbles with a minimum size of 0.64 mm and $Eo = 0.05$ to keep catalytic sites available for superior electrochemical HER. Such a positive impact of the prepared coating is also noted for various other electrodes.

References

1. Angana Borbora, Yang Xu, Souradeep Dey, Xin Wang, Yuxing Yao, Biman B. Mandal*, Xiaoguang Wang * and Uttam Manna* "Lubricated Interfaces Enabling Simultaneous Pulsatile and Continuous Chemical Release Modes" Advanced Materials, 2023,35, 2302264.
2. Borbora, A.; Dhar, M.; Shome, A.; Barman, N.; Roy, S.; Manna, U.* Adv. Funct. Mater. 2023, 33, 2302569.
3. Barman, N.; Shome, A.; Kumar, S.; Mondal, P.; Jain, K.; Tenjimbayashi, M.; Manna, U.* Adv. Funct. Mater. 2023, 2214840.
4. Shome, A.; Das, A. Borbora, A.; Dhar, M.; Manna, U.* Chemical Society Reviews, 2022, In Press.
5. Dhar, M.; Das, A.; Parbat, D.; Manna, U.* Angewandte Chemie International Edition, 2022, 61, e20211676.
6. Borbora, A.; Dupont, L. R.; Xu, Y.; Wang, X.; Manna, U.* Materials Horizon, 2022, 9, 991-1001.
7. Shome, A.; Das, A.; Manna, U.* Chem. Mater., 2021, 33, 8941–8959.
8. Baruah, U.; Manna, U. Chem. Sci.*, 2021, 12, 2097–2107.
9. Jaysri Das, Subhankar Mandal, Angana Borbora, Sonam Rani, Mizuki Tenjimbayashi* and Uttam Manna* Adv. Funct. Mater., 2023, 2311648.

Prof. Angshuman Nag
Professor, Department of Chemistry, Indian Institute of Science Education and Research (IISER) Pune, India

Prof. Nag, an Associate Professor in the Department of Chemistry, Indian Institute of Science Education and Research (IISER) Pune, is a distinguished scholar and alumnus of IIT Guwahati. Holding a Ph.D. in chemistry from IISc Bangalore (2009). He was a post-doctoral fellow at University of Chicago and IISc Bangalore (2009-2012) and later joined as a Ramanujan Fellow & Assistant Professor at IISER Pune (2012).

He is a recipient of Swarnajayanti Fellowship, awarded by Department of Science and Technology, Govt. of India (2020). The Editorial Advisory Board Member of Nano Letters (2020) and Chemistry of Materials (2019). He was awarded the Young Scientist Platinum Jubilee Award by National Academy of Sciences India (NASI), Allahabad (2014). Developing novel semiconductors for optoelectronic properties is the main focus of his research. Thermodynamics create intrinsic defects in a crystal. Additionally, nanocrystals have surface defects. The major contribution of his group is in rational design of semiconductor nanocrystals, microcrystals, and centimeter-sized single crystals to eliminate the detrimental effects of defects. Research topics of his group include: (i) colloidal $CsPbX_3$ (X = Cl, Br, I) perovskite nanocrystals, (ii) Pb-free metal halide perovskite for optoelectronics, (iii) optical properties of centimeter sized single crystals of 2D layered perovskites, (iv) doping semiconductors for luminescence, plasmonics and magnetism, and (v) surface engineering of nanocrystals for better charge transport.

Nanoscale Interface within a Hybrid Perovskite Crystal for Optoelectronics

Herbert Kroemer said that “the interface is the device”. Typically, interface is the region that connects two different materials. Here we discuss about a different kind of interface, a repeating interface that exists within the same crystalline material. Hybrid perovskites like $(C_4H_9NH_3)_2PbI_4$ have fascinating layered crystal structure with periodic nanoscale interfaces between the inorganic $\{PbI_4\}^{2-}$ and organic $C_4H_9NH_3^+$ layers. Because of these interfaces, electron and hole are confined in atomically thin $\{PbI_4\}^{2-}$ inorganic well layers. Therefore, these layered perovskites are electronically 2D systems (quantum well), irrespective of their crystallite sizes.[1-3] Importantly, the crystal structure allows numerous combinations of different organic cations and inorganic anions. So, a rational molecular design of the nanoscale interfaces, and hence, tunable optoelectronic properties are feasible. For example, if structural non-centrosymmetry is introduced in such semiconductors, then important functionalities like chirality, non-linear optical properties, Ferroelectrocity, and anomalous photovoltaic effect can be achieved. In this talk, I will discuss about design principles of achiral and chiral non-centrosymmetric hybrid perovskite single crystals. The key parameter that yields the desired non-centrosymmetric structure is the rationally designed non-covalent (hydrogen- and halogen-bonding) interactions, between the organic cation sublattice and the inorganic $\{PbI_4\}^{2-}$ sublattice.[4] Controlling such non-covalent interactions also allows us to control solid-melt phase transition temperatures, allowing us to develop melt-processed films of optoelectronic applications.

References:

1. Sheikh, T.; Nawale, V.; Pathoor, N.; Phadnis, C.; Chowdhury, A.; Nag, A. *Angew. Chem. Int.* Ed. **2020**, 59, 11653–1659.
2. Nag, A. *Nano Lett.* **2021**, 21, 8529 – 8531.
3. Shinde, A.; Rajput, P. K.; Makhija, U.; Tanwar, R.; Mandal, P.; Nag, A. *Nano Lett.* **2023,** 23, 6985 – 6993.
4. Chakraborty, R.; Rajput, P. K.; Anilkumar, G. M.; Maqbool, S.; Das, R.; Rahman, A.; Mandal, P.; Nag, A. *J. Am. Chem.* Soc. **2023**, 145, 1378–1388.

Prof. Taslimarif Saiyed
Director and CEO, C-CAMP
Bengaluru, India

Dr. Taslimarif Saiyed is the CEO and Director of C-CAMP. His initial training has been in neurosciences, where he received his PhD from Max-Planck Institute for Brain Research, Germany and followed it up by postdoctoral training at University of California San Francisco (UCSF). At the same time, he also underwent training in management for Biotech and Innovation from QB3 at UC Santa Cruz, UC Berkeley and UC San Francisco. He has also completed a biotech management program for biotech executives at Wharton School of Management. In the Bay area, he served as a Management Consultant with QB3 New Biotech Venture Consulting and in an individual capacity, he also consulted for many biotech firms in the US.

Dr. Saiyed is an Adjunct Faculty at Indian Institute of Technology (IIT) Madras and also Amrita Institute - School of Biotechnology. He also heads the Discovery to Innovation Accelerator program at C-CAMP. He is actively involved in promoting innovation in lifescience / healthcare by supporting translation of discoveries to application, entrepreneurship and technology development.

Prof. Taslimarif Saiyed

Dr. Snehangshu Patra
Co-founder and CTO, Sustainable Hydrogen for Valuable Applications (SHYVA)

Dr. Snehangshu Patra is a prominent entrepreneur in green energy, currently based in France. As the Co-Founder and CTO of Shyva SAS since December 2020, he leads the development of green hydrogen using patented electrodes, resulting in highly efficient electrolyzers for applications like cooking and welding. Simultaneously, he serves as the Co-Founder and Director of Eliteck Industries Pvt. Ltd. since July 2018, facilitating the translation of advanced electrode technology into commercial products for the Indian market.

Before his entrepreneurial ventures, Dr. Patra held the position of Assistant Professor at the Indian Institute of Engineering Science and Technology from November 2015 to October 2020. During this time, he published 29 international scientific journals and secured three patents in the field of energy systems. His earlier experiences include postdoctoral research roles at the University of Picardie Jules Vernes in France and the Weizmann Institute of Science in Israel, where he contributed to the development of energy-independent hybrid devices and explored conducting polymer-nanoparticle interactions, respectively.

Dr. Snehangshu Patra holds an Integrated Ph.D. in Chemistry-Materials-Electrochemistry from the Indian Institute of Science, Bangalore. His research expertise is showcased in his thesis, focusing on electrochemical studies of PEDOT and supercapacitor studies. Furthermore, he completed his B.Sc. in Chemistry (Hons.) at Presidency College, Kolkata. Beyond his professional accomplishments, Dr. Patra is dedicated to social causes, co-founding and serving as the secretary of The Mitra Society, which focuses on enhancing primary education in rural India. In summary, his impactful contributions span green energy innovation, academia, and social responsibility.

Highly Efficient on Demand Green H_2 Vending Machine for Mass Decarbonization

The humanity is at this moment fighting a monster called global warming. It is no doubt thata paradigm shift in energy technology is required to drastically reduce the carbon-footprint for "net-zero carbon economy" by the year of 2050. Thus, along with Carbon Capture Utilization (CCU), H2 based technology is at this moment gaining huge momentum. Advantages of such technology lies in its potential to be completely sustainable; production and utilization both can be driven by renewable energy (solar energy). H2 production efficiency through electrolysis (green hydrogen; 1 kg CO2 foot-print for 1 kg green H2) is the bottleneck as the main operating expenditure (OPEX) is the cost of electricity. The efficiency of the H2 productions is the USP of SHYVA as our process could enhance the production of H2 by >92% (versus 66% for commercial process) of alkaline electrolysis. Our recent patent reveals a simple yet extremely cost-effective and scalable biochemical electrode manufacturing process by which the production of H2 can be enhanced enormously.[1] The electrode manufactured by this process enhance the efficiency of production at a rate of 40 kWh/kg versus 55 kWh/kg for commercial process. Thus, the OPEX may decrease ~30% which remove the road- block for mass commercialization of H2 based technologies. Another drawback is the explosivenature of H2 when stored. SHYVA relies on its on-demand vending machine which will be able to produce energy any time anywhere. Today SHYVA is engaged in manufacturing of such on- demand system for inhalation, for cooking (industrial and domestic), gas welding/cutting, industrial furnace which will be able to directly replace fossil fuel. SHYVA feels on-demand H2 vending machine is the key for mass-decarbonization where society will be directly be involved. In this talk I would discuss about the process of electrode manufacturing from scratch (research) to the industrialization (development) of on-demand H2 vending machine,a true tale of Academia-Industry collaboration.

References:

[1] (a) S. Patra. Hydrogen generation from waste water using self-healing electrodes, Patentnumber: 202031014945.

Prof. Ayan Roy Chaudhuri
Professor, Materials Science Centre,
Indian Institute of Technology, Kharagpur

Dr. Ayan Roy Chaudhuri is an associate professor at the Materials Science Centre, Indian Institute of Technology Kharagpur. He earned his Ph.D. degree (Integrated Ph.D., Chemical Sciences) from the Indian Institute of Science Bangalore in 2009, where he was affiliated with the Materials Research Centre. Dr. Roy Chaudhuri received the prestigious Alexander von Humboldt Fellowship for post-doctoral research to work on nanoengineering of functional oxide thin films at Max Planck Institute of Microstructure Physics in Halle (Saale). He worked as a senior research scientist at the Institute of Electronic Materials and Devices at Leibniz University in Hannover, Germany, where he worked extensively on MBE growth of epitaxial lanthanide oxides on Si for high k dielectric applications. Since January 2016, Dr. Roy Chaudhuri has been working as a faculty member of IIT Kharagpur. In 2017, he received the faculty excellence award of IIT Kharagpur for his contribution to teaching, research, and institute administrative works.

Resistive Switching in Amorphous WO_{3-X} Thin Films for High-Density Memory and Synaptic Device Applications

Resistive switching (RS) in metal oxides holds the potential for application in future electronic memory and neuromorphic computing devices. Realization of self-compliance and multiple resistance states in various metal oxide thin films have been considered promising for designing selector-less high-density resistive random-access memory devices. It is well known that oxygen vacancies (VOs) often play an important role in the RS mechanism of metal oxides. An in-depth investigation of VOs-engineered amorphous WO_{3-x} thin films suggests a changeover from forming free to forming required RS in W/WO_{3-x}/Pt stack depending on VOs concentration in the switching layer. Further, a near stoichiometric WO_{3-x} layer does not exhibit any RS characteristics even after applying a very large DC bias, which suggests a deterministic role of Vos on their RS characteristics. Through optimization of VOs concentration in a single layer non-stoichiometric WO_{3-x}, we demonstrate self-compliance and multi-level RS that does not require high voltage forming. Additionally, a large concentration of VOs leads to clear synaptic functions, e.g. potentiation and depression of the conduction and improved conduction modulation linearity, suggesting their potential application in neuromorphic computing devices. This study establishes that optimal concentration of VOs in WO_{3-x} layer leads to its forming-free filamentary switching characteristics. Reversible formation and annihilation of an oxygen-rich region in the filament at WO_{3-x}/electrode junction has been envisaged to be responsible for self-compliance set and voltage-controlled multiple reset resistance states. Our results demonstrate that non-stoichiometric WO_{3-x} with an active metal/oxide interface permeable to reversible oxygen migration can pave the way of producing high density, reliable RRAM devices for high-density memory and neuromorphic computing applications.

Keywords: electronic devices; oxide thin films; resistive switching; reactive sputtering.

References:

[1] K. Rudrapal, S. Das, R. Basori, P. Banerji, V. Adyam and Ayan Roy Chaudhuri, Featured article,
AIP Adv.13, 085011(2023).
[2] K. Rudrapal, M. Biswas, B. Jana, V. Adyam and Ayan Roy Chaudhuri, J. Phys. D: Appl. Phys. 56,
205302 (2023)
[3] K. Rudrapal, G. Bhattacharya, V. Adyam and Ayan Roy Chaudhuri, Adv. Electronic Mater. 8, 2200250, (2022).
[4] K. Rudrapal, A. Mukherjee, V. Adyam and Ayan Roy Chaudhuri, J. Appl. Phys. 129, 235302 (2021).

Dr. Sunil Dhole
Founder and Director, Chemdist Membrane Systems Pvt. Ltd., Pune, India

Dr. Sunil Dhole After completing his bachelor's in Chemical Engineering from Amravati University Maharashtra did Masters (2002) and Ph. D. (2006) from IIT Kanpur. After a post-doctoral research fellowship at ***non-Newtonian Rheology group at UCL, Belgium*** (2007-2008) he joined Reliance Technology Group as Senior Research Scientist (2008-2011).

His journey of entrepreneurship started in 2011 with the formation of Kanpur based company ***"Technorbital Advanced Materials Pvt. Ltd."*** The company has been started with the objective of converting potential lab-scale research in to the commercial reality. Sunil's expertise is in ***new generation water filtration membranes***, air purification membranes, and new generation waste water treatment technologies. The non-electric water purification solutions commercialized **(e.g., Tata Swach Desire Plus, Tata Swach Crystella Advanced, Tech Jal Inline, Tech Jal community water purifier, GRAFiL industrial UF membranes)** by Technorbital are serving around 4 million people in India per day.

Dr. Sunil Dhole is currently:

- Founder and director at Technorbital Advanced Materials Pvt. Ltd., Kanpur
- Founder and director at Chemdist Membrane Systems Pvt. Ltd., Pune
- Technical director at Espin Nanotech Pvt. Ltd., Kanpur
- Founder and director at Indeema Fibers Pvt. Ltd., Kanpur
- Founder and director at Vivocon Technologies Pvt. Ltd., Pune

He has published numerous research articles/patents and his contribution to the field of drinking water has been recognised with various national and international awards.

Newton's Laws of Entrepreneurship

Dr. Sunil Dhole, after graduating from a premier Indian Institute (IIT Kanpur) started "Technorbital Advanced Materials Pvt. Ltd." in 2011 with an objective of converting potential lab-scale research in to the commercial reality.

In particular, his focus and vision are to commercialize new generation technologies and promote R&D based entrepreneurship in India. Just to name a few, presently, Technorbital has commercialized a new generation water filtration membranes. Based on the same membranes, TATA has launched a non-electric household water purifier "Tata Swach". At present, Technorbital is serving around 6 million people per day in India with the clean and safe water.

The SWASA N95 Mask developed by Espin Nanotech Pvt. Ltd. is serving millions of people in India since the Pandemic started.

During the deadly second Covid-19 wave (April-21) in India, Sunil and his team of Chemdist Pune developed and commercialized an Indian Portable Oxygen Concentrator (CD-OXY) within 2 weeks. The CD-Oxy oxygen concentrator has been approved by Principal Scientific Advisor's board and PMO. It served three states in India during second Covid-19 wave and could save multiple lives.

He is also instrumental in the development technologies for new generation fuels like bio-ethanol and green Hydrogen based on Nano-Technology and Catalysis

In the present talk, he will explain the spirit of entrepreneurship for research student through Newton's laws of motion. He will be sharing his experiences on converting lab scale ideas to the commercial product.

Prof. Ravi Manjithaya

Professor, Autophagy Laboratory, Molecular Biology and Genetics Unit,
Associate Faculty & Chair, Neuroscience Unit
Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore

Ravi Manjithaya received his PhD degree studying Post-transcriptional Gene Regulation from Indian Institute of Science. He did his postdoctoral training in the autophagy related pathways at the University of California, San Diego before joining JNCASR in 2011. His lab is interested in understanding the mechanisms that govern autophagy and related pathways in health and disease. His lab uses disease models such as intracellular infections, neurodegeneration, and recently pancreatic cancer to address regulatory aspects of autophagy modulation in the context of basic research and therapeutic potential by using small molecule modulators of autophagy flux. He was a Wellcome Trust-DBT Intermediate fellow (2011-2016). He has been awarded Sir C.V. Raman Young Scientist Karnataka State Award in the field of Life Sciences for the year 2019. He has received the CDRI Award 2020 for Excellence in Drug Research in Life Sciences category and S Ramachandran-National Bioscience Award for Career Development by the Department of Biotechnology, Government of India.

His laboratory has extensively published using yeast, mammalian cell lines, mouse and Drosophila models. His laboratory has identified several small drug-like molecules that can therapeutically modulate autophagy pathways in the context of neurodegeneration and intracellular infections. Genetic screens carried out in his laboratory have identified moonlighting functions for certain multimolecular complexes. Currently his laboratory is interested in the contribution of non-synonymous SNPs in affecting autophagy in the context of health and disease.

Role of Autophagy in Health and Disease

Autophagy is an evolutionary conserved, intracellular catabolic process wherein unwanted and excess cellular contents are degraded inside vacuole or lysosomes. This is brought about by capturing the cargo in double membranous vesicles called autophagosomes, which then fuse with lysosomes and deliver the contents for degradation. The rate at which cargo capture, delivery to lysosomes, and degradation take place is called "autophagy flux." Autophagy has several implications in health and disease, and therefore, modulation of autophagy flux is very important. In my lab, we employ chemical biology and genetics approaches to understand the mechanism of different stages of autophagy flux.

I will highlight the identification of two protein complexes- septin and exocyst through an unbiased genetic screen. While septins migrate from bud-neck to PAS and form novel ring-like structures around autophagosomes, the exocyst subunit form an autophagy-specific sub-complex. Both these complexes were found to regulate Atg9 trafficking and were involved in autophagosome biogenesis during autophagy prevalent conditions. Further, I will also discuss about our recent findings where we identified two compounds by unbiased chemical screening: an inhibitor that inhibits loading of Syntaxin17 on autophagosomes and the other compound that acts as xenophagy inducer restricting replication of Salmonella in TFEB dependent but mTOR independent manner.

Prof. Michael Hirtz

Institute of Nanotechnology (INT) and
Karlsruhe Nano Micro Facility (KNMFi)
Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

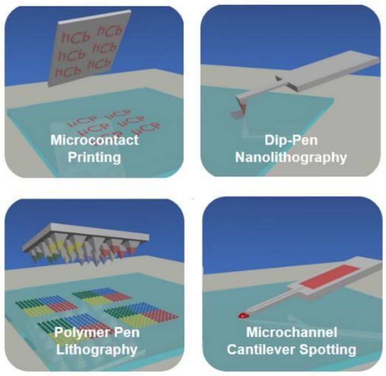
Michael Hirtz is leader of the group for "Scanning Probe Lithography for Biomaterials and Bioelectronics" situated in the research unit of Prof. Aghassi-Hagmann at the Institute of Nanotechnology (INT) of the Karlsruhe Institute of Technology (KIT), Germany. He holds a PhD in physics and in medical sciences from the University of Münster. After doing research on self-organization phenomena in phospholipid films generated by Langmuir-Blodgett technique during his PhD, he is now focusing on advancing Dip-Pen Nanolithography and other Scanning Probe Lithography methods for applications at the interface of physics, surface chemistry and biomedical applications. In 2018, he received the "High-End Foreign Talent" of Shanxi Province, China and recently became Honorary Faculty member at the Centre for Nanotechnology at IIT Guwahati, India (2021).

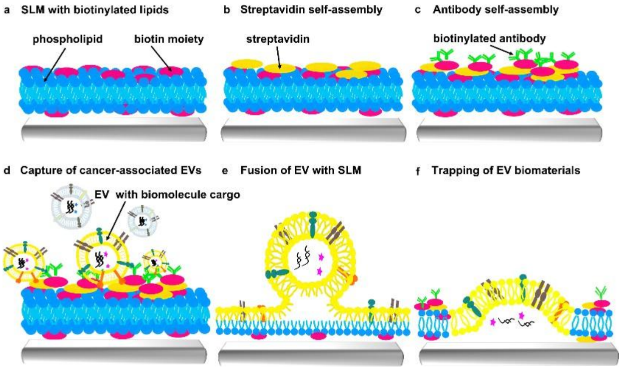
For an overview of his work and publications please visit:
https://www.researchgate.net/profile/Michael_Hirtz
http://www.researcherid.com/rid/C-8821-2011
http://scholar.google.de/citations?user=Wy00YA4AAAAJ

Or have a look at his group home page:
http://www.int.kit.edu/900.php

Scanning Probe Lithography for (Bio)Hybrid Devices in Biomedical Application

Scanning probe lithography (SPL) techniques like dip-pen nanolithography (DPN), polymer pen lithography (PPL) and spotting with microchannel cantilevers (μCS) offer unique opportunities for highly-localized chemical surface functionalization with resolutions in the micron to even nanometer scales. All these techniques have unique strengths in terms of resolution, obtainable throughput and patterning speed and broad compatibility with delicate chemical and biological inks.[1] Generally, they offer mild process parameters and are capable of multiplexing (i.e. deposition of different compounds within a desired micropattern). Hence, these methods are inherently of special interest for the generation of bioactive surfaces and biohybrid devices (i.e. devices combining conventional and biological materials) in biomedical applications.





We demonstrated the great utility of SPL methods for the generation of bioactive surfaces,[2] biosensing applications,[3] and in particular for deposition of biomimetic phospholipid membranes.[4] In this talk, we will briefly introduce relevant SPL techniques and showcase some applicationsof lipid membranes in biohybrid devices and as platform for rapid capture of extracellular vesicles (EVs) for cancer diagnostics and other biomedical applications.[5]

[1] G. Liu, M. Hirtz, H. Fuchs, Z. Zheng, Small, 15 (2019), 1900564.
[2] J. Striebel, M. Vorobii, R. Kumar, H.-Y. Liu, B. Yang, C. Weishaupt, C. Rodriguez-Emmenegger,
[3] H. Fuchs, M. Hirtz, K. Riehemann, Adv. NanoBiomed Res. 1 (2021) 2000029.
[4] J. Krämer, L. M. Grimm, C. Zhong, M. Hirtz, F. Biedermann, Nat. Commun. 14 (2023) 518.
[5] E. Berganza Eguiarte, M. Ebrahimkutty, S. Vasantham, C. Zhong, A. Wunsch, A. Navarrete, M.Galic, M. Hirtz, Nanoscale 13 (2021) 12642-12650.
[6] H.-Y. Liu, R. Kumar, C. Zhong, S. Gorji, L. Paniushkina, R. Masood, U. A. Wittel, H. Fuchs, I.Nazarenko, M. Hirtz, Advanced Materials, 33 (2021) 2008493.

Keywords: Scanning Probe Lithography, Phospholipid Membranes, Cancer Detection, Extracellular Vesicles, Nanolithography

Prof. Uttam Kumar Ghorai

Professor & Head, Department of Industrial Chemistry and Applied Chemistry, Ramakrishna Mission Vidyamandira, Howrah, India.

Dr. Uttam Kumar Ghorai is currently working as an Assistant Professor and Head of the Department in the Department of Industrial Chemistry and Applied Chemistry, Ramakrishna Mission Vidyamandira, Belur Math, India. His study focuses mostly on electrochemical methods for the synthesis of ammonia, urea, and nitric acid under ambient conditions. He has published 120 research papers in peer-reviewed international journals (H-index: 32 and total citations ~ 3016) and has been the co-inventor of seven patents.

In recognition of his contributions in the field of Materials Science & Engineering, Dr. Ghorai has received with "Young Engineer Award' (2019) from the Indian National Academy of Engineering (INAE), Young Scientist Platinum Jubilee Award from The National Academy of Sciences in 2020. Additionally, he was awarded the BRICS Young Innovator Prize in 2022. He has been elected to be an Associate Fellow of the INAE in 2019 and the Indian Academy of Sciences in 2021.

Electrochemical Synthesis of Green Ammonia and Green Urea: A Lab-to-Land Initiative

There are numerous varieties of fertilizers that primarily consist of macronutrients such as phosphorus, potassium, and nitrogen. As fixed nitrogen is typically the rate-limiting macronutrient for plant growth, the production of nitrogen-based fertilizers (ammonia, nitrate, and urea) has always posed a significant global challenge. To combat global starvation over the next three decades, nitrogen-based fertilizer usage will continue to rise. This will have a significant effect on energy and the environment, as nearly all nitrogen-based fertilizers are manufactured from ammonia and nitric acid, which have high energy and carbon footprints. In order to produce ammonia, urea, and nitric acid without the use of fossil fuels, therefore, new technological solutions must be invented.

In our laboratory, we have designed and developed electrocatalytic methods to produce green ammonia, green urea, and nitric acid under ambient conditions using electrocatalysts. All these processes are protected with appropriate IPR. We have completed the field trial of the green ammonia synthesis and initiated the technology transfer and process of licensing for pilot scale production of green ammonia with a multinational company.

References:

1. U. K. Ghorai* et al., **ACS Nano** 2021, 15, 3, 5230
2. J. Mukherjee and U. K. Ghorai* et al., **Advanced Functional Material,** 2022, 32, 2200882.
3. A. Adalder and U. K. Ghorai* et al., **ACS Catalysis**, 2023, 13, 13516
4. U. K. Ghorai* et al., **US patent** filed on green ammonia in 2022 (File No: 18/091910)
5. U. K. Ghorai* et al., **US patent** filed on green urea in 2022 (File No: 17/846753)

Prof. Ayan Roy
Assistant Professor, Materials Science Centre,
Indian Institute of Technology Kharagpur

Ahin Roy did his initial training in the Integrated Ph. D programme in Chemical Sciences from Materials Research Centre at IISc Bangalore, mostly focusing on DFT of metal nanowires. Following this, he moved to the Kyushu University, Japan as a JSPS Postdoctoral Fellow and had a rigorous training in aberration-corrected scanning transmission electron microscopy (AC-STEM) on various JEOL-ARM machines. After this, he spent a brief stint at IISc Bangalore as a visiting scientist experimenting with an aberration-corrected FEI (now ThermoFisher) TITAN G2. This was followed by another postdoc tenure at Trinity College Dublin at Advanced Microscopy Laboratory, where he carried out extensive work with a Nion UltraSTEM200. This actually covers training on all the aberration-correctors in TEMs across the world. In 2022, Ahin Roy started his own group at Materials Science Centre, IIT-Kharagpur focusing on his combinatorial expertise. His recent research focuses on structural and electronic interrogation and engineering of energy materials at atomic-scale.

Structure-Property Correlation in Functional Oxides from Atomic-scale Electron Microscopy & Synergistic Simulations

In recent times, breakdown of conventional wisdom at the atomic-scale has greatly facilitated the exploration of the quantum regime. In this quest, simulations and experiments can go hand in hand complementing each other. One such example is density functional theory based atomic-scale simulations, and atomic-scale experiments with an aberration-corrected transmission electron microscope. In this talk, I will focus on such synergistic microscopy and computation for two different oxides, viz. WO_3 and $BaMnO_3$.
In the first part, the talk will focus on WO3, which exists in a plethora of crystallographic phases. With judicious choice of chemistry, hexagonal and orthorhombic phases can be selectively accessed. Detailed conventional TEM coupled with simulations lead to insights on the operative growth mechanism in that process.[1] Moreover, recent atomic-scale electron microscopy has shown a phase transformation from hexagonal to monoclinic, involving a seamless interface - hitherto unknown in literature. This leads to a possibility of phase-selective ion-intercalation in this material, which will be discussed. Such structural changes have pronounced effect on the electrochromic property of the material – which can be explained through corroborative simulations.
In the second part, I will focus on oxide-based energy materials, venturing into hexagonal perovskite $BaMnO_3$ for oxygen reduction reaction. Electron energy loss spectroscopy (EELS) carried out on wet-chemically synthesized BaMnO3 nanorods shows that the surface amorphous and rich in reduced $Mn^{(4-x)+}$ state, while the bulk of the rod constitutes Mn^{4+} states. This is in-line with B-site cation-based faceting in perovskites, and for $BaMnO_3$, it can be exploited for oxygen reduction reaction.[2]

Keywords: AC-STEM, functional oxides, simulation, energy materials

References:

1. J. Mater. Chem. C, 5, 7307-7316 (2017)
2. Adv. Func. Mater., 2214883 (2023)

Prof. Debajyoti Mahanta
Associate Professor, Department of Chemistry, Gauhati University

Dr. Debajyoti Mahanta is currently serving as an Associate Professor in the Department of Chemistry at Gauhati University. His expertise lies in the fields of conducting polymers, nanomaterials, electrochemistry, and electrochemical energy storage.

Dr. Mahanta earned his M.Sc. degree in Chemistry with a specialization in Physical Chemistry from Cotton College, Gauhati University in 2004. He pursued his doctoral studies at SSCU, Indian Institute of Science, Bangalore, where he received his Ph.D. in 2011. His doctoral research focused on the synthesis and characterization of conducting polymer nanocomposites. He joined Department of Chemistry Gauhati University as an Assistant Professor in 2011.

Currently, his research group is focusing on the development of electrode materials for electrochemical energy storage. He has published 30 research articles in reputed international journals and 7 book chapters.

Binder-less approach for conducting polymer based Electrochemical Capacitors

Dr. Debajyoti Mahanta
Associate Professor, Department of Chemistry, Gauhati University,
Guwahati, Assam

Polyindole microspheres were produced through a straightforward one-step rapid mixing polymerization process without using any template or surfactant. Subsequently, these polyindole microspheres were doped with $HClO_4$, resulting in the formation of fractured microspheres exhibiting enhanced performance as electrode material in electrochemical capacitors. Following a comprehensive characterization of the synthesized materials, electrodes were constructed using water as a medium, omitting the use of any binders, thus preserving the morphologies of the electrode materials. To contrast the outcomes, an additional set of electrodes was prepared by substituting water with NMP as the electrode-preparing medium, leading to the dissolution of polyindole microspheres and broken microspheres during the process. All electrodes underwent characterization using 3-electrode cells with 1 M H_2SO_4 as the electrolyte and Ag/AgCl as the reference electrode to determine specific capacitance, specific energy, and specific power of the electrode materials. Specific capacitance values for polyindole microspheres, prepared with water and NMP as electrode preparation media, were 116 F g^{-1} and 72 F g^{-1}, respectively. Correspondingly, for doped polyindole, the values were 153 F g^{-1} and 90 F g^{-1} at a current density of 1 A g^{-1}. Cyclic stability calculations for polyindole microsphere and doped polyindole broken microsphere electrodes, prepared using water as the electrode preparation medium, revealed 80% and 87% retention of initial values of specific capacitance after 5000 charge-discharge cycles, respectively. Finally, all-solid-state symmetric electrochemical capacitor devices were fabricated using all four types of electrodes with a PVA/H_2SO_4 gel electrolyte. Notably, this approach also eliminated the need for binders in the electrode preparation of both materials. Similarly, polyaniline nanofibers were also deposited on pencil drawn paper substrate by in-situ synthesis of the polymer on the surface of flexible substrate to construct all solid state symmetric electrochemical capacitors

References:

1. G. Konwar, S. Deka, D. Mahanta, "Template free one step synthesis of polyindole microspheres for binder-less electrochemical capacitors" *Journal of Energy Storage*, **2023**, *62*, 106847.

2. S. Yeasmin, S. Talukdar, D. Mahanta, "Paper Based Pencil Drawn Multilayer Graphene Polyaniline Nanofiber Electrodes for All-Solid-State Symmetric Supercapacitors with Enhanced Cyclic Stabilities" *Electrochim. Acta*, **2021**, *389*, 138660.

Dr. Abhay Sachdev
Senior Scientist, CSIR-CSIO, Chandigarh, India

Dr. Abhay Sachdev is currently serving as a Senior Scientist at CSIR-CSIO, Chandigarh, India. He began his journey at CSIO in 2017 as a Scientist. His research interests are Nanomaterials synthesis, Hydrogels, Biomaterials, Biosensors, Microfluidics and Antmicrobials. Dr. Sachdev earned his M.Tech and Ph.D. degrees from the Indian Institute of Technology Roorkee. With a robust research background, he has successfully managed numerous nationally funded research projects, completing two and actively overseeing four others. He has been a reciepent of various awards and fellowships such as SERB-NPDF, SERB-ECRA, and the IIT Roorkee Nanotechnology Alumni Award. Dr. Sachdev has published 45 research articles in reputed SCI indexed international journals, accumulating over 2100 citations. Furthermore, has taken the lead in filing patents and holds 3 patents to his credit. Dr. Sachdev has supervised five Ph.D. students and provided guidance for ten M.Tech/MSc. dissertation thesis.

Nanocomposite Based Point-of-Care Electrochemical Microfluidic Sensors for Bioanalytical Applications

Abhay Sachdev[1*], Vijayesh Kumar[1], Deepak Kumar[1], Ishita Matai[2]
[1]Materials Science and Sensor Application Division,
CSIR- Central Scientific Instruments Organization (CSIO), Chandigarh-160030, India
Department of Biotechnology, Amity University Punjab, Mohali-140306, India
E. mail: abhay.sachdev@csio.res.in E. mail: barah@tezu.ac.in

Contamination by lipopolysaccharide (LPS), an endotoxin which is present in the outer membrane of Gram-negative bacteria causes adverse toxic effects on human health. Herein, we report a facile graphene nanoplatelets@cytochrome *c* (GNP@Cyt *c*) hydrogel based voltammetric electrochemical sensor for LPS. Firstly, the resultant hydrogel sensor facilitated a large electroactive surface coverage for electron transfer, and secondly provided a 3D porous microenvironment for interaction of abundant electrocatalytic sites in Cyt *c* with LPS. Under optimal incubation conditions, the heme iron of Cyt *c* in its reduced form (Fe^{2+}) can directly bind to highly anionic carbohydrate groups of LPS, thereby giving rise to specific interaction. Moreover, the binding of Cyt *c* (Fe^{2+}) with LPS served as a electrocatalytic unit, generating a strong oxidation peak current at 0.019 V. Importantly, no separate redox mediator was required and the electrochemical signal obtained by LPS- Cyt *c* (Fe^{2+}) complex sufficed for detection purposes. Cyclic voltammetry (CV) and Differential pulse voltammetry (DPV) were employed to investigate the electrochemical aspects of GNP@Cyt *c* hydrogel modified screen-printed carbon electrode (SPCE). Further, the GNP@Cyt *c* hydrogel/SPCE demonstrated LPS dose-dependent changes in oxidation current which enabled selective quantitative detection. This method exhibited a detection limit as low as 8.4×10^{-4} ng mL^{-1} with a wide linear range of 0.01-2.0 ng mL^{-1}. For continuous on-chip monitoring of LPS, a customized microfluidic electrochemical device approach was established which endorses the practical utility of the developed sensor. Further, the integrated microfluidic electrochemical device showed excellent recovery upon spiking LPS in lemon juice and tap water samples. Overall, the fabricated sensor holds great promise for point-of-care screening of trace LPS contamination, especially for food safety.

Keywords: Nanocomposites; Graphene Nanoplatlets; Cytochrome C; Electrochemical sensor; Lipolysaccharide; Microfluidic chip

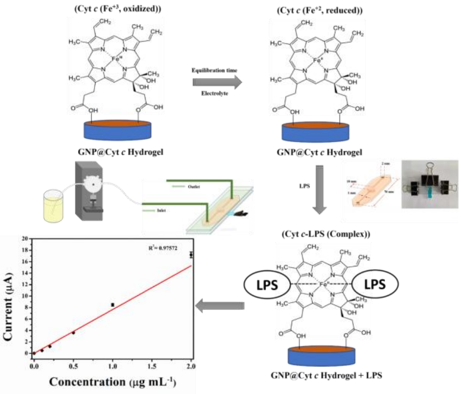


Figure 1: Reduced graphene oxide based nanocomposites for selective electrochemical detection of lipopolysaccharides and development of portable electrochemical microfluidic chip.

Prof. Ejaz Ahmad

Professor, Department of Chemical Engineering, Indian Institute of Technology (Indian School of Mines) Dhanbad, Jharkhand, India

Prof. Ahmad is an Assistant Professor in the chemical engineering department at IIT(ISM) Dhanbad. He is also a faculty in charge of sponsored research and industrial consultancy (FIC-SRIC) at his institute. Dr. Ahmad completed his Master's and Ph.D. from IIT Delhi as Prime Minster Doctoral Research Fellow with HPCL Green R&D Centre, CII, and DST support. He also visited Fraunhofer UMSICHT Germany as a DAAD Fellow for 15 months, where worked on a unique TCR process for agro residue conversion. Dr. Ahmad's research on low-temperature and high-temperature conversion of bio-renewable resources for chemicals and fuel production. In particular, the broad area of his research is “Waste to Wealth Technologies,” which involves agro residue conversion, waste plastic, and e-waste conversion. As a result, Dr. Ahmad has been awarded the Gandhian Young Technology Innovator Award twice (in 2018 and 2020) by the honorable president of India and the Science and Technology minister, respectively. Dr. Ahmad is also admitted to the Indian National Young Academy of Science (INYAS), a rare achievement. Dr. Ahmad has more than 40 plus publications, two edited books in Springer Nature, and a special issue in Elsevier's journal. He is also an “Associate Editor” in Materials Science for Energy Technologies, an Elsevier journal. Furthermore, Dr. Ahmad has received 10 externally funded projects as PI & co-PI in less than four years in the form of a Startup Research Grant, SUPRA from SERB, Delhi Science and Technology Cluster (DRIIV) project from the office of PSA to the Government of India, Tata Steel, DBT, DST and Science Outreach project from Department of Scientific and Industrial Research.

Biorenewable Fuel Additives and Chemicals: Opportunities, Challenges and Catalysis

Ejaz Ahmad*, Khwaja Alamgir Ahmad, Shariq Farhan Elahi, Shivshankar Prasad
*GreenCat Laboratory, Department of Chemical Engineering, Indian Institute of Technology (Indian School of Mines) Dhanbad, Jharkhand, India
Email: ejaz@iitism.ac.in
*Corresponding Author name: Ejaz Ahmad

Biorenewable fuel additives and chemicals are vital to mitigate greenhouse gas emissions and create a closed carbon cycle. Notably, agro residue and other biomass waste are used to produce these bio-renewable fuel additives and chemicals, which makes the process further promising. The current focus is developing high and low-temperature processes for converting to agro residue to produce syngas, bio-oil, bio-coal, fuel additives, and high-value chemicals. In particular, the design and operation of a high-temperature screw reactor to produce syngas, bio-oil, and bio-coal is discussed. On the contrary, the author's group has also developed low-temperature processes such as catalytic esterification and etherification to produce high-value chemicals such as artificial sweeteners, and fuel additives such as green gasoline, green diesel, and bio aviation fuel. It is observed that the low-temperature process effectiveness and desired product yield directly correlate with the acid content of the catalyst. Interestingly, the acidity of the considered catalyst depends on its deprotonation energy, thereby creating a direct correlation between the desired product yield and catalyst DPE. Furthermore, it has also been found that the acidity of the catalysts can be fine-tuned by incorporating additional atoms in the existing catalysts and simply replacing one central atom with another. Overall, the current study paves the way for the theoretical design of novel catalytic materials, thereby reducing long work hours and saving valuable feedstock and other resources.

Keywords: Biomass, Biofuel, Green Gasoline, Green Diesel, Bioavitaion Fuel

Prof. Rajiv K. Kar
Professor, JBM School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Assam, India

Dr. Rajiv Kar is an Assistant Professor at the School of Health Science & Technology, IIT-Guwahati. Previously, he worked as a Scientist in the Technische Universität Berlin, Germany. He did his PostDoc from The Hebrew University of Jerusalem, Israel & PhD from Bose Institute, India. Dr. Rajiv's research interest is in the field of medical device and diagnostics, biomaterials, and nanotechnology. His work includes both experimental and theoretical methods. He has published more than 50 articles in journals of international repute.

Tuning properties of carbonaceous materials by functionalization with biocompatible groups

Rajiv K. Kar[1,2,*]
[1] Jyoti and Bhupat Mehta School of Health Sciences and Technology and [2] Center for Nanotechnology, Indian Institute of Technology Guwahati, Assam – 781039, India
* rajivkar@iitg.ac.in

Carbonaceous materials are of high interest to the interdisciplinary research community due to their unique characteristics, such as electrical conductivity, mechanical strength, and optical properties. Over the years, graphene and its variants have been explored through physical and chemical modifications to tune their properties. The objective is to enhance properties such as improved solubility, enhanced interaction, unique relative changes, and improved processability. Herein, the discussion focuses on the functionalization of graphene oxide with biocompatible materials such as the amino acid cysteine [1] and a simple organic functional group – amine [2]. Characterization methods, including UV-vis spectrophotometry, Raman, and FT-IR, help confirm the functionalization. Other methods, such as XRD for determining crystalline properties, AFM for morphological properties, and dynamic light scattering for particle size distribution, are employed. Additionally, electrical characterization was elucidated using cyclic voltammetry experiments. Although experimental measurements provide crucial information, they do not offer atomistic details. Henceforth, molecular simulations are used to obtain dynamic properties of graphene variants in a solvent medium. Corroborating theoretical findings help assign experimental patterns, such as solvent adsorption, driving forces that stabilize the material-solvent interaction, and conformational variations in the three-dimensional hyperspace. Overall, these insights are highly relevant for large-scale material design and tuning for biomedical applications.

References:

[1] Singh R. and Kar R.K., **2023** Dynamic Properties of Graphene Oxide Functionalized with l-Cysteine, **Journal of Physical Chemistry C**, 127, 17438-53.

[2] Singh R., Tiwari S., Jena J., and Kar R.K. **2023** Characterization of Graphene Variants Using Spectroscopic and Electrochemical Analysis. **Journal of Chemical Education**, 100, 4462-4471.

Prof. Subrata Pramanik
Professor, JBM School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Assam, India

Subrata Pramanik is an assistant professor at IIT Guwahati (2022- Continuing), he is working on various aspects of molecular neurobiology focusing on the pathophysiology of neurodegeneration, brain sex-differentiations, cancer neuroscience, molecular pharmacology, toxicology, and computational biology. Currently, his group is elucidating molecular mechanisms and genetic regulation underlying the function of human-specific gene duplications (HSGDs) and their implication in human brain development and higher cognitive functions. Before joining IIT Guwahati, he did postdoctoral research on brain sex differentiations. His postdoctoral research identified key genes, e.g., *Sry, Eif2s3y*, and *Ddx3y*, which are associated with rat embryonic brain differentiations. In the year 2020, he received Dr. rer. nat. in from RWTH Aachen University, Aachen, Germany. He extensively worked on protein engineering in the group of Prof. Ulrich Schwaneberg (Postdoc fellow of *2018 Nobel Laureate chemistry, Prof. Frances H. Arnold*).

Understanding Brain-Sex Differentiation in Health and Disease – Implications in Sex/Gender-Specific Medicine in Healthcare

Subrata Pramanik[1, 2, *]
[1]Jyoti and Bhupat Mehta School of Health Science & Technology, IIT Guwahati, Assam 781039, India
[2]Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India
*Corresponding author: subrata.pramanik@iitg.ac.in (SP)

Sexual dimorphism including maternal care, sexual behavior, brain function, structure, and susceptibility to neurological disorders is evident in humans as well as in nonhuman species. Recent findings suggest that human male and female brains display differential connectome, methylome, and transcriptome profiles. Despite extensive advancement in neuroscience, the molecular regulation of these differences remains unclear. From the perspective of precision medicine for brain diseases/disorders, it is crucial to decipher diverse regulatory molecules in the brain cells that exhibit gender-specific characteristics. Investigating these aspects can establish a fundamental understanding of gender bias in the brain differentiation and development function within the brain. Here, we will highlight recent molecular understanding of brain-sex differentiations. This knowledge will enable us to precisely target gender-specific brain diseases, thereby optimizing therapeutic outcomes in precision medicine.

Prof. Madhulika Gupta
Assistant professor, Department of Chemistry and Cchemical Biology
IIT(ISM) Dhanbad, India

Prof. Madhulika Gupta is an Assistant professor in the Department of chemistry and chemical biology in IIT(ISM) Dhanbad. She did her Bachelors from St. Stephens college, University of Delhi and Masters from University of Delhi with a specialization in physical chemistry. She completed her PhD from IIT Delhi and went on to do her post doc from Oak Ridge National Laboratory, USA under the Dept. of Energy, USA. Some of her research interests include understanding biomolecular recognition in protein-receptor complexes involved in diseases to design antagonists, understanding plant cell wall interactions to overcome biomass recalcitrance and metal surface deactivation in heterogenous catalysis. She was the first PhD student to get a computational grant of Rs. 25 lakhs from High Performance Computing group, IIT Delhi. She recently got the SERB POWER grant in 2022 and her first Ph.D. student was awarded the prestigious Prime Minister Research Fellow last year.

Impact of position of substitution and degree of acetylation in driving xylan-cellulose interactions

The increasing concerns about climate change and exponential increase in CO2 emissions require concerted efforts to develop lignocellulosic biomass as a sustainable energy resource and isolate all its components in enough yields to be used in the production of biofuels and green materials. However, the cost-effective technology for the same remains under developed due to lack in understanding of the plant cell wall architecture and the multitude of interactions among cellulose, hemicellulose, lignins and pectins that comprise the cell wall biopolymer. We perform unrestrained molecular dynamics simulations to understand the role of effect of degree of acetylation and position of acetylation in dictating favourable cellulose-hemicellulose interactions. Both degree and position of acetylation were found to be the control factors for influencing xylan-cellulose interactions. O-2 acetylated xylan at alternate positions interact in 2-fold helical screw conformations with cellulose through a dovetail of hydrophobic contacts and hydrogen bonds. While, acetylation at O-3 position favours 3-fold helical screw conformations, thereby interacting with lignin rather than cellulose. Acetylation at all positions shows complete desorption of the cellulose surface implying the importance of unsubstituted residues in driving xylan-cellulose interactions. Interestingly, the xylan chain is stabilized on the cellulose surface when the unsubstituted residues form 20% higher contacts than the substituted residues of xylan. These studies are pivotal in designing alternate chemical treatments methods to overcome biomass recalcitrance.

Oral and Poster Abstracts

List of Oral Presenters

	Oral ID	Names
Day 1	H1-01	Pramod M Gawal
	H1-02	Rimlee Saikia
	H1-03	Pranabjyoti Patar
	H1-04	Jyotirekha Jena
	H1-05	Prathu Raja Parmar
	H1-06	Sawna Roy
	H1-07	Ramesh Babu Yathirajula
	H2-01	ANSARI ARHAMA TUFAIL AHD
	H2-02	Neha Saini
	H2-03	Saurabh Dubey
	H2-04	Pooja Yadav
	H2-05	Arishma Buragohain
	H2-06	Ramkrishna Das Adhikari
	H2-07	Sushma Thapa
Day 2	H1-08	Jenifer S
	H1-09	Anagha Jose
	H1-10	SOUMYADEEP BASAK
	H1-11	Shweta Mehrotra
	H1-12	Priya Pathmanathan
	H1-13	Manisha V Makwana
	H1-14	Nafisa Arfa
	H1-15	Abdul Kaium Mia
	H2-08	Anwesha Deb
	H2-09	Yeshudan Bora
	H2-10	SUJAY PAUL
	H2-11	Kanchan Swami
	H2-12	Ethireddy Radhika
	H2-13	Sonika Singh
	H2-14	Aman Paul

List of Poster Presenters, Day 1, 29th Nov 2023

FN Session	Name	Poster ID	Evaluation Time
PSE-1A	Amoghavarsha R Kini	PP001	12:25 - 13:15
	IMAN BISWAS	PP002	
	Anwesha Deb	PP003	
	Ashish Kar	PP004	
	Deepika Singh	PP005	
	Gariyasee Dutta	PP006	
	Abishek Kumar	PP007	
	Adwaita SR Nair	PP008	
	Aarti Devi	PP009	
	Arka Dey	PP010	
	Nasrin Sultana	PP011	
	Divya Pandya	PP012	
	Anagha Jose	PP013	
	AKANKSHA CHATURVEDI	PP014	
	Chandra kant Upadhyay	PP015	
	GANGADHAR MAHAR	PP016	
	Olayinka Oluwaseun Oluwasina	PP017	
	Babita Shashni	PP018	
	Yeshudan Bora	PP019	
	Sourav Dey	PP020	
	SOUMYADEEP BASAK	PP021	
PSE-1B	Sudipta Das	PP022	13:15 - 14:30
	Swetashree Acharya	PP023	
	MD Tarik Hossain	PP024	
	SUJAY PAUL	PP025	
	Ningthoujam Somorjit Singh	PP026	
	SUBRATA DUARY	PP027	
	Shweta Mehrotra	PP028	
	Subarna Samanta	PP029	
	Sadiya Sherin C.T	PP030	

	Monika	PP031	
	Manash Kalita	PP032	
	Pravesh Negi	PP033	
	Kanchan Swami	PP034	
	Rashi	PP035	
	Reek Mahapatra	PP036	
	Mritunjoy Prasad Ghosh	PP037	
	Nabajit Barman	PP038	
	Nikhita H Ingalagi	PP039	
	Sayali Shrishail Harke	PP040	
	Priya Pathmanathan	PP041	
	Mukesh Kumar Yadav	PP042	
	Paromita Bhattacharjee	PP043	
	Debabrata Sahu	PP044	

AN Session	Name	Poster ID	Evaluation Time
PSE-1C	Kaushik Kokil Nath	PP045	16:15-17:10
	Sampriti Ghosh	PP046	
	Manashree Dutta	PP047	
	Archismita Hajra	PP048	
	Mizanur Alam	PP049	
	Ethireddy Radhika	PP050	
	Ipshita Majumdar	PP051	
	Jenifer S	PP052	
	Kanchan Negi	PP053	
	Jayapriya Mishra	PP054	
	Amzad Laskar	PP055	
	ravinder chahal	PP056	
	Chockalingam S	PP057	
	Raghunath Sahoo	PP058	
	MOIRANGTHEM DINENDRA	PP059	
	Laiba Noor	PP060	
	S Jogita Devi	PP061	
	Divya D	PP062	
	Brateen Datta	PP063	

PSE-1D	Upama Das	PP064	17:10-17:50
	Kangkan Jyoti Goswami	PP065	
	Sonika Singh	PP066	
	Achala Rana	PP067	
	BARTHOLOMEW RICHARD	PP068	
	NIYAS K K	PP069	
	Panchali Barman	PP070	
	Leimapokpam Sophia Devi	PP071	
	Nafisa Arfa	PP072	
	Suvra Prakash Mondal	PP073	
	Manisha V Makwana	PP074	
	Aman Paul	PP075	
	Anabadya Dash	PP076	
	Prem Kumar	PP077	
	AKRITI SRIVASTAVA	PP078	
	Maansi Aggarwal	PP079	
	Jigyas Das	PP080	
	Amrit Kumar	PP081	
	Arpan Kotal	PP082	
	Gobinda Chhetry	PP083	
	Abdul Kaium Mia	PP084	

List of Poster Presenters, Day 2, 30th Nov 2023

FN Session	Name	Poster ID	Evaluation Time
PSE-2A	Pramod M Gawal	PP085	12:20-13:10
	Rimlee Saikia	PP086	
	Monika Narwal	PP087	
	Mihir Manna	PP088	
	Shipra Aswal	PP089	
	NIKHIL KUMAR DAIMARI	PP090	
	Bhairov Kr Bhowmik	PP091	
	Anamika Sharma	PP092	
	Pranabjyoti Patar	PP093	
	Bhagwatsingh chouhan	PP094	
	Sushovan Jena	PP095	
	J. Dutta	PP096	
	Akshita	PP097	
	Arijit Mohanta	PP098	
	Chintak K Parashar	PP099	
	Kiran mayawad	PP100	
	Srijita De	PP101	
	Deepraj Sarkar	PP102	
	Kiran Vilas Dhobale	PP103	
PSE-2B	Pooja Rani Kuri	PP104	13:10-14:30
	Jyothsna Unnikrishnan	PP105	
	NABANITA MAITY	PP106	
	Kiran Sebastian K	PP107	
	Sayantani Mukhopadhyay	PP108	
	Poulami Mukherjee	PP109	
	Kritika Sood	PP110	
	Mayank Maan	PP111	
	Jyotirekha Jena	PP112	
	Sayantani Biswas	PP113	
	Chevella Maheshwari	PP114	
	Rajat Dadheech	PP115	
	Sawna Roy	PP116	

	Tadasha Jena	PP117	
	Shubhi Joshi	PP118	
	Subhashree Mishra	PP119	
	Sheetal Das	PP120	
	Hirakjyoti Roy	PP121	
	Cinmoyee Baruah	PP122	
	Srinivasan Venkatesan	PP123	
	Raghavv Raghavender Suresh	PP124	
	Depanjan Sarkar	PP125	
	Prathu Raja Parmar	PP126	
	Indranil De	PP127	
	Eeshan Kalita	PP128	
	ANSARI ARHAMA TUFAIL AHD	PP129	
	Yashmeen	PP130	
	Ayush Ransingh	PP131	
	Uma Narayan M	PP132	
	Neha Saini	PP133	
	Saurabh Dubey	PP134	

AN Session	Name	Poster ID	Evaluation Time
PSE-2C	Manisha Pandey	PP135	16:30-17:20
	Nitika Garg	PP136	
	Parul Sood	PP137	
	Bhavna Sharma	PP138	
	AMEER SUHAIL M	PP139	
	Anjana Ratheesh	PP140	
	Arishma Buragohain	PP141	
	Jayaramulu Kolleboyina	PP142	
	Ashish Kumar Patel	PP143	
	Abhilasha Tiwari	PP144	
	Manish Chauhan	PP145	
	Pooja Yadav	PP146	
	Shamim Hossain Shah	PP147	
	Ramkrishna Das Adhikari	PP148	

	Shivani Choudhary	PP149	
	SALMA AKHTARA KHANAM	PP150	
	Soumalya Bhowmik	PP151	
	SARIKA S	PP152	
	Sajid Saikia	PP153	
	Shumile Ahmed Siddiqui	PP154	
PSE-2D	Rakesh Deka	PP155	17:20-18:10
	ZAHIR ABBAS	PP156	
	Rajib Samanta	PP157	
	RESHMA S BABU	PP158	
	Ramesh Babu Yathirajula	PP159	
	Himangshu Baishya	PP160	
	Sarmistha Baruah	PP161	
	GARIMA GUPTA	PP162	
	GOVINDA CHANDRA BEHERA	PP163	
	Pranshu Kumar Gupta	PP164	
	Neeraj Kumar	PP165	
	Tonmoy Jyoti Bora	PP166	
	Arpita Devi	PP167	
	Uddandarao Priyanka	PP168	
	Rei Star	PP169	
	SHIVANEE BORPATRA GOHAIN	PP170	
	Haider Ali	PP171	
	Sushma Thapa	PP172	
	Namita N Kashyap	PP173	
	Antara Srivastava	PP174	
	Mintu Sarma	PP175	
	Baint Singh	PP176	
	Niharika Tanwar	PP177	

Nano-mechanical Investigations on Isomorphic Crystals of Tetranuclear Copper Nanoclusters

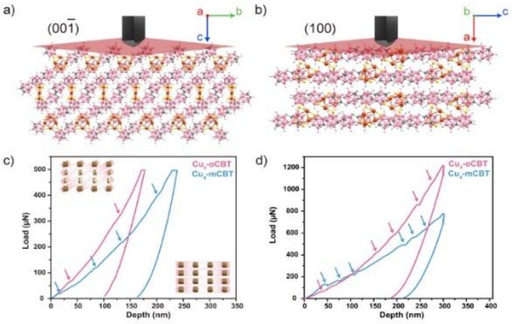
Amoghavarsha Ramachandra Kini [a], Arijit Jana [a], Sanghamitra Debta [b], Tomas Base* [c], Pijush Ghosh [b]* and Thalappil Pradeep* [a]

[a] DST unit on nanoscience and Thematic unit of excellence (TUE), Department of Chemistry, IIT Madras, Chennai.
[b] Department of Applied Mechanics, IIT Madras, Chennai.
[c] Institute of Inorganic Chemistry, The Czech Academy of Science, Czech Republic

Email: pradeep@iitm.ac.in

Metal nanoclusters with atomic precision form a novel category of materials, possessing a wide range of distinctive properties such as photoluminescence, catalysis, magnetism, conductivity and more. These properties can be precisely adjusted through optimized synthetic protocols, introducing dopant metals, ligand engineering, and inter-cluster reactions.[1,2]The potential of cluster-assembled solids in miniaturized solid-state devices is immense due to their unique mechanical properties. Understanding the mechanical characteristics of such cluster-assembled solids gives us insights into how they respond under stress, which is crucial for their effective utilization in nanoelectronic devices.

In this study, we focus on examining the nanomechanical properties of crystals of isomorphic copper nanoclusters, specifically Cu_4 clusters (protected by ortho-carborane-9-thiol (Cu_4-oCBT) and meta-carborane-9-thiol (Cu_4-mCBT), respectively).[3] Nanomechanical measurements, carried out by applying various loads, indicated that the crystals of Cu_4-oCBT are harder than those of Cu_4-mCBT. Despite its lower density, crystals of Cu4-oCBT demonstrated increased hardness, owing to the presence of locked slanted layers that efficiently interact with each other through various supramolecular short contact interactions. During indentation studies, multiple 'pop-in' events were observed for both crystals, suggesting the translocation of molecular layers within the crystal lattice. Dynamic mechanical analysis conducted at different loading frequencies indicated that crystals of Cu_4-oCBT have higher storage modulus and greater hardness than those of Cu_4-mCBT. In conclusion, the isomorphic copper nanoclusters show different mechanical properties owing to their difference in molecular packing and short contact interactions within the crystals. The unique mechanical properties of cluster-assembled solids with atomic precision, emphasized in this study, can contribute towards the development of miniaturized solid-state devices.



Extended order supramolecular packing of a) Cu_4-oCBT and b) Cu_4-mCBT along with the marked indentation planes. c) Load-displacement curves of both crystals under a fixed load of 500 μN. d) Load-displacement curves with a fixed displacement of 300 nm. Arrows indicate pop-in events occurring during nanoindentation experiments.

Reference:

1. Chakraborty and T. Pradeep, *Chem. Rev.*, 2017, 117, 8208–8271
2. Jana, A. R. Kini and T. Pradeep, *AsiaChem Magazine*, , DOI:10.51167/acm00040.
3. Jana, M. Jash, W. A. Dar, J. Roy, P. Chakraborty, G. Paramasivam, S. Lebedkin, K. Kirakci, S. Manna, S. Antharjanam, J. Machacek, M. Kucerakova, S. Ghosh, K. Lang, M. M. Kappes, T. Base and T. Pradeep, *Chem. Sci.*, 2023, 14, 1613–1626.

Investigation on resistive memory of sequentially vapour deposited $Cs_2AgBiBr_6$ thin-film

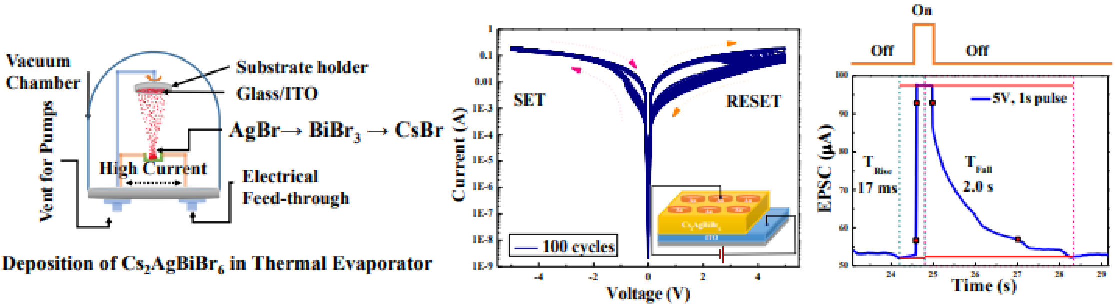
I. Biswas*; A. Dey and A. Mondal

[1] Department of Physics, Gauhati University, Guwahati, India-781014
[2] Department of Energy Engineering, Assam Science and Technology University, Guwahati, India-781013
[3] Department of Physics, Pragjyotish College, Guwahati, India-781009

Email: imanbiswas08@gmail.com

In this investigation, we developed a memristor device utilizing a $Cs_2AgBiBr_6$ thin-film, which was fabricated using a three-step thermal evaporation method. Subsequently, the phase purity and film quality were assessed through X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) analyses. Additionally, the optical properties were characterized via UVVisible (UV-Vis) absorption spectra, revealing an optical bandgap of approximately 2.0 eV. A comprehensive examination of the current-voltage (I-V) characteristics of the Au/$Cs_2AgBiBr_6$/ITO device was conducted over 100 cycles, demonstrating that the device retained over 50% of its resistive memory during this period. Notably, the application of a 5V electrical pulse at a constant interval resulted in a spike with a short rise time (~17 ms) and an elongated fall-time (~2 s). The resistive memory arises from uneven Br atom distribution, driven by a voltage that separates electrons from Br ions, altering Fermi level pinning between the halide perovskite layer and the metal to enable set and reset conditions. The performance of the device can potentially be enhanced by constructing two successive perovskite layers with varying halogen concentrations, positioned between two metal contacts. Overall, this material exhibits promise as a non-toxic alternative for resistive memory applications, such as artificial synaptic devices, based on halide perovskites.

Keywords: double perovskite; sequential vapour deposition; resistive memory; halide memristor; I-V hysteresis



Deposition of $Cs_2AgBiBr_6$ in Thermal Evaporator

Figure: Schematic diagram of Cs2AgBiBr6 thin-film deposition followed by its memristor characteristics

Paper-Based Flexible Electrodes using Silver Nanowires ink for Room Temperature Gas Sensing Applications

A Deb, D. C. Patra, A. Dash, S. Das and S. P. Mondal*

Department of Physics, National Institute of Technology, Agartala, India -799046

Email: suvra.phy@nita.ac.in

Nowadays stretchable and flexible devices have been studied intensively for numerous application such electronic textiles, triboelectric nanogenerators, flexible sensors etc. In case of flexible electronics, all electrodes deposited on the flexible substrates should offer desired conductive properties despite repeated deformations. Silver nanowires have been studied extensively for conducting electrode on various flexible substrates due to its excellent stretchability, flexibility, high optical transparency and high electrical conductivity. In this report, Ag nanowire (NWs) based flexible interdigitated electrodes were fabricated on tracing paper substrates for room temperature nitric oxide gas sensing application. Ag NWs were grown using the Polyol method and as grown nanowires were centrifuged at 6000 rpm for purification and preserved in Methanol. Ag NWs were characterized using scanning electron microscopy (SEM), x-ray diffraction (XRD) and x-ray photoelectron spectroscopy (XPS) measurements. SEM study confirmed the growth of Ag NWs of average length and diameter ~1.22 µm and ~76 nm, respectively. The dominant diffraction peaks at Miller indices (111), (200) and (220) confirmed the formation of highly crystalline Ag NWs with face cantered cubic (fcc) phase. Interdigitated electrodes were fabricated on tracing paper substrates using Ag NWs ink. Room temperature NO gas sensing was performed by depositing a PEDOT-PSS polymer on Ag NWs based interdigitated electrodes painted on tracing paper substrates. Sensor response was monitored by measuring current response at -7V bias under exposure of 7.16 ppm, 9.74 ppm and 12.19 ppm dry NO gases. Our present study demonstrates the potential use of paper-based Ag NWs flexible electrodes for room temperature gas sensing applications.

Keywords: Ag nanowires, Flexible electrode, Nitric Oxide, Gas Sensor

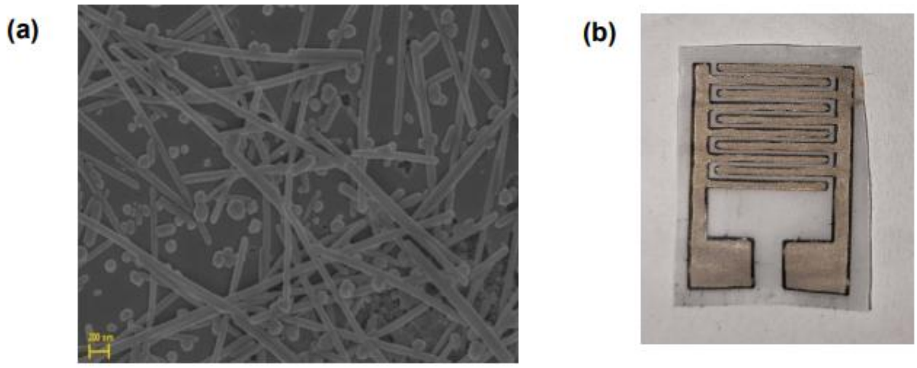


Figure 1: (a) Scanning electron micrograph of Ag NWs. (b) Digital photograph of a typical Ag NWs based interdigitated electrode painted on tracing paper.

Harnessing the Plasmonic Field for Single-Molecule Investigation: DNA GQuadruplex-Ligand Interaction to Optical Mapping of DNA

Ashish Kar[1] , **Bhaskar Datta**[2]* , **Johan Hofkens**[1]*

[1] Department of Chemistry, KU Leuven, Leuven 3001, Belgium
[2] Discipline of Chemistry, Indian Institute of Technology Gandhinagar, Gujarat 382355, India

Email: bdatta@iitgn.ac.in, johan.hofkens@kuleuven.be

Single-molecule techniques provide the advantage of studying molecules individually which eliminates the loss of information from ensemble averaging. However, the reach of singlemolecule studies has been limited to species with high fluorescence quantum yield, due to weak light-matter interaction limited by the diffraction of light. This restricts study on weakly emitting species. Additionally, limited molecular fluorescence rates reduce bandwidth for measurements requiring high photon budget, such as single-molecule localization microscopy techniques. A way of overcoming these limitations is by enhancing emission rates from single emitters. Plasmonic nanostructures are known to enhance the emission of nearby fluorescent molecules. We demonstrate their utility in two applications: firstly, using enhanced fluorescence from single gold nanorod antennas, we observe real-time DNA G-quadruplex-ligand interactions at the single-molecule level, revealing distinct binding behaviors for different GQ DNA topologies with TmPyP4, a weakly emitting species (QY: 5%).[1] Plasmon-enhanced fluorescence enables high-sensitivity visualization of dynamic binding/unbinding interactions. Secondly, we apply plasmon-enhanced fluorescence to DNA optical mapping, a technique relying on site-specific DNA labeling with fluorophores, followed by imaging of linearly stretched DNA and sub-diffraction localization to determine fluorophore distances.[2] Due to high photon budget, optical mapping analysis is slow, as longer acquisition times are required to build up sufficient photons. By employing a plasmonic substrate covered with gold nanoplates, we enhance the signal from labeled DNA, looking to expedite the analysis process due to increased photon yield.

Keywords: Plasmon-enhanced fluorescence, Gold nanoparticle, DNA G-Quadruplex, DNA optical mapping.

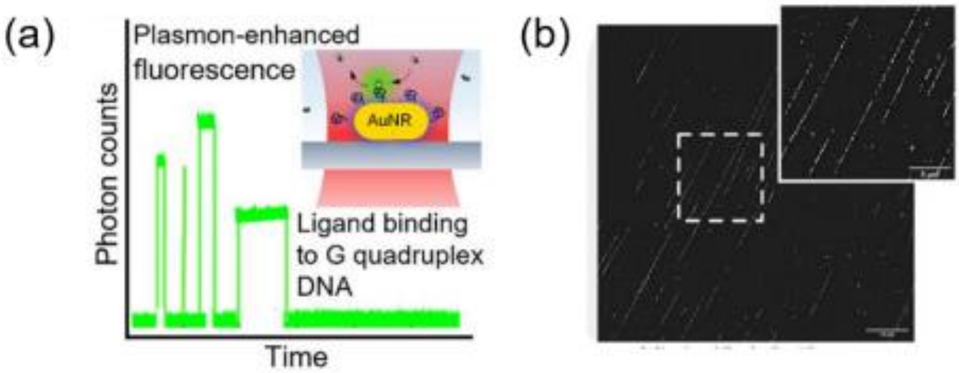


Figure: (a) Schematic description of GQ-Ligand interaction probed via plasmon enhanced fluorescence. (b) Fluorescence image of sequence-specifically labelled lambda DNA

Reference:
1. Kar, A., Praneeth, N. V. S., Khatua, S., & Datta, B. (2023). Use of Single-Molecule Plasmon-Enhanced Fluorescence to Investigate Ligand Binding to G-Quadruplex DNA. The Journal of Physical Chemistry Letters, 14(27), 6321-6327.
2. Neely, R. K., Dedecker, P., Hotta, J. I., Urbanavičiūtė, G., Klimašauskas, S., & Hofkens, J. (2010). DNA fluorocode: A single molecule, optical map of DNA with nanometer resolution. Chemical science, 1(4), 453-460.

NIR Activated Nanoparticles for Enhanced Antibacterial Activity

Deepika Singh[1,2], Pravesh Negi[1], Arup Samanta* [1,3], Saugata Hazra* [2,3]

[1] Department of Physics, Indian Institute of Technology Roorkee, Uttarakhand, India, 247667
[2] Department of Biosciences and Bioengineering, Indian Institute of Technology Roorkee, Uttarakhand, India, 247667
[3] Center for Nanotechnology, Indian Institute of Technology Roorkee, Uttarakhand, India, 247667

Email: arup.samanta@ph.iitr.ac.in, saugata.hazra@bt.iitr.ac.in

The escalating dissemination of drug-resistant bacteria has increased morbidity and mortality on a global scale. Nowadays, conventional anti-bacterial drugs are less effective and help bacteria to evolve their drug resistance behavior. Thus, it is obligatory to investigate efficacious alternatives to antibacterial drugs that hold profound significance. In this study, we propose the utilization of semiconductor nanoparticles, Copper Oxide (CuO), and Tin Sulfide (SnS) as potential alternatives to antibiotic-resistant drugs for bactericidal. These nanoparticles are engineered to precisely destroy the targeted bacterial cell driven by Near Infrared (NIR) light. In vitro, antibacterial experiments unfold a detailed antibacterial efficacy of CuO and SnS against gram-negative Escherichia coli (E. coli) and Gram-positive Staphylococcus aureus (S. aureus).

Keywords: Copper Oxide (CuO), Tin Sulfide (SnS), NIR-activated nanoparticles, Antibacterial activity

Facile Synthesis of MgFe-layered double hydroxides (LDHs) for the adsorptive removal of malachite green dye from aqueous solution

Gariyasee Dutta, Xavy Borgohain, Md. Harunar Rashid*

Department of Chemistry, Rajiv Gandhi University, Rono Hills, Doimukh 791 112, Arunachal Pradesh, India

Email: harunar.rashid@rgu.ac.in

Water contamination caused by the discharge of hazardous dyes from industrial effluents has turned into a serious environmental problem. This work aims to develop an environmentally acceptable material that can be utilized to successfully eliminate the malachite green (MG) dye from aqueous solutions. In this work, we report the synthesis of MgFe-layered double hydroxides (LDHs) by the hydrothermal method in the absence of any additive at 180 °C for 6 h. The formation of well-crystalline intercalated MgFe LDH has been confirmed by the diffractometric analysis. The electron microscopic analysis has confirmed the formation of flakes-like cubic structures of sizes less than 10 nm. To evaluate the adsorption performance of malachite green dye by the MgFe LDH, batch studies have been carried out under various adsorbent loadings, contact time, initial dye concentrations, and pH. The synthesized LDHs have shown an adsorptive efficiency of ~98.0% from aqueous solutions under the optimized conditions. The adsorption process follows pseudo-second-order kinetics. Both the Langmuir model and the Sips model can be used to fit the isotherm data with the maximum adsorption capacity according to the Langmuir isotherm (q_m), and the Sips isotherm (q_{ms}) being 1541.3 mg g^{-1} and 1568.3 mg g^{-1} at 303 K, respectively. The MgFe LDHs are stable and reusable up to the fourth cycle with no dramatic drop in the adsorption performance.

Keywords: MgFe-layered double hydroxides, adsorption, malachite green, kinetics, isotherm

Diverse patterns of polydimethylsiloxane (PDMS) using maskless reactive ion etching for anti-bacterial applications

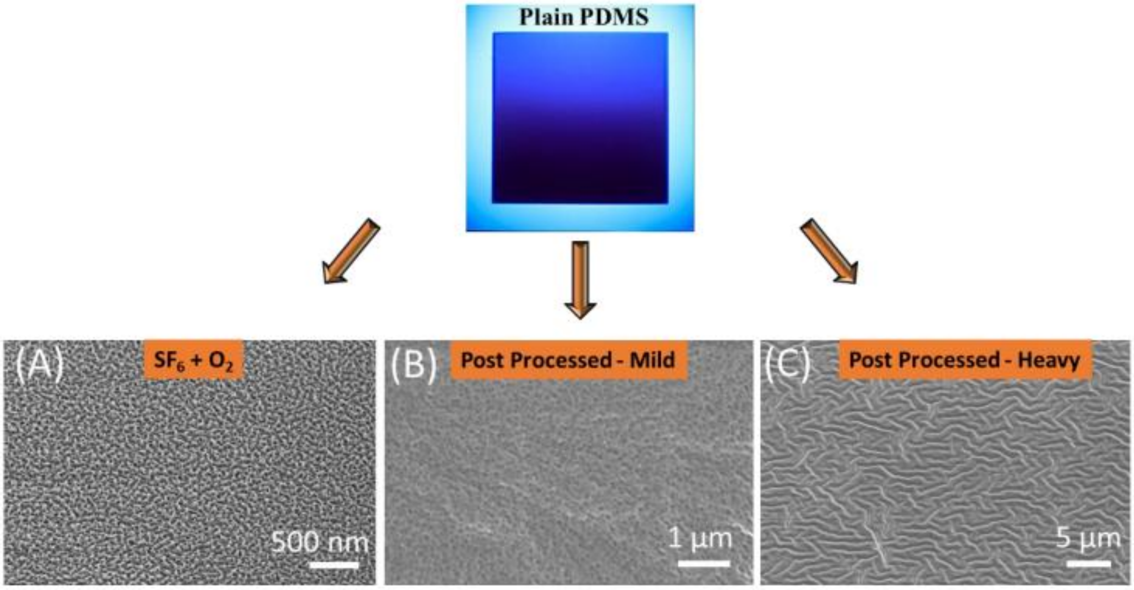
A Kumar*; **N. Thomas and P. Swaminathan**

Electronic Materials and Thin Films Lab, Department of Metallurgical and Materials Engineering, IIT Madras, Chennai, India.

Email: mm21d067@smail.iitm.ac.in

Polymer substrates having sensing, electronic and anti-microbial capabilities are of wide interest to the scientific community. Studies suggest that the polymer substrates with nanopatterns tends to become excellent sensing framework for different analytes due to the deposition of a specific metal or molecule and tuneable wetting properties. However, the methods to impart surface structures in polymers remains a challenge either in the process throughput or in the achievable critical dimensions (CD) of the features. In the current work, we propose a maskless random etching of PDMS using Inductive Coupled Plasma – Reactive Ion Etching (ICP-RIE) technique to prepare consistent and modifiable pattern morphologies. Sulphur hexafluoride (SF_6) is chosen as a primary etchant gas and when SF_6 was mixed with oxygen in a specific ratio, black silicon like grassy structure was observed. When the material is post-processed with argon (Ar) gas etching, consistent craters and maze-like patterns was observed at different etching durations. The etched samples, except the one extensively postprocessed with Ar resulted with identical transparency of PDMS across the visible range. These nanostructured PDMS are currently being investigated for their mechano-bactericidal activity.

Keywords: Reactive Ion Etching, Polymer nanostructures, Maskless etching, Anti-microbial surfaces, multi-stage recipe.



SEM images of different morphologies on ICP-RIE etched PDMS. (A) Grass, (B) craters, and (C) maze structures can be obtained by changing the process conditions.

Comprehensive spectroscopic study of β-lactamase-gold nanoparticle conjugates towards development of diagnostic device against AMR

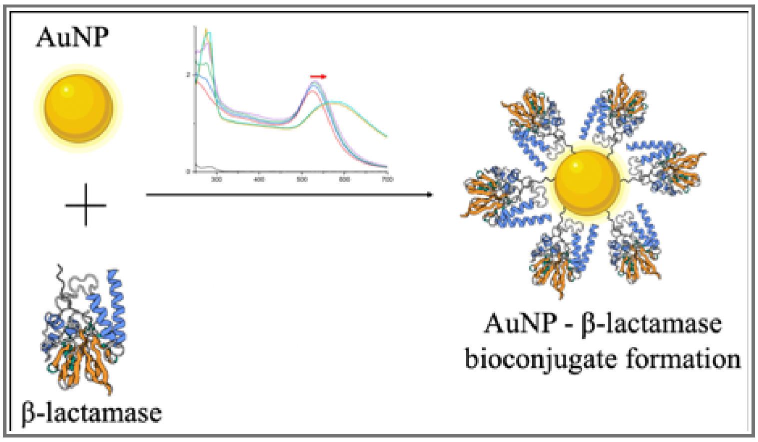
A.S.R.Nair[a], A.Samanta[a,b], S. Hazra*[a,c]

[a] Centre for Nanotechnology, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand 247667, India
[b] Department of Physics, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand 247667, India
[c] Department of Biosciences and Bioengineering, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, 247667, India

Email: saugata.iitk@gmail.com, saugata.hazra@bt.iitr.ac.in

As the number of deaths caused by bacterial resistance to antibiotics rises, developing a rapid and early detection biosensor for β-lactamase enzyme detection has become critically important. Gold nanoparticles' remarkable optical and electromagnetic properties have made them a popular biosensor choice. This research aims to lay the groundwork for future nanosensor system development by examining the interaction between gold nanoparticles and the β-lactamase enzyme and the effect on conformation and activity upon conjugation. UV-visible spectroscopy has been used to investigate the bioconjugates' stability and the effect of medium pH on the conformational state by monitoring the alterations in the localized surface resonance plasmon band (LSRP). The confirmation of protein conjugation and absence of gold nanoparticle aggregate due to protein are both demonstrated by the slight red shift of the LSPR peak post β-lactamase conjugation. Zeta potential was used to track the surface charge shift following protein conjugation to the nanoparticle surface. The surface charge dramatically changed from negative to positive after adding protein. Monitoring of fluorescence quenching of tryptophan residues from β-lactamase in the presence of gold nanoparticles is exploited for determining the binding constant and number of binding sites. The extent to which β-lactamase retains its native structure upon conjugation was evaluated further using circular dichroism (CD) and fourier-transform infrared (FTIR) study. This study provides useful information for characterizing the interactions between β-lactamase and gold nanoparticles for futureendeavours.

Keywords: Gold nanoparticles; β-lactamase; Localized surface plasmon resonance; Zeta potential, Fluorescence.



Enhancing Luminescence of D-penicillamine capped Au_{14} NCs through Zn^{2+}-Induced Aggregation and its potential in Therapeutic Applications.

A. Devi[1], D. Bain[1], Rashi[1], and A. Patra* [1,2]

[1] Institute of Nano Science and Technology, Knowledge City, Sector 81, Mohali 140306, India
[2] School of Materials Sciences, Indian Association for the Cultivation of Science, Kolkata 700032, India

Email: amitava@inst.ac.in

Ultrasmall metal nanoclusters (NCs) have attracted tremendous attention in many applications such as bio-imaging, sensing, light-harvesting, and catalysis owing to their unique physicochemical properties. Here, we report the synthesis of near-infrared emitting (NIR) Au_{14} nanoclusters using a small therapeutic molecule D-penicillamine (DPA) as a surface stabilizing agent. We found molecular-like absorption features with three distinctive absorption bands at 390 nm, 456 nm, and 590 nm, and a photoemission band at 696 nm. We observed Au NCs specifically inhibited cancer cells in a dose-dependent manner through preferential uptake and imparting significant intracellular ROS.[1] Further, we explored the AIE of D-penicillamine-capped Au_{14} NCs by introducing Zn^{2+} ions with intriguing photophysical properties[2]. The huge PL enhancement (50-fold) in the Zn-induced AuNCs compared to Au_{14} NCs, which corresponds to PL QY enhancement from 0.56 to 4.31%. The PL enhancement is attributed to the surface rigidification of Au_{14} NCs in cross-linked aggregated nanoclusters which causes the suppression of non-radiative relaxation and facilitates the ligand-to-metal charge transfer process (LMCT). The disaggregation of Zn-induced Au_{14} NCs in the presence of a chelating ligand, which can be reversed by reintroducing Zn^{+2} ions further supporting the coordinating mechanism of Zn^{+2} ion with Au_{14} NCs. Finally, we proposed to use Zn-Au_{14} NCs aggregates for specific and selective detection of Zn^{2+} ion in water with a detection limit of 754 nM in the linear concentration range 0.5-0.25 μM.

Keywords: gold,nanoclusters, luminescence, therapeutic, aggregation

References:

1. Bain, D.; Mimansa; Devi, A.; Maity, S.; Shanavas, A.; Patra, A., Penicillamine-Capped Red-Emitting Gold Nanoclusters for Therapeutic Application. ACS Sustainable Chem. Eng. 2022, 10, 12730-12737.Jana, A. R. Kini and T. Pradeep, *AsiaChem Magazine*, , DOI:10.51167/acm00040.
2. Bain, D.; Devi, A.; Rashi; Chakraborty, S.; Kolay, S.; Patra, A., Enhanced Luminescence in Zn+2-Induced Au14 Nanocluster Aggregates. *J. Phys. Chem. C* **2023**.

A distinctive one-step hydrothermal synthesis of a thermochromic VO2 (M) thin film and its temperature-dependent properties

A. Dey*, I. Biswas and A. Mondal

Department of Physics, NIT Durgapur, West Bengal, 713209, India

Email: arka.dey2021@gmail.com

Due to its remarkable ability to transition from a semiconductor to a metal state at temperatures near room temperature, vanadium dioxide (VO_2) presents itself as an ideal candidate for thermochromic applications. In this study, we present a straightforward and cost-effective method for synthesizing highly crystalline monoclinic-phase VO_2 (M) using a hydrothermal approach. The X-ray diffraction patterns clearly reveal the presence of a well-defined, highly crystalline pure monoclinic-phase VO_2 thin film, as evidenced by the prominent (011) peak. Upon examining field-emission scanning electron microscopy (FESEM) images, we observed that the thin VO_2 film had a thickness of approximately 1.2 µm, comprised of particles with an average size ranging from 320 to 350 nm. To investigate the temperature-dependent optical properties, we employed a custom-designed chamber integrated into the spectrophotometer. The data obtained from this chamber revealed transition temperatures of 60.5 °C during heating and 47.1 °C during the cooling process, with an overall transition temperature of 53.8°C—significantly lower than the 68 °C characteristic of crystalline VO_2. Furthermore, we conducted electrical transport measurements to characterize the thin VO_2 film across its electronic phase transitions. Remarkably, this thin film displayed rapid metal-to-semiconductor transitions spanning nearly two orders of magnitude. These findings not only demonstrate the successful one-step hydrothermal synthesis of monoclinic VO_2 but also offer valuable insights into its potential applications in advanced infrared smart windows.

Keywords: VO_2, Hydrothermal Synthesis, Thermochromic, Transmission, Metal-to-semiconductor transitions.

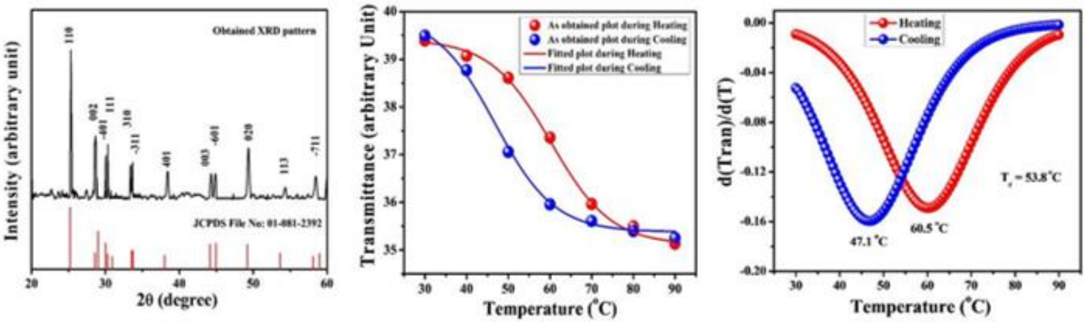


Figure: XRD patterns of synthesized VO_2 and its temperature dependent optical characteristics.

An Optical Sensing Platform for the Detection of Anti-Cancer Drug and cytotoxicity screening

Nasrin Sultana* [1,2], **Neelotpal Sen Sarma**[1,2]

[1] Institute of Advanced Study in Science and Technology, Paschim Boragaon, Guwahati-35, Assam, India
[2] Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India

Email: snasrin.iasst@gmail.com

Abstract: Monitoring therapeutic drugs is crucial for preventing delayed elimination, which can have severe side effects on the human body. Methotrexate (MTX) is one of the widely used anti-cancer drugs. Managing high doses of MTX is extremely challenging due to their high cost and the fact that traditional procedures required more time for analysis. In this work, we have developed a nano composite material using phosphorene, cystine, and gold (Ph-Cys-Au) which shows excellent optical properties. This nano composite can be used as an optical sensing platform for the detection of MTX in the range 0-260 μM. The synthesized sensing platform is very much sensitive, selective, and cost-effective for the detection of MTX. The Ph-Cys-Au can effectively detect MTX in aqueous media with a limit of detection (LOD) of about 0.0621 μM (for linear range 0-140 μM) and 0.0205 μM (for linear range 160-260 μM). The nano composite is equally selective for real samples such as human blood serum (HBS) and artificial urine (AU) with a LOD of 0.1951 μM and 0.1711μM respectively. We have also determined the limit of quantification (LOQ) in addition to LOD. The LOQ values for the aqueous medium were 0.01867 μM (for linear range 0-140 μM) and 0.0616 μM (for linear range160-260 μM), whereas the values for HBS and AU were around 0.5859 μM and 0.5140 μM, respectively.

Keywords: Phosphorene, phosphorene-based composite, methotrexate.

Bulk to micro: Radio luminescent study of CsI:Tl scintillator

Divya Pandyaa, Nisha Oadb, Sheetal Rawata*, Brijesh Tripathia, Pavan Gurralac, Mohit Tyagid* and Manoj Kumara

[a] Department of Physics, School of Technology, Pandit Deendayal Energy University, Gandhinagar 382426 India.
[b] Department of Chemistry, School of Technology, Pandit Deendayal Energy University, Gandhinagar 382426 India.
[c] Department of Mechanical Engineering, School of Technology, Pandit Deendayal Energy University, Gandhinagar 382426 India
[d] Technical Physics Division and Glass and Advanced Materials Division, Bhabha Atomic Research Centre, Mumbai 400085 India

Email: sheetal.rawat@sot.pdpu.ac.in

Thallium-doped cesium iodide (CsI:Tl) microcrystals have garnered significant attention in various scintillation applications, such as medical imaging, nuclear safety, and high energy particle detection. In this pioneering study, we introduce an innovative antisolvent recrystallization method for the synthesis of CsI:Tl microcrystals. This novel approach enables the efficient production of microcrystals at room temperature, atmospheric pressure, and humidity conditions, yielding an impressive ~90% product yield. The structural analysis of the CsI:Tl microcrystals through X-ray diffraction confirmed their polycrystalline nature, with crystallite sizes ranging from 20 to 25 nanometers. Scanning electron microscopy further revealed the microcrystals' size distribution to be within the range of 1 to 13 microns. Radioluminescence spectra of microcrystals are compared with the crushed single crystal of CsI:Tl. Wherein 0.2 mol% thallium doping resulted in the strongest luminescence yield which is around 76% of luminescence compared to single crystal of CsI:Tl. This work not only introduces a groundbreaking synthesis method for CsI:Tl microcrystals but also underscores the practical advantages of this approach as a low-cost alternative to traditional single crystal growth techniques. These findings open up new avenues for enhancing radioluminescent materials' efficiency, making them more accessible and promising for a wide range of scintillation applications.

Keywords: Radioluminescence, microcrystal

Vertically Aligned Nanoplates of Atomically Precise Co_6S_8 Cluster for Practical Arsenic Sensing

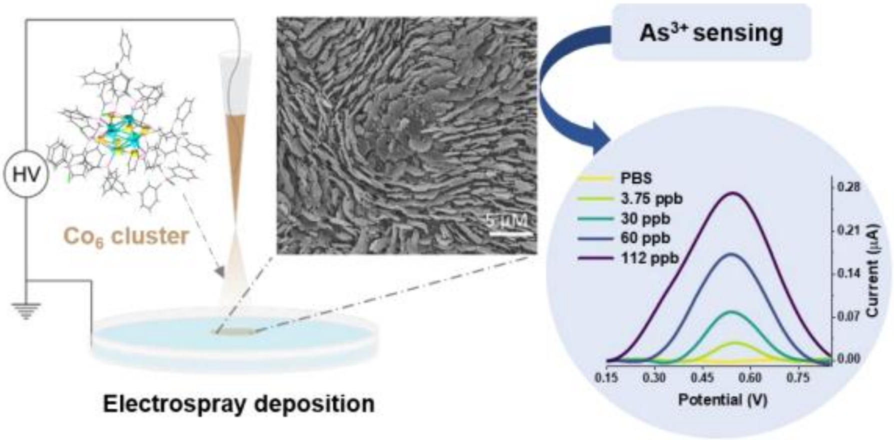
A Jose[1]; A Jana[1]; T. Gupte[1]; A. S. Nair[2]; K. Unni[1]; A. Nagar[1]; A. R. Kini[1]; B. K. Spoorthi[1]; B. Pathak* [2] and T. Pradeep* [1]

[1] Department of Chemistry, DST Unit of Nanoscience (DST UNS) and Thematic Unit of
Excellence (TUE), Indian Institute of Technology Madras, Chennai 600036, India.
[2] Department of Chemistry, Indian Institute of Technology Indore (IIT Indore), Indore453552, India

e-mail: pradeep@iitm.ac.in, biswarup@iiti.ac.in

Two-dimensional nanostructures with atomically precise building blocks have potential applications in catalysis and sensing. However, structural instability and surface reactivity limit their practical use. In this work, we demonstrate the formation of vertically aligned nanoplates of $[Co_6S_8DPPE_6Cl_6]$ cluster (Co_6 in short), protected by 1,2-bis(diphenylphosphino)ethane, using ambient electrospray deposition (ESD). Charged microdroplets of Co_6 formed by ESD on a water surface created such nanostructures. Preferential arrangement of clusters in the nanoplatelets with enhanced surface area results in sensitive and selective electrochemical response towards arsenite down to 5 parts per billion, in tap water. Density functional theory calculation reveals the preferential binding of arsenite with Co_6. Our work points to a practical application of atomically precise clusters of large societal relevance.

Keywords: Cluster chemistry, Nanoplates, Arsenic sensor, Drinking water



LRP-engineered liposomes as potential therapeutics for brain delivery

Akanksha Chaturvedi, Rahul Shukla*

Department of Pharmaceutics, National Institute of Pharmaceutical Education and Research-Raebareli, Lucknow, U.P., India-226002

ApoE has been identified as a molecule with a strong binding affinity to the low-density lipoprotein receptor (LRP). This binding affinity is crucial for its ability to effectively interact with lipoproteins that are directed toward brain cells, highlighting its potential as a promising option for treating neurodegenerative diseases. Wilson disease also termed hepatolenticular degeneration is an autosomal recessive disorder caused by excessive accumulation of copper leading to neurological damage. Though there are current therapies available for mitigating copper overproduction, their limited therapeutic activity is the major cause of the design of a new therapeutic entity purporting the pathophysiological consequences associated with the same. Therefore, in our current research, we have encapsulated ApoE3 in the hydrophilic core of liposomes (LPS) using the ethanol injection method with DSPE-PEG. Coating the liposomes with ApoE3 enhances their ability to enter the brain and remove excess copper. The results obtained from the physicochemical characterization demonstrated that liposomes show a particle size of 125.7 ± 1.16 nm and a zeta potential of -19.6 ± 1.23. The % entrapment efficiency and % drug loading were found to be 85% and 21.71%, respectively. The data obtained from electron microscopy studies revealed that the particle size of the LPS was less than 200 nm. Moreover, in vitro drug release also suggested the sustained release of the prepared formulation. Further studies are required to establish the therapeutic efficacy of the liposomes and prove itself as a potential candidate to mitigate Wilson's disease.

Keywords: Apolipoprotein 3, Liposomes, Wilson disease, Pharmacokinetic and Biodistribution.

Investigation of Titanium Dioxide (TiO_2) Nano Particles Synthesized by Chemical Route For Application in Wastewater Treatment

Chandra Kant[1], Ali Alsuraifi[2], K.P. Tiwari[1], Anand Pandey[1]

1Department of Physics, Agra College, Dr. B. R. Ambedkar University, Agra , India (282002)
2*College of Dentistry,University of Basrah, Basrah(61004), Iraq*

e-mail: cksharma4050@gmail.com

The utilization of sol-gel techniques has been explored in the investigation of the application of titanium dioxide (TiO2) nanotechnology in salinity and wastewater treatment processes. Scanning electron microscope (SEM) micrographs revealed the presence of TiO_2 nanoparticles (NPs) in a homogeneously dispersed state, exhibiting spherical forms. The SEM graphs of nanopowder with high transparency reveal their detectability in the visible spectrum, namely in the UV/visible range. Similarly, X-ray diffraction analysis revealed that TiO_2 had a crystalline size of 18.3 nm. Further, the UV-DRS analysis was conducted to confirm that in its anatase form, TiO_2 had a high energy band gap. Finally, the Fourier Transform Infrared Analysis (FTIR) showed that the bond between oxygen and metal differed according to peaks. The examination of the deposited NPs has been conducted to validate the presence of both anatase and rutile phases in the liquid state. Further, it suggests that the utilization of photodegradation using a solar absorber could have significant implications in the fields of salinity and wastewater treatment.

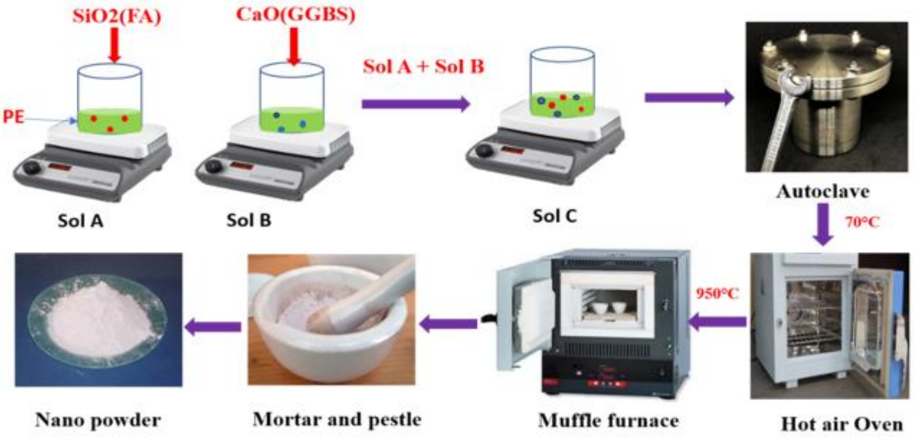
Keywords: Titanium Dioxide; SEM; XRD; UV-DRS; FTIR

Green synthesis of porous akermanite nanorods derived from industrial waste for supercapacitor applications

Gangadhar Mahar, Sushil Patel, Pooja Yadav, P Abdul Azeem*
*Corresponding author: Dr P Abdul Azeem
National Institute of Technology Warangal, Telangana, India, 506004
e-mail: drazeem2002@nitw.ac.in

Recently more attention paid towards renewable energy sources, production of energy from recycling wastes and energy storage due to the scarcity of fossil fuels and increasing environmental pollution. The device cost is expensive for the material synthesized from chemicals. So, people have been fascinated for developing functional material from recycling waste to produce cost effective devices. Perovskite oxides have enhanced physical and chemical properties which promise their use in multifunctional application. The present study focused on the synthesis of akermanite perovskite nano powder from two major industrial waste coal fly ash (C-FA) and ground granulated blast furnace slag (GGBS) as initial precursor by completely chemical free hydrothermal route. Further leaf extract has been used as stabilizing and chelating agent to modify shape and size of the nanoparticles. The structural, morphological and optical properties of the synthesized powder were investigated by XRD, Fourier transform infra -red (FTIR) spectroscopy, Field emission scanning electron microscopy (FE-SEM), Ultraviolet visible (UV-visible) spectroscopy. The detailed structural studies implied that the fabricated powder is akermanite and the average crystallite size and lattice strain were calculated. Field emission scanning electron microscopy analysis showed that particles adopt rod like morphology and size in nano range. The bandgap of the developed powder was calculated from the UV Visible absorbance spectra. The powder was characterized by BET analyzer to know the porosity and specific surface area of the nanoparticle. Electrochemical studies like cyclic voltammetry(CV), Galvanostatic charge- discharge (GCD) and electrochemical impedance spectroscopy(EIS) results showed that the developed material could be used as an working electrode in supercapacitor.

Keywords: Hydrothermal, mesoporous, industrial waste, Akermanite, Supercapacitor



Sequestration of brilliant green from aqueous solution using composites of reduced graphene oxide with chitosan and chitosan beads

O. O. Oluwasina[1]*, A. A. Adelodun[2], O. O. Oluwasina[3]
[1]School of Earth and Mineral Sciences, Federal University of Technology, Akure, Nigeria
[2]School of Earth and Mineral Sciences, Federal University of Technology, Akure, Nigeria
[3]School of Physical Sciences, Federal University of Technology, Akure, Nigeria
e-mail: ojoolayinka01@gmail.com

The uptake of brilliant green (BG) onto composites of either reduced graphene oxide/chitosan (RGCHI) or reduced graphene oxide/chitosan beads (RGCBD) from aqueous solution was explored via batch experiments. The adsorption capacity was assessed as a function of pH, contact time, adsorbent dose, initial dye concentration and temperature. The adsorption capacity of RGCHI (72.05 mg g^{-1}) was found to be higher than that of RGCBD (41.41 mg g^{-1}) and the optimum pH for RGCHI and RGCBD is pH 6. Equilibrium was attained after 120 min for both adsorbents. The Freundlich isotherms best fitted the equilibrium data for RGCHI and RGCBD, respectively. The adsorption was spontaneous and exothermic for the two adsorbents. Nitric acid solution was able to desorb the dye from the loaded adsorbents. This study confirms the successful modification of chitosan and chitosan beads with reduced graphene oxide for the sorption of the cationic dye brilliant green and the experimental data revealed that the adsorption capacity of RGCHI was almost twice that of RGCBD.

Keywords: adsorption, reduced graphene oxide/chitosan, reduced graphene oxide/chitosan beads, brilliant green

Potential of Self-assembling Nanoparticle-based Prodrug in *In vivo* Disease Models for Various Therapeutics

B. Shashni[1]* **and Y. Nagasaki**[1-5]
[1]Faculty of Pure and Applied Sciences, University of Tsukuba, Tsukuba 305-8573, Japan
[2]Master's School of Medical Sciences, University of Tsukuba, Tsukuba, 305-8573, Japan
[3]Center for Research in Radiation, Isotopes, and Earth System Sciences (CRiES), University of Tsukuba, Tsukuba 305-8573, Japan
[4]Department of Chemistry, The University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan
[5]High-value Biomaterials Research and Commercialization Center (HBRCC), National Taipei University of Technology, Taipei 10608, Taiwan
e-mail: shashni@ims.tsukuba.ac.jp

Butyric acid (BA), a bacterial metabolite is reported to alleviate symptoms of diseases in mouse models, including cancer, ulcerative colitis, non-alcoholic steatohepatitis (NASH), liver fibrosis, diabetes, and obesity. However, due to the poor pharmacokinetic (PK) properties of BA, viz., short systemic half-life and fast renal clearance, a treatment regimen using BA requires frequent administrations in a short time which leads to adverse effects. In order to improve the PK-based therapeutic potential of low-molecular-weight (LMW) BA, we designed an amphiphilic block copolymer possessing tens of BAs as a side chain of the hydrophobic segment (poly(ethylene glycol)-b-poly(vinyl butyrate) (PEG-*b*-PV(BA)). This block copolymer self-assembles in aqueous media, functioning as a nanoparticle-type prodrug (Nano^{BA}; **Fig 1A**). The hydrolytic liberation of BA from the polymer backbone is catalyzed by the physiological enzyme (such as esterase), providing a sustainable supply of BA for an extended period of time, which is expected to enhance its PK characteristics. Herein, we discuss Nano^{BA} extends the *in vivo* retention of BA for at least 24 h compared to LMW BA which clears within 10 min post intraperitoneal administration (**Fig. 1B**). The improvement in the PK characteristic has been observed to enhance the efficacy of Nano^{BA} in mouse disease models of B16-F10 (melanoma) cancer, diet-induced NASH and liver fibrosis, diabetes, dextran sulfate sodium (DSS)-induced ulcerative colitis, and as a radiosensitizer for cancer-based radiation (**Fig. 1C**). These findings suggest that Nano^{BA} has superior efficacy over LMW BA, which can be attributed to its improved PK characteristics. We sincerely appreciate the contributions as part of these studies by Y. Tajika, Y. Hayasaki, Y. Ikeda, and Y. Nishikawa.

Keywords: Short chain fatty acids, self-assembling polymers, micelle prodrugs, sustained release

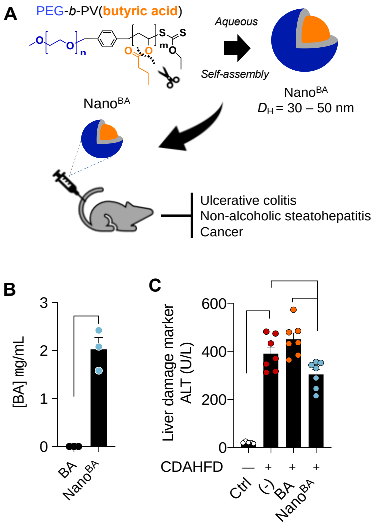


Fig.1. (A) Design of amphiphilic block copolymers, poly(ethylene glycol)-b-poly(vinyl butyrate) (PEG-b-PV(BA)), which self-assemble to NanoBA. (B) Levels of plasmatic BA at 24 h after intraperitoneal injection of equivalent NanoBA or BA (250 mg/kg) in C57BL/6J mice, **P<0.005, Student's t-test. (C) Plasma levels of alanine transaminase (ALT), a liver damage marker, in high fat diet-induced NASH in mice, after providing BA and NanoBA (100 mM) by ad libitum drinking *P<0.05, ****P<0.0001, Tukey's multiple comparisons tests.

Membrane-less Microfluidic Channels for Green Hydrogen Production

Yeshudan Bora[1], Jiwajyoti Mahanta[1], Dipankar Bandyopadhyay* [1]
[1]Department of Chemical Engineering, Indian Institute of Technology Guwahati, Assam, India
[2]Centre for Nanotechnology, Indian Institute of Technology Guwahati, Assam, India
[3]School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Assam, India *
e-mail: dipban@iitg.ac.in

Microfluidics is a promising platform for the creation of micro-reactors for the production of green hydrogen, which has the potential to replace fossil fuel-based energy systems. This research focuses on fabricating a cost-effective and energy-efficient membrane-less microfluidic channel using a conventional soft lithography technique. Microfluidics allows for the manipulation of reactions and fluids on a micrometre scale, providing precise control and efficient utilization of resources. It offers a sustainable and long-lasting fuel solution by enabling the production of green hydrogen. The fabrication of the membrane-less microfluidic channels involves the use of polydimethylsiloxane (PDMS) and its cross-linker, Sylgard 184. Graphite electrodes and N-type semiconducting materials are used in the channels. The production of hydrogen through electrochemical reforming of alkaline ethanol is very appealing. This single-step process for producing hydrogen offers a sustainable and environmentally responsible method.

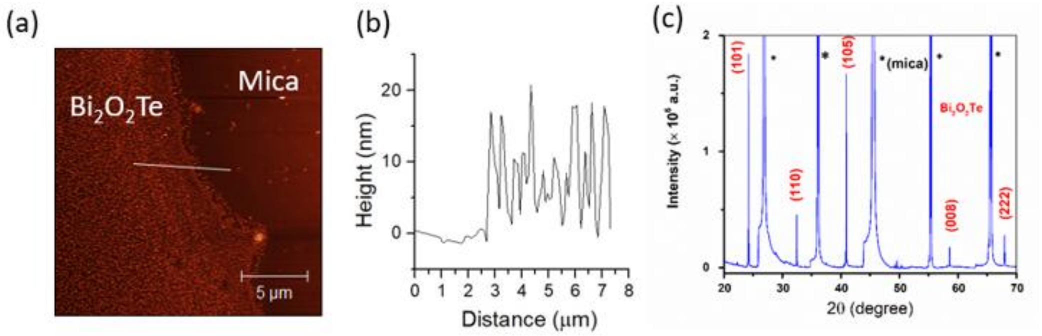
Keywords: Membrane-lessmicrofluidic channel, Graphite electrodes, N-type semiconducting materials,

Controlled CVD growth of non-van der Waals two-dimensional bismuth oxytelluride

Sourav Dey[1*]; Md Tarik Hossain[2]; P. K. Giri[1,2]
[1]Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati-781039
[2]Department of Physics, Indian Institute of Technology Guwahati, Guwahati-781039
e-mail: d.sourav@iitg.ac.in

Two-dimensional (2D) materials with the van der Waals (vdW) gap have been extensively studied due to their layer-dependent band gap and functionalities. However, vdW materials are sensitive to air exposure, which limits the corresponding device performance. Recently emerged non-van der Waals type 2D bismuth oxytelluride (Bi_2O_2Te) has captured remarkable research attention due to its high electron mobility and excellent air stability. In addition, 2D Bi_2O_2Te is demonstrated as potential candidate for various device applications including transistors, artificial synapses, optical switch and photodetectors. [1] However, preparing 2D Bi_2O_2Te is challenging due to the electrostatic interaction among the layers. Herein, we present the chemical vapor deposition (CVD) growth of an air-stable large-area 2D Bi_2O_2Te (Figure 1a, b) with high structural and chemical uniformity, as confirmed by X-ray diffraction (Figure 1c) and Raman spectroscopy.). Interestingly, we can tune the thickness of 2D Bi_2O_2Te layer by varying the pre-CVD process on the substrate, which is measured from the AFM height profile analysis. Details of the growth parameters and characterization of the 2D Bi_2O_2Te layer will be presented.

Keywords: 2D Bi_2O_2Te, CVD, X-ray diffraction, Raman spectroscopy, AFM



Reference:

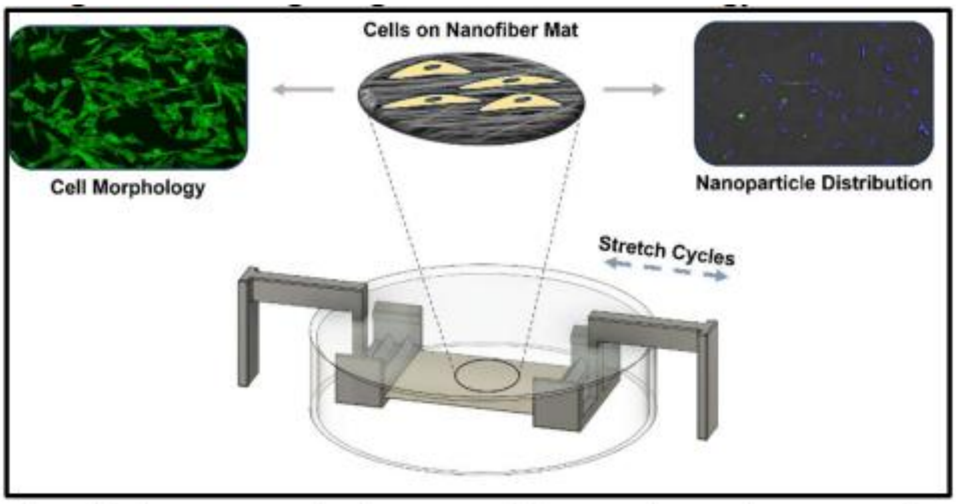
1. Wang, F, Yang, S, Wu, J, et al. Emerging two-dimensional bismuth oxychalcogenides for electronics and optoelectronics. InfoMat. 2021; 3(11): 1251–1271. https://doi.org/10.1002/inf2.12215.

Design and development of 3D printed device and nanofiber-based scaffold for understanding the mechanobiology of cells

Soumyadeep Basak; Gopinath Packirisamy*
Department of Biosciences and Bioengineering, Indian Institute of Technology Roorkee, Roorkee, Haridwar, Uttarakhand-247667
e-mail: gopi@bt.iitr.ac.in

Biomedicine, tissue culture, and regenerative medicine- are amongst a few of the allied sectors in biotechnology, where cellular behavior and molecular pathways are investigated for generating products or knowledge essential for human survival. Most such studies are performed using adherent cells on flat, electrically charged surfaces or, from the past few decades, nanofiber or hydrogel-based scaffolds [1-3]. However, such static culture conditions do not correctly represent the in-vivo mimetic cellular microenvironment, called extracellular matrix (ECM), where they perceive and react considerably to a vast magnitude of the mechanical forces (both intrinsically generated or extrinsic) through mechanotransduction [3]. Although, in specialized laboratories of some developed nations, the use of a few available commercial and non-commercial technologies is gaining tremendous attention, developing countries like India still lack an affordable, accessible, compact, and reliable solution for considering mechanical attrition, e.g., in the form of stretch cycles, in their cell-biology experiments [4]. To address these challenges, we developed a 3D printed, wirelessly controlled, cyclic mechanical attrition device that uses a microcontroller, batteries, sensors and stepper motor assembly to provide uniaxial stretch cycles to any thin substrate. We prepared electrospun, nanofiber-based, water-stable, and stretchable substrates of different fiber orientations for studying its effect on the C2C12 myoblast-like cell's morphology and orientation upon mechanical stretch cycles. Moreover, using BSA-Epirubicin nanoparticles; a fluorescently active, potential drug-delivery candidate for future therapeutic investigations; we also studied their uptake and distribution properties inside the cells upon mechanical stimulation. Our work, therefore, provides a comprehensive study of cellular behavior when cells loaded on different architectures of nanofiber mats are uniaxially stretched. We also offer a cost-effective alternative solution to the long-standing need for a compact, easy-to-operate, and tunable device for generating more exciting insights into mechanobiology.

Keywords: Mechanobiology, 3D Printing, Stretching Device, Microcontroller, Nanofiber



Reference:
1. S. Basak, V. Kumar,; G. Packirisamy, ACS Omega. 2021, 6, 7605-7614
2. S.J. Phang, S. Basak, et. Al., ACS Biomater. Sci. Eng. 2022, 8, 8, 3220-3241
3. U.K.Sukumar, G.Packirisamy; ACS Appl. Bio Mater. 2019, 2, 12, 5323–5339
4. K.H. Vining, D.J. Mooney,; Nat. Rev. Mol. Cell Biol, 2017, 18, 728-742 5.
5. F. Melo-Fonseca, et. Al, Biodes Manuf., 2023, 6, 340–371

Electrochemically Grown TiO2 Nanotube Arrays for Non-Enzymatic Glucose Sensing Application

S Das, D C Patra, A Dash, A Deb and S P Mondal*
* Corresponding author
Department of Physics, National Institute of Technology, Agartala, India -799046.
e-mail: suvra.phy@nita.ac.in.

Diabetes is a chronic metabolic disease that affects the sugar metabolism of the body; affecting nearly 422 million people and accounting for more than 2% deaths worldwide. Moreover, people suffering from diabetes also suffer from feet damage, nervous disorders, heart diseases, kidney failures, etc. Therefore, continuous monitoring of glucose is required for helping in the reduction and controlling of diabetes and various diabetes induced diseases. Development of a low cost hand-held glucose sensor is very much essential for physician and patient for diabetes monitoring applications. Most of the commercially available hand-held glucose sensors are enzymatic and invasive in nature. The major bottlenecks of such sensors are poor shelf-life, high cost of enzyme electrode and invasive in nature. On the other hand, development of a non-enzymatic and noninvasive glucose sensor with high sensitivity and longer shelf-life would be attractive especially for neonatal and elderly people. Among the various electrode materials being studied, transition metal-oxide nanostructure based electrodes has gained more interest owing to their larger surface area, high sensitivity, easy fabrication process and most importantly longer shelf-life. In this report, we fabricated a non-enzymatic electrochemical, glucose sensor using titanium oxide (TiO2) nanotube arrays as sensing material. TiO2 nanotubes were grown by a simple electrochemical anodization of titanium foil. The glucose sensing measurements were carried out using TiO2 nanotubes as the working electrode after adding various concentrations of glucose. The TiO2 nanotubes electrode demonstrated high sensitivity (~4.93mM/μA/cm^2)and wide linear detection range (100 μM – 10 mM) which is attractive for non-enzymatic glucose sensing in biological fluids.

Keywords: glucose sensor, TiO2 nanotubes, non-enzymatic electrode, electrochemical sensor

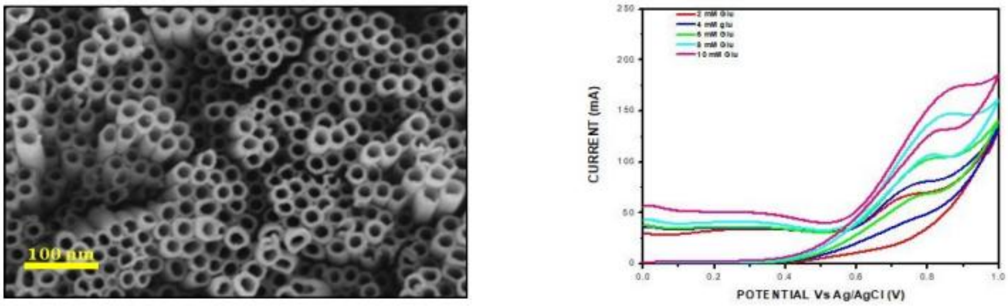


Fig. 1: (a) Scanning electron micrograph of TiO2nanotubes grown on Ti foil and (b) Cyclic voltammetry plots of the sensing electrode with various concentrations of glucose

Formation of molybdenum-oxo clusters via soft chemistry; its tungsten doping and optical sensing of Arsenic

S. Acharya; A. Nag; S. Jana; R. Islam; P. Srikrishnarka; A. R. Kini; T. Pradeep*
DST Unit of nanoscience and Thematic unit of excellence, Department of Chemistry, IIT Madras, India
e-mail: pradeep@iitm.ac.in

Polyoxometalates (POMs) are discrete all-inorganic anionic molecular clusters having metal−oxygen bonds forming clusters of different nuclearity.[1] Generally, transition metals in their highest oxidation state behave singularly, forming large and discrete polyatomic anions with terminal oxo groups, called polyoxometalates.[2] Over recent years, the field of polyoxometalate (POM) chemistry has undergone a profound transformation, and offer remarkable structural diversity, unlocking a wide array of potential applications across multiple domains, including materials science, sensing, catalysis, medicine, biomedical applications, energy conversion, and storage. Yet, the challenge lies in developing efficient synthetic protocols for integrating these oxo clusters, a domain that remains relatively unexplored. This challenge pertains to the necessity of establishing robust methodologies for their integration into hybrid architectures and devices. In this research, we introduce a novel top-down synthetic method for generating water-soluble sub-nanometre molybdenum-oxo clusters through a soft chemistry approach. This approach involves reacting molybdenum powder with water under ambient conditions, resulting in the formation of molecular molybdenum-oxo clusters, specifically $[Mo_{12}O_{33}(H_2O)_8]^{3-}$. Various analytical techniques, including UV-vis spectroscopy, ESI mass spectrometry, and X-ray photoelectron spectroscopy (XPS), were employed for this cluster characterization. Furthermore, we achieved the selective extraction of molybdenum (98.7%) from a mixture of molybdenum and tungsten, leading to the incorporation of tungsten into the $[Mo_{12}O_{33}(H_2O)_8]^{3-}$ cluster. This approach offers a straightforward method for doping tungsten into this noble material synthesis. The synthesized molybdenum-oxo cluster demonstrates exceptional sensitivity in detecting arsenic, relying on simple optical absorption spectroscopy as the analytical tool. This arsenic sensing mechanism operates through charge transfer interactions with the Mo-oxo cluster, making it a promising sensor for real-world arsenic detection in field samples.

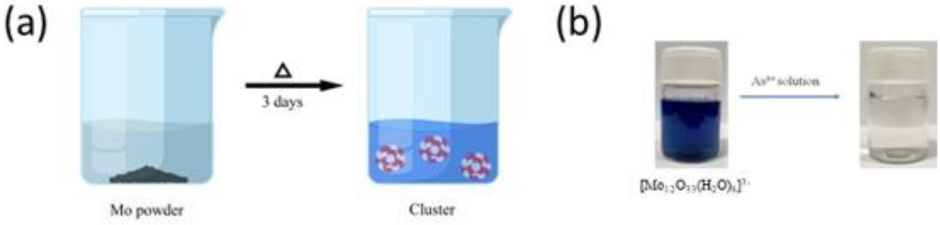


Figure: (a) Schematic of the synthesis procedure (b) Arsenic detection

Reference:

1. Gumerova, N. I.; Rompel, A. Polyoxometalates in solution: speciation under spotlight.*Chem. Soc. Rev.*, **2020,** 49, 7568-7601
2. Day, V. W.; Klemperer, W. G. Metal Oxide Chemistry in Solution: The Early Transition Metal Polyoxoanions. *Science*, **1985**, 4699, 228, 533-531

Room temperature excitonic absorption and visible photoluminescence from CVD-grown two-dimensional bismuth oxyselenide layer on various substrates

Md Tarik Hossain[1]*, Tadasha Jena[2], P. K. Giri[1,2]

[1]*Department of Physics, Indian Institute of Technology Guwahati, Guwahati-781039, India*
[2]*Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati 781039, India*

Email: tarik@iitg.ac.in

Recently emerged non-van der Waals (non-vdW) two-dimensional (2D) bismuth oxyselenide (Bi_2O_2Se) crystals possess fascinating optoelectronic properties and are comparable to conventional silicon semiconductors. Low-cost preparation of 2D Bi_2O_2Se and understanding the basic optical and electronic properties are essential for further use in miniaturized device applications. Chemical vapor deposition (CVD) is a low-cost method to grow high-quality ultrathin 2D materials on arbitrary substrates. To date, the CVD growth of an ultrathin film of Bi_2O_2Se is mostly on mica substrates, and understanding the fundamental properties is in its infancy. Specifically, the broadband absorption with certain features, the origin of photoluminescence (PL) at visible and near-infrared (NIR) wavelengths, and the effect of growth substrates on the structure and optical properties are largely unknown. Herein, we have grown ultrathin 2D Bi_2O_2Se layer (thickness ~10-50 nm) via the CVD technique on various substrates (mica, sapphire, quartz, SiO_2, and glass) and elucidated their impact on structure and optical properties, including the reason for broadband absorption and visible PL, despite its intrinsic bandgap in the near-IR region. We show that the growth substrates influence the lattice constant, absorption coefficient, optical bandgap, and PL properties of the Bi_2O_2Se crystals due to substrate-induced strain/doping. In addition, the possible direct/indirect multiple excitons formation at different symmetry points (see Fig. 1) of Bi_2O_2Se is responsible for broadband (visible-NIR) absorption and PL, which are probed from experimental observations and supported with the density functional theory (DFT) calculation of the electronic band structure. These findings shed new light on the photo-physics of 2D Bi_2O_2Se-crystals and their exploitation in futuristic optoelectronic devices.

Keywords: 2D material, Chemical vapor deposition, Photoluminescence

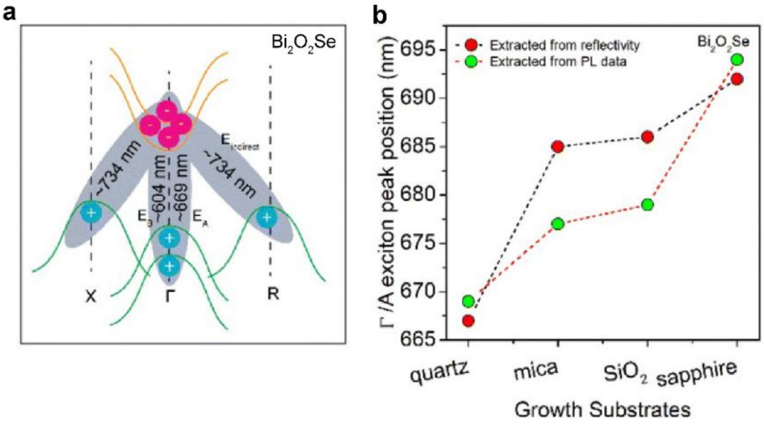


Figure 1. a. A schematic illustration of excitons formation at different symmetry points resulting in a broad absorption/emission spectrum of Bi_2O_2Se in the visible wavelength. b. Γ/A exciton peak positions extracted from the reflectivity (red circle with black dotted line) and photoluminescence (green circle with red dotted line) measurements for different growth substrates.

Reference:

[1] Hossain *et al.*, Nanoscale, vol. 15, 11222-11236 (2023)

Single Phase Transition Leads to the Nanoparticle Deposition in an Evaporating Sessile Droplet

S. Paul; A. Chattopadhyay*
* Department of Chemistry, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India.
e-mail:arun@iitg.ac.in

The ubiquitous natural ring stain formation upon evaporation of a sessile droplet with dispersed particles continues to attract great scientific attention. The fundamental understanding of the process is that evaporation of the liquid at the pinned three-phase contact line is faster than that at the center. This drives a capillary flow taking the particles towards the contact line that get deposited there. Particle deposition at contact line during sessile colloidal droplet evaporation is a gradual process with a rapid acceleration of the flow in the final leg of drying. However, we observed the process is akin to a phase transition with particles depositing at the contact line in a short span of time and well before the complete drying of the droplet. We used surface enhance Raman scattering (SERS) of sodium 4-mercaptobenzoate capped gold nanoparticles (NaMBA-AuNPs) to probe vibrational spectrum of MBA on their surfaces as they were deposited on the substrate surface from the liquid dispersions. Thus, when aqueous droplets of sodium 4-marcaptobenoate-stabilized plasmonic gold nanoparticles (NaMBAAuNPs) were evaporated under ambient conditions, the Raman signal of the molecules were observed to have sharply increased in a short window of time. Raman signal of MBA in evaporating droplet sharply increased in a short window of time. Simultaneous digital photographic images imaging showed the solid particles deposited in the form of ring accompanying the change. The time taken for phase transition decreased with increase in the initial concentration of the AuNPs in the medium. Importantly, the final concentration of the AuNPs before sudden deposition at the contact line was the same for all initial (nanomolar) concentrations of the NPs studied and that was on the order of 13 μM for ~25 nm AuNPs.

Keywords: Coffee-ring effect, gold nanoparticles, phase transition, surface enhanced Raman spectroscopy

Fabrication of graphene oxide based photodetector and the role of attached oxygen functional groups in the device

[1]Ningthoujam Somorjit Singh; [1,2]H.B. Nemade; [1,3]P.K. Giri*
1Centre for Nanotechnology, Indian institute of Technology Guwahati, Guwahati India-781039; 2Department of EEE, Indian institute of Technology Guwahati, Guwahati India-781039; 3Department of Physics, Indian institute of Technology Guwahati, Guwahati India-781039
e-mail: somorjit@alumini.iitg.ac.in

In last decades, scientific communities have focused on the two-dimensional materials, especially graphene oxide (GO) due to the large surface area, tunable electronic properties, high presence of defects, ease of synthesis, and low-cost. We synthesized low-cost and large surface area GO sheets using a facile exfoliation method known as Mild heating. We used the GO as an active material for photodetector devices. The quality of GO is characterized using FESEM, FETEM, XRD, Raman, XPS, PL, UV absorbance, FTIR, and IV measurement. Using the I-V measurement, the GO behaved in an electrically semiconducting nature, and the electron flow was increased up to 14 times during the exposure of a 405 nm laser. A detailed analysis of the GObased photodetector device and its figure of merits, such as responsibility, on/off ratio, response time, external quantum efficiency, etc.., is demonstrated during the presentation.

Keywords: Graphene oxide; photodetector; interdigitated electrode; photo-response

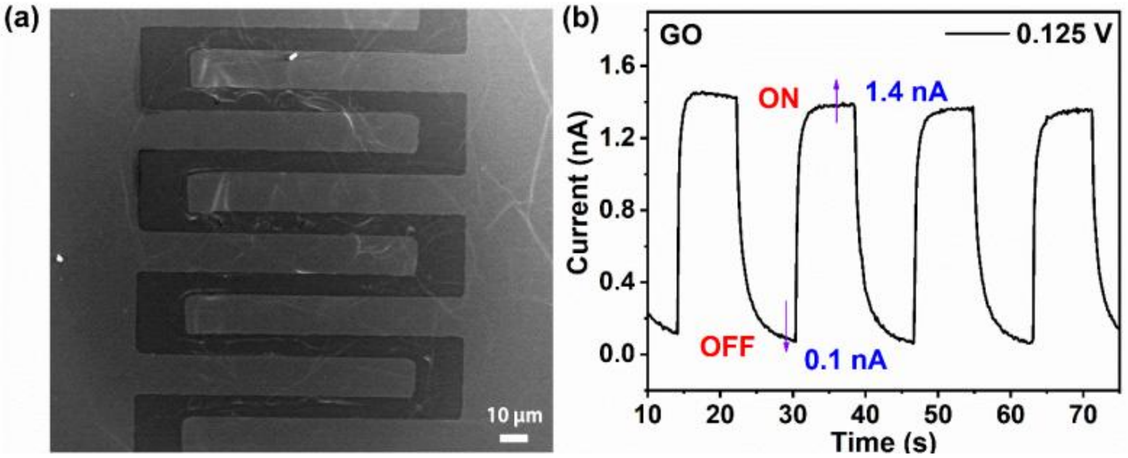


Figure 01: (a) Graphene oxide sheets on the IDE pattern; (b) Photo-response characteristics of the GO based photodetector.

A New Cu8 Nanocluster Showing Aggregation Induced Emission for Nitro Compound Vapor Sensor

<u>Subrata Duary</u> and Thalappil Pradeep*
Indian Institute of Technology Madras
e-mail: pradeep@iitm.ac.in

Atomically precise copper nanoclusters are emerging due to their rich optical properties. We have synthesized and characterized a new Cu8 copper cluster protected by phosphine and 4- hydroxy-6(trifluoromethyl)pyrimidine ligand. We have synthesized the cluster by ligand exchange strategy from [Cu18H16(DPPE)6] 2+nanocluster. The single crystals were grown by hexane diffusion to the DCM solution of the cluster. The structure is mentioned in Figure 1.

Atomically precise copper nanoclusters are emerging due to their rich optical properties. We have synthesized and characterized a new Cu8 copper cluster protected by phosphine and 4- hydroxy-6(trifluoromethyl)pyrimidine ligand. We have synthesized the cluster by ligand exchange strategy from [Cu18H16(DPPE)6] 2+nanocluster. The single crystals were grown by hexane diffusion to the DCM solution of the cluster. The structure is mentioned in Figure 1.

Keywords: Nanoclusters, Aggregation induced emission

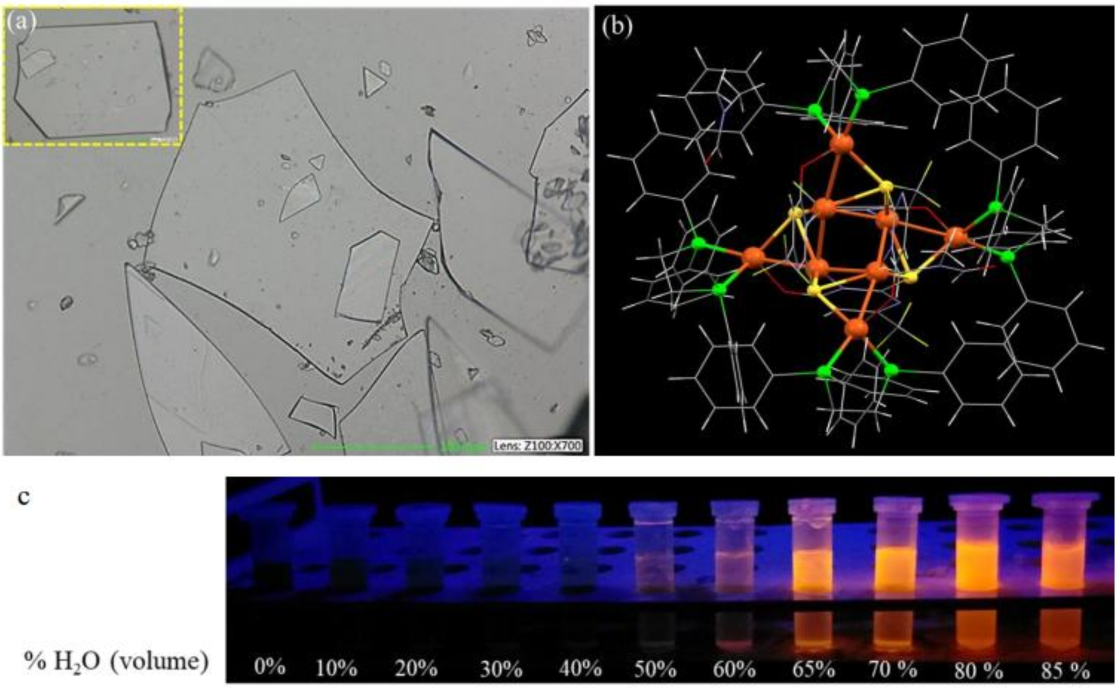


Figure 1: (a) Single crystals (b) Single crystal structure of Cu8 NC and (c) Aggregation induced emission upon water addition

Green synthesis and characterization of edible ginger-derived nanoparticles

Shweta Mehrotra, and Vinod Chhokar
Department of Bio and Nano Technology Guru Jambheshwar University of Science & Technology, Hisar-125001, India
e-mail:shwetamehrotragoyal@gmail.com

The genus Zingiber belongs to the family Zingiberaceae and has immense medicinal importance. Zingiber officinale (Ginger) is a popular spice having a wide range of bioactive compounds and has multiple pharmacological properties and therapeutic values such as antitumorigenic, anti-apoptotic, anti-inflammatory, anti-oxidant activities which are attributed to its active phenolic compounds, gingerols and shogaols. The metabolites, 6-gingerol and 6- shogaol have anticancer activities against cancers of gastrointestinal tract, pancreas, skin, liver, lung, rectal, breast, and ovary. Ginger derived nano-formulations offer a safe and efficient way of targeting cancer treatment and hold sufficient potential in minimizing toxicity and circumventing multidrug resistance. Nanoparticle based treatment is linked with enhanced pharmacokinetics, biocompatibility, tumor targeting, stability and controlled release rate as compared to conventional drugs. We synthesized and characterized bio-active copper and silver nanoparticles using ethanol extracts of fresh ginger rhizome and studied their anti-microbial effects. UV-Visible Spectrophotometry studies were performed. The peak of silver and copper derived nanoparticles obtained at 412nm and 420nm, respectively indicated the formation of nanoparticles. The silver and copper nanoparticles had a particle-size of 81 nm and 92 nm and a poly dispersity index of 0.510 and 0.377, respectively. The negative zeta potential of -17.1 and -31mV indicated the stability of respective silver and copper nanoparticles; and Fourier Transform Infrared Spectroscopy revealed that the nanoparticles were surrounded by various biomolecules such as ether, ester, alcohols and carboxylic acids. We anticipate testing nanoparticles against cancer cell lines since the ginger extract exhibited anti-microbial activities and could inhibit the growth of bacteria like Escherichia coli, Pseudomonas aeruginosa, Salmonella typhimurium, Streptococcus pyogenes, Staphylococcus aureus, Bacillus subtilis, Rhizopus sp, Aspergillus niger, and Candida albicans. Transforming the natural particles of ginger to nanoparticles will yield enhanced therapeutic values and will find greater application in healthcare industries.

Interfacial Chemistry of Plasmonic Au@CsPbBr3 Hybrid Nanocrystal: Obtaining Ligand-free Au Nanoparticle

S. Samanta and T. Debnath*
Centre for Nanotechnology, Indian Institute of Technology, Guwahati, Assam-781039, India
e-mail: t.debnath@iitg.ac.in

Plasmonic materials exhibit strong light absorption properties, leading to their usage in solar energy conversion. In this regard, plasmonic metal/semiconductor hybrid nanomaterials have been extensively studied where Au, Ag, etc. have been used as a metal and classical inorganic quantum dots (e.g. CdSe, PbS) has been used as a semiconductor. While perovskite nanocrystals (NCs) have been at the forefront of solar energy research over the last few years, the corresponding plasmonic hybrids are largely missing in the literature. In this work, we prepared photostable Au@CsPbBr3 hybrid NCs from pure CsPbBr3 NCs using a molecular shuttle at the water-hexane interface. The Au@CsPbBr3 NCs exhibit simultaneous exciton resonance and localized surface plasmon resonance (LSPR) with equal dominance, covering the full visible region, which is exciting but challenging. This allows a strong exciton and plasmon coupling in this plasmonic perovskite nanocrystal, which is directed by intrinsic quenching of the photoluminescence via the electron transfer process from perovskite to the Au domain where the rate of electron transfer is determined to be 4.8 × 109 s −1 . Importantly, through a control interfacial surface modification strategy, we regenerate CsPbBr3 NCs from Au@CsPbBr3NCs with simultaneous eruption of larger size ligand-free aqueous Au nanoparticle (NPs). Both Au@CsPbBr3 NCs and ligand-free Au NPs show two-order enhancement in the surface-enhanced Ramon Scattering (SERS) signal of a commercially available probe molecule, indicating their opportunity for biomedical applications. Moreover, the Au@CsPbBr3 NCs are found to be photostable upon longer time laser irradiation, directing their long-term stability which may open their possibility for photocatalysis. Overall, our result on interfacial chemistry provides two new plasmonic materials, viz. Au@CsPbBr3NCs and ligand-free aqueous Au NPs, both of which may become champions in solar energy and biomedical research.

Keywords: Plasmonic perovskite nanocrystal, Interfacial chemistry, Au@CsPbBr3 nanocrystals, Ligand-free Au nanoparticle, Exciton – plasmon coupling

Green Synthesis of Gold Nanoparticles Using Leaf Extracts of *Pterospermumcanescens* and *Vernonia elaeagnifolia*, Characterization and Cytotoxic Studies on Rat Glioma Cells

C.T Sadiya Sherin[1]*, T. Jayakumar[1], T.S. Anitha[2] and SM. Sundarapandian[1],
[1]Department of Ecology and Environmental Sciences, Pondicherry University, Puducherry, India-605014,
[2] Department of Biochemistry and Molecular Biology, Pondicherry University, Puducherry, India-605014.
e-mail: sadiyasherin6@gmail.com.

Green synthesized nanoparticles are a novel and promising approach comparing to the chemically synthesized products in the field of biomedical applications. The gold nanoparticles were synthesized from locally available and less exploited medicinal plants, *Pterospermumcanescens*(P.C)and *Vernonia eleaegnifolia*(V.E)leaf extracts. The green synthesized nanoparticles were characterized using UV-VIS, XRD, HRTEM-SAED, FESEM-EDX, and FTIR analysis, confirms the formation, size range, shape, morphological features and involvement of secondary plant metabolites in the synthesized particles. The size of nanoparticles synthesized were below 50 nm (P.C AuNP- 27.48 nm and V.E AuNP- 14.79 nm) and shapes were mostly of spherical or distorted spherical. The gold nanoparticle synthesized from both the plants showed the most potent minimal effective concentration with IC_{50} values of 84. 85 (V.E AuNP) and 82.32(P.C AuNP). The gold nanoparticles from *Vernonia eleaegnifolia* showed 78% of apoptotic cells after cell viability assay in the glioma cells and *Pterospermumcanescens* showed 50% confirming their cytotoxic efficiency towards the test cell line. The gene expression studies using qRT-PCR analysis also endorses the efficiency of the green synthesised nanoparticle in the cancer treatment applications.

Keywords: Green synthesis, Gold nanoparticle, *Pterospermumcanescens*, *Vernonia elaeagnifolia*, cytotoxic studies.

Synthesis of Large Area Graphene Using Thermal CVD

Monika[1,a)]Pooja Yadav[1,b)] and Arup Samanta[1, c)] ,
[1]Department of Physics
Indian Institute of Technology Roorkee, 247667 Uttarakhand, India
e-mail: monika@ph.iitr.ac.in.

Graphene, two-dimensional allotrope of Carbon, has gained tremendous attention due to its exotic mechanical and electronic properties. Chemical vapor deposition (CVD) of graphene on copper foils has become a key technique for the preparation of high-quality, large-area graphene sheets for use in practical applications. Present study covers the growth of large area multilayer graphene on copper foil substrate. Scanning tunneling microscopy (STM) confirms the honeycomb structure of the graphene. Surface morphology of the grown layer is characterized using Field emission scanning electron microscopy (FESEM), which confirms the synthesis of multilayer graphene on copper foil with domain size greater than 225 μm. To investigate the chemical bonding and valence state in the structure, X-Ray photoelectron Spectroscopy (XPS) has been employed, which confirms the sp^2 bonding between the carbon atoms. The three peaks at 284.8 eV, 285.7 eV and 288.35 eV are attributed to the sp^2carbon bonds, sp^3 carbon bonds and $O - C = O$ bonds, respectively. Raman spectroscopy counts the layers by comparing the peak intensities of the G and 2D bands.

Keywords: Graphene, Thermal Chemical Vapor Deposition, Copper foil

Study of intrinsic emission bands of barium aluminate ($BaAl_2O4$) phosphor

Manash Kalita*;J.M. Kalita
* Corresponding author Department of Physics, Cotton University, Guwahati 781001, India
e-mail: manashkalita181@gmail.com

Barium Aluminate (BaAl2O4) is a wide band gap material which has a stuffed tridymite structure. We carried out the steady-state and time-resolved -photoluminescence (PL) property of the Barium Aluminate (BaAl2O4) phosphor. The sample was synthesized using the conventional solution combustion method at 500 oC. The structural analysis revealed that the synthesised sample contains hexagonal BaAl2O4 and BaAl12O19 phases with space group P6322 and P63/mmc respectively. Quantitatively, the sample has 61% of BaAl2O4 and 39% of BaAl12O19. An UV-Vis spectrum shows a high absorption maximum at ~209 nm along with three secondary absorption maxima at ~250, 288 and 338 nm. The optical bandgap of the sample was found to be ~5.05 eV. A PL emission spectrum recorded under 345 nm UV light excitation shows three maxima at ~405, 428 and 456 nm. The intensity of the peak at 428 nm is found to be higher than the others. The time-resolved PL measurement was carried out under 405 nm excitation pulse and the luminescence decay of the primary emission peak was recorded. The time-resolved PL decay consists of three components with their respective decay constants of 0.62, 2.05 and 5.62 ns. The average lifetime corresponding to the emission band at 428 nm is found to be 3.3 ns. The different emission peaks observed in the sample are attributed to oxygen vacancy and other aggregated defects. Our analysis of the time-resolved PL spectrum reveals exitance of F + centre in the sample.

Keywords: BaAl2O4, Photoluminescence, Oxygen vacancy, F^+ -centre

Hydrogenated Silicon Nanowire Arrays as Promising Photocatalyst for Dye Degradation and Solar Hydrogen Generation

Pravesh Negi1 , Deepika Singh1 , Arup Samanta1,2,*
1Department of Physics, Indian Institute of Technology Roorkee, Uttarakhand, India, 247667 2Center for Nanotechnology, Indian Institute of Technology Roorkee, Uttarakhand, India, 247667
e-mail: arup.samanta@ph.iitr.ac.in

Since semiconductors have a wide range of band gaps, they are frequently utilized as photocatalysts. For commercial applications, choosing affordable novel nanomaterials with excellent catalytic activity and high recovery is crucial. Silicon is a cheap and affordable semiconductor material widely used in photovoltaics. One-dimensional silicon nanowires (SiNWs) having a large surface-to-volume ratio are receiving much attention in various applications. In this study, we fabricated SiNW arrays using the metal-assisted chemical etching method, hydrogenated them by the wet chemical method, and then studied their photocatalytic activity. These hydrogenated SiNW arrays show excellent photocatalytic activity in the degradation of methylene blue (MB) dye and in the photocatalytic hydrogen generation by solar water splitting.

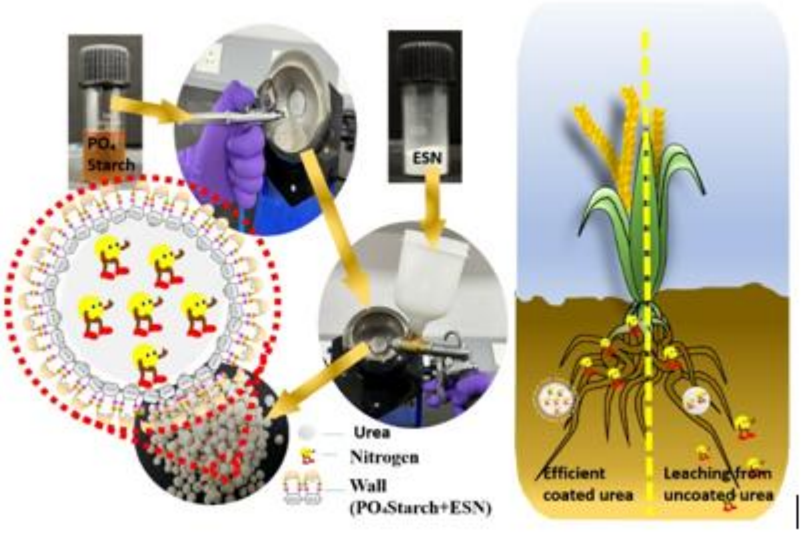
Keywords: Silicon nanowires (SiNWs), Methylene Blue (MB), Photocatalytic activity, Dye degradation, Hydrogen generation

Starch wall of urea: facile starch modification to residue-free stable urea coating for sustained release and crop productivity

K. Swami, B. K. Sahu, V. Shanmugam*
Institute of Nanoscience and Technology, Mohali, Punjab 140306, India
e-mail: vijayakumarshanmugham@gmail.com

A stable coating for urea fertilizer that impedes quick leaching, without the use of toxic linkers, remains a significant challenge. In this study, achieving a stable coating without toxic linkers has been addressed by employing starch, a readily available bio-polymer. The starch was modified with phosphates to enhance its properties, and the addition of eggshell nanoparticles (ESN) was used to reinforce the coating. The ESN offers a calcium ion binding site for the phosphate to cause bio-mimetic folding. The resulting coating exhibited a stable structure, with hydrophilic ends retained in the core and an excellent hydrophobic surface, as evidenced by a water contact angle of 123°. Moreover, the phosphorylated starch combined with ESN enabled the coating to release only around 30% of the nutrient content within the initial 10 days. This controlled release continued for up to 60 days, with approximately 90% of the nutrient being gradually released. The stability of the coating was attributed to its resistance to major soil factors, such as acidity and amylase degradation. Additionally, the incorporation of ESN increased elasticity, helped control cracking, and enhanced self-repairing capabilities, acting as buffer micro-bots. The application of the coated urea resulted in a notable improvement in rice grain yield, with an increase of approximately 10%.

Keywords: Coating,Phosphorylated starch, Eggshell nanoparticles, and Slow-release.

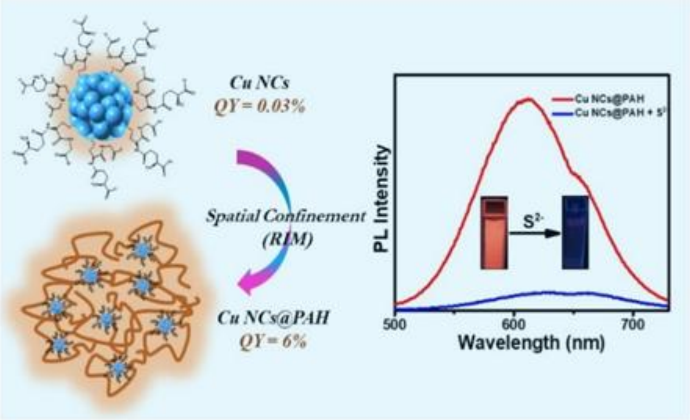


Cationic Polymer functionalized Copper Nanocluster based Fluorescent probe for the selective and sensitive detection of S^{2-} ions

Rashi,[1] A. Devi[1] and A. Patra[1,2*]
[1]Institute of Nano Science and Technology, Knowledge city, Sector 81, Mohali 140306,India
[2]School of Materials Sciences, Indian Association for the Cultivation of Science,Kolkata 700032, India
e-mail: amitava@inst.ac.in

The sensitive and selective detection of Sulphide (S^{2-}) ions in water is of major interest due to its physiological effects on organisms. Herein, we have designed a fluorescent probe based on electrostatic interactions of negatively charged red-emitting Cu nanoclusters and positively charged poly(allylamine) hydrochloride (PAH) for the detection of S^{2-} ions. We have successfully enhanced the photoluminescence (PL) intensity of Cu NCs by 22 fold and we have achieved a 20% enhancement in quantum yield (QY) (0.3% to 6%). The steady-state and time-resolved fluorescence measurements give the perception of the aggregation-induced emission (AIE) phenomenon as a mechanism for PLQY enhancement. In addition, the Cu NCs@PAH exhibits excellent selectivity towards aqueous S^{2-} ions. The probe displays a reasonable quenching response for S^{2-} ions over a concentration range of 0 – 20 μM with a detection limit of 2.39 μM. We believe that this facile and economical synthesis methodology of Cu NCs@PAH with interesting AIE properties will extend the scope of previously available techniques for the detection of sulfideion

Keywords: copper nanoclusters, electrostatic interactions,AIE, sulfide ions, quenching, LOD



Reference:

1. Rashi, Bain, D.; Devi, A.; Chakraborty, S.; & Patra, A. *ACS Sustainable Chemistry & Engineering*, **2023**, 11(5), 1995-2004

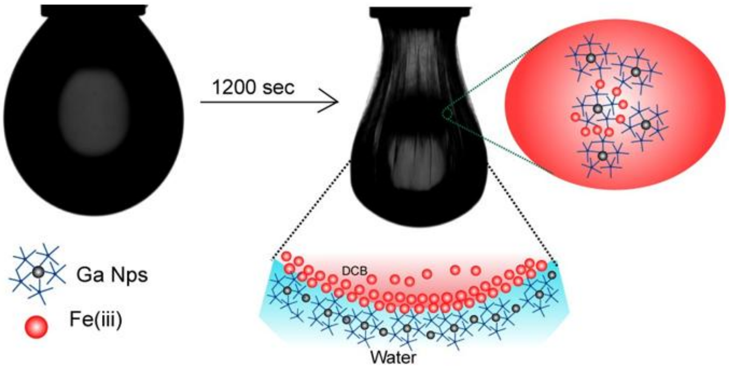
Sculpting Liquid Metal Nanoparticles using Metal-Phenolic Network at Liquid-Liquid Interface

Reek Mahapatra, Debabrata Patra*
*Energy and Environment unit; Institute of Nano Science of Technology, Knowledge City, Mohali-140306, Punjab, India
e-mail: *patra@inst.ac.in*

The liquid-liquid interface offers an intriguing pathway for developing and understanding the non-equilibrium shape of the liquid. At the oil-water interface, the metal-phenolic network is employed to investigate the impact of self-assembly in controlling the shape of the liquid. The interfacial self-assembly of metal ions and tannic acid (TA) coated liquid metal nanoparticles in biphasic systems has the capacity to stabilize the interface by diminishing the interfacial tension Furthermore, the intriguing phenomenon of transition from a jammed to an unjammed state is effectively illustrated through the process of ascorbic acid-mediated reductive disassembly. By utilizing self-assembly phenomena at the interface, liquids can be effortlessly 3D printed or molded into precise shapes. Through the self-assembly of liquid metal nanoparticles at the interface, the demonstration of conductive liquid letters becomes possible.

Keywords: Interface, Liquid metal, jamming, 3D printing, Conductivity

Figure1



Reference:

1. Varshney, R.; Agashe, C.; Gill, A. K.; Alam, M.; Joseph, R.; Patra, D. Modulation of liquid structure and controlling molecular diffusion using supramolecular constructs. *Chem.Commun.* **2021**, *57*, 10604– 10607
2. Shi, S.; Russell, T. P. Nanoparticle assembly at liquid–liquid interfaces: From the nanoscale to mesoscale. *Adv. Mater.* **2018**, *30*, 1800714
3. Patra, D.; Sanyal, A.; Rotello, V. M. Colloidal Microcapsules: Self-Assembly of Nanoparticles at the Liquid–Liquid Interface. *Chem. Asian J.* **2010**, *5*, 2442– 2453, DOI: 10.1002/asia.201000301
4. Xie, G.; Forth, J.; Zhu, S.; Helms, B. A.; Ashby, P. D.; Shum, H. C.; Russell, T. P. Hanging droplets from liquid surfaces. *Proc. Natl. Acad. Sci. U.S.A.* **2020**, *117*, 8360– 8365

Nanocrystalline Ni-Zn spinel ferrites: size-dependent physical, photocatalytic and antioxidant properties

Mritunjoy Prasad Ghosh[1], Nur Jalal Mondal[1,2], Rahul Sonkar[1,2], Bitopan Boro[1,2], Devasish Chowdhury[1,2*]
[1]*Material Nanochemistry Laboratory, Physical Sciences Division, Institute of Advanced Study in Science and Technology, Paschim Boragaon, Garchuk, Guwahati-781035, Assam, India*
[2]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India*
e-mail: devasish@iasst.gov.in

The physical properties of magnetic nanoparticles are expected to be highly dependent on their size. In this study, besides the promising applications of nanocrystalline Ni-Zn spinel ferrites in the area of photocatalysis and free radicals scavenging, we presented a detailed study with appropriate scientific explanations on the role of size change in modifying and tuning the microstructural, optical and magnetic properties. Three nanostructured $Zn_{0.3}Ni_{0.7}Fe_2O_4$ samples of different particle sizes were prepared using wet chemical co-precipitation method. Crystallographic phase purity and formation of spinel cubic phase for all the samples were tested by x-ray diffraction studies. Magnetic properties of as-synthesized ferrite nanoparticles have been examined thoroughly at both 5 K and 300 K. Emergence of superparamagnetic behavior has been observed for the sample containing smallest size ferrite nanoparticles. The photocatalytic efficiency of all the nanocatalysts was tested on methylene blue (MB) dye and the smallest sized nanocatalyst was identified as the most efficient catalyst in degrading MB dye under light illumination. The degradation efficiency was noticed to decrease with increasing mean particle size of prepared samples. The antioxidant properties of prepared ferrite samples were also studied. The smallest sized nanoparticles exhibited maximum scavenging of free radicals in comparison to other samples. Hence the present study clearly demonstrates smaller-sized Ni-Zn spinel ferrites are efficient material for tuning the physical properties as well as used in photocatalytic and antioxidant applications.

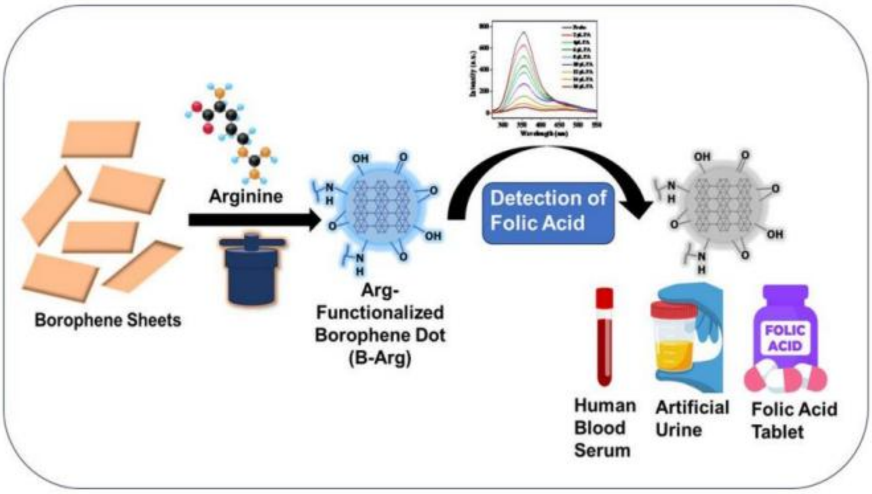
Keywords: ferrite nanoparticles; magnetic properties; BET studies; photodegradation; antioxidant testing

Mixed Solvents Assisted Synthesis of Borophene Sheets Followed by Surface Modification for the Detection of Folic Acid

Nabajit Barman[ab], Kangkan Jyoti Goswami,[ab] Nasrin Sultana[ab], Neelotpal Sen Sarma[*ab]
[a]Advanced Materials Laboratory, Institute of Advanced Study in Science and Technology, Paschim Boragaon, Guwahati 35, Assam, India bAcademy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India
e-mail: neelot@iasst.gov.in.

The emergence of a new 2D nanomaterial Borophene, which shows promising properties that make it a potential alternative against the formerly evolved 2-D nanomaterials. In recent years borophene has vastly been investigated for possible applications in highspeed electronics, flexible and transparent electrodes, alkali metal ion batteries, hydrogen storage, Gas sensing, etc. The main synthesis methods of borophene have serious limitations, namely CVD, molecular beam epitaxy, mechanical cleavage, ion intercalation exfoliation, etc., and are quite expensive and difficult to use. Therefore, facile and scalable synthesis procedures are quite important for synthesizing borophene sheets in order to explore their applicability in diverse fields. Here in this work, we have adopted a mixed solvent-based liquid phase exfoliation strategy for the synthesis of scalable products. We have used a 50:50 ratio of ethanol-water mixture for synthesis. The thin sheets of borophene are obtained and characterized using TEM, UV-visible spectroscopy, FT-IR, XRD, and XPS. Further, we have modified the surface of borophene sheets with arginine molecules which leads to the formation of an arginine functionalized Borophene Quantum Dot. This Functionalized Borophene dot is further used as a fluorescent probe for the detection of Folic Acid (FA) in aqueous media, human blood serum (HBS), artificial urine (AU), and folic acid tablet solutions. The observed detection limit was about 14.90 nM, 15.08 nM, 14.98 nM, and 15.50 nM in the case of Aqueous media, AU, HBS, and FA tablets respectively.

Keywords: Borophene, functionalized borophene quantum dots, fluorescence sensor



ICANN2023 **ID: PP039**

Synthesis of $CdCO_3$-Ag nanocomposites using homogeneous precipitation method for novel applications

Nikhita H Ingalagi and P. Jeevanandam*
Centre for Nanotechnology, Indian Institute of Technology Roorkee, Roorkee-247667, India
e-mail: p.jeevanandam@cy.iitr.ac.in

Nanocomposites possess interesting physicochemical properties compared to their constituents with potential applications in diverse areas such as biomedicine, photocatalysis, sensors, optoelectronics, etc. Although there are many chemical and physical methods for the synthesis of nanocomposites, often new simple, economical, and environmentally friendly methods are explored. In the present study, $CdCO_3$-Ag nanocomposites were synthesized using a novel approach. First, $CdCO_3$ particles with cubic morphology were synthesized by homogeneous precipitation method, starting from cadmium acetate, and urea. Then, the $CdCO_3$ particles were surface modified using ammonium oxalate. The surface modification of $CdCO_3$ was confirmed using FT-IR and TG analysis. Ag nanoparticles were then deposited on $CdCO_3$ cubes using an electroless deposition method using $AgNO_3$ and aqueous HCHO to obtain $CdCO_3$-Ag nanocomposites. The $CdCO_3$-Agnanocomposites were characterized using various techniques such as XRD, FTIR, FE-SEM, EDX, DRS, etc. The characterization results indicate successful formation of Ag-$CdCO_3$ nanocomposites (Figure 1). These nanocomposites are expected to have potential applications in bio-medicine (e.g., anti-bacterial activity), photocatalysis, removal of pollutants from waste water, etc.

Keywords: Nanocomposites, homogeneous precipitation, surface modification, electroless deposition

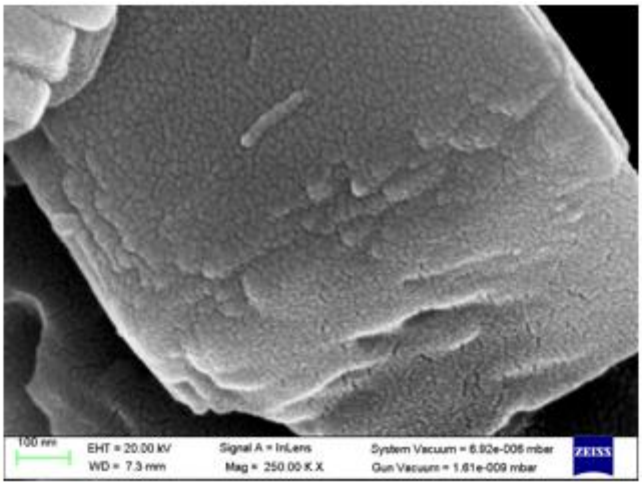


Figure 1: FE-SEM image of Ag-$CdCO_3$ nanocomposite

Evolution of Growth of Nanostructured M_2S_3 (M=Sb or Bi) *via* Single Source Precursor Route

S. S. Harke[1]; C. Gurnani[1]*
*Corresponding author
1Department of Chemistry, Ecole Centrale School of Engineering, Mahindra University, Hyderabad, Telangana, India.
e-mail: chitra.gurnani@mahindrauniversity.edu.in

The growth of layered binary metal chalcogenides, specifically M_2E_3 (M = As, Sb, Bi; E = S, Se, Te), has garnered attention due to their unique optical and electronic properties[1]. Specifically, antimony sulfide (Sb_2S_3) and bismuth sulfide (Bi_2S_3) are notable V−VI semiconductor materials with applications in batteries, solar cells, and resistive memory switching, owing to their high stability and reduced toxicity.

Despite advancements, the deposition of Sb_2S_3 and Bi_2S_3 nanostructures via *in-situ* solution-based methods particularly using single-source precursors (SSPs), remains underexplored. We have successfully developed a one-step, simple, scalable, reproducible, and *in-situ* method that serves as an alternative low-temperature solution-based deposition for the growth of M_2S_3 (M=Sb or Bi) nanostructures on various rigid and flexible substrates[2,3]. The morphology of the Sb_2S_3 and Bi_2S_3 nanostructures deposited on a variety of substrates exhibited bunches of rods and flower-like nanostructures, respectively. The variations in film in accord with the substrates were characterized by XRD, Raman, SEM, EDX, and UV-Vis spectroscopy and will be further discussed. The manufactured film is uniform and compact, and the film can be utilized as a multifunctional device.

Keywords: M_2S_3, single-source precursors (SSPs), thin films, nanostructures, low-temperature deposition

Reference:

1. Zhuo R. et al. "Large-size and high-performance visible-light photodetectors based on two-dimensional hybrid materials SnS/RGO." *RSC advances* 8.2 (2018): 761-766.
2. Harke S. S. and Gurnani C., Method of preparation of M_2S_3 (M=Sb, Bi) films at low temperature, India Patent application IN202341027475, April 2023.
3. Harke S. S. et al. "Solution-based in situ deposition of Sb_2S_3 from a single source precursor for resistive random-access memory devices." *Materials Advances* (2023).

Novel Au@CeO_2 nanostructure - an effective electrocatalyst for oxygen evolution reaction

Priya Pathmanathan; A. Gomathi*
Department of Chemistry, Mahindra University, Hyderabad, Telangana-500043
e-mail: gomathi.anandhanatarajan@mahindrauniversity.edu.in

Increasing consumption of natural resources and global warming have accelerated motivation towards research in designing materials for generation of renewable and sustainable energy. Among various energy harvesting methods, electrolysis of water is one of the most soughtafter pathways to produce green fuel because it has zero carbon dioxide emission1 . In water splitting reactions, hydrogen evolution reaction (HER) and oxygen evolution reaction (OER), the OER is often considered a bottleneck due to its slow kinetics, high overpotential and low durability, hindering the commercial application of the OER catalyst2,3 . Herein, a novel noble metal supported cerium oxide-based nanoelectrocatalyst has been synthesized by a surface assisted reduction (SAR) reaction. The electrocatalyst shows an OER overpotential of 310 mV at a current density of 10 mA cm-2 with excellent stability over 8,000 cycles in an alkaline solution. The results obtained from X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), Raman spectroscopy, high-resolution transmission electron microscopy (HRTEM), and X-ray photoelectron spectroscopy (XPS) suggest that the presence of Ce3+ plays a vital role in the anchoring of active gold centers on cerium oxide matrix. This SAR induced synergistic relationship between gold and cerium oxide imparts significant OER activity and extended stability of the nanostructured electrocatalyst.

Keywords: oxygen evolution reaction, cerium-based hydroxide, surface assisted reduction, extended electrocatalytic stability

Reference:

1. Zhou et al., J. Phys. Chem. C 2016, 120, 51, 29348–29357
2. Zhao et al., Chem. Rev. 2023, 123, 9, 6257–6358.
3. Liu et al., ACS Appl. Nano Mater. 2022, 5, 1, 1252–1262

Study the crystal structure and Tuning the Dielectric Properties of BTO – BHF Polymer nanocomposite

Mukesh Kumar Yadav[a] *, Anant Shukla[a],Jyoti Rekha Mallick[a] Amar Dev[a], Tupan Das[a], *Manoranjan Kar[a]
aDepartment of Physics, Indian Institute of Technology Patna Bihta,, Patna Bihar-801103
e-mail: mano@iitp.ac.in

Storing electrical energy in an efficient way is a key challenge for modern technology. Dielectric materials are highly applicable to energy storage devices. [1] The dielectric property of the materials is mostly driven from the polarization of bound electrons near the lattice sites. But most of the high dielectric materials suffer from poor processing, brittleness, less flexibility and low break down strength. Tuning its dielectric, magnetic and mechanical properties is need of the hour. In this report we have explored the dielectric properties of ceramic-modified polymer nanocomposites. The polymers are flexible and have a high breakdown strength. So, creating a high -performance flexible composite with a large energy density can be accomplished by adding some atom particle or molecules into a polymer matrix and making a polymer nanocomposite[2]. This resultant polymer Nano-composites will be very useful for technological application. likes us Actuators, FRAM, Capacitors, EMI Shielding Microwave Absorber [3].
The barium titanate and barium hexa ferrite nanoparticle has been prepared by solid state reaction method. The BTO+BHF (5%,10%,15%) polymer nanocomposite have been prepared by solution cast method. The crystal structure and the phase of the material were determined by XRD technique and all observed Bragg's pick is indexed to p4mm space group (BTO) and $p6_3$/ mmc space group (BHF).The characteristic bond vibration of the different PVDF crystalline phase can be determined using FTIR techniques. In the FTIR spectra the absorbance band at 613 cm^{-1}, 795 cm^{-1} and 973 cm^{-1} represent the α phase and the absorbance band 761 cm^{-1}, 835 cm^{-1} and 875 cm^{-1} are represents the β phase. The dielectric constant has been enhanced 19 times at 1KHz in BTO+BHF (5%) polymer nanocomposite compared to that of PVDF. The enhancement of dielectric constant in the sample due to increase of β-phase, the maximum β-phase has been obtained in BTO+BHF (5%) polymer nanocomposite sample. The electric polarization of BTO+BHF due to the nanoparticle and PVDF interaction at the interface has been observed. The β-phase is enhanced in BTO+BHF (5%) sample of crystallite size (21nm), hence has maximum dielectric constant

Keywords: Dielectric; Polarization; Frequency

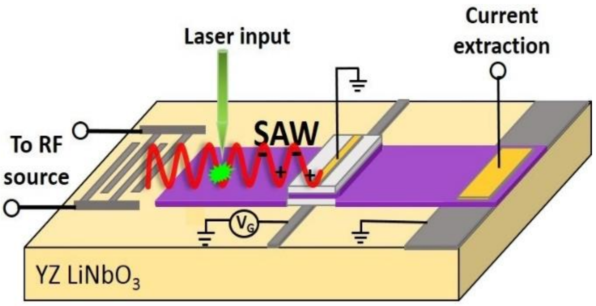
Reference:

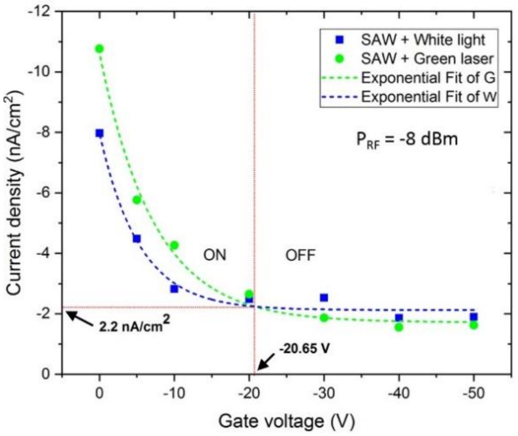
1. Kumar, S.; Supriya, S.; Kar M., Composites Sci.,2018, 157,48-56
2. Zeng, W.; Shu, L.; Li, Q.; Chen, S.; Wang, F.; Tao, X. M., Adv. Mater., 2014, 26, 5310
3. Prasad, P. D.; Hemalatha, J., Physica B: Condensed Matter, 2019, 573, 1

Organic Semiconductor based Excitonic Transistor mediated by Surface Acoustic Wave

Paromita Bhattacharjee[1,*], Parameswar Krishnan Iyer[1,2] and Harshal Bhalchandra Nemade[1,3]
[1]Centre for Nanotechnology, IIT Guwahati
[2]Department of Chemistry, IIT Guwahati
[3]Department of Electronics and Electrical Engineering, IIT Guwahati
*Corresponding author: paromita.b@iitg.ac.in

Demonstration of an excitonic transistor using a thin film of organic semiconductor, regioregular poly(3-hexylthiophene) (rrP3HT) deposited on a piezoelectric YZ lithium niobate substrate has been presented. The working of the excitonic transistor has been facilitated by surface acoustic wave (SAW) propagating through a dual metal-insulator-semiconductor (MIS) structure. The excitons generated via optical source are ionized, stored and carried forward by SAW modulated potential field in rrP3HT with the electrical control of the exciton flux being achieved by the MIS stack. A long-range excitonic transport of ~4.7 mm at room temperature has been observed with a threshold voltage of −20.65 V at an applied RF power of −8 dBm.





Keywords: excitonic transistor, surface acoustic wave, acoustic charge transport, organic semiconductor, regioregular poly(3-hexylthiophene)

Plasmonic nanoparticle functionalized high performance broadband photodetector utilizing formamidinium based hybrid perovskite

Debabrata Sahu1* and P.K. Giri1,2
1Department of Physics, IIT Guwahati, India
2 Centre for Nanotechnology, IIT Guwahati, India
*E-mail: debabrata.sahu@iitg.ac.in

Metal halide perovskites have garnered significant research interest because of their remarkable performance in solar cells, LEDs, and photodetectors (PDs). Low-cost perovskite-based photodetectors produced through solution processing exhibit exceptional photodetection capabilities, featuring high photoresponsivity and relatively rapid response times attributed to their high absorption coefficient, wide UV-visible absorption range, superior carrier mobility, and extended electron-hole diffusion length. For the most part, perovskites are utilized as photoactive layers in optoelectronic devices, where their crystal quality and stability assume a significant part in the device performance. However, the most widely studied Methylammonium (MA)-based perovskite was found to be thermally unstable. Formamidinium based FAPbI3 has great potential to replace MA cation in halide perovskite, due to its good thermal stability and optimum band gap. Chemically engineering the composition of hybrid perovskite has been an effective way for improving operational stability and performance. Herein, a high-performance photodetector composed of formamidinium cesium lead iodide (FA1-xCsxPbI3) thin film was synthesized through one step spin coating method, which has shown broad-band photo response from visible to NIR wavelength range with a high on/off ratio of 103, a high responsivity and a significant specific detectivity. Interestingly, the incorporation of plasmonic metal nanostructures in perovskite-based photodetectors can significantly boost light-harvesting efficiency by harnessing the generation and extraction of highly energetic hot carriers induced by plasmon resonance. To improve the performance further, we fabricated plasmonic metal nanostructure embedded hole transport layer in the device. Due to plasmonic layer, there is substantial improvement in the absorption and this enhances the photodetector performance. The details of these results will be presented. This work will stimulate further investigations on plasmon enabled hybrid perovskite-based photodetectors.

Keywords: Hybrid perovskites; Plasmonic metal nanoparticle; Hole transport layer; Broad-band photodetection; High responsivity.

DBD treated PVA/Aloe Vera Nanofiber as a Novel Dressing Platform

K. K. Nath*, L. P. Bora, G. A. Ahmed, R. Biswas*
Department of Physics, Tezpur University, Assam
e-mail: nathkaushik72@gmail.com ,rajivb27@gmail.com

Atmospheric dielectric barrier discharge (DBD) has gained recognition as a practical technique for modifying the surface properties of polymers. With its ability to alter the chemical and physical properties of material surfaces at room temperature without any change to their bulk properties, there has been notable interest in the advancement of innovative wound dressings. Aloevera, recognized for its ability to naturally break down, compatibility with the body, and minimal harmfulness, contains numerous bioactive substances that offer advantageous qualities such as antimicrobial, anti-inflammatory, and immune-modulating effects. These qualities can effectively enhance the process of wound healing. For this study, 12 wt.% Polyvinyl Alcohol (PVA) is blended with Aloe vera gel at a ratio of 5:1. These fabricated nanofiber mats are subjected to DBD plasma treatment in oxygen (O_2) gas at atmospheric pressure. The morphology of the produced nanofibers is examined using a Field Emission Scanning Electron Microscope (FE-SEM), which confirms the production of beads-free electrospun nanofibers. Additionally, various physical properties such as crystallinity, functionality, and mechanical strength of the nanofiber mat is assessed using techniques including Powder X-Ray Diffraction (PXRD), Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) spectroscopy, and mechanical property testing. Furthermore, the contact angle of the nanofiber mat is measured before and after plasma treatment, and the results demonstrated satisfactory outcomes. The DBD plasma treated nanofibers shows relatively better antibacterial activities against Gram-negative Escherichia coli and Gram-positive Staphylococcus aureus bacteria. These findings suggest that the electrospun PVA/Aloevera nanofibers treated with DBD plasma hold promise for utilization as wound dressings in the treatment of skin and wound infections.

Keywords: poly (vinyl alcohol), aloe vera, nanofiber, plasma modification, dielectric barrier discharge.

Exploring the Oxidase Mimetics Properties of Electrochemically Synthesized Graphene Quantum Dot and its Application to Biomolecule Detection

S. Ghosh*, R. Singh, R. P. Paily
Department of Electronics and Electrical Engineering, Centre for Nanotechnology Indian Institute of Technology, Guwahati
e-mail: sampritighosh@iitg.ac.in

Zero bandgap 2D material, Graphene is a popular material in nanoelectronics due to its high conductivity and the large surface-to-volume ratio. However, due to its zero-band gap, its use in photonics and FET devices is limited. The bandgap can be tuned by reducing the dimension. The 0D form of Graphene is in the range of 1-10 nm and is known as the Graphene quantum dot (GQD). The bandgap of GQD increases due to quantum confinement and edge effect. Recently, GQD has become very popular due to its chemical stability, biocompatibility, fluorescence etc. The higher band gap and fluorescence made GQD, a desirable material for optical sensing and nanoelectronics. There are various types of GQD synthesis methods, which can be categorized into two types: bottom-up and top-down strategies. In the top-down approach (hydrothermal, electrochemical oxidation and acidic exfoliation) large graphene pre-cursors were cut in small sizes, whereas in the bottom-up method, GQD is prepared from small molecules. In comparison with the topdown method bottom-up method produces GQD with more size control. However, it is a timeconsuming process, whereas, in the top-down approach, the production of GQD is rapid and simple. Electrochemical oxidation is one of the popular methods for rapid synthesis of the GQD. Mainly, the possibility of one-pot synthesis of the functionalized or doped GQD via electrochemical oxidation made this method more popular than the other synthesis methods. The various groups also tried to find the process of doping or functionalization of the GQD within the exfoliation time. Depending on the electrolyte, the time of reaction and the applied bias, the size of GQD varies. Hence, by appropriately choosing all the reaction parameters, one can tune the size of GQD. Due to its unique shape and functional group-rich structure, it also shows enzyme-mimicking properties. From the study until now, it can be found that it shows both oxidase and peroxidase type characteristics, which is very useful in the non-enzymatic detection of biomolecules. The catalytic effect of GQD can vary with the degree of oxidation, doping and surface charge density. Hence, it is an interesting topic to explore more about the catalytic effect of GQD. Although the peroxidase nature of the GQD was explored thoroughly, the oxidase nature is somewhat neglected. The oxidase nature of various nanocomposites of GQD was a subject of study for a longer time instead of only GQD. Here, we had used a one-pot synthesis electrochemical method for co-doping of Nitrogen and Sulfur with GQD. The resultant GQD have a size of 3-6 nm and is stable for up to one month. We also explored the oxidase-type nature of GQD by allowing it to interact with Uric acid. Also, the detection of Uric acid as a proof of oxidase-type nature is thoroughly studied.

Optical properties of blue-light emitting Y2O3:Ce nanophosphor

M. Dutta*, J.M. Kalita, G. Wary
Department of Physics, Cotton University, Guwahati-781001, India
e-mail: manashreed2111@gmail.com

In this work, structural, optical absorption and emission properties of Y_2O_3 and Y_2O_3:Ce (1–5%) have been studied. The samples were synthesised by a solution combustion method. The samples exhibit body-centred cubic crystal structure. The undoped Y_2O_3 sample has a crystallite size of 29.03 nm. The crystallite size increases slightly to 29.27 nm after doping of Ce at 1% and thereafter decreases monotonically to 28.93 nm with increase in concentration of the Ce to 5%. Both undoped and doped samples show a strong absorption band at 206 nm. In particular, the undoped sample shows a weak absorption band at ~330 nm. The doped samples show a broad secondary band centred at 250 nm. The optical bandgap of the undoped sample is estimated to be ~5.37 eV and the bandgap decreases to 5.20 eV with an increase in Ce concentration to 5%. All the samples under 350 nm excitation show multiple photoluminescence (PL) peaks with the brightest one at 466 nm and secondary ones at ~397, 436, 488 and 563 nm. The 1% Ce doped sample has the strongest emission intensity. However, as the concentration increases, this intensity diminishes due to concentration quenching of the activator. This study reveals that for getting efficient and bright blue light emission from Y_2O_3:Ce solid-state phosphor, a well-distributed concentration of Ce activators in the Y_2O_3 host is vital.

Keywords: Y_2O_3; Phosphor; Photoluminescence; Quenching; Bandgap

Dimension-Dependent Magnetic Behavior of Manganese-Cysteine Inorganic Complex Nanoparticles

Archismita Hajra[a], Arun Chattopadhyay* [a,b]
aCentre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati, 781039, Assam, India
bDepartment of Chemistry, Indian Institute of Technology Guwahati, Guwahati,781039, Assam, India
e-mail:arun@iitg.ac.in

A cysteine-based complex of Mn^{2+} led to the formation of nanoparticles in aqueous medium under ambient conditions. The formation and evolution of the nanoparticles in the medium were followed by UV-vis, circular dichroism and electron spin resonance spectroscopy that also revealed a first order process. The magnetic properties of the nanoparticles isolated as solid powders exhibited strong crystallite and particle size dependence. At low crystallite as well as particle size, the complex nanoparticles showed super-paramagnetic behavior similar to other magnetic inorganic nanoparticles. The magnetic nanoparticles were found to undergo superparamagnetic to ferromagnetic, and then to paramagnetic transition with a gradual increase in either their crystallite size or particle size. The discovery of dimension-dependent magnetic property of inorganic complex nanoparticles may usher in a superior option for tuning the magnetic behavior of nanocrystals, depending on the component ligands and metal ions.

Keywords: Metal complex, Cotton effect, UV-Visible spectroscopy, Magnetic nanoparticles.

Concentration-dependent solution processable resistive switching properties of hybrid perovskite device

M. Alam[1], Parameswar K. Iyer[1,2] *
Centre for Nanotechnology[1], Department of Chemistry[2], Indian Institute of Technology Guwahati, Guwahati-781039, Assam
e-mail: pki@iitg.ac.in

The dependence on tailoring in organic halide perovskite material is essential to achieving the computational complexity of in-memory applications. This displays three distinct concentration-based $CsFAPbI_3$ memristor designs and their associated studies. With a low set and reset voltage in comparison to other devices, one of these resistive switching devices displays a high on-off ratio (~ 10^3). Additionally, this device exhibits nearly steady behavior over the course of numerous scans and about the same set voltage over the course of several days. The log I-log V plot has now been used to understand the conductive process underlying this resistive switching phenomenon. A look at the neuromorphic computing space is provided by the stability of the device features.

Keywords: Memristor, Resistive switching, solution-processable, set voltage, neuromorphic computing.

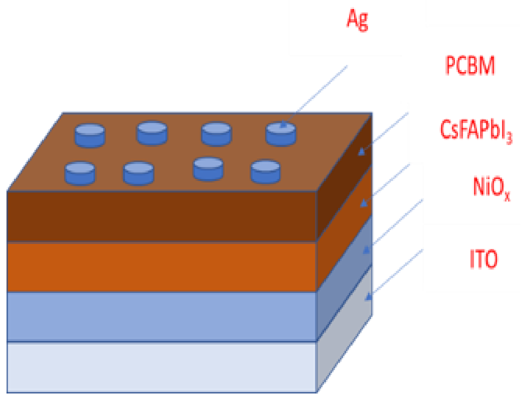


Fig 1: Device architecture of memristor

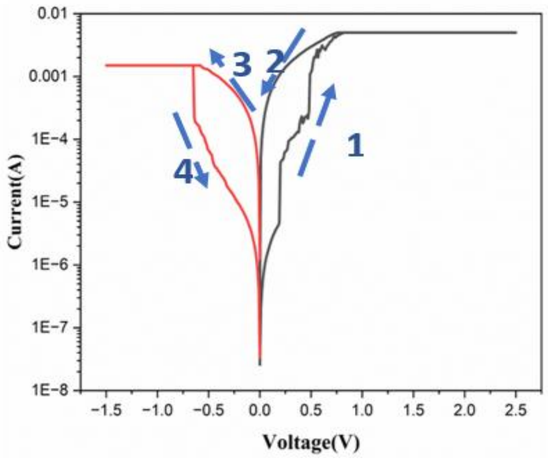


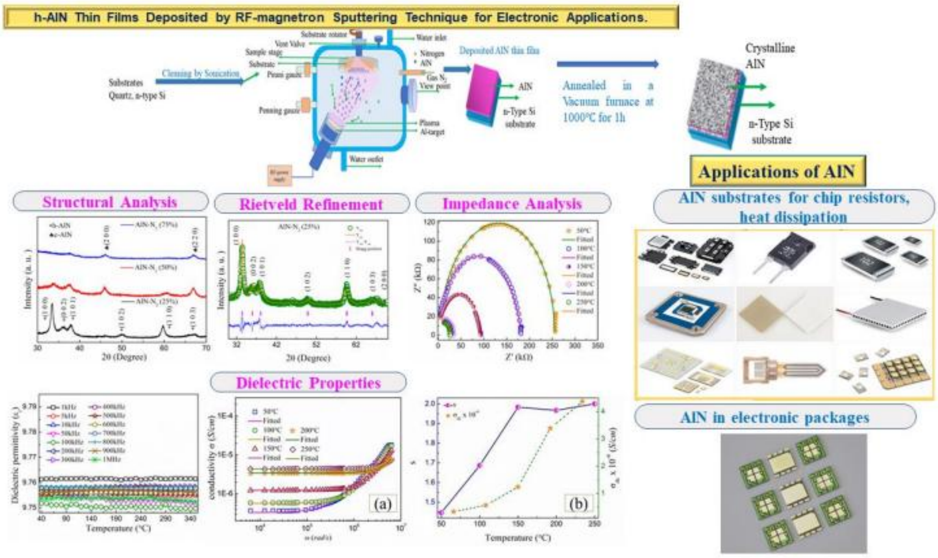
Fig 2: I-V plot of CsFAPbI3 memristor.

Structural and Dielectric Properties of h-AlN Thin Films Deposited by RFMagnetron Sputtering

Ethireddy Radhika; Pamu Dobbidi*
Center for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati, India. * Department of Physics, Indian Institute of Technology Guwahati, Guwahati, India.
e-mail: pamu@iitg.ac.in

AlN thin films are widely investigated due to their unique properties and applications in various fields, such as high-frequency wide band gap communications, microelectronics, energy harvesting devices, power semiconductor devices, and ultrasonic transducers. AlN thin films among group III nitride thin films are promising materials for various applications such as photodetectors, deep ultraviolet light emitters, high-frequency filters, as well as laser diode applications. The h-AlN thin films are difficult to fabricate due to oxidation and lattice mismatch issues. It is challenging to fabricate h-AlN since depending on the deposition conditions, the orientation of the thin film changes. This study investigated the effect of nitrogen pressure in the formation of structural modification of AlN thin films and dielectric properties. Here, h-AlN thin films fabricated using RF-magnetron sputtering using 90W RF power, 25% nitrogen, under 3.1 x 10-2 mbar deposition pressure. XRD pattern of obtained thin films contain hexagonal AlN structure confirmed by JCPDS card no: 00-066-0534. The best dielectric properties achieved, such as εr=8.985 at 5GHz, 8.865 at 10GHz, and 8.764 at 15GHz, and tan $\delta \times 10-3$= 3.435 at 5GHz, 4,145 at 10GHz, and 4.435 at 15GHz are best suited for microelectronic applications. The temperaturedependent dielectric properties, conductivity, and impedance analysis convey the stability of h-AlN properties.

Keywords: Hexagonal AlN; RF-magnetron sputtering, dielectric properties, Rietveld refinement.



Eu,Tb codoped UiO-66 nanoparticles for ratiometric temperature sensing

Ipshita Majumdara , Ashok K. Gangulia,b*
a Department of Chemistry, Indian Institute of Technology, Delhi, 110016, India b Department of Chemical Sciences, Indian Institute of Science Education and Research, Berhampur, Ganjam, Odisha 760010, India
e-mail:ashokganguliiitd@gmail.com

Metal organic Frameworks (MOFs) are rapidly emerging as exciting materials for ratiometric thermometry, due to their tunability with respect to both the metal clusters, which form the inorganic core as well as the bridging organic ligands. Lanthanide doped Zirconium based MOFs such as UiO-66, combine the accuracy and self-calibration properties of lanthanide luminescence, with the permanent porosity and exceptional stability of Zr based metal organic frameworks. In this report, we have synthesized Europium and Terbium co-doped UiO-66 (UiO-66:Eu,Tb) nanoparticles via a room temperature, microemulsion route with a reaction time of 72 hrs. These nano-MOFs have particle sizes ranging from 20 to 40 nm; N2 adsorption-desorption studies show BET surface area, pore volume and average pore diameter of ~ 400 m2 g -1 , 0.49 cm3 g -1 and 0.9 nm, respectively. The reverse micelles composed of CTAB and 1-butanol form a soft template that yields a combination of micro and mesoporous UiO-66. The thermometric properties of these UiO-66:Eu,Tb nanothermometers, measured in the 10–400 K temperature range, give a maximum relative sensitivity (SRmax) of 0.8%/K, and a linear fit between Luminescence Intensity Ratio (LIR) and temperature in the range of 80 K to 400 K. Thus, we have synthesized a ratiometric thermometer that utilizes the intrinsic luminescence of lanthanides and has higher stability and temperature of operation compared to pure Lanthanide MOFs. The permanent high porosity of these UiO-66:Eu,Tb nanoparticles can be explored further for local temperature measurements during catalytic reactions as well.

Keywords: Metal organic frameworks, Nanoparticles, Luminescence, Ratiometric Thermometer, Micelles

Antibacterial Spheroids of Cu17 Cluster, Protected by Cysteine for Arsenic Detection

J. Shantha Kumara, A. Janaa, J. Ramanb, H. V. b, A. R. Kinia, J. Roya, S. K. Janaa, T. Thomasc, *T. Pradeep

aDepartment of Chemistry, DST Unit of Nanoscience (DST UNS) and Thematic Unit of Excellence (TUE), Indian Institute of Technology Madras, Chennai 600036, India. bVel Tech High Tech Dr Rangarajan Dr Sakunthala Engineering College, Chennai 600062, India cDepartment of Metallurgical and Materials Engineering, Indian Institute of Technology Madras, Chennai 600036, India d International Centre for Clean Water, Second Floor, B-Block, IIT Madras Research Park, Kanagam Road, Taramani, Chennai 600113, India
e-mail: pradeep@iitm.ac.in

Visible, rapid detection of water-based contaminants using molecularly precise nanomaterials become a central research theme for preventing the exposure of such ingredients to humans. Here, we present luminescence-based arsenic (As) detection in water using a red-emitting spherical cluster-assembled-superstructure (CASs). The composition was Cu17 cluster, protected by L-Cysteine (Cys-H) and 1,2-bis-(diphenylphosphine) ethane (DPPE) mixed ligands, with a molecular composition of [Cu17S(Cys)3(DPPE)4] +. Various spectroscopic and mass spectrometric investigations confirm the formation of this cluster. This luminescent sensing platform composed of CASs-spheroids shows high sensitivity towards As3+ and As5+ ions in water through fluorescence quenching. Also, electron microscopic investigations reveal the disruption of the surface morphology of the spheroids upon its interactions with As spiked water. The sensor possesses a limit of detection of 1 ppb in tap water and can detect As selectively in the presence of other metal ions. The sensing ability of the CASs was verified with As spiked tap water and groundwater collected from West Bengal. In water, CASs have high antibacterial activity against gram-negative Escherichia coli and gram-positive Staphylococcus aureus. They also exhibit antibiofilm properties against Bacillus subtilis. Thus, they can apply as broad-spectrum antibacterial and anti-biofilm coatings.

Keywords: Nanocluster Spheroids, Red emission, Arsenic sensor, Anti-bacterial, Antibiofilm

NIR Light-Responsive Carbon Dots for Two-Photon Targeted Photodynamic Therapy

Kanchan Negi, Nitesh Kumar Pathak and Sumanta Kumar Sahu*
[a]Department of Chemistry and Chemical Biology, Indian Institute of Technology (ISM), Dhanbad 826004, Jharkhand, India.
e-mail: sumantchem@gmail.com, sksahu@iitism.ac.in;

Photodynamic therapy (PDT) has demonstrated tremendous potential in clinical cancer treatment in recent years. The removal of solid tumors using a conventional photosensitizer is challenging due to the limited depth range of UV or visible laser light penetration. Therefore, we use a strategy to develop a photosensitizer with twophoton absorption. Here, we report newly developed carbon dots (CDs) as a photosensitizer using pyromellitic acid, pphenylenediamine, and 1,2,4-triaminobenzene dihydrochloride that exhibit a broad band centered at 545 nm due to n-π* transition and were able to generate reactive oxygen species (ROS) in the presence of near-infrared light irradiation (980 nm) for imaging-guided PDT. The CDs were conjugated with folic acid to target cancer cells that overexpress the folate receptor. Although there are few articles in the literature on the use of CDs as a two-photon photosensitizer, targeted PDT under >900 nm wavelength has not been reported to the best of my knowledge. The initial findings presented here indicate that multifunctional carbon dots for targeted two-photon PDT in the context of higher wavelength light irradiation have a great deal of potential in the future.

Keywords: Carbon dots, Two-photon, Targeted Photodynamic Therapy, Near-infrared, Reactive Oxygen Species.

Reference:

1. Nasrin, A.; Hassan, M.; Gomes, V.G. Nanoscale 2020, 12 (40), 20598-20603.
2. He, H.; Zheng, X.; Liu, S.; Zheng, M.; Xie, Z.; Wang, Y.; Yu, M.; Shuai, X. Nanoscale 2018, 10 (23), 10991-10998

Combating dysregulated mitochondrial activity by Piperine loaded casein micelles in Alzheimer’s disease

J. Mishra[1] , C. Singh[2] , J.S. Bhatti*[1]

[1] Laboratory of Translational Medicine and Nanotherapeutics, Department of Human Genetics and Molecular Medicine, School of Health Sciences, Central University of Punjab, Bathinda, India 2 Department of Pharmaceutical Sciences, School of Sciences, H.N.B. Garhwal University (A Central University), Srinagar-Garhwal, Uttarakhand, India
e-mail: jasvinder.bhatti@cup.edu.in

As the intricate interconnections of the several mechanisms involved in the disease make it impossible for monotherapeutic treatments to be used in clinical contexts, multi-targeted therapy has emerged as a promising technique for the treatment of Alzheimer's disease (AD). It has received a lot of spotlight recently how mitochondrial damage contributes to the aetiology of AD. Piperine is an alkaloid isolated from black pepper, exhibits miscellaneous pharmacological properties including antidepressant, anticonvulsant and also enhancing activities of other nutraceuticals. The pharmacokinetic and bioavailability characteristics of medications in use can be significantly regulated by the modulatory actions of piperine such as action of drug metabolising enzymes and therefore, it can be used as a suitable therapeutic candidate for multifactorial degenerative disease like AD.

Aim: Investigating the preventive efficacy and neuroprotective mechanisms of piperine loaded casein micelles against Aβ (1-42) induced neurotoxicity was our primary goal in the current study.

Methodology: The human neuroblastoma SHSY.5Y cell lines were treated with Human recombinant protein Aβ (1-42) peptide, Piperine (PIP) and Piperine loaded casein micelles (PIP@CMs) in a dose-dependent manner. Intracellular homeostasis and cell death were evaluated using various in-vitro assays like intracellular ROS generation, ATP production, Ca^{2+} measurement and apoptotic assay. Therapeutic efficacy of PIP@CMs against Aβ (1-42) induced neurotoxicity was explored by these aforementioned assays.

Key findings: Experimental data revealed that PIP@CMSs protects the SH-SY5Y cells from oxidative damage and altered mitochondrial homeostasis caused by Aβ (1-42) induced neurotoxicity in a dose-dependent manner.

Keywords: Alzheimer’s disease, Piperine, intracellular homeostasis, mitochondrial biogenesis

Metal Organic Framework - carbon dot nanocomposites for efficient photoconversion of CO_2 into value added products

Amzad H. Laskar[1,*], Gangaraju Gedda[2,3], Shagufi Naz Ansari[4]
[1]Geosciences Division, Physical Research Laboratory Ahmedabad
[2]Central Research Laboratory, K. S. Hedge Medical Academy, Deralakatte, Mangaluru
[3]Department of Animal Science & Technology and BET Research Institute, Chung-Ang University Anseong, Republic of Korea
[4]Presidency University, Bangalore
Corresponding author: amzad@prl.res.in

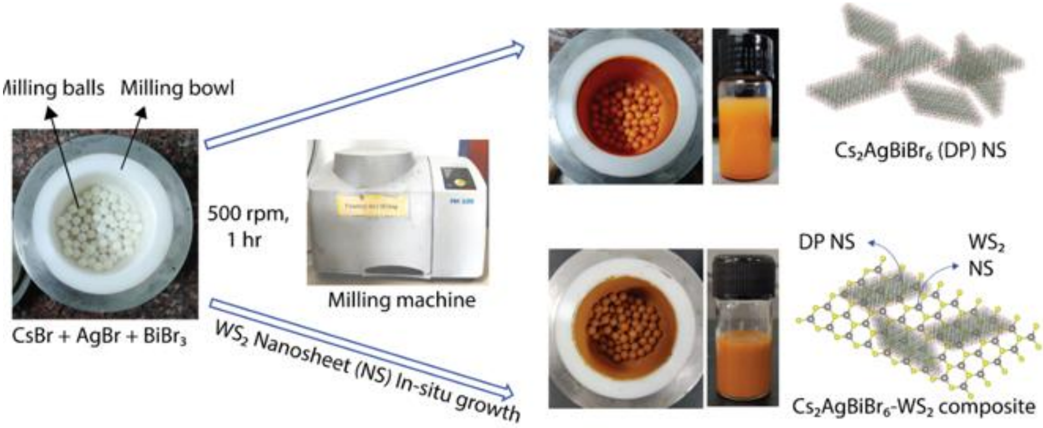
It is obvious that the concentration of CO_2, the main greenhouse gas in the earth's atmosphere is going to increase at least for several more decades even if the nations act as per the agreements reached in the recent climate negotiation summits. Therefore, alternative approaches to reduce atmospheric CO_2 such as geo-engineering techniques are getting popular. One such technique is to capture the CO_2 from point sources and convert it into useful chemicals. We are developing some economic nano-materials based green techniques for turning CO_2 emitted from point sources into renewable and value-added fuels utilizing photocatalytic CO_2 conversion through synergistic effects of Metal Organic Frameworks (MOFs) and nano-composites. MOFs are a class of 3D crystalline micro-mesoporous photoactive materials and many of them show excellent CO_2 adsorption capability due to high surface area, crystalline structure, chemical and thermal stability. However, their bulk nature constrains the photocatalytic efficiency because of their limited visible light response. Nanomaterials such as carbon dots with unique physicochemical properties, including tunable photoluminescence, fast electron transfer capability, and efficient light harvesting have the potentials to enhance the photoconversion efficiency of MOFs when doped with suitable metals. In the conference we will present the recent developments of photocatalytic CO_2 conversion and its future potentials in converting CO_2 emitted from point sources into value added products.

Mechanochemically Synthesized Inorganic Lead-Free In-Situ Growth of $Cs_2AgBiBr_6$-WS_2 Nanocomposite for Photodetector Application

R. Chahal[1]*, A. K. Mia[2], A. Bora[2], P. K. Giri[1,2]
[1]Department Of Physics, Indian Institute of Technology Guwahati, Guwahati, Assam, 781039
[2]Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati, Assam, 781039
e-mail: giri@iitg.ac.in

In recent times, lead-based halide perovskites have shown great promise in optoelectronic applications. However, despite their superior performance, lead toxicity and poor stability hinder long-term applications in the optoelectronic device industry. Herein, we have successfully synthesized lead-free $Cs_2AgBiBr_6$ double perovskite (DP) nanosheets and their heterostructures with WS_2 nanosheets by the ball mill method for high-performance photodetector applications. The resulting $Cs_2AgBiBr_6$-WS_2 nanocomposite phase was confirmed by the selected area electron diffraction (SAED) pattern and Raman analysis. The clear signature of WS_2 was observed in the Raman spectra. We obtained a clear shift in the A_{1g} and E_g modes of the DP in the nanocomposite, confirming charge transfer. The FESEM-EDX mapping confirmed the uniform nanocomposite formation. The enhanced absorbance, reduction of bandgap, and PL quenching are also attributed to the charge transfer from $Cs_2AgBiBr_6$ to WS_2 nanosheets. The charge transfer aids in enhancing the photodetection performance of our device. The detailed analysis of the photodetection performance will be discussed in detail later.

Keywords: Double perovskite, Nanocomposite, Photodetector



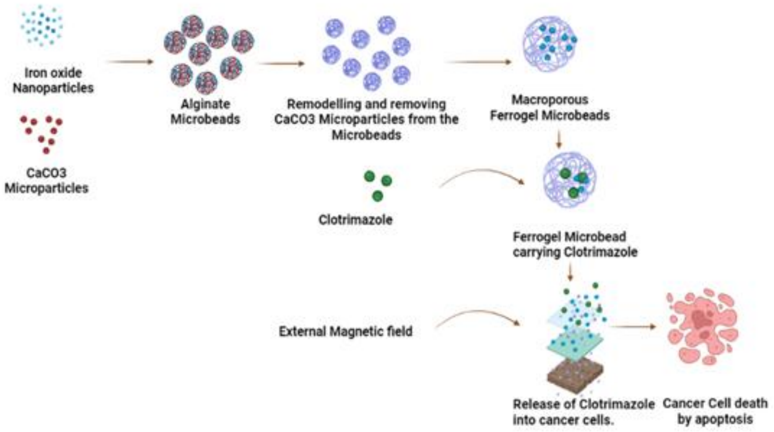
Iron Oxide Ferrogel Microbeads Mediated Delivery System for the Release of Clotrimazole

Sreya Prasannakumar, S Chockalingam*
Department of Biotechnology, NIT Warangal
e-mail: chocks@nitw.ac.in

Clotrimazole (CTZ) is an anti-fungal drug, widely used for treating mycotic diseases. CTZ is reported to inhibit hexokinase, phosphoinositide 3-kinases (PI3K) pathway, and Vascular Endothelial Growth Factor (VEGF) mediated signaling pathways, thereby with a potential to be used as an anti-cancer drug. In this study, we propose a novel therapeutic method for drug delivery using iron oxide ferrogel microbeads fabricated using green synthesized Fe_2O_3 and Fe_3O_4 nanoparticles from *Hibiscus rosa-sinensis* flower and leaf extracts. Macroporosity was created in the ferrogel microbeads through the template removal method by using $CaCO_3$ microparticles as a sacrificial template. The ferrogel microbeads demonstrated excellent drug encapsulation capacity for both Fe_2O_3 and Fe_3O_4 variants, and their drug release can be efficiently controlled using an external magnetic field, enabling targeted and precise delivery of Clotrimazole. The magnetically controlled drug delivery potential of Fe_2O_3 and Fe_3O_4 ferrogel microbeads was thoroughly investigated in this study. This research not only contributes to the development of a promising drug delivery system but also highlights the sustainable utilization of natural resources for synthesizing nanoparticles, promoting a greener and more eco-conscious approach to the utilization of nanotechnology in biopharmaceutical applications.

.

Keywords: Clotrimazole (CTZ), Fe_2O_3 and Fe_3O_4 nanoparticles, ferrogel microbeads.



Ni-coated Ag Core-Shell Nanowires for EMI Shielding Application

Raghunath Sahoo[1,2], Ramaprabhu Sundara[2], Venkatachalam Subramanian[1,*]
[1]Microwave Laboratory, Department of Physics, Indian Institute of Technology Madras, Chennai, Tamil Nadu, India-600036
[2]Alternative Energy and Nanotechnology Laboratory, Department of Physics, Indian Institute of Technology Madras, Chennai, Tamil Nadu, India-600036
Corresponding author Email ID: manianvs@iitm.ac.in

It is essential to develop effective electromagnetic interference (EMI) shielding materials, given the growth of high-frequency-capable gadgets and the quickly expanding market for portable electronics. Additionally, there is a considerable demand for absorption-based materials that can lower the secondary EMI effects brought out by the reflection of incident EM waves. In this work, a simple modified polyol technique is used to synthesize nickel-coated silver core-shell nanowires (Ag-Ni NWs). High pressure is used to compress the produced materials into rectangular pellets with X-band dimensions, which are then investigated for structural, morphological, electrical conductivity, and EMI shielding characteristics. The results are compared with pellets prepared from Ni nanowires. The morphological studies by SEM and TEM techniques confirm the formation of the silver (core)-nickel (shell) structure. The electrical conductivity of the prepared Ag-Ni NW pellet shows an enhanced value of 8630 S/cm compared to 389 S/cm of NiNW pellet. Similarly, Ag-Ni NW exhibits an exceptional EMI SE of 90.5 dB compared to 45.9 dB for NiNW in the X-band frequency region with similar thickness. The results indicate the importance of core-shell-structured materials for the enhanced protection of electronic devices against high-frequency EMI.

Photoconductivity Properties of Chemically Deposited nCdS Nanocomposite Films

M. Dinendra Singh*; Dr. K. Kunjabali Singh
*Department of Physics, Himalayan University, Itanagar, Arunachal Pradesh, India.
Thin Films and Nanomaterials Research Laboratory
Department of Physics, Thambal Marik College, Oinam-795134, Manipur, India.
e-mail: *kksphystmc@yahoo.com*

The effect of moloar concentrations in the growth of nCdS nano-composite films by CBD technique on ITO glass substrates for photoconductivity properties of the films is found significiently improved. The dark and photo I-V characteristics of the films at different molars show fairly ohmic which increases with the increase of molars and film thicknesses in both polarities of applied bias. The study of transient photocurrent on the intensity of white light illumination in the films show almost linear which increase with Cd^{2+} and S^{2-} ion concentrations and film thickness due to bi-molecular re-combinations between carriers. The phototransport mechanism in the photoconductivity process in the nCdS films revealed poor double activations, dominated by direct photo-activated process at higher concentrations of Cd^{2+} and S^{2-} ions.

Keywords: Cadmium Sulphite, CBD, Photoconductivity, Molars, Activation energy

Use of flavonoid-encapsulated chitosan nanoparticles as therapeutic targets for immunomodulation of glioblastoma

Laiba Noor; Manu Smriti Singh; Vibhuti Joshi*
*Corresponding Author Department of Biotechnology, School of Engineering and Applied Sciences Bennett University (Times of India Group) Plot Nos. 8-11, TechZone 2, Greater Noida, Uttar Pradesh 201310.
e-mail: vibhuti.joshi@bennett.edu.in

Chitosan is a naturally occurring linear polysaccharide. Chitosan-based nanomaterials are at the forefront and attracting much attention due to their diverse physicochemical properties, such as biodegradability, biocompatibility, and non-toxicity, which play a promising role in biological applications, including medicines and biomedical engineering. One such application is the use of chitosan nanoparticles as nanocarriers. They can encapsulate drugs as well as bioactive compounds and deliver them to a specific location in the body for controlled release and improved cellular absorption, making them a suitable carrier for increasing therapeutic efficacy while reducing systemic adverse effects. It is a versatile excipient that can improve bio-adhesion and absorption in a formulation intended to selectively transport drugs to specific cellular locations like the central nervous system. Otherwise, it would be difficult to reach such cellular spaces adequately. This study presents the synthesis of flavonoid-encapsulated chitosan-based nanoparticles for the controlled release of drugs for clinical intervention of glioblastoma. In this study, we have prepared the flavonoid-encapsulated chitosan-based nanoparticles by chemical method and optimized them for adequate drug delivery. We have specifically selected flavonoids, the plant's secondary metabolites, which are known for their anti-cancer, neuroprotective, anti-oxidative, and immunomodulatory properties. Flavonoids have not only been reported before for their scavenging ability to assess the free radicals by giving electrons or hydrogen radicals but are also known to affect immunologically essential proteins. We confirmed flavonoid antioxidant activity by DPPH (2,2-diphenyl-1-picrylhydrazyl-hydrate) free radical assay and are currently optimizing chitosan nanoparticles loaded with flavonoids for their encapsulation efficiency. Further, we will investigate the immunomodulatory role of these flavonoid-encapsulated nanoparticles with some glioblastoma and immune cells. We believe combining nano-therapy and immunotherapy will make a more effective therapeutic agent against deadly glioblastoma.

Keywords: Glioblastoma; Chitosan Nanoparticles; Flavonoid, Antioxidant activity.

Photoconductivity properties of chemically synthesized CdTe: Ce^{3+} nanocrystalline thin films.

S Jogita Devi [1] and K Kunjabali Singh[2]
[1]Department of Physics, Biramangol (Govt) College, Sawombung -795010, India
[2]Department of Physics, Thambal Marik (Govt) College, Oinam-795134, India
Email: kkunjabali@gmail.com

Nanocrystalline CdTe matrix: Ce^{3+} thin films at different implanted Ce^{3+} ion dozes were grown by SILAR method on ITO glass substrates at RT. The photoelectrical properties of the host films were studied with constant illumination of white light (WL) of varied intensity under d.c. applied bias in vacuum pressure 2.67Pa. The I-V characteristics of the films at Ce^{3+} at 2 at. % and 8 at. % revealed distinct linearity and symmetrical about zero applied bias. This shows ohmic nature between the film –electrode contact which is enhanced with Ce^{3+} - ion concentrations. The photocurrent, photoconductivity and photosensitivity in the host samples showed linear dependent on intensity of WL and applied bias and Ce^{3+} - ion concentrations. Bimolecular recombination between carriers were observed predominating the photoconduction mechanism of the films. The dark and photoactivation energies as well as dark and photomobility energies in high and low temperature regions in CdTe: Ce^{3+} films were observed slightly decreased with increase of $Ce^{3+\text{ - ion}}$ concentrations. The activation energy in higher regions being higher than corresponding values at lower temperature regions.

Keywords: CdTe thin films, doping, photoelectrical properties.

A Fluorescent Chemosensor for Selective Detection of Chromium (III) ions in Environmentally and Biologically Relevant Samples

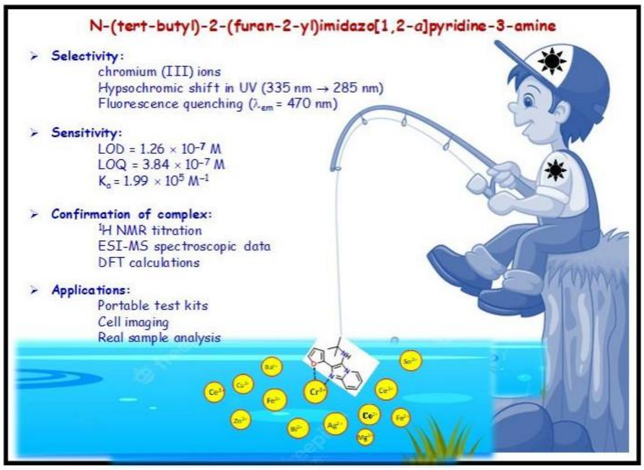
D. Divya[a,b] , M. Ramanjaneyulu[c] , M. Nandhagopal[d] , V. Srinivasan[a] , S. Thennarasu[b] *

[a] Department of Chemistry, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Avadi, Chennai, 600062, Tamil Nadu, India. [b]Organic and Bioorganic Chemistry Laboratory, CSIR-Central Leather Research Institute, Adyar, Chennai 600020, Tamil Nadu, India. [c]Academy of Scientific and Innovative Research (AcSIR), CSIR-Central Leather Research Institute, Adyar, Chennai 600020, Tamil Nadu, India. [d]Saveetha Medical College and Hospital, Institute of Medical and Technical Science, Thandalam, Chennai 602105, Tamil Nadu, India.

Email: thennarasu@gmail.com

A simple single step one pot multicomponent reaction was performed to synthesize N- (tert-butyl)-2-(furan-2-yl)imidazo[1,2-a]pyridine-3-amine (TBFIPA).[1] The synthesized TBFIPA was subjected to library of cations to study its ability for selective and sensitive detection of specific metal ions. The fluorescent TBFIPA displays complete quenching of fluorescence under UV lamp (365 nm) only in the presence of chromium without the interference of common metal ions. Selective detection of chromium ions by TBFIPA were found from the significant hypsochromic shift (335 nm → 285 nm) in the UV-Visible spectra. Binding constant (ka) obtained from Benesi-Hildebrand plot is 1.99 × 105 M^{-1}, limit of detection (LOD) and limit of quantification (LOQ) of TBFIPA toward Cr^{3+} ions are 1.26×10^{-7} M and 3.84×10^{-7} M, respectively. The mechanism proposed during complex formation were supported by stoichiometric Job continuous variation plot, 1H NMR titration and ESI-MS spectroscopic data. All the experimental confirmation for complex formation were corroborated with theoretical DFT studies optimized using RB3LYP/6-31G(d) basis set. The selectivity and sensitivity of TBFIPA toward Cr^{3+} ions are found suitable to design a user-friendly silica based portable test kit. Alongside, TBFIPA was successfully utilized for imaging onion epidermal cells. Furthermore, the results obtained for biological, environmental and industrial samples provided solid evidence to estimate chromium ions using TBFIPA in these real samples.

Keywords: Imidazo[1,2-a]pyridine, Chromium sensing, Fluorescence, DFT, Cell imaging.



Reference:

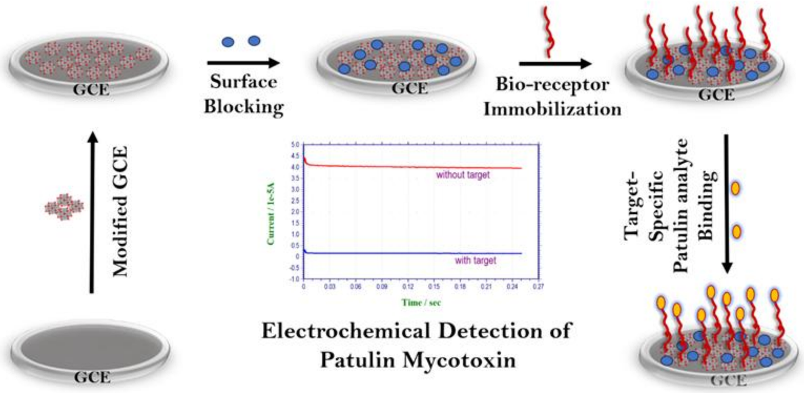
1. D. Divya, R. Mala, M. Nandhagopal, M. Narayanasamy, S. Thennarasu, Coordination of Distal Carboxylate Anion Alters Metal Ion Specific Binding in Imidazo[1,2-a]pyridine Congeners, J Fluoresc. 33 (2023) 1397–1412.
2. R. Mala, K. Suman, M. Nandhagopal, M. Narayanasamy, S. Thennarasu, Chelation of specific metal ions imparts coplanarity and fluorescence in two imidazo[1,2- a]pyridine derivatives: Potential chemosensors for detection of metal ions in aqueous and biosamples, Spectrochim Acta A Mol Biomol Spectrosc. 222 (2019) 117236
3. R. Mala, M. Nandhagopal, M. Narayanasamy, S. Thennarasu, An Imidazo[1,2-a]pyridine Derivative That Enables Selective and Sequential Sensing of Cu2+ and CN− Ions in Aqueous and Biological Samples, ChemistrySelect. 4 (2019) 13131–13137.

Enhancing Patulin Toxin Detection in Apple Juice: Pseudocapacitive Nanomaterials and Electrochemical Biosensors

Brateen Datta[1], Praveena Bhatt Mudliar[2], Gorachand Dutta[1,*]
1NanoBiosensors and Biodevices Lab, School of Medical Sciences and Technology, Indian Institute of Technology, Kharagpur, Kharagpur-721302, India.
2Department of Food Engineering, CSIR- Central Food Technological Research Institute (CFTRI), Mysore570020, India
*Corresponding author.
E-mail address: g.dutta@smst.iitkgp.ac.in

Patulin is a water-soluble mycotoxin produced mainly by Aspergillus, Byssochlamys, and Penicillium, molecular weight of 154.12 g/mol. Patulin has a disastrous effect on many human body organs and can cause neurological, gastrointestinal, and immunological problems if not detected in the first place. Compared with conventional detection strategies, electrochemical biosensors have been proven to be highly sensitive, cost-effective, and accurate methods of analyte detection. Herein a simple, sensitive electrochemical biosensor was successfully developed for the determination of patulin. Moreover, due to surface-tuneable chemical properties, pseudocapacitive nanomaterials have garnered considerable attention in the field of electrochemical biosensors in recent times. The fast response time, long cycle life, high surface area, compatibility with biomolecules, and superior energy storage capabilities of pseudocapacitive nanomaterials offer the electrochemical biosensor's very sensitive analytical performance. In this report, we presented for the first time, the potential of using pseudocapacitive nanomaterials in electrochemical biosensors for the detection of patulin mycotoxin, in apple juice. The prepared bio-electrode exhibits a good linear response ($10\text{-}10^{6}$fg/ml) with an excellent detection limit (1.65 fg/ml) of patulin concentration within a few microseconds time frame. The excellent selectivity, stability, and sensitivity of the electrochemical aptasensor exemplify the potential for using pseudocapacitive nanomaterials for a wide variety of electrochemical sensing applications.

Keywords: Pseudocapacitive nanomaterials, aptamer, electrochemical biosensor, apple juice



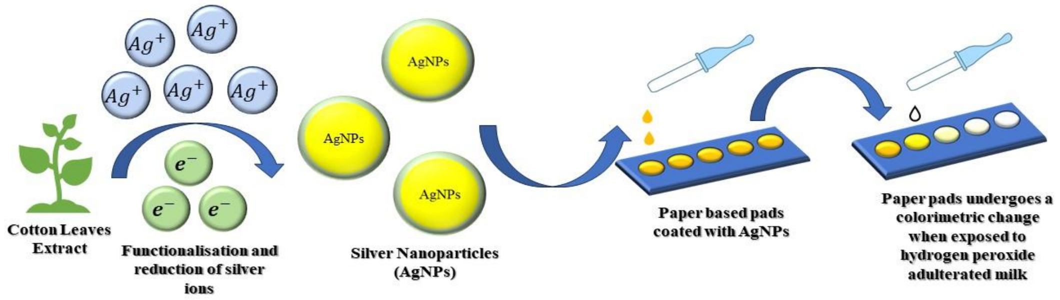
ICANN2023 **ID: PP064**

Exploring Biofunctionalized Silver Nanoparticles in a Paper-Based Sensing Framework for Precise Estimation of Hydrogen Peroxide Content in Milkin Environmentally and

Upama Das, Rajib Biswas*
*Corresponding Author
Applied Optics and Photonics Research laboratory, Department of Physics, Tezpur University, Tezpur-784028, Assam, India
Email: rajib@tezu.ernet.in

The alarming increase in incidents of milk adulteration through addition of various toxic elements, including hydrogen peroxide, as a preservative to extend its shelf life, has of late led to rising concern. Hydrogen peroxide, a highly toxic chemical compound utilized across various industrial sectors, continues to be illicitly incorporated into food products—despite stringent advisories against its use. However, milk adulteration still persists. To address this pressing issue, we have developed a straightforward and user-friendly paper-based sensing architecture for the colorimetric detection of hydrogen peroxide in milk. Initially, silver nanoparticles were synthesized using an extract from cotton leaves. These biofunctionalized nanoparticles were subsequently applied to paper for fabrication of the sensing unit. Owing to presence of hydrogen peroxide, the paper pads change its colour from yellow to colourless. The synthesized nanoparticles were characterised by using UV-Vis spectrophotometer, revealing a prominent absorbance peak at 434 nm. Furthermore, X-Ray Diffraction analysis confirmed the crystalline nature of these nanoparticles. Complementing this, Field Emission Scanning Electron Microscopy (FESEM) and Transmission Electron Microscopy (TEM) characterizations unveiled the spherical morphology of the nanostructures—with an estimated size of approximately 16 nm. This method reliably provides results even in the presence of other interfering substances that are commonly added in milk as adulterants. Notably, we established a linear calibration curve that correlates measured absorbance with H_2O_2 (Hydrogen peroxide) concentration. The observed colorimetric change can be attributed to the oxidizing behaviour of H_2O_2 and the catalytic reduction properties of the functionalized AgNPs—thus offering an effective solution to combat milk adulteration.

Keywords: Silver nanoparticles, Hydrogen peroxide, Paper based Sensing, Biofunctionalized.

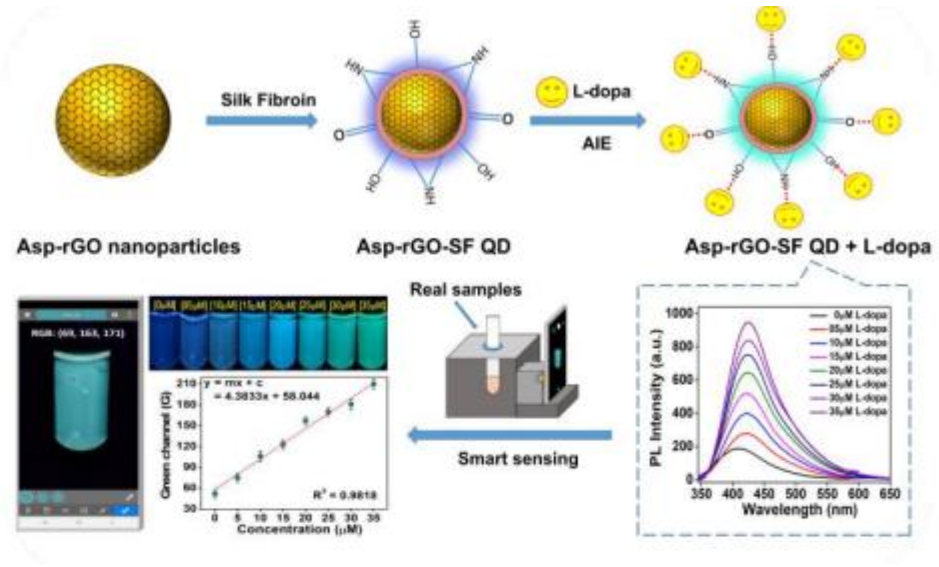


Smart-Phone-Assisted Optical Sensors Based on Biopolymer-Decorated Reduced Graphene Oxide Core-Shell Quantum Dots for Fluorescent Turn-on Detection of L-

Kangkan Jyoti Goswami,[ab] Neelotpal Sen Sarma * [ab]
aAdvanced Materials Laboratory, Institute of Advanced Study in Science and Technology, Paschim Boragaon, Guwahati 35, Assam, India
[b]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India.
Email: neelot@iasst.gov.in

Levodopa (L-dopa) is a neurological drug considered a gold standard for symptomatic medication for Parkinson's disease. The long-term use of L-dopa therapy frequently leads to L-dopa-induced dyskinesia and several other non-motor flocculants for fluctuating plasma levels concentration. To alleviate the adverse effect of dopamine replacement therapy, sensitive detection of L-dopa is still challenging. Therefore, in this study, a facile strategy is presented to develop an inexpensive, easy-to-use, portable smartphone-based fluorescence turn-on sensory system, based on aggregation-induced emission enhancement (AIEE) phenomenon, and applied to low-level detection of L-dopa in biological samples instantly. In this regard, we have synthesized naturally occurring biopolymer-decorated reduced graphene oxide quantum dots which exhibit a progressive increase in fluorescent intensity when L-dopa concentration is gradually elevated in a variety of real samples, such as human blood plasma, sweat, and urine samples. The L-dopa concentration was measured over a linear range of 0 - 35 μM with a detection limit (LOD) of 76.184 nM in an aqueous medium. We have further designed a smartphone-based electronic device for capturing the fluorescent color changes of the solution during sensing. From these images, RGB values are analyzed using a mobile phone application, and the corresponding LOD was found to be 0.286 μM in deionized water. This kind of simple, cost-effective, and rapid screening gadget is very demanding in terms of on-spot detection of analytes in remote areas where sophisticated instrumentation is not available usually.

Keywords: Parkinson's disease, L-dopa, functionalized reduced graphene oxide, AIE, smart sensor



Investigation of Electrical Transport in Transition Metal Oxide (VO2) and Dichalcogenide (MoS2) Thin Films and their Heterojunction

S. Singh[1], J. K. Anand[2], A. Goswami[2]*, R. Singh[3]*
1School of Interdisciplinary research, IIT Delhi, Hauz Khas, New Delhi, India-110016
2Department of Material Science and Engineering, IIT Delhi, Hauz Khas, New Delhi, India,110016
3Department of Physics IIT Delhi, Hauz Khas, New Delhi, India-110016
Email: rsingh@physics.iitd.ac.in , agoswami@mse.iitd.ac.in

The unique property of VO_2 to undergo a metal-insulator transition (MIT) near room temperature has gained significant interest for its potential in various technological applications such as bolometer, memristors and IR detector [1]. In recent years, integrating two-dimensional (2D) transition metal dichalcogenides (TMDs) have emerged as a distinctive platform for photo and IR detector applications due to their unique electronic and optical properties [2]. By creating heterojunction of VO_2 and MoS_2 we would like to explore the synergistic effect of their photodetection at different wavelength in the visible range which is underexplored in literature except very few [3]. In this work, we present a comprehensive overview of the design, fabrication, and characterization of a MoS_2/VO_2 heterostructure-based photodetector, highlighting its potential for next-generation optoelectronic devices. In order to make MoS_2/VO_2 based heterostructure device, we first deposited VO2 thin film on c-cut sapphire substrate using pulsed laser deposition system (PLD) [4], focusing on the VO_2 (M1) phase which transforms from a high-temperature metallic (rutile) to a low-temperature insulating (monoclinic) phase at approximately 60 °C. This was followed by depositing thin layer MoS_2 above VO_2 using layer transfer technique [5]. To study opto-electronic properties, of this heterostructure device, in plane contact of Ti/Au (20/80 nm) was made. The heterostructure of MoS2/VO_2 showed excellent photodetection in the visible to near IR range with improved detectivity 7.2×10^9 Jones and the time response in visible range. Further we show that the van der Waals MoS_2/VO_2 heterojunction club the blocking capability of an n-n junction with a high conductivity in on-state, and it can be turned into a Schottky rectifier at high applied voltage or at temperatures higher than 68 °C, exploiting the metal state of VO_2.

Keywords: Vanadium dioxide, 2D/3D van der Waals heterostructure, MIT controlled photodetection

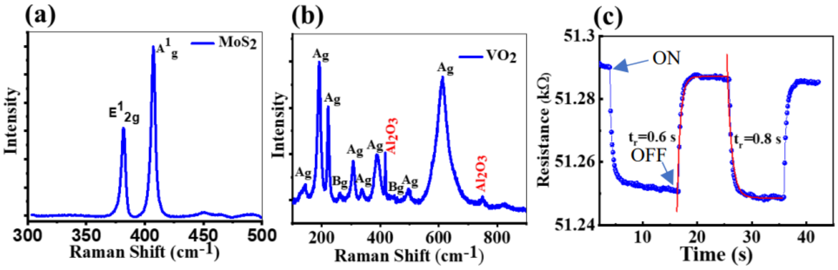


Figure 1. Raman Spectra of as prepared Films of (a) MoS_2 and (b) VO_2 on c-cut sapphire, (c) Time response plot of VO_2 on sapphire.

Reference:

1. R. McGee et al., Effect of process parameters on phase stability and metal-insulator transition of vanadium dioxide (VO2) thin films by pulsed laser deposition, Acta Mater. 137 (2017) 12–21
2. Q.H. Wang et al., Electronics and optoelectronics of two-dimensional transition metal dichalcogenides, Nat. Nanotechnol. 7 (2012) 699–712
3. J. Zhou et al., Mixed-Dimensional Van der Waals Heterostructure Photodetector, ACS Appl. Mater. Interfaces. 12 (2020) 18674–18682
4. U. Chitnis et al., Microstructural and electrical investigation of polymorph stabilization and multistate transition in interface engineered epitaxial VO2 films, Appl. Surf. Sci. 637 (2023) 157916
5. A.Singh et al., Effect of different precursors on CVD growth of molybdenum disulfide, J. Alloys Compd., 782(2019) 772-779.

A Coumarin-Based Optical Probe for the Quantitative Determination of Fe^{3+} Ions in Water, Petroleum Crude Oil, and Catalyst Samples

Achala Rana, Ganesh Naik*
Climate Change and Data Science, Analytical Sciences Division, CSIR-Indian Institute of Petroleum, Haridwar Road, Mohkampur, Dehradun-248 005, India
Email:ganesh.naik@iip.res.in

A simple and cost-effective coumarin-based optical probe; "N-((9-benzyl-9H-carbazol-3-yl)methylene)-7-(diethylamino)-2-oxo-2H-chromene-3-carbohydrazide)" was designed, synthesized, and presented for the quantitative determination of Fe^{3+} ions in water, petroleum crude oil, and catalyst samples. This probe (Probe-L) acts as a visual chemosensor, undergoing a noticeable color change from light yellow to dark brown in an acetonitrile-water medium. It exhibits exceptional selectivity for Fe^{3+} ions, even in the presence of interfering elements such as Na^+, K^+, Ca^{2+}, Mg^{2+}, Ba^{2+}, Cr^{3+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Al^{3+}, Cd^{2+}, As^{3+}, Sn^{2+}, and Hg^{2+}. To determine the sensitivity of Probe-L towards Fe^{3+}, we conducted experimental tests and found that it can detect Fe^{3+} ions with a concentration as low as 0.001 parts per million (ppm). Through Job's plot, Thermogravimetric, and high-resolution mass spectrometry (HRMS) studies, we confirmed the 1:1 binding interaction between Probe-L and Fe^{3+} ions. Furthermore, computational experiments were carried out to determine the optimal alignment of Probe-L and its metal complex and calculate the HOMO-LUMO energy gaps. Finally, we compared the quantitative results obtained using Probe-L for measuring Fe^{3+} content in different samples with those obtained using the ICP OES technique. Remarkably, our data showed good agreement with the ICP OES results, hence, the new techniques can be used for diverse practical applications.

Biologically derived metal-organic framework embedded MXene integrated carbon yarn for the real-time monitoring of the "sleep-wake cycle" in Environmentally and

Bartholomew Richard[a,b] **, Niyas K K**[a,b] **, Ankitha Menon**[b] **, P Abdul Rasheed**[a,b*]
[a]Department of Biological Sciences and Engineering, Indian Institute of Technology Palakkad, Palakkad, Kerala, India- 678557
[b]Department of Chemistry, Indian Institute of Technology Palakkad, Palakkad, Kerala, India- 678557
Email: abdulrasheed@iitpkd.ac.in

In the present study, we have designed a sensing podium based on niobium carbide (Nb_2CTx) MXene entangled with a zinc-based metal-organic framework (Zn-Glu). The combined features of the efficient electrocatalyst with improved electrical conductivity, more active sites, with a high surface area were employed for the electrochemical sensing of melatonin (MLT). MLT is a naturally secreted hormone in our brain responsible for maintaining our daily circadian cycle. The detection of such hormones in clinical studies can help maintain several problems. The Nb_2CTx-Zn Glu was initially characterized to analyze the physicochemical properties. The MOF rods were entangled on the single Nb_2CTx MXene sheet. The synergistic effect between the catalyst enhances the electrochemical performance of MLT. The Nb2CTxZn Glu fabricated carbon yarn electrode obtained an enhanced oxidation response of MLT. The linearity range of MLT was about 1 µm –1 mM with a low detection limit. The fabricated electrode showed high selectivity to the interfering compounds added. The real samples like sweat, blood serum, and cerebrospinal fluid (CSF) showed good results at the Nb2CTx-Zn Glu/CY. Thus, the low cost, with improved electrochemical performances and significant features of the prepared electrode will be of great interest. Since we used carbon yarn as the electrode it can be integrated in E-textile sensor applications in the future. To the best part of our knowledge, this is the first MXene as well as MOF-based melatonin sensor.

Keywords: MXene, MOF, Electrochemical sensing, Melatonin

Synthesizing highly stable NiCo2O4 - APTES composite for the selective and sensitive electrochemical detection of immunosuppressant drug mycophenolate mofetil

Niyas K K[a,b], Ankitha Menon[b] , P Abdul Rasheed[a,b]*
[a]Department of Biological Sciences and Engineering, Indian Institute of Technology Palakkad, Palakkad, Kerala, India- 678557
[b]Department of Chemistry, Indian Institute of Technology Palakkad, Palakkad, Kerala, India- 678557
Email: abdulrasheed@iitpkd.ac.in

Mycophenolate mofetil (MPM) is a medication used to prevent the rejection of transplanted organs, particularly in kidney, heart, and liver transplants. It is a member of the class of medications known as immunosuppressants and reduces the growth of T and B lymphocytes, immune system cells important in the rejection of transplanted organs. Mycophenolate mofetil frequently causes nausea, vomiting, diarrhoea, headaches, and stomach discomfort as side effects. It is extremely important to be conscious that MPM can raise the risk of some cancers as well as infections, especially severe and sometimes deadly infections. Patients who use this drug should be regularly monitored by their doctor and adhere to their recommended treatment schedule. So, it is essential to monitor the dosage of MPM in real time. In this work, we have synthesized $NiCo_2O_4$-3-aminopropyltriethoxysilane (APTES) composite by solvothermal method and it has been used for developing an electrochemical sensor for the detection of MPM. We have used carbon cloth as the electrode material and modified it with $NiCo_2O_4$- APTES. The APTES functionalization leads to amine modification on the surface of $NiCo_2O_4$ which enhances the adsorption of MPM on the material. The material showed a very low detection limit in a linear range and its practical applicability was examined using real samples of blood serum and cerebrospinal fluid. The synthesized composite shows very high storage stability and ultrasensitive sensing capability towards MPM.

Keywords: Nickel cobaltite, APTES, Electrochemical sensing, Mycophenolate mofetil

A sustainable peptide-functionalized gold nanoparticle based colorimetric strip biosensor for on-site detection of Prostate cancer

P. Barman[1], S. Sharma[1], A. Saini[2]*
[1]Institute of Forensic Science and Criminology, Panjab University, Chandigarh, India - 160014
[2]Department of Biophysics, Panjab University Chandigarh, India - 160014
Email: avneet@pu.ac.in

Prostate cancer is the third most widely diagnosed cancer among males, contributing to around 10% of cancer-related mortalities. Early and sensitive detection of prostate cancer in order to ensure a high rate of survival is crucial. Prostate specific antigen (PSA) is the most significant biomarker to clinically diagnose prostate cancer. This study illustrates the design and development of a sustainable colorimetric strip-based biosensor as a proof-of-concept detection system for on-site detection of PSA. Here, the surface of gold nanoparticles (AuNPs) was functionalized with a novel PSA-specific peptide P1. The resulting P1 functionalized AuNPs (P1@AuNPs) were drop-casted on a cellulose nanofiber strip (CNFS). The developed CNFS demonstrated a colorimetric response toward PSA, resulted by the interaction between P1 and PSA, which lead to the aggregation of AuNPs. The colorimetric strips displayed remarkable sensitivity with a limit of detection (LOD) of 7 ng/mL, with a reaction time of less than 1 minute. The localized surface plasmon resonance (LSPR) effect of AuNPs were explored in the strategy for visual detection of PSA, which was also corroborated by RGB (Red Green Blue) analysis performed using Image J software. This biodegradable colorimetric strip-based biosensor is an economic and easy-to-use device for a single-shot measurement of PSA.

Keywords: Prostate cancer; Prostate-specific antigen; Colorimetric biosensor, Peptide; Cellulose strips.

The multi-cycle freeze-thaw (FT) conducting hydrogel for sensing application

Leimapokpam Sophia Devi[1], Roy Paily Palathinkal[1,2], and Ashok Kumar Dasmahapatra[1,3*]
1Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati, India-781039
2Department of Electronics and Electrical Engineering, Indian Institute of Technology Guwahati, Guwahati, India-781039
3Department of Chemical Engineering, Indian Institute of Technology Guwahati, Guwahati, India- 781039
Email: akdm@iitg.ac.in

Stretchable and wearable sensors have been attracting a lot of interest lately, and this is primarily due to the intrinsic properties of hydrogel-based sensors, such as their ability to self-heal and their ability to be stretchable with tunable conductivity. Hydrogels have a tremendous amount of potential for stretchable electronics, demonstrated by recent developments in hydrogel-based sensors featuring novel sensing processes, outstanding performance, and a wide range of application possibilities. A comprehensive examination of hydrogel-based sensors which addresses their working principles, distinctive qualities, aging effects, and interesting applications, however, is still notably lacking.

This study presents hydrogel-based sensors that use a multi-cycle freeze-thaw (FT) process to improve their morphological structure and sensitivity. The samples that have undergone multi-cycles of FT exhibit excellent sensitivity, notably when sensing ammonia gas, with a remarkable improvement of 94 % which is attributed to the increased pore size and enhanced inter and intra-molecular hydrogen bonding.

Keywords: Conducting hydrogel, Freeze-Thaw, Hydrogen-bonding, Gas sensing, Ammonia sensing.

Self-propelled catalytic rod-like Gold micromotor

Nafisa Arfa[1], Prathu Raja Parmar[1], Dipankar Bandyopadhyay*[1,2,3]
[1]Department of Chemical Engineering, Indian Institute of Technology Guwahati, Assam, India
[2]Centre for Nanotechnology, Indian Institute of Technology Guwahati, Assam, India
[3]School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Assam, India
Email: dipban@iitg.ac.in

Self-propelled, synthetic microscale devices capable of autonomous mechanical movement by utilizing chemical energy are of great research interest in recent times. Herein we report the development of a self-propelled micromotor derived from gold nanorod (AuNR) by invoking anisotropic overgrowth. So far, preferential overgrowth of AuNRs has been realized using chemical methods with a significant setback in sustainability and biocompatibility. This work demonstrates a green approach for the preferential deposition of gold on specific crystallographic facets of gold nanorods synthesized by silver mediated seeded growth method. Gold nanorod solution is prepared by centrifuging the seed solution once, ensuring the removal of excess surfactant and reducing agents. To this solution, 0.216 M gold (III) chloride is added, and the mixture is left overnight undisturbed. The pH is maintained around 7. The exposed facets and remnant-reducing agents facilitate selective longitudinal growth favorable at that pH. Optical microscopy images show the presence of gold micro-rods of sizes ranging from 10-20 micrometers. Etching occurs on gold micro rods from particular facets in the presence of hydrogen peroxide, resulting in propulsion from the longitudinal axis. This property is exploited to develop a self-propelling motor out of an Au micro-rod in an H_2O_2 medium. Different propulsion speed has been recorded corresponding to different concentration of hydrogen peroxide. These observations enable the Au micromotors to be used as a potential sensing platform for the detection of hydrogen peroxide.

Keywords: Micromotors; Au nanorods; Overgrowth; Self-propulsion; Hydrogen Peroxide Sensor

Electrochemical Nitric Oxide Sensors for Biomedical Applications

Suvra Prakash Mondal* and Dulal Chandra Patra
Department of Physics, National Institute of Technology, Agartala, India -799046
Email: suvraphy@gmail.com, suvra.phy@nita.ac.in

Nitric oxide (NO) is one of the smallest biologically important cellular signalling molecule plays important roles in numerous physiological processes including neurotransmission, vasodilation, blood pressure regulation, wound healing and immune response. Change in concentration of NO in our body fluid causes several diseases such as diabetes, Parkinson's disease, ischemia, fibrosis, hypertension, excessive bleeding, rheumatoid arthritis etc. Here, we report the fabrication of non-enzymatic nanomaterial based electrochemical sensing electrodes for non-invasive NO detection in human saliva and tears. Platinum (Pt) decorated titanium dioxide (TiO_2) nanoparticles were synthesized for NO detection in human saliva. The sensor demonstrated high sensitivity (~7.81 µA mM^{-1} cm^{-2}) in wide linear detection range (10 nM-28 mM) and very low detection limit (~2.47nM). Pt-TiO2 nanoparticle composite deposited on carbon-based screen-printed electrodes have been studied for salivary NO detection. Au nanoparticle decorated carbon cloth sensing electrode was studied for NO detection in human tears. Sensing electrodes (working, reference and counter electrodes) have been fabricated by painting carbon ink on paper substrates. Au nanoparticle decorated carbon cloth sensor achieved NO detection sensitivity of 0.42 µA μM^{-1} in the linear range 10 nM to 1.4 mM. The detection limit of such paper based NO sensor was found to be 2.34nM. Our NO sensing electrodes also demonstrated excellent stability, reproducibility and selectivity towards various interfering agent present in human saliva and tears. This present study revealed the potential use of electrochemical NO sensors for biomedical applications.

Keywords: NO, Electrochemical Sensors, Metal NPs, TiO2 NPs, Biomedical application

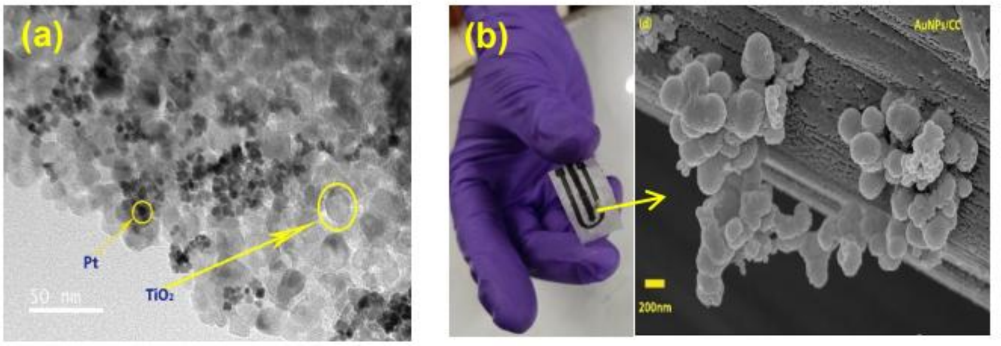


Figure 1: (a) Transmission electron micrograph of Pt and TiO2 nanoparticle composite, (b) Digital photograph of a typical paper-based sensor fabricated by painting carbon ink on paper substrates. Sensing electron was made of Au NPs deposited on carbon fabric.

Identification and Characterization of Corona Microbes Using Single Layer Graphene

***Manisha Makwana[1], Ajay M Patel[2]**
[1] Mechanical Engineering Department,A D Patel Institute of Technology, Vallabh Vidyanagar, Gujarat, India
[2] Mechatronics Engineering Department,G.H. Patel College of Engineering & Technology, Vallabh Vidyanagar, Gujarat, India
Email: me.manisha@adit.ac.in, ajaympatel2003@yahoo.com

Tiny microbes called airborne pathogens can lead to a range of diseases. There is a high need to precisely monitor pathogen presence and behaviour since they can spread from infected hosts through a variety of mechanisms. The objective of this study is to create a sensor by investigating the vibration responses of cantilever and bridged boundary conditioned single layer graphene sheets with attached microorganisms on the tip and at the centre of the sheet. The biological substances used for investigation is Coronaviridae. Atomistic finite element method (AFEM) has been used to carry out the dynamic analysis of SLG with various boundary conditions and length. Simulations have been performed to see how SLG behaves when employed as sensors for biological entities. By altering the length and applied mass of a biological object, the difference in frequency observed. The detection of virus that might be linked to graphene will be facilitated with the use of this sensor.

Keywords: Zigzag, SLG, virus, Mass Sensor, Frequency

Soft Lithographic Plasmonic-Based Refractive Index Sensor

A.Paul[1] , M.Basak[2] , M.M.Ahmed[1] , D.Singha[1] , D.Bandyopadhyay[1,2,3,*]
1Dept. of Chemical Engineering, Indian Institute of Technology, Guwahati, India
2Centre for Nanotechnology, Indian Institute of Technology, Guwahati, India
3 Jyoti and Bhupat Mehta School of Health Science and Technology, Indian Institute of Technology, Guwahati, India
Email: dipban@iitg.ac.in

A soft-patterned lithography-mediated patterning technique of metal nanoparticles is employed to fabricate an enhanced localized surface plasmon resonance (LSPR) sensor. The metal nanoparticles like gold and silver, with varying shapes, sizes, surface characteristics and internal structures, have shown plasmonic characteristics, known as localized surface plasmon resonance (LSPR). These particles have received much attention from the scientific community in the past few years due to their excellent optoelectronic characteristics, high surface-to volume ratio, outstanding biocompatibility and low toxicity. They have piqued the interest of researchers worldwide for their extensive utilization in fields including biology, engineering, and contemporary medicine. One such focused area of research is point-of-care detection for early and accurate diagnosis of life-threatening diseases targeting frugal healthcare. In view of this, we have developed a soft lithography-based patterned flexible substrate utilizing the moulding of CD/DVD patterns on a PDMS substrate to monitor the real-time change in the LSPR property with respect to the change in the refractive index of the surrounding medium. Further, the patterned substrates are immobilized with plasmonic metal nanoparticles of gold. A change in absorbance and wavelength shift was observed in the presence of glycerol as the surrounding media. These plasmonic optoelectronic substrates with LSPR characteristics have better sensitivity towards biosensing applications.

Keywords: Nanoparticle, Plasmonic Biosensor, Localized Surface Plasmon Resonance, COMSOL

ICANN2023 **ID: PP076**

Hydrogen Peroxide Detection using Nickel Oxide Nanostructures Grown on Carbon Paper based Sensing Electrodes

A Dash, D. C. Patra, A. Deb, S. Das and S. P. Mondal*
Department of Physics, National Institute of Technology, Agartala, India -799046.
Email: suvra.phy@nita.ac.in

Hydrogen peroxide (H2O2), a crucial biological compound found within human cells, is a consequence of the regular metabolic activities requiring oxygen. Extensive research suggests that an abundance of presence of H2O2 within cells can significantly disrupt natural physiological functions and lead to many health issues, including cancer, inflammation, neurodegenerative conditions, DNA damage, and more. Therefore, development of a highly sensitive, selective, low cost and handheld sensor is very much useful for detecting and monitoring H2O2 in human cells for biomedical applications. In this report, a highly sensitive and selective non-enzymatic H2O2 sensing electrode was developed using nickel oxide (NiO) nanostructures grown on carbon paper (CP) substrates. Porous NiO nanostructures were synthesized by a simple sol-gel approach on CP substrates followed by annealing at 5000C for improving crystalline nature. Growth and microstructures of NiO nanostructures grown on CP substrates were characterized using scanning electron microscopy (SEM), x-ray diffraction (XRD) and x-ray photoelectron spectroscopy (XPS) study. Electrochemical H_2O_2 detection was conducted in 0.1 M NaOH solution using NiO grown CP as working electrode, Pt wire as counter electrode and Ag/AgCl was used as reference electrode. The sensing characteristics were demonstrated using cyclic voltammetry and amperometric i-t study. The sensor exhibited high sensitivity ~24.40 μAmM^{-1} cm^{-2} and very low detection limit up to 10.3 nM with linear detection range from 0.10 μM to 10 mM. Such CP based porous NiO sensing electrode is highly stable and selective towards H_2O_2 detection.

Keywords: Nickel Oxide, Carbon Paper, Hydrogen peroxide, Electrochemical Sensor

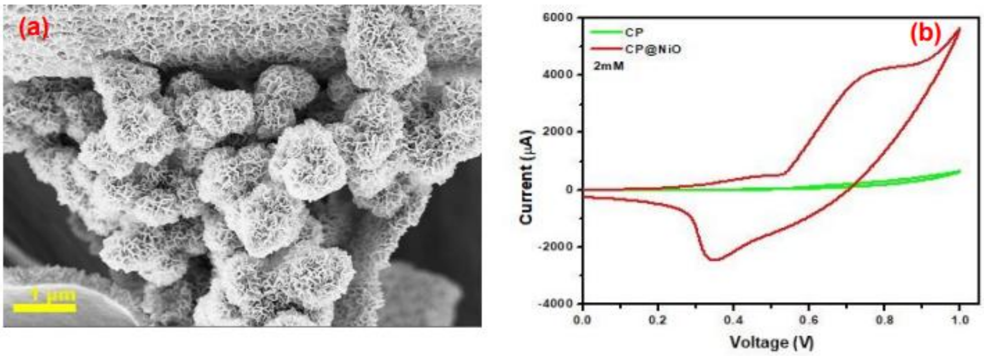


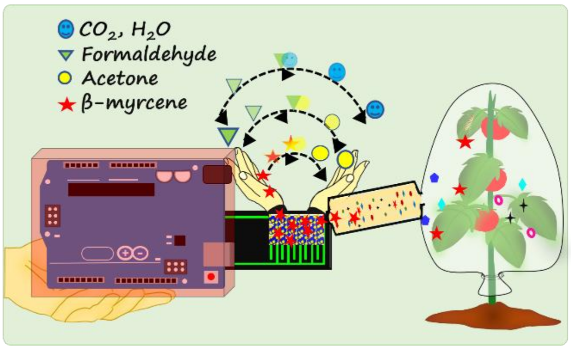
Fig.1: (a) Scanning electron micrograph of NiO nanostructures grown on CP. (b) Cyclic voltammetry (CV) plots of CP and NiO modified CP electrodes after addition of 2mM H2O2 in 0.1 M NaOH solution.

Hand-held crop sensor using oxidative signal amplification from volatile

P. Kumar, V. Shanmugam*
Institute of Nano Science and Technology, Mohali 140306, India
Email: vijayakumarshanmugham@gmail.com

The growing global population necessitates advanced techniques to increase food production in sustainable way.To fulfill this demand, farming is going to depend on IoT (Internet of Things), which in turn needs the support of real time sensors.(1) Recently volatile gas sensorsare gaining importance for the diagnosis of diseases in human, which has been improved for the early diagnosis of the diseases in the crop.(2)Crop releases volatiles in response to the herbivore stress, hence sensing these volatile signal at very early stage will make the management easier. Hence a chemoresistive signal transducer, loaded with the reactive catalysts that amplifiy the oxidation signal has been developed. This strong catalyst may oxidize nontarget volatiles and can cause false signal, hence a filter has been coupled to ensure highly selective detection. Finally with the support of mobile power bank, the optimized sensor has been assembled into a light weight handheld device.

Keywords: crop stress, signature volatile, gas sensor, SnO_2.



Reference:

1. K.Kaur, Bandana Kumari Sahu, Kanchan Swami, and Vijayakumar S. Phone camera nano-biosensor using mighty sensitive transparent reusable upconversion paper. *ACS Appl. Mater. Interfaces*, 2022, 14, 23, 27507–27514.
2. M. Chandel, P. Kumar, A. Arora, and Vijayakumar S. Nano-catalytic interface to decode phyto-volatile language for latent crop diagnosis in future farms. *Analytical chemistry* 2022 94, 31, 11081–11088.

Dual peptide imprinting for highly selective MIP sensor

Akriti Srivastava, Meenakshi Singh*
Department of Chemistry, MMV, Banaras Hindu University
Varanasi-221005, India
Email: meenakshi70@bhu.ac.in

A goal of modern sensor research is the creation of synthetic receptors that mimic the natural antibody-antigen behavior with similar specificity and sensitivity. Molecularly imprinted polymers, MIPs, are best described as synthetic analogues to the natural, biological antibody-antigen systems. First proposed by Rachkov and Minoura in 2000, the epitope approach attempted to solve the issues, particularly those related to molecular complexity and flexibility, and high costs. Recently, dual-template molecular imprinted technology (DMIT) has been proposed and applied for specific recognition toward two types of targets simultaneously. In this study, a novel epitope imprinting strategy is reported by employing double cysteine-modified peptides of bacterial protein as the templates and adsorbing the templates on gold nanoparticles by means of forming self-assembled monolayer, followed by bulk polymerization using AIBN and electrodeposition to create a polymer network. 3-sulfoporopyl methacrylate potassium salt (3-SPMAP) and benzyl methacrylate (BMA) are selected as functional monomer and N, N-methylene-*bis*-acrylamide (NNMBA) is as crosslinker. AuNPs were synthesized to enhance sensitivity and used as signal amplification agents. The synthesized polymer was electrodeposited on a gold-coated QCM electrode *via* cyclic voltammetry (CV). To form an imprinted matrix, gold-coated QCM is treated with PBS to extract the template molecules. Rebinding and extraction of template molecules are monitored piezogravimatrically. Rebinding of reference template molecules and real patient samples were used to monitor the response of the fabricated sensor that had been created. Fluorescence spectroscopy, HPLC, and CV were used to confirm the extraction of template. As a control experiment, non-imprinted polymer (NIP) was also made without template molecule. The fabricated EQCM sensor's cross-selectivity and selectivity have been examined against probable interferents.

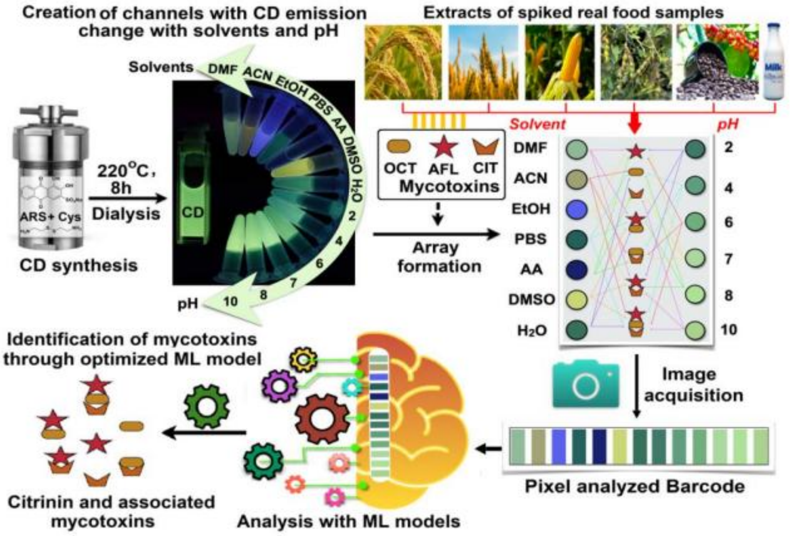
Keywords: Molecularly imprinting technology, dual epitope imprinting, gold nanoparticles, quartz crystal microbalance (QCM).

Machine Learning Mediated Ultrasensitive Detection of Citrinin and Associated Mycotoxins in Real Food Samples Discerned from Photoluminescent Carbon Dot

Maansi Aggarwal[1] , Pranab Sahoo[2] , Sriparna Saha[2] , Prolay Das* [1]
[1]Department of Chemistry, Indian Institute of Technology Patna, Patna 801103, Bihar, India 2Department of Computer Science and Engineering, Indian Institute of Technology Patna, Patna 801103, Bihar, India
Email: prolay@iitp.ac.in

Economically viable remote sensing of foodborne contaminants using minimalistic chemical reagents and simultaneous automation calls for a concrete integration of chemical detection strategy with artificial intelligence. In a first of its kind, we report the ultrasensitive detection of citrinin and associated mycotoxins like aflatoxin B1 and ochratoxin A using an Alizarin Red S and Cystamine derived Carbon Dot (CD) that aptly amalgamate with machine learning algorithms for automation. The photoluminescence response of the CD as a function of various solvents and pH is used to generate array channels that are further modulated in the presence of the mycotoxins whose digital images were acquired to determine pixelation, essentially creating a barcode. The barcode was fed to machine learning algorithms that actualize and intertwine convoluted databases, demonstrating Extreme Gradient Boosting (XGBoost) as the optimized model out of eight algorithms tested. Spiked samples of wheat, rice, gram, maize, coffee and milk were used to evaluate the testing model where exemplary accuracy of 100% even at 10 pmol of mycotoxin concentration was achieved. Most importantly, the coexistence of mycotoxins could also be detected through the CD-array and XGBoost synergy hinting towards a broader scope of the developed methodology for smart detection of foodborne contaminants.

Keywords: Mycotoxin, Array sensing, Carbon dot, and Machine learning.



Scheme: Array formation with CD and decoding mycotoxins using machine learning.

ZnO film-based X-ray sensor derived by sol-gel spin coating method: effect of chemical complexing agents

Jigyas Das, J.M. Kalita
Department of Physics, Cotton University, Guwahati- 781001
Email: Indiajigyasdascu@gmail.com

Research concerning X-ray sensors has been increasing from the last decade due to their wide applications in X-ray imaging, security and medical sectors. Here we report a comparative study of X-ray sensing features of two ZnO film-based X-ray sensors synthesized by sol-gel spin coating method using two different complexing agents, monoethanolamine (MEA) and triethanolamine (TEA). Zinc acetate dehydrate is used as a precursor and ethanol as a solvent for synthesis of both the films. X-ray diffraction analysis reveals that both films have a polycrystalline nature. Measurements of *current-voltage* (*I-V*) characteristics under dark condition shows that the *I-V* characteristics of the sensor fabricated by using TEA has a *pseudo-rectifying* nature from 0.0 to 15.0 V bias voltage. On the other hand, the sensor derived by using MEA shows two sublinear regions from 0 to 6.0 V and 6.0-8.0 V followed by a saturation region between 8.0 and 12.0 V. The electrical resistivities under dark condition of the films synthesized by using TEA and MEA are of the order of 10^7 and 10^{11} Ω cm respectively. The currents recorded under 30 keV X-ray illumination condition is found to be significantly higher than their dark currents for both the sensors. However, the TEA-derived sensor shows higher signal-to-noise ratios (SNR) than the MEA-derived one. Both the sensors are found to be visibly blind within 300-700 nm. At 3.0 V bias voltage, the rise-time of the TEA and MEA-derived sensors are found to be 0.87s and 1.05 s respectively. The corresponding fall-time of the sensors are estimated to be 1.08 s and 0.98 s respectively. The dose-response characteristics of the two sensors show a sublinear response of X-ray induced current with the dose rate between 0.015 and 0.220 Gy/s. The sensitivities of the MEA and TEA-fabricated sensors for 0.220 Gy/s dose rate at a bias voltage of 3.0 V are found to be 29.41 μC/Gy.cm^3 and 85.5 μC/Gy.cm^3 respectively. Analysis of thermoluminescence glow curve confirm the presents of various trap states in the samples which affect their sensitivities. This study reveals that both the sensitivity and SNR of the TEA-derived sensor are higher than that of the MEA-derived one.

Keywords: ZnO, X-ray sensor, Sol-gel spin coating method, Complexing agent

Twisted graphene: Optical solutions for advancement in SPR biosensing

Amrit Kumar & R. K. Gupta*
Department of Physics, BITS-PILANI, Pilani Campus Rajasthan, India, 333031

Graphene has become a highly promising material for optical biosensing applications due to its unique physiochemical and optical properties. The advancement in highly sensitive and real time optical bio-sensors, especially surface plasmon resonance (SPR), relies on a profound understanding of the optical properties of the materials employed. In traditional SPR sensors, plasmonic materials (Au/ Ag) surfaces are typically functionalized with ligands or bio-affinitive layers such as graphene to enhance the adsorption capabilities. However, the thickness of these ligands or layers often diminishes the plasmonic field strength with analyte adsorption. To circumvent this limitation, we explored the potential of graphene to serve as both a plasmonic material and a ligand, leveraging π-π interactions for analyte attraction. The employment of graphene for SPR requires an understanding of its refractive index (RI) and absorption coefficient in the ultrathin regime. In this study, we utilized first principle based density functional theory (DFT) to calculate the RI of various graphene systems, including monolayer graphene (MLG) and AA/AB stacked bilayer graphene (BLG). However, the important part of our investigation was on twisted bilayer graphene (BLG), which offers a unique possibility for modulating the optical characteristics of BLG by introducing inplane twists between its layers [1]. The findings hold substantial promise in SPR-based biosensing, where monitoring RI change upon analyte adsorption is vital. Further, using FDTD, we proposed a novel SPR design using MLG, BLG, and in-plane twisted layers of BLG (TBLG) deposited on a zinc-selenide substrate for bio-sensing applications. Our results demonstrated that T-BLG systems, especially those with twist angles close to the magic angle (approximately 1°), exhibited exceptional sensing performance with a sensitivity of 29,000nm/RIU due to the strong coupling between the twisted layers [2]. In conclusion, our research provides crucial insights into the optical properties of twisted BLG and highlights its potential in developing highly sensitive SPR-based biosensors. The distinctive characteristics of twisted BLG open new frontiers for designing and optimizing advanced optical devices and promise substantial advancements in biosensing and related fields.

Keywords: Twisted bilayer graphene, Magic angle, Surface plasmon resonance, Finite difference time domain method.

Reference:

1. A. Kumar, V. Manjuladevi, R.K. Gupta, Refractive index of graphene AA and AB stacked bilayers under the influence of relative planar twisting, J. Phys. Condens. Matter. 34 (2022) 15302. https://doi.org/10.1088/1361-648X/ac2d5f
2. A. Kumar, V. Manjuladevi, R.K. Gupta, The Effect of Relative In-Plane Twisting in Graphene Bilayer on Sensing Using Surface Plasmon Resonance, Plasmonics. 18 (2023) 213–224. https://doi.org/10.1007/s11468-022-01760-2

Dispersion Stability of Graphene Variants with Biocompatible Flavin for Biomedical Application

Arpan Kotal [1], Rajiv K. Kar [1,2]*
Jyoti and Bhupat Mehta School of Health Sciences and Technology; 2 Center for Nanotechnology, Indian Institute of Technology Guwahati, Assam – 781039, India
Email: a.kotal@iitg.ac.in; rajivkar@iitg.ac.in

Graphene is a two-dimensional material composed of a single layer of carbon atoms in a honeycomb lattice-like arrangement. Graphene oxide (GO) and its reduced variants (rGO) is a well-known carbonaceous material with unique physical, chemical, and electrical properties, which makes them a potential candidate for versatile applications. Certainly, it requires a stable dispersion of graphene flakes in an aqueous media as the starting material. This is critical due to its hydrophobicity nature, the higher surface energy of GO, and the presence of higher van der Waals forces between adjacent sheets, it disperse however, as suspensions in water alone.[1] From the biomedical engineering perspective, stable dispersion holds high significance for covalent functionalization, formation of nanocomposite, and improved optical properties. These properties are required for point-of-care technology to achieve reliable and sensitive sensor performance. Surfactants (cation, anionic, and neutral) are known to be good dispersive agents that are capable of achieving a stable GO dispersion in the aqueous medium. Surfactant functions as a stabilizer molecule, which functions to reduce the surface free energy.[2] The major challenge is the associated biocompatibility and sustainable usage. Since surfactant-based dispersion agents are not environment-friendly and toxic, they limit their use as dispersants for biological applications. An alternative strategy is to use bio-based materials (more appropriately, bio-dispersants), which can minimize the existing challenges associated with environmental sustainability and biological compatibility. One such agent is the biocompatible Flavin-based molecules such as Riboflavin, FMN, and FAD. with high degrees of reduced toxicity.[3] Here in this study, we revisited riboflavin's potential of being a dispersive agent with varying degrees of dispersion stability to GO and its reduced variant. We employed continuous optical measurement in the UV-vis region along with the dialysis method for the removal of excess riboflavin from the surface. Interestingly, the variable behavior has been characterized using spectroscopy, microscopic, and electrochemical methods. Overall, the relative changes in the physical properties help explore the rationale of Flavin's use to tune the low-dimensional material's properties and design suitable biosensors.

Keywords: Surfactants, Flavin, Dispersion, Biocompatible, Sensor.

Reference:

1. Ayán-Varela et al. Achieving Extremely Concentrated Aqueous Dispersions of Graphene Flakes and Catalytically Efficient Graphene-Metal Nanoparticle Hybrids with Flavin Mononucleotide as a High-Performance Stabilizer. *ACS Appl Mater Interfaces* **2015**, *7* (19), 10293–10307.
2. Vera-López et al. Study of Graphene Dispersions in Sodium Dodecylsulfate by Steady-State Fluorescence of Pyrene. *J Colloid Interface Sci* **2018**, *514*, 415–424. https://doi.org/10.1016/j.jcis.2017.12.052.
3. Díez-Pascual et al. Effect of Graphene and Graphene Oxide Dispersions in Poloxamer-407 on the Fluorescence of Riboflavin: A Comparative Study. *Journal of Physical Chemistry C* **2017**, *121* (1), 830–843. https://doi.org/10.1021/acs.jpcc.6b09800.

Detection of Na^+ /K^+ ion on a hydrogel platform

Gobinda Chhetry[1]**, Partho S G Pattader**[1,2]
[1] Centre for Nanotechnology,[2] Department of Chemical Engineering IIT Guwahati, Assam- 781039

Detection of Na+ /K+ in blood serum is mostly performed by the ion selective electrode or the flame photometry. Here we are demonstrating an alternative pathway to detect these ions. A hydrogel is used as a matrix and an Arduino based photometric prototype is developed to quantify these ions. This frugal prototype consists of a suitable LED light source, a Light Dependent Resistor (LDR) and a circuit board to provide the digital values for the quantification of the concentration of these ions. The hydrogel platform can be used not only for the Na+ /K+ ions, but can be used for other analytes as well. The hydrogel facilitates the detection process by improving the management of the sample materials, its transportation from the view of point of care applications, etc.

Label-Free Detection of Staphylococcus aureus using Aptamerfunctionalized Monolayer WS2 Grown by CVD

Abdul Kaium Mia*[1], Swapnil Sinha[2], P.K. Giri[1,3]
[1]Centre for Nanotechnology, Indian Institute of Technology Guwahati, India 781039
[2]CEO, BioNEST, Indian Institute of Technology Guwahati, India 781039
[3]Department of Physics, Indian Institute of Technology Guwahati, India 781039
Email: thennarasu@gmail.com

Staphylococcus aureus (S. aureus) is a harmful gram-positive spherical-shaped human pathogenic bacterium commonly associated with various contagious clinical infections. Tungsten disulfide (WS$_2$), a member of the two-dimensional (2D) transition metal dichalcogenide (TMD) family with its advanced optoelectronic properties, was used for highly selective real-time detection of pathogenic bacteria such as S. aureus. We carried out controlled growth of monolayer WS$_2$ films on Si/SiO$_2$ substrates by chemical vapor deposition (CVD). Sulfur vacancies are innately present in the as-grown films, which were passivated by thiolmodified ssDNA aptamers specific to S. aureus. This was confirmed by photoluminescence (PL) and X-ray photoelectron spectroscopy (XPS). We have studied S. aureus sensing by aptamer-functionalized monolayer WS2 using PL emission as a recognition tool. As the concentration of S. aureus increased, we observed a systematic blue shift in the monolayer WS2 PL as well as an enhanced trion-to-neutral exciton ratio. The enhancement in the triontо-exciton ratio is attributed to the electron transfer from the targeted S. aureus to the WS2 surface as a result of interaction through the probe aptamers. These highly selective aptamers identify and bind to S. aureus, enabling its specific detection. The selectivity of the system was tested using non-targeted Escherichia coli (E. coli) that did not exhibit any change in the PL spectra of the monolayer WS$_2$. Our findings highlight the promising applications of monolayer WS2 in the realm of optical biosensors.

Keywords: Monolayer WS$_2$; Optical biosensor; Bacteria detection; photoluminescence

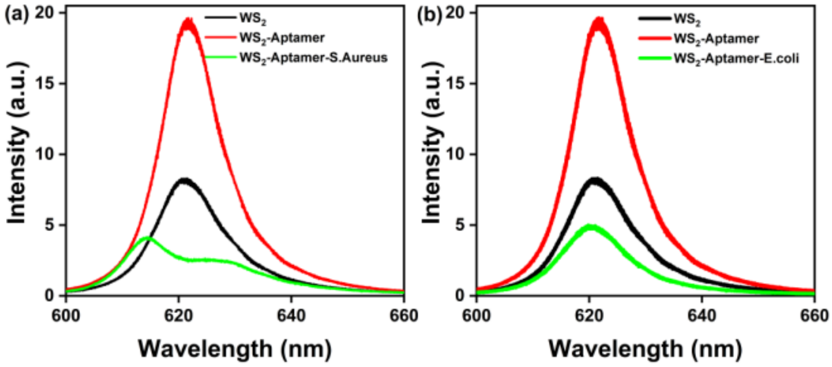


Figure 1: PL emission spectrum of monolayer WS2 by 532 nm laser excitation in presence of (a) S. aureus (b) E. coli bacteria.

Plant-based Phytochemicals for Synthesis of Z-scheme In_2O_3/CdS Heterostructure for Photocatalytic CO_2 Reduction to Fuels

Pramod M Gawal and Animes K Golder*

Department of Chemical Engineering, Indian Institute of Technology Guwahati, Assam-781039, INDIA

Email: animes@iitg.ac.in

The detrimental effects of greenhouse gases primarily largely originated from the escalating global energy demand. The world is actively looking for sustainable energy technologies to address this issue and mitigate greenhouse gas emissions [1]. One promising approach is photocatalytic CO_2 reduction, which utilizes solar energy to convert CO_2 by reacting with water into valuable fuels like ethanol, methanol, formic acid, and methane[2].

Bio-based methods for synthesizing semiconductor nanoparticles (NPs) offer numerous advantages over traditional chemical-based approaches. These advantages include environmental friendliness, cost-effectiveness, one-step synthesis, and the abundant availability of biomaterial sources[3,4]. Employing green pathways for NPs synthesis and incorporating them into CO_2 photo-reduction processes could be a promising strategy to curb industrial CO_2 emissions. The Northeastern states of India, with their rich diversity of tropical and subtropical plants, could serve as a source of environmentally friendly phytochemicals. These phytochemicals could act as potential agents for capping and reducing semiconductor nanomaterials efficiently.

In this research study, we present the synthesis of CdS nanoparticles using phytochemicals derived from *Aegle Marmelos*. Subsequently, we modified these CdS nanoparticles to reduce oxidative photo-corrosion and minimize the recombination of electron-hole pairs. To enhance charge carrier separation and transportation and CO_2 adsorption while reducing electron-hole recombination and photo-corrosion, we employed a bio-based method to incorporate In_2O_3 into the CdS semiconductor (Figure 1). The resulting catalyst was assessed for its ability to catalyze the reduction of CO_2 under visible light, producing formic acid, and carbon monoxide as the primary products. Additionally, stability and reusability studies were performed.

Keywords: CdS nanoparticles; In_2O_3 nanoparticles; Bio-based heterostructure; Photocatalytic CO_2 reduction; Formic acid production

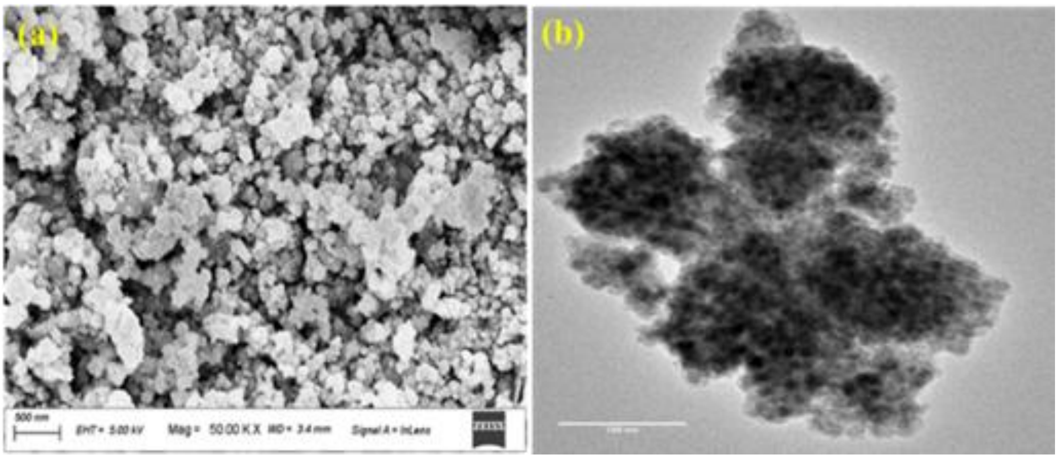


Figure 1: (a) FESEM image (b) FETEM image of In_2O_3/CdS(bio) heterostructure (microwave irradiation at 100°C for 5 min).

Fabrication of Wide Band-Gap Hydrogenated Amorphous Silicon Thin Films using Direct Current Magnetron Sputtering

Rimlee Saikia*[1,2], Riya Sharma[2], Tonmoi Hazarika[1,2], Bharat Kakati[2], Manoj Mahanta[3]

[1] Department of Physics, Gauhati University, Guwahati, India-781014
[2] Department of Energy Engineering, Assam Science and Technology University, Guwahati, India-781013
[3] Department of Physics, Pragjyotish College, Guwahati, India-781009

Email: rimleesaikia@gauhati.ac.in

Hydrogenated amorphous silicon (a-Si:H) thin films have been extensively studied for the development of wide-band-gap silicon thin films. The broader band gap in a-Si:H thin film makes it a suitable material for silicon heterojunction (SHJ) solar cells. In the present work, the process of direct current (DC) magnetron sputtering is investigated for the deposition of a-Si:H thin films at a fixed hydrogen-to-argon gas pressure ratio of 1:10. A simultaneous study on the effect of substrate temperature on deposited a-Si:H thin film is carried out by changing the temperature from room temperature (RT) to 200°C. The UV-Vis spectroscopy results define that the deposited film's optical band energy gap plot shows two distinct band gap energies. The optical band gap (E_g) of 1.85 eV, 2.34 eV, and 2.00 eV is observed corresponding to the substrate temperature RT, 100°C, and 200°C respectively. As observed from Raman spectroscopy, the lowering of bandgap from 2.34eV to 2.00eV can be related to a transition in thin film crystallinity as the temperature rises from 100°C to 200°C. The optical emission spectroscopy (OES) shows a stable plasma with intense Ar (I) lines at 811nm and 763nm with the presence of the H_α line at 656nm. Thus, at a controlled substrate temperature between 100°C and 200°C, the process of DC magnetron sputtering can be useful in developing wide bandgap a-Si:H thin films as a passivating layer in SHJ cells.

Keywords: Hydrogenated, Silicon Heterojunction, Magnetron Sputtering, Optical band gap, OES

Reference:

1. Ge, J., Ling, Z. P., Wong, J., Stangl, R., Aberle, A. G., & Mueller, T. (2013). Analysis of intrinsic hydrogenated amorphous silicon passivation layer growth for use in heterojunction silicon wafer solar cells by optical emission spectroscopy. *Journal of Applied Physics*, 113(23), 234310.
2. Balaji, P., Dauksher W. J., Bowden S. G. & Augusto A. (2020). Improving surface passivation on very thin substrates for high efficiency silicon heterojunction solar cells. *Solar Energy Materials and Solar Cells*, 216, 110715.

A facile synthetic approach for surface modification of ZnO nanorods using stearic acid for self-cleaning application

Monika Narwal and P. Jeevanandam*

Department of Chemistry, Indian Institute of Technology Roorkee, Roorkee, 247667, India

Email: p.jeevanandam@cy.iitr.ac.in

ZnO is an n-type semiconductor that is non-toxic, and economical. ZnO nanorods (NRs) have several applications, e.g. photocatalysis, antibacterial activity, pigments, drug delivery, sensors, hydrogen storage, cosmetics, field emitting diodes, etc. ZnO nanoparticles have limitations in self-cleaning applications due to a lack of hydrophobicity and dispersibility. To overcome these limitations, the surface of ZnO nanoparticles can be modified using different organic groups such as stearic acid, silane coupling agents, and dodecanoic acid. The surface modifiers chemically alter the surface properties of ZnO nanoparticles and the surface-modified nanoparticles have been used in various applications such as adsorption, removal of heavy metal ions, and oil-water separation. In the current study, ZnO nanorods were synthesized using the solid-state thermal decomposition method and characterized using various analytical techniques. Then, a simple and cost-effective strategy was used to modify the surface of ZnO nanoparticles using varying amounts of stearic acid. FT-IR analysis of stearic acid-modified ZnO NRs shows characteristic IR bands due to stearic acid confirming the presence of stearic acid on the surface of ZnO NRs. TGA and CHO analyses also confirm the presence of stearic acid on the surface of ZnO NRs. Electron microscopy studies on the unmodified and stearic acid-modified ZnO nanoparticles show rod-like morphology which is retained on surface modification. XPS results show the presence of Zn^{2+} and O^{2-} in unmodified and stearic acid-modified ZnO NRs. Contact angle measurements on the unmodified and modified ZnO NRs indicate that there is an increase in contact angle from 45.4° to 141.4° in the stearic modified ZnO NRs. The higher contact angle of stearic acid ZnO NRs indicates their hydrophobic nature. The hydrophobic stearic acid-modified ZnO NRs were explored for self-cleaning and they show better self-cleaning properties compared to the unmodified ZnO NRs.

Keywords: ZnO nanorods, Surface modification, Hydrophobicity, Self-cleaning

Surfactant-modified quantum dot-complex with enhanced FRET efficiency for ratiometric detection of food colorants

M. Manna*[1] **and S. Bhandari**[2]

[1] *Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati, Assam 781039, India*
[2] *Department of Chemistry, University of North Bengal, Darjeeling, West Bengal, 734013, India*

Email: mannamihir@iitg.ac.in

Herein we report that, compared to pure QDC, the surfactant-modified quantum dot-complex (S-QDC; with λ_{em}-515 nm) nanocomposite exhibits better Förster resonance energy transfer (FRET) efficiency to an acceptor organic dye (λ_{em}-576 nm). The proposed S-QDC, which is composed of ZnS quantum dot, zinc quinolate inorganic complex, and cetyltrimethylammonium bromide (CTAB) surfactants, offers the one-of-a-kind and selective ratiometric visual detection of organic dyes present as food colorants in commercial chili powder, tomato ketchup, and mixed fruit jam. Notably, the limit of detection (LOD) for food colorants in the linear range (0.17 – 4.89 μM) of the S-QDC is as low as 2.2 nM. Additionally, the current research will open up new avenues for deciphering the chemistry of surfactants, inorganic complexes, and quantum dots to create newer optical materials with a futuristic range of applications, including optical sensors and light-emitting devices.

Keywords: Surfactant-modified quantum dot-complex (S-QDC), Förster resonance energy transfer (FRET), ratiometric visual detection, food colorants.

Realization of Borophene Quantum Dots through Chemical Exfoliation and their Application in dopamine Sensing

Shipra Aswal[1], **P.K. Giri***[1,2]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati- 781039, India
[2] Department of Physics, Indian Institute of Technology Guwahati, Guwahati- 781039, India

Email: rimleesaikia@gauhati.ac.in

Borophene is a relatively unexplored two-dimensional (2D) layered material that is known for its high carrier mobility and high robustness. Being the lightest 2D layered material, borophene quantum dots (BQDs) with small lateral dimensions have triggered a surge of interest in the material research community due to their distinct electronic and optical properties. In this work, we have carried out a sonication-assisted liquid-phase exfoliation method assisted with ball milling of low-cost boron chunks to synthesize ultrasmall-sized BQDs of dimensions ~5 nm. The BQDs are few layered in nature, confirmed by atomic force microscopy. The as-synthesized BQDs exhibit extraordinary visible photoluminescence (PL) with high quantum yield and emission wavelength is found to be excitation wavelength-dependent (Figure 1). Interestingly these QDs show quenching in PL in the presence of dopamine at ultra-low concentration. The selective coordination of different biomolecules with the BQDs has been studied systematically. The proposed sensor is successfully implemented, for the first time, for the sensitive detection of dopamine ions, and the mechanism of sensing is explored in detail. Our results indicate that BQDs hold great potential for the development of highly sensitive ion sensors in the future.

Keywords: Borophene, 2D Quantum dots, biomolecule sensor.

Relative Size Comparison of Silver and Gold Nanoparticles Utilizing a Microcontroller Aided Setup

N. K. Daimari, U. Das, P. P. Bhattacharyya, R. Biswas*

Applied Optics and Photonics Research Laboratory, Department of Physics, Tezpur University, Napaam, Assam - 784028, India

Email: rajib@tezu.ernet.in

Nanoparticles distinctive characteristics have led to their growing significance across a range of domains, encompassing material science, electronics, and medicine. Nevertheless, effectively and precisely determining the dimensions of nanoparticles remains a formidable undertaking. This research introduces an approach that employ a microcontroller - driven arrangement to juxtapose the relative sizes of silver nanoparticles (AgNPs) and gold nanoparticles (AuNPs). The configuration consists of light sources like blue LED (450 - 500 nm) and green LED (500 - 570 nm), along with a light - dependent resistor (LDR) as a detector. The localized surface plasmon resonance (LSPR) characteristics of AgNPs and AuNPs synthesized through various methods were studied using a UV-Visible spectrophotometer. Initially, the device output was calibrated using an established LSPR peak position versus nanoparticle size equation. A linear correlation was found between the slope of various concentrations of NPs and theoretical size with R^2 values 0.9838 and 0.9799 for AgNPs and AuNPs respectively. Furthermore, to validate the results, the slope of unknown-size nanoparticles was recorded and evaluated using a linear fit equation. It was found that experimentally calculated measurement was in good agreement with theoretical showing a relative standard deviation (RSD) of 95.50% for AgNPs and 80.52% for AuNPs, indicating that the proposed device has the promising capability of measuring the relative size of different types of NPs in a cost – effective and user-friendly manner.

Keywords: Silver Nanoparticles, Gold Nanoparticles, Localized Surface Plasmon Resonance, Relative Size, Relative Standard Deviation

TE and TM polarization insensitive Metasurface based ultra-narrowband absorber in optical C band

Bhairov Kumar Bhowmik*[1], **Tanmay Bhowmik**[2], **Debabrata Sikdar**[2], **Gagan Kumar**[1]

[1] *Department of Physics, Indian Institute of Technology Guwahati, Assam, 781039*
[2] *Department of EEE, Indian Institute of Technology Guwahati, Assam, 781039*

Email: bhairov.kumar@iitg.ac.in

High Q perfect absorption in metasurfaces garnered large attention due to their promising potential in the application of photodetector, optoelectronic systems, and sensing. Here we theoretically proposed and numerically simulated an all-dielectric split ring resonator metasurface-based absorber supported by a gold back reflector. The design consists of a Silicon split ring resonator separated by a dielectric SiO_2 spacer from the gold back reflector. The design exhibits a sharp reflection dip in the optical C band wavelength (1530 nm-1565 nm) and an almost 99 % narrow absorption peak (linewidth~2 nm) due to the excitation of symmetry-protected quasi-BIC (Bound State in Continuum) resonance mode. The proposed metasurface-based absorber shows the same response for both TE and TM polarization of incident electromagnetic waves, unlike conventional asymmetric metasurface-based designs. The quasi-BIC mode is excited by breaking the in-plane structural symmetry of the all-dielectric split ring resonator. The addition of the gold layer makes the design a one-port system and eliminates the transmittance. In such cases, the reflectance is canceled due to the destructive interference of the wave that exits from the cavity formed by the Si-SiO_2-Gold cavity film.

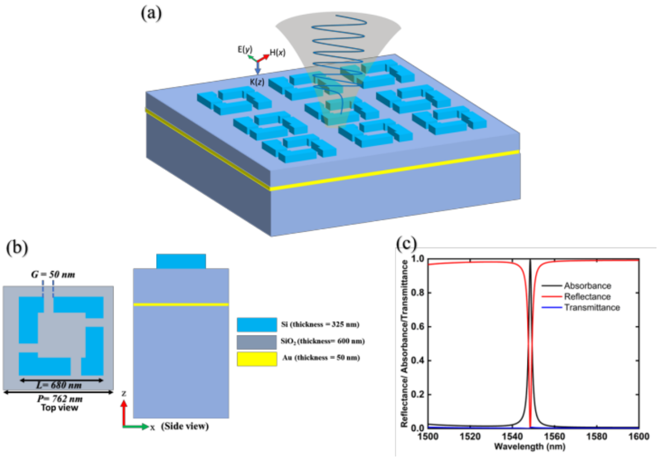


Figure 1 (a) The periodic array of the Si-based split ring resonator metasurface, (b) the top view and the side view of the optimized design, (c) the simulated reflectance, transmittance and absorbance of the proposed design.

Graphene-enhanced Raman spectroscopy of crystal violet and IR-780 iodide molecules

Anamika Sharma and Venkata Ramanaiah Dantham*

Department of Physics, Indian Institute of Technology Patna, Bihar 801103, India

Email: dantham@iitp.ac.in

Due to its extraordinary properties, such as uniform surface area, fluorescence quenching, and high optical transmission in the visible region, graphene is highly regarded for biological and chemical sensing research. The Graphene-enhanced Raman Scattering (GERS) technique is introduced by replacing the metal nanostructure in the most popular surface-enhanced Raman scattering (SERS) technique with graphene thin film. Electromagnetic mechanism plays a significant role in the SERS technique. However, in the GERS technique, the chemical mechanism is responsible for enhancement, and this mechanism relies on the graphene-molecule distance, electronic structure, energy bandgap variation, and adsorption properties of the probe molecule. The uniform and clean surface instead of a rough metal surface for better molecular orientation, better signal-to-noise ratio, low detection limit, and high reproducibility are some of the merits of GERS over SERS.

Herein, we report the GERS of crystal violet (CV) and IR-780 iodide molecules. In the case of CV molecules, the charge transfer is found to take place always from the monolayer graphene film to CV molecules. Interestingly, in the case of IR-780 iodide molecules on the MGF, the charge transfers from dye molecules to MGF, and vice versa is observed depending upon the location of the laser spot during the spectral measurements.

References:

1. H. Lai et al. *J. Mater. Chem. B 6*.24 (2018): 4008-4028 (2018).
2. X. Weigao et al. *Small* 9.8: 1206-1224 (2013).
3. J. C. Yoon et al. *RSC advances* 5.77: 62772-62777 (2015).
4. R. S. Swathi et al. *J. Chem. Phys.* 129.5 (2008).

Silicon nanoparticle-based near-infrared surface enhanced fluorescence without any "dielectric spacer"

Pranabjyoti Patar, Prerna Joshi, and Venkata Ramanaiah Dantham*

Department of Physics, Indian Institute of Technology Patna, Bihta, Bihar, India – 801103.

Email: dantham@iitp.ac.in

Near-infrared (NIR) fluorescence spectroscopy is found useful for several biomedical applications such as; immunotherapy, imaging, and diagnosis of cancer and various nephron-urological diseases. It offers a lower background compared to UV and visible fluorescence due to reduced scatter and lower auto-fluorescence of common assay substrates. However, the NIR fluorophores are not good emitters due to their lower intrinsic quantum yield than the UV and visible fluorophores. Therefore, there is a need to enhance the NIR fluorescence. A few researchers have successfully demonstrated the metal or plasmon-enhanced NIR fluorescence using suitable thin dielectric spacers between the fluorophore and metal nanoparticles [1].

High refractive index silicon (Si) nanoparticles recently attracted the researcher's attention due to their interesting optical properties [2] and many useful applications in cloaking and spectroscopy, nanoantennas, sensors, solar cells, and multi-functional metal surfaces. Unlike plasmonic nanoparticles, the Si nanoparticles support the geometrical (Mie) electric and magnetic multipolar modes upon optical illumination [3], allowing confinement of incident light components into the sub-wavelength region. The local electric field intensity enhancement due to the excitation of multipolar modes can be used to enhance the NIR fluorescence. However, the Si nanoparticle-based NIR-SEF is not reported in the literature. Therefore, the present theoretical study emphasized Si nanoparticle-based NIR surface-enhanced fluorescence (SEF).

Initially, the scattering spectra of single spherical-shaped Si nanoparticles of different sizes are plotted and characterized by the observed modes using the multipolar decomposition. Later, the electric field intensity enhancement distribution inside and outside Si nanoparticles is plotted at the wavelengths of electric and magnetic type modes. Finally, the SEF enhancement (χ_{SEF}) is estimated by varying the excitation wavelength (λ_{ex}), fluorescence wavelength (λ_{em}), and separation (d) between the fluorophore and Si nanoparticle of different sizes. The χ_{SEF} is found to vary from 1 to 3 orders of magnitude when the λ_{em} falls in the NIR region. In contrast to the plasmonic or metal nanoparticle-based SEF, the maximum χ_{SEF} is observed when $d = 0$, indicating that the thin dielectric spacers between the fluorophores and Si nanoparticles are not required in the Si nanoparticle-based SEF technique. This can be considered as a notable advantage over the conventional metal nanoparticle-based SEF, where dielectric spacers are mandatory. Finally, the average SEF enhancement $\langle\chi_{SEF}\rangle$ is also estimated.

Keywords: Si nanoparticles, Near-infrared fluorescence, Surface enhanced fluorescence

References:

3. T. Mahata et. al., *Spectrochim. Acta A Mol. Biomol. Spectrosc.* 283, 121739 (2022).
4. C. Meier et. al. *Vol. 79, Springer, Heidelberg*, pp.209 (2012).
5. P. D. Terekhov et. al. *Phys. Rev. B*, 96, 035443 (2017).

Metamaterial based Terahertz broadband active modulator using VO_2 material for the 6G communication systems

Bhagwat Singh Chouhan*, Soumyadeep Ray

Department of Physics, Indian Institute of Technology Guwahati, 781039, Assam, India.

Email: bhagwatsingh@iitg.ac.in

Terahertz waves, also known as terahertz radiation, is an electromagnetic wave that spans frequencies ranging from 0.1 THz to 10 THz. It occupies the unexplored region between microwave and infrared waves in the electromagnetic spectrum, often referred to as the terahertz gap. This terahertz gap can be bridged by using artificial structures known as metamaterials, whose unit cell is smaller than the wavelength of the incident wave. Broadband terahertz metamaterial-based modulations are crucial for the development of various THz devices, such as wave plates, switches, modulators, and filters. Active modulation of terahertz radiation is essential for communication systems, and the integration of various semiconductor materials, such as graphene, MoS_2, perovskite, and VO_2, with metamaterials can provide active tunability for terahertz radiation.

In this project, we integrated the phase-sensitive VO_2 material with metamaterial to actively tune the transmission of terahertz radiation. This design consists of two layers of multi-stacked resonators. Each resonator is made up of VO_2 material and is separated by a polyimide dielectric material, as shown in figures (a) and (b). Vanadium dioxide (VO_2) is a remarkable material known for its reversible phase transition near room temperature, shifting between insulating and metallic states. When we heat the VO_2-based metamaterial from room temperature to above 68 ℃, VO_2 changes its phase from insulator to conductor, resulting in the modulation of terahertz radiation, as shown in Figure (c).

In summary, our Terahertz broadband active modulator, incorporating VO_2 material within metamaterials, has the capability to modulate the terahertz transmission spectra, making a significant contribution to the advancement of 6G communication systems.

Keywords: Terahertz metamaterial, tunable filter, broadband filter, active modulator.

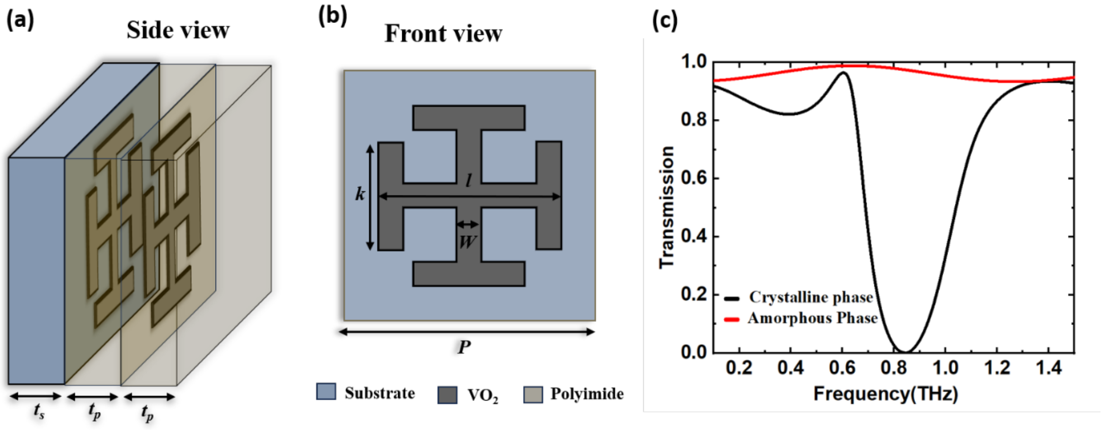


Figure 1: (a) shows the side view of the unit cell of the VO_2 resonator-based metamaterial. The metamaterial consists of two multistacked layers of VO_2 resonators. (b) shows the front view of the metamaterial unit cell. (c) shows the transmission spectra of the terahertz modulators. As the temperature of the VO_2 resonators changes from room temperature to 68 ℃, the VO_2 changes from an insulator to a conductor, resulting in the broadband modulation of terahertz amplitude.

Photophysical evaluation on the electronic properties of synthesized biologically significant pyrido fused imidazo[4,5-*c*]quinolines

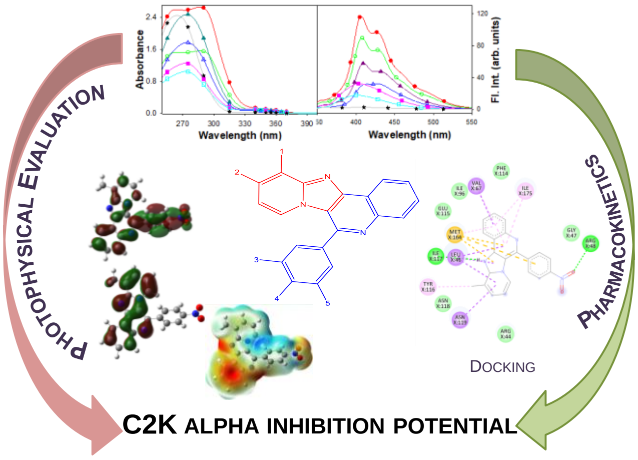
S. Jena,[a] B. Choudhury,[a] M. G. Ahmad,[a] and K. Chanda*[a]

[a] Department of Chemistry, School of Advanced Sciences, Vellore Institute of Technology, Vellore - 632 014, Tamil Nadu, India

Email: chandakaushik1@gmail.com

A single-pot microwave-assisted method was employed to synthesize a series of novel pyrido-fused imidazo[4,5-*c*] quinolines. The electronic properties of these derivatives were investigated by following their photophysical behaviour under isolated and solvated conditions *via* computational and experimental approaches. The solvatochromic effect of these derivatives was investigated in the ground and excited singlet states by following the absorption and fluorescence emission and excitation spectra. The biological applications of these derivatives as potential drug candidates were evaluated by *in silico* computational methods followed by pharmacokinetic properties predictions. The ability of these derivatives to inhibit human casein kinase 2 (CK2) was evaluated. The structure activity relationships were correlated by evaluating the electronic properties through experimental photophysical investigations including solvatochromic effect and computational electronic structure calculations. Of the various derivatives, p-nitro phenyl substituted pyrido fused imidazo[4,5-c] quinoline exhibited good inhibitory activity against CK2 enzyme and hence could serve as a promising drug candidate.

Graphical abstract:



Intermolecular Noncovalent Interactions with Carbon in Solution

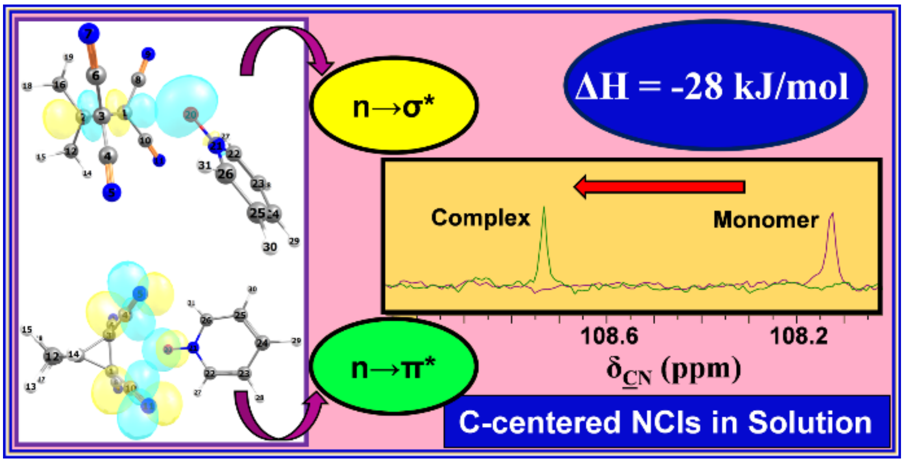
J. Dutta,[a, b, §] **and H. S. Biswal***[a, b]

[a] National Institute of Science Education and Research, Bhubaneswar, Jatni-752050, Odisha, India
[b] Homi Bhaba National Institute, Training School Complex, Anushakti Nagar, Mumbai- 400094, India
[§] Current Address: CSIR-Institute of Minerals and Materials Technology, Bhubaneswar- 751013, Odisha, India

Email: himansu@niser.ac.in

One of the most familiar carbon-centered noncovalent interactions (NCIs) involving antibonding π*-orbital situated at the Bürgi-Dunitz angle from the electron donor, mostly lone pairs of electrons, is known as n→π* interactions, and if it involves σ* orbital in a linear fashion, then it is known as carbon bond. These NCIs can be intra or inter-molecular and are usually weak in strength but have a paramount effect on the structure and function of small molecular crystals and proteins. Surprisingly, the experimental evidence of such interactions in the solution phase is scarce. It is even difficult to determine the interaction energy in the solution. Using NMR spectroscopy aided with molecular dynamics (MD) simulation and high-level quantum mechanical calculations, herein we provide the experimental evidence of intermolecular carbon-centered NCIs in solution. The challenge was to find the appropriate heterodimers that could sustain room temperature thermal energy and collisions from the solvent molecules. However, after several trial model compounds, the pyridine-N-oxide:dimethyltetracyanocyclopropane (PNODMTCCP) complex was found to be a good candidate for the investigation. The NBO analyses show that the PNO:DMTCCP complex is stabilized majorly by intermolecular n→π* interaction when a weaker carbon bond gives extra stability to the complex. From the NMR study, it is observed that the NCIs between the DMTCCP and PNO are enthalpy driven with an enthalpy change of -28.12 kJ/mol and dimerization energy of ~-38 kJ/mol is comparable to the binding energies of a conventional hydrogen-bonded dimer. This study opens up a new strategy to focus on the weak interactions like intermolecular n→π* interaction and carbon bonds that can be used in biological and chemical systems in the solution phase.

Keywords: n→π* interaction; Carbon bonding; Molecular dynamics; Quantum mechanical calculations; NMR spectroscopy



Computational Investigations into the Mechanistic Aspects of Nonribosomal Peptide Synthesis by Cyclodipeptide Synthases

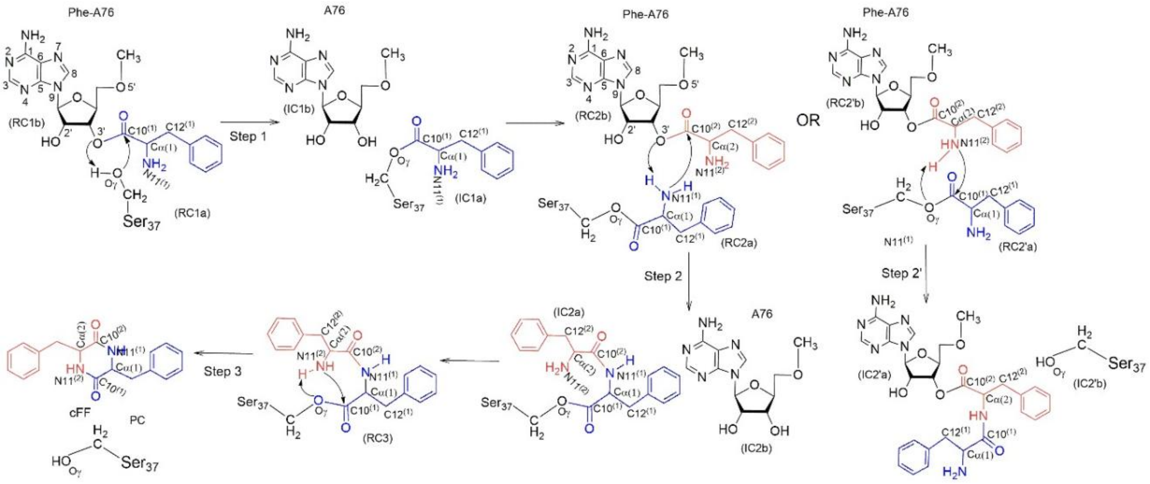
A. Goel[a], **I. Negi**[a] **and P. Sharma***[a],[b]

[a] Department of Chemistry and Centre for Advanced Studies in Chemistry, Panjab University, Chandigarh, 160014, India.
[b] Department of Chemistry and Biochemistry, University of Windsor, 401 Sunset Ave. Windsor ON, N9B 3P4, Canada

Email: psharma@uwindsor.ca

Cyclodipeptide synthases (CDPSs) constitute a relatively newly defined family of peptidebond forming enzymes that utilize two aminoacyl-tRNAs (aa-tRNAs) as substrates to synthesize the two peptide bonds of cyclodipeptides. Despite experimental efforts, the exact mechanistic steps of cyclodipeptide formation are not well understood. This work attempts to provide a preliminary understanding of the mechanism of cyclodipeptide formation by AlbC, a representative CDPS that synthesizes cyclo(L-Phe-L-Phe), using an amalgamation of QM calculations to determine the plausible reaction pathway and the associated intrinsic transformation barriers, and MD simulations to identify the catalytically important residues for each step of the CDP synthesis. The overall process is divided into three steps – activation of the Ser37 residue of AlbC and the attack of first tRNA^{Phe} to form the Phe-enzyme intermediate, attack of second tRNA^{Phe} to form the dipeptidyl enzyme intermediate, and intramolecular cyclization of this intermediate to form the desired cyclodipeptide. In synchrony with previous proposals, our results suggest that Asn40 and His203 may be required in all mechanistic steps, whereas Glu182 as a catalytic base is required during the formation of the dipeptidyl enzyme intermediate step and the intramolecular cyclisation steps. The identified pathways can guide future large-scale enzymatic modelling of AlbC. Further, our modelling approach can be extended to analyse the mechanism of other CDPS enzymes.

Keywords: Cyclodipeptide synthases, tRNA, Molecular dynamics simulations, Quantum mechanical calculations



Efficient Fabrication Technique for 3D-Printed Microfluidic Devices

Arijit Mohanta[1], Prathu Raja Parmar[1], Saurabh Dubey[2], Nafisa Arfa[1], Srijita De[2], Dipankar Bandyopadhyay*[1,2,3]

[1] Department of Chemical Engineering, Indian Institute of Technology Guwahati, Assam, India
[2] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Assam, India
[3] School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Assam, India

Email: dipban@iitg.ac.in

3D-printing technology offers a cost-effective and time-saving alternative for creating microfluidic devices. This research aimed to develop an efficient, affordable method for crafting 3D-printed microfluidic devices. Acrylonitrile butadiene styrene (ABS) is the chosen material for microfluidic channel molding. It makes a perfect and acceptable mold for microfluidic channel fabrication. This process allows low-cost fabrication methods, rapid prototyping, and the creation of complex structures. In this approach, a detailed 3D CAD design is created digitally prior to fabrication. The design can be assembled in a modular fashion, allowing remote collaboration among teams, and its mechanical and fluidic behavior can be simulated using finite-element modelling techniques.

Keywords: 3D-Printing, Microfluidic channel, Acrylonitrile butadiene styrene

Destabilization of a fluid flow using electrical force

C. K. Parashar[1]; **A. Singh**[2]; **A. Ghosh**[3]; **O. Deshmukh**[2] **and D. Bandyopadhyay*** [1,2,4]

[1] Center for Nanotechnology, Indian Institute of Technology Guwahati, Assam 781039, India
[2] Department of Chemical Engineering, Indian Institute of Technology Guwahati, Assam-781039, India
[3] Department of Chemical Engineering, Indian Insitute of Technology (BHU) Varanasi, Uttar Pradesh-221005, India
[4] School of Health Science and Technology, Indian Institute of Technology Guwahati, Assam-781039, India

Email: dipban@iitg.ac.in

The dominance of frictional force inside a microfluidic geometry strongly resists the intermixing of fluid layers causing sluggish diffusion dominated mass, momentum and heat transport. Under the action of an electric field, insulating fluids can manifest various electrohydrodynamic (EHD) flow patterns that are suitable for micromixing.

In this study, we examine the transition of flow from laminar to disordered behavior in two cases of fluid originally being under no-flow and flow state. The interplay between electrical, inertial and viscous forces is explored in view of assessing the fluid velocity and flow morphology. The background knowledge about the mechanism of non-linear current-voltage characteristics exhibited by dielectric fluid is also discussed.

The results suggest that the interplay between a destabilizing electric field with the stabilizing inertia and viscous forces decides the inception and transportation of vortices in a fluid. The charge distribution of a molecule is distorted under the influence of an external electric field, resulting in a relative displacement of the positive and negative atomic charges. In liquids, the typical charge carriers are electrons and ions, and their behavior is much more complicated than solids. As the ionization energy of dielectric liquids is typically greater than the work-function of electrode material, this causes charge injection in the liquid as a result of field emission due to lower threshold voltages, rather than causing field ionization only. The space charge is potentially unstable, and instability sets in above a critical value of electric force which depends upon the field strength, injection level, and electrode configuration along with the hydrodynamic and electrical properties of fluid. There is to a certain degree an analogy with the Rayleigh-Benard problem of a horizontal fluid layer heated from below.

Keywords: electrohydrodynamic, micromixing, dielectric, transition, ionization.

Layered materials based Nanofluidic System for Stimuli responsive Controlled & Selective delivery of Ions

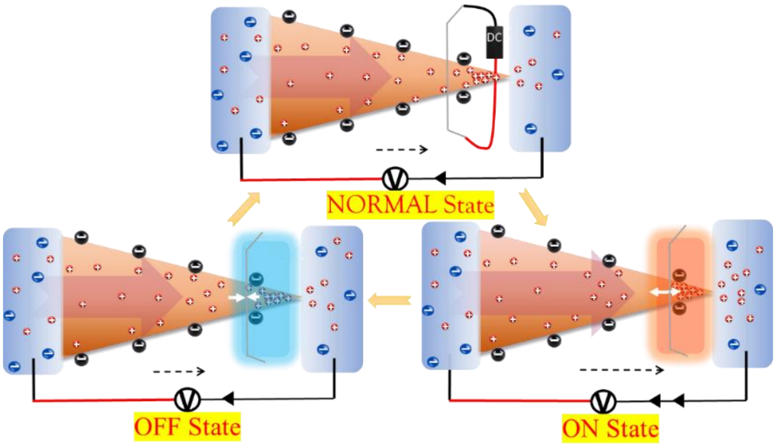
K. Mayawad* and Kalyan Raidongia*

Indian Institute of Technology, Guwahati, Assam, India - 781039

Email: k.raidongia@iitg.ac.in

Biological ion channels or ion pumps have the basic function of concentration regulation across the membranes, maintaining the overall health of cells and thus ensuring proper functioning of the body. Getting inspiration from this, we try to fabricate a simple nanofluidic iontronic device for achievement of delivery of ions in a controlled manner. The average delivery rate obtained is approximately 34nmol/hr with concentration gradient of 10^4-fold. Modulation of the rate of delivered ions was also pondered upon and is acquired using heat as a medium. A pulse of ions can be delivered from the source to the target reservoirs as per the requirement. It can also be regulated through the temperature regulation. Ion pumping nature which works against the concentration gradient, can also be observed in the system. Thus, an ion delivery device for the delivery of Potassium ions mainly, is fabricated with a special effect of heat modulation. Such devices can be helpful in various fields like, Biomedical and drug delivery, Neurosciences, Electrochemical Analysis, Water Treatment and Environmental Monitoring, etc.

Keywords: Ion transport, Nanofluidic, Iontronic, Controlled ion delivery.



Exploring Dynamic Interactions in Microfluidic Crown Formation: A Comprehensive Investigation

<u>Srijita De</u>[1], Saurabh Dubey[1], Prathu Raja Parmar[2], and Dipankar Bandyopadhyay* [1, 2, 3]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Assam, India
[2] Department of Chemical Engineering, Indian Institute of Technology Guwahati, Assam, India
[3] Jyoti and Bhupat Mehta School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Assam, India

Email: dipban@iitg.ac.in

This article provides a comprehensive investigation into the phenomenon of crown formation occurring within microfluidic channels, with the primary objective of predicting and controlling the intricate flow patterns associated with it. The crown formation is characterized by a sequence of events that initiate with the development of a core-shell structure composed of water at the channel's central axis, driven by high shear rates, and surrounded by an annular region of oil. The subsequent intrusion of high-pressure oil into this water core-shell induces a reversal in interfacial curvature, resulting in distinctive velocity stratifications and the emergence of Kelvin-Helmholtz fringes.

In conjunction with the contraction of the contact line and the onset of Rayleigh-Plateau instability, these fringes ultimately lead to the formation of water droplets and threads. The interplay between the penetration of high-pressure oil and the Kelvin-Helmholtz instabilities in the core-annulus region reveals a dynamic and potentially unstable interface between the water and oil phases. Various factors, including flow rates, fluid properties, channel geometry, and boundary conditions intricately govern this dynamic behavior inside the microchannel. It offers a captivating insight into the intriguing fluid dynamics observed in microfluidic systems.

Keywords: Crown formation, Core-shell structure, Kelvin-Helmholtz fringes, Rayleigh-Plateau instability

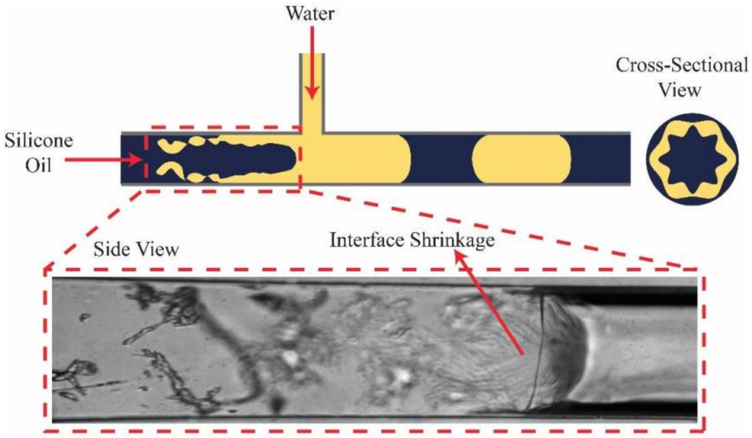


Figure 1: A schematic diagram of the experimental setup of the microchannel is shown. The micrograph image is the magnified version of the crown formation captured through the experiment.

Detection of Species-Specific Adulteration in Camel Milk and It's Origin by Multiplex PCR

Deepraj Sarkar[1], Rakesh Ranjan[2], Sumnil Marwaha[2], Artabandhu Sahoo[2] and Sanay Naha1*

[1]Department of Forensic Science, National Forensic Sciences University-Tripura Campus,
Agartala, Tripura, 799001
[2]ICAR-National Research Centre on Camel, Bikaner, Rajasthan, 334001

Email: sanay.naha_tripura@nfsu.ac.in

In analytical sciences, the detection of adulteration in food products is one of the promising fields [1]. In food products the authentication of milk species is becoming extremely important due to concerns about food safety and quality, driven by incidents of milk adulteration and mislabelling in the recent years [2, 3]. The study aimed to detect adulteration of cattle and goat milk in camel milk using multiplex PCR targeting the Cytochrome b gene. The reported primers exhibited excellent specificity and successfully amplified DNA fragments of 208 bp for camel, 274 bp for cattle, and 174 bp for goats. These results were subsequently confirmed through gene sequencing analysis. The limits of quantification (LoQ) for camel, cattle, and goat DNA were determined to be 2×10^{-6} ng/µL, 2×10^{-7} ng/µL, and 2×10^{-2} ng/µL, respectively. Additionally, the limit of detection (LoD) for cattle and goat milk in camel milk was determined to be 10% and 5%, respectively. Therefore, multiplex PCR is a reliable approach for milk samples authentication.

Keywords: Multiplex PCR, Species identification, Gene sequencing, Milk adulteration.

Reference:

1. El Sheikha, A. F. (2019). DNAFoil: novel technology for the rapid detection of food adulteration. Trends in Food Science & Technology, 86, 544-552.
2. Mafra, I., Honrado, M., & Amaral, J. S. (2022). Animal species authentication in dairy products. Foods, 11(8), 1124.
3. Baptista, M., & Domingues, L. (2023). Mitochondrial DNA D-Loop Amplification and Sequencing for Species Differentiation in Milk. In PCR: Methods and Protocols (pp. 173-180). New York, NY: Springer US

Stress-Associated Metabolic Profile of Apoplast and Cytosol and Characterization of Plant Leaf Nano-vesicles

K. V. Dhobale and L. Sahoo1*

Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Guwahati- 781039

Email: ls@iitg.ac.in

A dynamic environment of plant leaf apoplast is involved in important biological processes like cell wall formation, transport of nutrients, signal transmission, defense responses to pathogens, etc. Changes in the apoplastic composition have been described in biotic and abiotic stresses where extracellular vesicles (EV) such as nanosized exosomes play a crucial role. Recent evidence indicates there is a role for apoplast and secreted EVs as vehicles for intercellular communication and transport of complete or partial viral components. However, the effects of economically important begomovirus infection on the host plant apoplast are unstudied. Here, a vacuum-infiltration-centrifugation method was optimized to collect the apoplastic washing fluid (AWF) from Mungbean Yellow Mosaic India Virus (MYMIV) infected and non-infected mungbean leaves. The apoplast metabolome profile by NMR analysis identified differences in their composition. The presence of begomovirus was observed by the viral DNA-specific PCR reaction and Rolling Circle Amplification (RCA) of MYMIV DNA. Based on ultracentrifugation speed, two different populations of EVs (P50 and P100) were purified from AWF. The particle size of each population of EVs was determined using Dynamic Light Scattering (DLS) and TEM. Whereas DiOC6 dye was used to stain the total EVs lipid vesicle for quantification purposes which revealed an increase in the number of EVs in MYMIV infected apoplast of symptomatic mungbean leaf. In conclusion, for the first time, this study showed the presence of begomovirus-like particles in the apoplast region, benchmarked the EV isolation & characterization protocol from mungbean leaf, and identified various apoplastic metabolites in response to the pathogen.

Keywords: Apoplast, Exosome, NMR, MYMIV, Mungbean.

Synthesis, Characterization and Application of L-Glutamate Derived Carbon Dots for the Development of Rotavirus Genosensor

P. R. Kuri and P. Goswami*

Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, India 781039

*Email: pgoswami@iitg.ac.in

A carbon quantum dot (CQD)-labeled molecular beacon was designed and applied to detect the human Rotavirus A (RVA) *VP6* gene as the target. The CQDs exhibit low cytotoxicity, excellent water solubility, and photostability. The CQDs were synthesized from L-glutamate using the pyrolysis method and characterized through transmission electron microscopy, dynamic light scattering, Fourier-transform infrared spectroscopy, and fluorescence spectroscopy. A molecular beacon probe was designed through sequence analysis of the Human RVA VP6 gene to identify unique conserved regions. The molecular beacon (MB) was then commercially synthesized with Dabcyl at the 3' end as a quencher and a 5' amino-modified end. The synthesized CQDs were conjugated to the 5' amino-modified end as a fluorophore using EDC-NHS chemistry. The Dabcyl and CQDs serve as the acceptor and donor components of a FRET system, respectively. Only weak fluorescence is observed in the absence of the RVA VP6 target and in the presence of scrambled or mismatched sequences. However, in the presence of the RVA VP6 target, the fluorescence intensity of the CQDs recovers. The hybridization of the hairpin structure of the MB with the RVA target opens the loop of the MB. Consequently, the distance between the Dabcyl quencher and the CQD fluorophore increases, leading to changes in the fluorescence signal. The probe can distinguish between the RVA target and its single mismatch mutant, making it a valuable tool for the potential diagnosis of RVA-mediated gastroenteritis.

Keywords: Carbon quantum dots, Rotavirus, Molecular Beacon

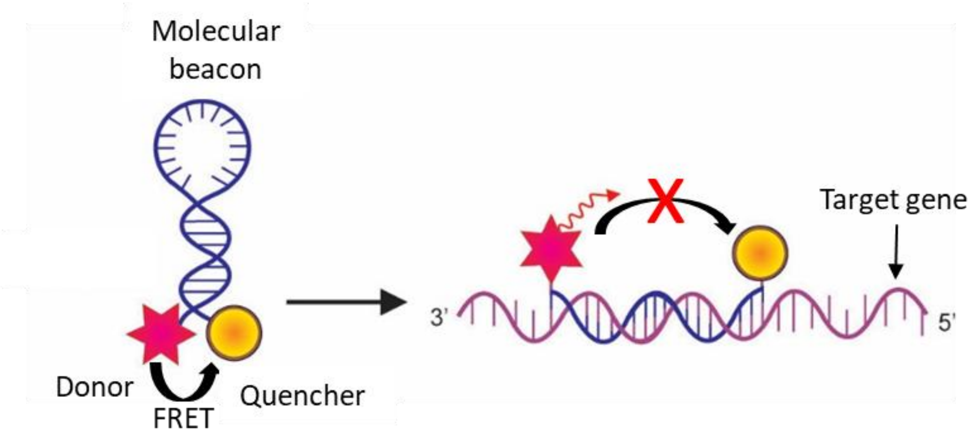


Figure 1. Schematic of MB-based target sensing.

Gold nanoparticle conjugated ethyl ferulate and epoxy azadiradione for the treatment of triple negative breast cancer

J. Unnikrishnan[1], P. Satpati*[1] and A. B. Kunnumakkara*[2]

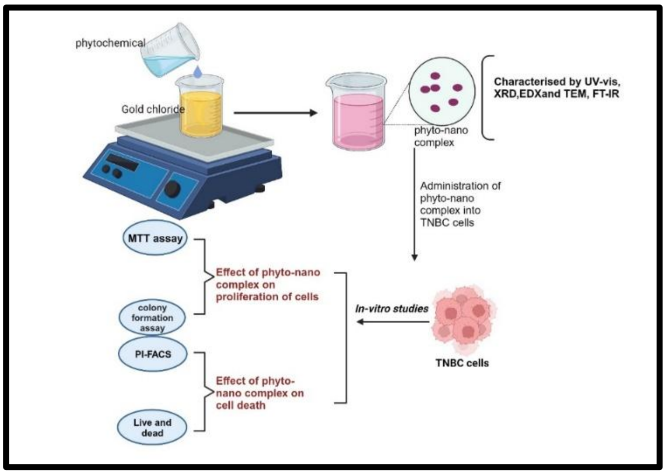
[1] Computational Biology Lab, Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Assam 781039, India.

[2] Cancer Biology Laboratory, Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Assam 781039, India.

Triple negative breast cancer (TNBC) has garnered significant attention from the global scientific community due to its enigmatic and multifaceted characteristics. Distinctly, TNBC is characterized by the absence of estrogen receptors, progesterone receptors, and HER2 receptors. This absence complicates the direct targeting of these cells with contemporary targeted therapies. Historically, the efficacy of phytochemicals in cancer prevention and treatment has been well-established. Recent advances suggest that gold nanoparticles (AuNps) can potentially address the limitations of phytochemicals. In this study, the phytochemicals epoxy azadiradione and ethyl ferulate were employed to chemically reduce gold chloride, resulting in the synthesis of EAZD-AuNp and EF-AuNp complexes, respectively. These AuNps, possessing hexagonal and triangular morphologies with sizes ranging from 10-50nm, can target tumor tissues passively via the enhanced permeability and retention (EPR) effect. Their cellular uptake is further facilitated through receptor-mediated endocytosis, aided by the adsorbed "protein corona" on the AuNps. The formation of EAZD-AuNp and EF-AuNp was verified using UV-visible spectroscopy, XRD, EDX, and TEM. Moreover, FT-IR analysis highlighted the role of carbonyl and hydroxyl groups in the bio-reduction of gold chloride. Subsequent in vitro assessments, such as the MTT and colony formation assays, demonstrated the anti-proliferative effects of EAZD-AuNp and EF-AuNp on TNBC cells, with IC_{50} values of 6μg/ml and 18μg/ml, respectively. PI-FACS and live-dead assays further affirmed that EAZD-AuNp and EF-AuNp induced higher cellular mortality than their phytochemical equivalents. While these findings suggest the potential anticancer efficacy of EAZD-AuNp and EF-AuNp, additional in vitro and in vivo investigations are imperative to further validate these conclusions.

Keywords: AuNps, phytochemicals, epoxy azadiradione, ethyl ferulate, triple-negative breast cancer.

Schematic representation



Role of surface functionalization of gold nanorods (GNRs) in inducing apoptosis in murine fibrosarcoma model

N. Maity and M. Sengupta*

Department of Biotechnology, Assam University, Silchar-788011, Assam, India.

Email: nabnitaamaiity9@gmail.com, senguptamahuya35@gmail.com*

Gold nanoparticles (GNPs) have gained attention in cancer theragnostic as an effective photosensitizing agent i.e., ability to convert light into heat, leads to photoablation of cancer cells, due to its strong localized surface plasmon resonance (LSPR). Apart from its use in photothermal therapy (PTT), intrinsic role of GNPs on cancer cells are not well studied. Intrinsic properties of GNPs depend on various factors such as size, shape, concentration and surface functionalization. Our study aims to investigate the effects of cetyltrimethylammonium bromide (CTAB) and polyethylene glycol (PEG) coated gold nanorods (GNRs) in 3-methylcholanthrene (MCA) induced fibrosarcoma mice model.

Selected dose of CTAB-GNRs and PEG-GNRs were applied intravenously for 4 weeks in fibrosarcoma induced Swiss albino mice. CTAB and PEG coated GNRs were characterized via UV- spectrophotometric study, transmission electron microscopy (TEM) and FT-IR. Isolated liver and spleen of control, MCA, CTAB and PEG treated mice were subjected to assessment of oxidative stress [quantification of reactive oxygen species (ROS) via 2′,7′-dichlorofluorescin diacetate (DCFH- DA) and nitroblue tetrazolium (NBT)], antioxidants [catalase (CAT), superoxide dismutase (SOD) and glutathione reductase (GSH)], cytokine profiling and apoptosis study. MCA, CTAB and PEG-GNRs treated tissue histology of liver and spleen were examined by H&E staining.

The results showed that CTAB-GNRs were able to induce apoptosis by inducing oxidative stress via an upregulation of pro-inflammatory cytokines like TNF-α and IL-1β whereas, PEG-GNRs were also inducing apoptosis but reduced pro-inflammatory cytokines (TNF-α and IL-1β) and lower oxidative stress was observed as compared to CTAB-GNRs. Our findings, clearly indicates surface functionalization imparts an essential role in modulating the function of gold nanorods. Both CTAB and PEGylated gold nanorods were effective to inhibit the progression of carcinogenesis through apoptosis induction but it can be said their mode of action involved different cell signaling pathways.

Keywords: Gold nanorods, surface functionalization, cetyltrimethylammonium bromide (CTAB), polyethylene glycol (PEG), apoptosis

Construction and evaluation of physico-chemical and biological characteristics of chitosan/gelatin composite scaffolds reinforced with strontium doped 58S bioglass for bone tissue engineering application

Kiran Sebastian K[a], Amit Kumar Singh[a,b] and Amit Biswas*[a]

[a] Center of Excellence in Tissue Engineering, Department of Biotechnology and Medical Engineering, National Institute of Technology Rourkela, Rourkela, India
[b] Dr. D. Y. Patil Biotechnology and Bioinformatics Institute, Dr. D. Y. Patil Vidyapeeth, Pune, India

Email: amitb79@gmail.com

Bioglass (Bg) is accepted as a revolutionary material and doping with strontium (Sr) ions in Bg network exhibits improved bio functionality towards the bone tissue regeneration and inhibit the osteoclast formation. Keeping in this view, the present study focused on the development of chitosan (CS)/gelatin (GE) porous scaffold incorporated with Sr doped Bg nanoparticles (nSrBg) for bone tissue engineering application. The nSrBg was introduced in CS/GE polymeric network in varying amount. Various characterizations were performed to assess the properties of synthesized nSrBg and freeze-dried composite scaffolds. SEM and DLS results revealed that SrBg nanoparticles were synthesized. XRD and FTIR spectra confirmed the formation of glass network in the nSrBg. The SEM analysis illustrated that the fabricated scaffold possessed homogenous microstructure with interconnected porous network having pore size of 100 – 300 µm. Controlled swelling and slowest degradation was achieved. The compression test disclosed that the incorporation of nSrBg in CS/GE polymeric network increased the compressive strength. I*n vitro* bioactivity assay suggested that presence of nSrBg enhanced the bone like deposition of apatite layer which possessed cell supportive properties that allowed the cells to attach and proliferate over the scaffold surface. MTT assay and live-dead staining revealed that the increase in nSrBg in CS/GE polymeric network enhanced the proliferation of the cells over the scaffold surface. ALP assay suggested that the nSrBg addition improved the osteogenic potential of the CS/GE scaffold. Overall, the fabricated scaffold showed superior mechanical and biological properties that can be a promising platform for the bone tissue regeneration.

Keywords: Bioglass; strontium; chitosan; gelatin; bone tissue engineering

Targeting Lysosomal Protease in Cancer Theranostics: a nanocarrier based repurposed drug delivery approach

S. Mukhopadhyay*[1], P. K. Iyer[1,2] and S. S. Ghosh[1,3]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Assam, India.
[2] Department of Chemistry, Indian Institute of Technology Guwahati, Assam, India.
[3] Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Assam, India.

Email: msayantani@iitg.ac.in

Cancer is such a pre-eminent disease that has emerged as a matter of great concern in the field of healthcare as well as research worldwide, owing to the absence of fully efficient treatment modalities till date. While the conventional therapies for the disease are lacking the ability of reporting any dependable curative phenomenon as well as to establish a new drug to combat the disease, the province of drug repurposing is showing a ray of hope. Cancer is as a whole known for its phenomenal characters of uncontrolled cell proliferation and metastasis, which some lysosomal cysteine proteases have been identified to play a critical role in. Although, several research works are being carried on to establish new drugs targeting these proteases, the process of drug discovery is time consuming and in most of the cases they fall short at any one of the phases of clinical trial. Under these circumstances, drug repurposing is emanating as a convenient as well as promising alternative of drug discovery. Moreover, to acquire the highest effectivity of a drug, it is important to make sure that the drug preferably reaches the desired target site at an effective amount to minimize undesired toxicity. This is where a suitable drug delivery vehicle plays its role.

Here in this study, we have performed a drug repurposing study targeting a lysosomal protease that has been reported to have critical role in cancer formation and in the progression of the disease. We have also inspected the cytotoxic effects and the mechanisms through which the drug works. We have also developed a quantum dot based nanocarrier to deliver the drug to the desired location.

Self-assembled Nanoscale Upconversion Porous Organic Polymer Composite for Overcoming Drug Resistance and Boosted Chemotherapy

P. Mukherjee and S. K. Sahu*

Department of Chemistry and Chemical Biology, Indian Institute of Technology (ISM), Dhanbad -826004, Jharkhand, India

Email: sksahu@iitism.ac.in

Uncontrolled proliferations and altered metabolism of cancer cells result in an imbalance of oxygen supply, persuading hypoxia which in turn induces multi-drug resistance. Covalently linked nanoscale porous organic polymer (POP) enriched the application of cancer theranostics by serving as an ideal vehicle with a high therapeutic payload. In this work, we have synthesized nanoscale POP conjugated upconversion nanoparticles and immobilized with oxygen-producing moiety for targeted anticancer therapy. Upconversion POP composite is synthesized at room temperature via a condensation reaction. Further, the targeting ligand lactobionic acid (L) was attached to the composite after surface modification. Finally, the composite was immobilized with oxygengenerating catalase leading to the composite (POP@UCNPs@P-L-C). A high amount of drug DOX was loaded into the composite. The nanoscale composite possesses good biocompatibility and exhibit fluorescence property after NIR excitation. The drug and catalase-loaded composite exhibits more cytotoxicity in the case of hypoxic liver cancer cells than the normal cells by downregulating the hypoxia-inducible factors.

Keywords: Hypoxia; POP; NIR imaging; Targeted delivery and Upconversion nanoparticle.

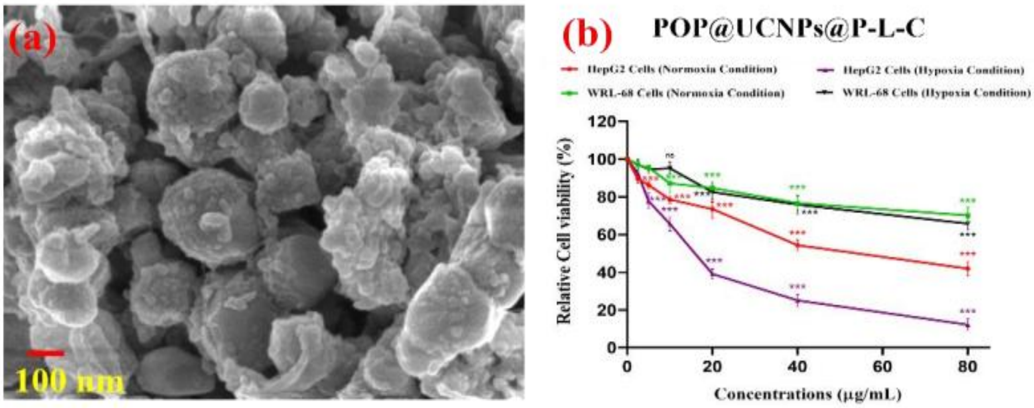


Fig. (a) FESEM image of POP@UCNPs@P and (b) cell cytotoxicity study of POP@UCNPs@P-L-C in liver cells

Aqueous reconstitutable lyophilized plasmonic semishells as near infra- red photothermal nanotransducers for cancer treatment

Kritika Sood* and Asifkhan Shanavas

Institute of Nano Science and Technology, Knowledge City, Sector – 81, Mohali, Punjab

Email: kritika.ph17227@inst.ac.in

In this work, we have developed a rapid colloidal one-pot synthetic procedure for in-situ formation of gold semishells at room temperature using a biocompatible MOF (Metal Organic Framework) with a unique self-etching property as a sacrificial template without the need of any additional etching agents. This is a first such study to report the rapid colloidal synthesis of gold semishells at room temperature without using any additional etching agents to dissolve the template, to the best of our knowledge.

These anisotropic gold semishells (SS) absorb strongly in NIR region (>750 nm) and thereby exhibit an excellent photothermal transduction efficiency of about 38% due to which they can act as excellent nanotransducers for photothermal treatment of cancer cells. The biocompatibilty as well as hemocompatibility of these semishells was studied prior to their photothermal ablation effect on triple negative breast cancer cells MDA MB 231 (808 nm, 650mW/cm2, 5mins of laser irradiation) which depicted ~ 75% cell death. Further, preclinical safety analysis was carried out in C57BL/6 mice to determine acute inflammation as well as sub-acute toxicity and biodistribution analysis over a period of 28 days. Due to the absence of any acute inflammatory response as well as their preclinical sub-acute safety, the SS mediated photothermal therapy were analysed for their tumor regression response was studied in CD1 nude mice xenografted with 4T1 breast tumor cell. The results revealed that SS mediated photothermal therapy was efficient in not only the photothermal ablation of the primary tumor but also in the prevention of its lung and bone metastasis. Furthermore, we carried out a preclinical survival study over a period of 3 months to assess their translational potential in clinical setup and found that the mice treated with SS mediated PTT had chances of ~75% survival thereby indicating the chances of higher survivability of mice after treatment. Hence, these gold semishells due to their excellent photothermal transduction efficiency, high preclinical subacute safety, tumor inhibition and metastasis prevention as well as higher overall survivability, have the potential to become as the new generation nanotransducers for photothermal ablation of cancer in a clinical translation.

Synthetic peptides containing D-amino acids and termini protection: a possible prevention strategy for antibiotic resistance

Mayank Maan[1] and Avneet Saini*[1]

[1]Department of Biophysics, Panjab University, Sector 25, Chandigarh, India

Email: avneet@pu.ac.in

Small, synthetic peptides have been designed to counter the problems associated with natural peptides. Antimicrobial peptides (AMPs), which have demonstrated better antibacterial activity against pathogenic bacterial strains than commercially available antibiotics, are a class of medicines with considerable promise for therapeutic application. However, the usage of naturally-derived antimicrobial peptides AMPs has a number of drawbacks, especially when treating invasive diseases. These restrictions include high manufacturing costs because of their complex design; host toxicity; protease degradation; extensive serum binding; loss of antibacterial action in the presence of physiological concentrations of salts. For AMPs to become potent therapeutic agents that may be employed in clinical settings, these constraints must be overcome. Synthetic peptides offer several advantages over their natural counterpart such as, potent antibacterial activity, low production cost and no or very low toxicity while maintaining their superior antibacterial action. De novo minimalist design of amphipathic peptides, sequence modifications from naturally occurring template peptides, and the use of bioinformatics and combinatorial libraries to assist in the identification of new lead sequences are some of the general approaches used in the design and structural–activity relationship (SAR) studies of synthetic AMPs. This current work is a pilot study which involves the design, development, and validation of synthetic peptide analogues with improved potency and bioavailability. *In vitro* activity of the designed peptides against a set of pathogenic bacterial strains confirmed their antimicrobial potential.

Comparing the Dispersion stability of Carbonaceous material for Interfacial processes

Jyotirekha Jena*[1] and Rajiv K. Kar*[1,2]

[1] Jyoti and Bhupat Mehta School of Health Sciences and Technology,
[2] Center for Nanotechnology, Indian Institute of Technology Guwahati , India.

Email: j.jyotirekha@iitg.ac.in; rajivkar@iitg.ac.in

The search for a substance for multi-purposes interfacial processes along with being compatible with biosystems has been of high interest in the field of biomedical science. In this study we focus to compare the dispersibility of a low-dimensional material - graphene oxide (GO) in different organic solvents has been investigated. To completely exfoliate the graphite oxide material into single-layer graphene oxide sheets in each of these solvents, sonication was performed. The GO solution shows significant dispersion stability in NMP, DMF, THF and ethylene glycol compared to the rest. The dispersions exhibited long-term stability up to three weeks. We confirmed it by analyzing the crystalline nature and number of sheet layers which ranges from few micrometers to nanometers to. Following this, we used cationic and anionic surfactants to re-evaluate the stability. The interactions of GO with cetyltrimethylammonium bromide (CTAB) and sodium dodecyl sulfate (SDS) were characterized using low-resolution methods like AFM, Dynamic Light Scattering, UV-vis, and XRD. The interfacial utility of dispersion solutions is confirmed by probing into bacterial growth. The distinct behaviors among the graphene-based system provide critical insights that pave way for tuning material properties for desirable optical properties. The results obtained will also facilitate the manipulation and processing of carbonaceous materials for different biomedical applications.

Keywords: Graphene oxide, surfactants, dispersion stability, AFM, Dynamic light scattering, UV, interfacial processes.

Protein-Nanocarrier-Based Drug Repurposing for Cancer Theranostics

Sayantani Biswas [a], Arun Chattopadhyay* [a, b] and Siddhartha Sankar Ghosh* [a, c]

[a] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India.
[b] Department of Chemistry, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India.
[c] Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India

Cancer, one of the most notorious disease of all time, were some healthy cells start to show uncontrollable growth leading to malignant phenotype. Among all the cancer breast cancer is one of the leading cause of death in India. Breast cancer is a complex and often life-altering and affects millions of individuals worldwide. It is the most common cancer among women, with a significant impact on both genders. This insidious condition originates in the breast tissue when cells begin to grow uncontrollably, forming tumors that may or may not be cancerous. Triple-negative breast cancer (TNBC) is a subtype of breast cancer that lacks three key receptors commonly found in other types of breast cancer: estrogen receptors (ER), progesterone receptors (PR), and human epidermal growth factor receptor 2 (HER2). These receptors play a crucial role in the growth and proliferation of breast cancer cells, and their absence in TNBC makes this subtype more challenging to treat with hormonal therapies or drugs that target HER2. In this study we are trying to target TNBC using the principle of drug repurposing. Drug repurposing, also known as drug repositioning or reprofiling, involves the exploration of new therapeutic uses for existing drugs that were initially developed for different medical indications. Unlike the conventional process of creating entirely new drugs, researchers in drug repurposing investigate the potential of existing pharmaceuticals to address different diseases or conditions. Repurposed drugs have their own limitation, as they are required in higher concentration to have the same effect as the conventional drugs, to address that we are incorporating the drug with a nano-carrier. For our study we are considering protein nanoparticles embedded with gold nanoclusters for more effective drug delivery.

Keywords: Breast cancer, Triple negative breast cancer, Drug repurposing, Protein nanoparticles, gold nano-cluster.

3D biphasic scaffold-based osteoarthritis disease model for evaluation of injectable hydrogel formulations for cartilage tissue engineering

Chevella Maheshwari [2], Ashutosh Bandyopadhyay [1] and Biman B. Mandal* [1,2,3]

[1] Department of Biosciences and Bioengineering; Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India,
[2] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India,
[3] Jyoti and Bhupat Mehta School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India

Email: c.maheshwari@iitg.ac.in; biman.mandal@iitg.ac.in

Animal models are the gold standard for screening of drugs. The use of animals as test subjects for scientific research requires ethical consent. It also causes the animals enormous discomfort and, in the end, leads to their sacrifice. Invitro disease models that resemble human organs are being created as a solution for this problem, and efforts are still being made to find materials that are both biocompatible but also bio available. A wide variety of in vitro models, including 2D, co-culture, 3D, bioreactor, bio assembly, organoids, and organ-on-a-chip models, have been developed and are currently in use. Still, these models need to be improved in order to meet the requirements because they still contain significant problems of mimicking the in vivo conditions, cellularity, biochemical makeup and the multi-organ availability. In this regard, we're attempting to develop a model of osteoarthritis that closely resembles the tissue found in people with the illness. We aim to mimic osteoarthritis using a biphasic scaffold technology. This biphasic system comprises of an upper part made of cartilage and the lower part of bone. This osteo-chondral replica will be in healthy condition. We'll use a chemical process to inflict illness. Depending on the chemical concentration we use, we can create different phases of osteo-arthritis. We will assess our treatment strategies and formulation, which would be chondrogenic in nature, after developing the disease model. This formulation could be delivered as an injectable modality so that it can be localised to the diseased part while avoiding any side effects to the healthy tissues. With this, we hope to develop a targeted injectable modality with cartilage regeneration capabilities to be assessed in the osteoarthritis disease model.

Keywords: cartilage, tissue regeneration, biphasic model, osteoarthritis.

Gelatin Methacryloyl Microspheres as an Efficient Targeted Anticancer Drug Delivery System

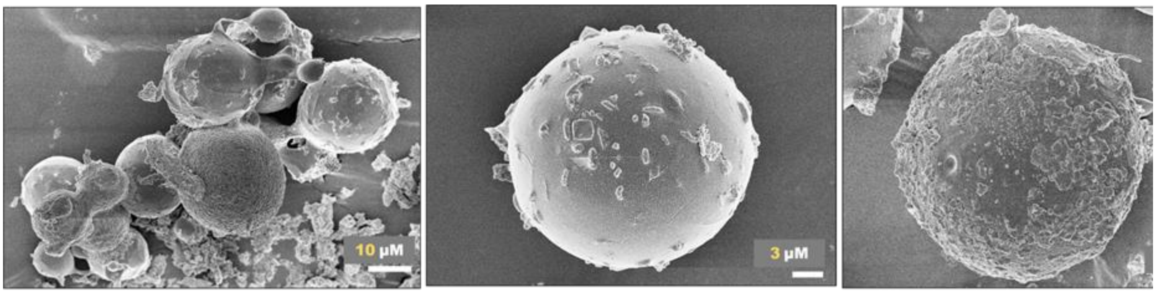
Rajat Dadheech[1] and Biman B. Mandal* [1,2,3]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India,
[2] Department of Biosciences and Bioengineering; Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India,
[3] Jyoti and Bhupat Mehta School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India,

Email: d.rajat@iitg.ac.in; biman.mandal@iitg.ac.in

Cancer has been perceived as one of the foremost causes of the deaths (~10 million in 2020) around the world by the World Health Organization (WHO). Surgery, chemotherapy, and radiation therapy are the basic modalities for tumor management. These treatment options are associated with high-risk factors like tumor recurrence and late/systemic toxicities of radiation and chemotherapeutic drugs resulting in non-cancer related mortality. Targeted drug delivery through encapsulation of anticancer drug in a carrier provides several advantages like improved drug stability, decreased toxicity, and enhanced pharmacokinetics over direct administration. Gelatin stands out as a biopolymer in biomedical engineering, due to its unique qualities of low immunogenicity, solubility, biocompatibility, and low cytotoxicity. Herein we have fabricated gelatin methacryloyl (GelMA) microspheres in a facile manner by emulsification of aqueous solution of methacryloyl gelatin followed by photo-crosslinking. Characterization of GelMA microspheres using FESEM revealed their spherical morphology and average size of 69.16 ± 21.33 μm. Anticancer drug was adsorbed onto the microspheres and release kinetics confirmed the sustained release of the drug from microspheres. FT-IR analysis of GelMA microspheres confirmed the crosslinking and presence of the anticancer drug. Further, *in vitro* functionality assessments will be carried out using cell cytotoxicity assays, FACS and confocal microscopy. These GelMA hydrogel spheres can protect labile drugs from degradation while acting as local reservoirs of anticancer drug. Therefore, GelMA microsphere DDS would be a viable solution for sustained and localized delivery of the anticancer therapeutic in tumor vicinity of external tumors such as head and neck cancer and breast cancer via passive targeting scheme.

Keywords: cancer, biomaterials, drug delivery, GelMA microspheres, sustained release.



Role of Bacteria-Bots in Cancer Theranostics

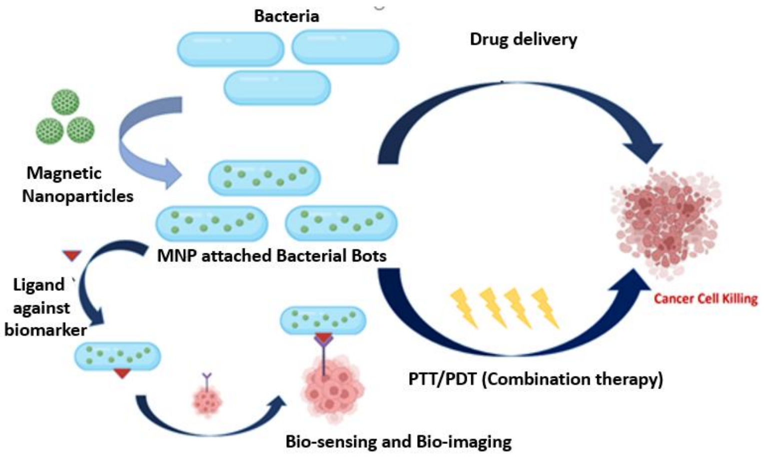
S. Roy[1], S.S. Ghosh* [1,2] and A. Chattopadhyay* [1,3]

[1]Centre for Nanotechnology, IIT Guwahati, India
[2]Department of Biosciences and Bio Engineering, IIT Guwahati, India
[3]Department of Chemistry, IIT Guwahati, India

Email: roy.sawna@iitg.ac.in

Cancer is a complex disease that involves uncontrolled growth and spread of cells, leading to detachment from their original site and invasion of other organs. Traditional treatments have limitations, including drug resistance, low specificity, and treatment failure. Recent research has focused on developing bacterial micro-bots that can target cancer cells and deliver drugs more effectively. These "bacterial bots" can be created by attaching nanoparticles to bacterial cells. They offer benefits such as minimal immune stimulation, maximum drug payload, improved efficacy with combination therapy, and other potential applications in bio-imaging and bio-sensing. This research has the potential to improve cancer therapy and offer new possibilities for medical treatment.

Keywords: Bacterial bot, Cancer, Nanoparticles, Cancer theranostics.



Self-folding and unfolding of $PdSe_2$ nanowire for killing of cancer cells

Tadasha Jena[1], Md Tarik Hossain[2] and P. K. Giri[1, 2]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati - 781039, India
[2] Department of Physics, Indian Institute of Technology Guwahati - 781039, India

Email: tadasha.j@iitg.ac.in

$PdSe_2$ based nanomaterials have distinguished advantages and potential applications in various biomedical fields. However, their biological effects in physiological systems remain largely unexplored. Here, we explored the plasmonic palladium nanoparticles (Pd NPs) decorated inside $PdSe_2$ nanowire to unravel the complex and dynamic biological processes involved in killing of cancerous cells, realized using plasmonically enhanced Raman spectroscopy. We report the discovery of a new method for creating $PdSe_2$ nanostructures using AFM-induced self-folding. The self-folding does not require multiple processing steps or any polymer coatings that could affect the physical properties of $PdSe_2$. Our findings illustrate the vast possibilities of plasmonically enhanced Raman spectroscopy in real-time tracking of complex biomolecules, which could provide new insights to the development of cancer and many other diseases.

References:

1. Jena et. al., npj 2D Materials and Applications (2023) 8.
2. Xu et al., Sci. Adv. 2017;3: e1701084.

Peptide functionalized graphene oxide as a two-dimensional antibacterial and antibiofilm nanocoating

S. Joshi[1,2], G. Verma[2,3] and A. Saini*[1]

[1] Department of Biophysics, Panjab University, Sector 25, Chandigarh, India
[2] Energy Research Centre, Panjab University, Chandigarh, India
[3] Dr. S. S. Bhatnagar University Institute of Chemical Engineering & Technology, Chandigarh, India

Email: avneet@pu.ac.in

Antimicrobial resistance is a global health threat aggravated by unregulated use of antibiotics. Need of the hour is development of novel antimicrobial agents with antibacterial activity and low propensity towards resistance development. The conjugation of peptides with graphitic nanoparticles such as graphene oxide (GO) results in development of broad-spectrum antibacterial biomaterials with enhanced hemocompatibility. Peptide functionalized nanoparticles have emerged as versatile tools for multifarious biomedical applications. Conjugation between the two promising classes of materials allows enhanced control over their biological behaviors thereby overcoming the intrinsic limitations of the individual materials. In the present work, a multifunctional nanoformulation was synthesized by covalently coupling a novel synthetic antimicrobial peptide DP1 (RFGRFLRKILRFLKK) to (GO). Interaction between GO and DP1 was affirmed by application of different biophysical techniques. The nanoformulation (GO-DP1) was evaluated for antibacterial as well as antibiofilm activity against multi-drug resistant pathogenic organisms. Further, biomedical applicability of GO-DP1 was assessed by evaluating its hemocompatibility and antibiofilm potency in a *Pseudomonas aeruginosa* contaminated hypodermic needle model. This is the first study of its kind that paves the way for future applications of this nanoformulation in environments and settings that serve as reservoirs of microbial contamination.

Keywords: Graphene oxide; peptide functionalized nanoformulation; covalent conjugation; broad-spectrum antibacterial activity; non-hemolytic.

Dependence of structure on the hydrophilicity of TiO_2 nanotubes for suitable hemocompatible applications

Subhashree Mishra*[a,b], Vignesh Muthuvijayan[b] and Somnath Chanda Roy[a]

[a] Semiconducting Oxide Materials Nanostructures and Tailored Heterojunction (SOMNaTH) lab, Department of Physics, Indian Institute of Technology Madras, 600036, India.
[b] Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences, Indian Institute of Technology Madras, 600036, India

Email: ph20d302@smail.iitm.ac.in

Hemocompatibility is the fundamental criteria for the successful *in-vivo* application of blood-contacting biomaterials. Blood is a colloidal solution consisting of 55% plasma proteins and 45 percent other formed elements like erythrocytes, leukocytes and platelets. Blood Plasma contains 92% of water and 8% solids like coagulation factors, fibrinogen, albumin, globulins *etc*[1]. It has a unique property of hemostasis by virtue of which it ceases to bleed in case of an injury. However, it acts adversely when blood comes in direct contact with any implant or any artificial surface like catheter, stent, or mechanical valve placed in the human body and is intended to stay in contact with blood for years or lifetime. Exposure of a foreign surface to blood will either trigger the body's immune system or trigger the coagulation cascade that further leads to the formation of blood clot or thrombus[2]. That is why people undergoing these implant surgeries have to take anticoagulants throughout their life so as to inhibit the formation of thrombus. These anticoagulants are also not devoid of side effects. They often lead to blood thinning disorders. This work aims to tune the hydrophilicity of TiO_2 nanotubes by modifying various parameters like voltage, time and current so as to make them hemocompatible. The scope of this work includes preparation of TiO_2 nanotubes by anodization, and study of its hydrophilicity by contact angle measurements. The dependence of morphology on the roughness was studied by AFM. The structure and morphology of the nanotubes was studied by SEM. The anticoagulant properties of the coating were characterized by aPTT, PT measurements.

Keywords: Hemocompatibility; Anticoagulant; Hydrophilicity; Roughness; Morphology.

References:

1. M. Weber, H. Steinle, S. Golombek, L. Hann, C. Schlensak, H.P. Wendel, M. Avci-Adali, Blood-Contacting Biomaterials: In Vitro Evaluation of the Hemocompatibility, Front. Bioeng. Biotechnol. 6 (2018) 99.
2. I.H. Jaffer, J.I. Weitz, The blood compatibility challenge. Part 1: Blood-contacting medical devices: The scope of the problem, Acta Biomater. 94 (2019) 2–10.

Bioinformatics Insights into Allantoinase for its Suitability to Design Enzyme-Based Sensors

Sheetal Das[1] **and Rajiv K. Kar**[1,2]

[1] Jyoti and Bhupat Mehta School of Health Sciences and Technology; [2] Center for Nanotechnology, Indian Institute of Technology Guwahati – 781039, Assam

Email: d.sheetal@iitg.ac.in; rajivkar@iitg.ac.in

Allantoinase, a key player in the purine metabolic pathway, catalyzing the conversion of allantoin to allantoic acid in purine metabolism. The metabolic breakdown of purines generates reactive oxygen species (ROS), when overproduced can generate oxidative stress. Allantoin, produced through the action of allantoinase in this pathway, is a stable metabolite and its elevated levels serve as a biomarker for oxidative stress [1,2]. This provides valuable insights into the degree of oxidative damage occurring within the body. Therefore, this study delves into a comprehensive analysis of allantoinase enzymes (DAL1 and PuuE genes), elucidating its structural intricacies and spatial characteristics critical for protein adsorption. In the realm of enzyme-based sensors, researchers traditionally emphasize the protein's function, instead of detailed information about the enzyme's specific biochemical properties, such as cofactor interactions and substrate binding. However, our study sheds light on the often-neglected computational insights relevant to structural and biochemical properties like enzyme stability and solvation parameters.

The study amalgamates dataset of 86 allantoinase protein sequences, focusing on parameters like isoelectric points (pI) and hydropathy index, providing insights into their solubility and stability much required for biosensing application[3]. The proteins exhibit a diverse range of pI values, emphasizing their potential to adapt varied physiological and environmental conditions, which aligns precisely with our research objective. More insights into parameters like, protein volume, aliphatic index, and stabilizing residues shed light on the enzyme's structural properties [4]. The analysis of stabilizing amino acid residues corroborates the role of surrounding hydrophobicity and long-range order in protein stabilization. Extinction coefficients, crucial for spectrometric analysis, were computed, enhancing the understanding of absorption properties at 280 nm, crucial during protein purification. Our objective is to employ bacterial allantoinase for protein adsorption and sensor development. The bioinformatics analysis have confirmed suitable characteristics and the expected stability and solubility from the bacterial datasets. Incorporating these multifaceted analyses, this study sets the stage for the potential development of biosensors utilizing allantoinase as a biomarker for oxidative stress.

Keywords: Protein-adsorption, Enzyme-sensors, Bioinformatics, Sequence-structure-function, allantoin.

References:

1. Kozlik, P.; Hasikova, L.; Stiburkova, B.; Zavada, J.; Kalikova, K. Rapid and Reliable HILIC-MS/MS Method for Monitoring Allantoin as a Biomarker of Oxidative Stress. *Anal Biochem* **2020**, *589*. https://doi.org/10.1016/j.ab.2019.113509.
2. Gruber, J.; Tang, S. Y.; Jenner, A. M.; Mudway, I.; Blomberg, A.; Behndig, A.; Kasiman, K.; Lee, C.-Y. J.; Seet, R. C. S.; Zhang, W.; Chen, C.; Kelly, F. J.; Halliwell, B. *Original Research Communication Allantoin in Human Plasma, Serum, and Nasal-Lining Fluids as a Biomarker of Oxidative Stress: Avoiding Artifacts and Establishing Real in Vivo Concentrations*.
3. Golovanov, A. P.; Hautbergue, G. M.; Wilson, S. A.; Lian, L. Y. A Simple Method for Improving Protein Solubility and Long-Term Stability. *J Am Chem Soc* **2004**, *126* (29), 8933–8939. https://doi.org/10.1021/ja049297h.
4. Nehete, J.; Bhambar, R.; Narkhede, M.; Gawali, S. Natural Proteins: Sources, Isolation, Characterization and Applications. *Pharmacognosy Reviews*. July 2013, pp 107–116. https://doi.org/10.4103/0973-7847.120508.

Aggregation-Induced Emission (AIE)-based luminogens in Cancer Theranostics

Hirakjyoti Roy[1] , Laxmi Raman Adil[2], Thirukumaran K.[3], Parameswar K. Iyer [1,2] and Siddhartha Sankar Ghosh[1,3]

[1] Centre for Nanotechnology, IIT Guwahati, India
[2] Department of Chemistry, IIT Guwahati, India
[3] Department of Biosciences and Bioengineering, IIT Guwahati

Email: hirak174106056@iitg.ac.in

Organic fluorescent materials are widely used in cell imaging, drug delivery, cancer therapy and optoelectronic devices. Traditional fluorescent materials show intense fluorescence (PL) in the soluble state, but their PL completely quenches or is weakened in the solid or aggregate state, this phenomenon is called aggregation-caused quenching (ACQ). ACQ has detrimental effects, such as they limit the practical application of organic fluorescent materials. Non-planar materials designed by Tang et al. exhibit intense solid state and aggregate emission are termed aggregation-induced emission (AIEgens) materials. AIEgens can be significantly utilized to novel biomedical, sensing and various new technologies. Research in aggregation-induced emission has grown to become a hot topic in material and biological science. Therefore, in our work, we have designed and synthesized new red-emitting AIEgen 3T for cancer theranostics application.

Physicochemical Characterization of Gallstones and Their Role in the Pathogenesis of Gallbladder Cancer in Assam, North-East India

C. Baruah[a], G. Gogoi[b], S. Mahanta[a], S. Khanna[c], A. Sarma[d], A. Kumar[e], P. Barah[a]*

[a]Tezpur University, Tezpur-28, Assam.
[b]Assam Medical College, Dibrugarh-02, Assam.
[c]Swagat Super Speciality Surgical Institute, Guwahati-11, Assam.
[d]Dr. B. Borooah Cancer Institute, Guwahati-16, Assam.
[e]Indian Institute of Technology Guwahati, Guwahati-39, Assam.

Email: barah@tezu.ernet.in

Background: Assam in North-east India exhibits the highest incidence of gallbladder cancer (GBC), with gallstone disease (GSD) identified as a primary predisposing risk factor. However, knowledge regarding the types of gallstones, their physicochemical properties, and their associated risks in GBC development within this region remains limited.
Methodology: A comparative analysis was conducted on gallstone samples collected from 20 GSD and 10 GBC patients. Techniques including Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction (XRD), Scanning Electron Microscopy-Energy Dispersive X-Ray (SEM-EDX), and Nuclear Magnetic Resonance (NMR) were employed.
Results: Morphological identification classified a total of 30 gallstones into four categories: Cholesterol (5), Mixed (19), Pigment (3), and Rare-Calcium Carbonate (3) types. Gallstones from GSD study groups predominantly comprised Cholesterol (4), Mixed (10), Pigment (3), and Calcium Carbonate (3) types, whereas GBC stones were mainly of mixed (9) and a single cholesterol type. This classification was corroborated by characteristic FTIR, PXRD, and NMR peaks. Elemental analysis revealed that the average constituents on the gallstone surfaces of GBC were C>O, while GSD stones exhibited elements in the order of C>O>Ca>S>P>Cu>Mg>Zn>Na.
Conclusion: The type of gallstone, along with its elemental constituents and physical properties, significantly influences the development of GBC in Assam, North-East India.

Keywords: Gallstone disease, gallbladder cancer, characterization, physicochemical properties, Assam.

Rhodamine based Colorimetric Point-of-Care Testing Device for Sensing Divalent Zinc

V. Srinivasan[a] and **D. Divya***[a]

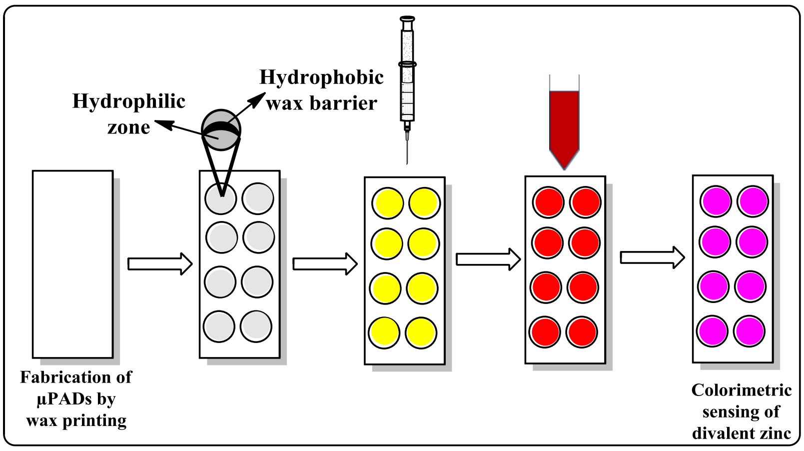
[a] Department of Chemistry, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Avadi, Chennai, 600062, Tamil Nadu, India.

*Email: divyadhakshinamurthy@gmail.com

A Schiff base containing 2,2'-((1,2-phenylenebis(methylene))bis(oxy))dibenzaldehyde and 2-amino-3',6'-bis(ethylamino)-2',7'-dimethylspiro[isoindoline-1,9'-xanthen]-3-one were refluxed in methanol to yield a new rhodamine derivative (Rh6GBMB). After confirmation of product using ^{1}H, ^{13}C NMR, FTIR and ESI MS, the sensing ability of it toward various cations were monitored. The Rh6GBMB showed an intense peak at 300 nm in the UV-Visible spectroscopy, when used various metal ions divalent zinc showed a new band at 530 nm with a prominent change in color from colorless to pink. Alongside, same test solutions were taken emission spectra several fold enhancements (yellow emission) are observed when divalent zinc is added with Rh6GBMB at 550 nm. The detection limit (LOD) and association constant (K_a) were found comparable with the similar probes already reported for the detection divalent zinc. ^{1}H NMR titration results suggested the formation of complex between Rh6GBMB and divalent zinc. Theoretical DFT studies also confirmed the complex formation. A user-friendly point-of-care testing (POCT) kit is demonstrated implying the suitability of Rh6GBMB toward Zn^{2+} ions. Rh6GBMB was also used to image onion epidermal cells with success. Furthermore, results for the biological, environmental, and industrial samples offered strong support for the estimation of divalent zinc in these actual samples utilizing Rh6GBMB.

Keywords: Divalent zinc, Colorimetric & Fluorescence, Sensor, DFT, POCT device.

Graphical Abstract



Fabrication of Blue Laser-Induced Graphene Electrodes and Evaluation of their Physiochemical and Electroanalytical Characteristics

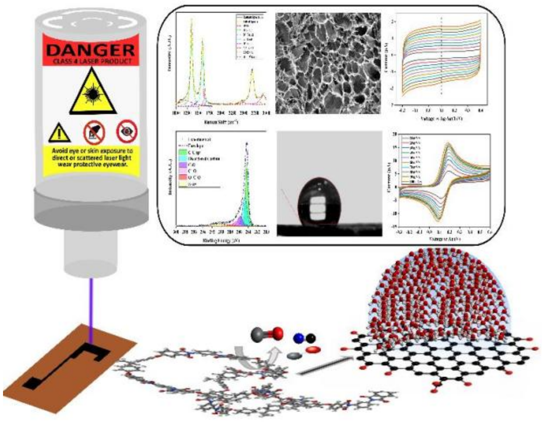
Raghavv Raghavender Suresh and Gorachand Dutta*

NanoBiosensors and Biodevices Lab, School of Medical Sciences and Technology, Indian Institute of Technology, Kharagpur, Kharagpur-721302, India.

*Email: g.dutta@smst.iitkgp.ac.in

Laser-induced synthesis of graphene (LIG) offers the advantages of being environmentally benign, scalable, and highly customizable. Furthermore, graphene obtained *via* this methodology possesses edge defects, oxygen functionalities and is advantageous for electroanalytical applications. The scientific literature on LIG is replete with works based on the CO_2 laser, which possesses large absorption energy and results in significant heating of the underlying substrate. On the other hand, blue laser (405 nm) anchors graphene production *via* both the photothermal and photochemical effects and minimizes the problem associated with overheating of substrates. Considering these advantages, we fabricated LIG at a particular laser setting and investigated its physiochemical and electrochemical properties. The Raman, XRD and XPS spectrum results revealed formation of graphitic structure with sufficient defects and functional groups. The 3D porous structures obtained *via* lasing was confirmed from SEM images, wherein the pores acted as air pockets conferring surface hydrophobicity, CassieBaxter state. Non-faradic and faradic electrochemical characterization (voltammetry and impedance studies) revealed large electrical double layer capacitance, electrolyte accessible surface area, rapid electrochemical kinetics, and constant phase element (CPE) traits that is in corroboration with the physiochemical features (defective, chemical functionalities and surface roughness) of formed graphitic structures. Future works shall involve utilizing the fabricated disposable electrodes for a variety of electroanalytical applications.

Keywords: Laser induced graphene, Electrical double layer capacitance, porous electrodes, Electrochemical sensor, Graphene.



Nose to Diagnose-tics: a Data-Driven Discovery

Depanjan Sarkar[1], Drupad K Trivedi[1], Eleanor Sinclair[1], Sze Hway Lim[2], Caitlin WaltonDoyle[1], Kaneez Jafri[1], Joy Milne[1], Monty Silverdale[2], and Perdita Barran[1]

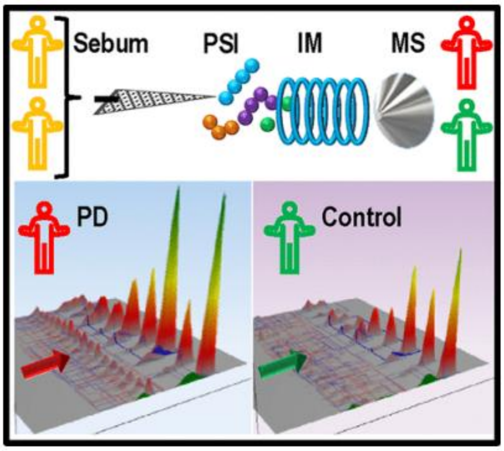
[1] Manchester Institute of Biotechnology, School of Chemistry, the University of Manchester, Princess Street, Manchester, UK, M1 7DN.

[2] Department of Neurology, Salford Royal Foundation Trust, Manchester Academic Health Science Centre, University of Manchester, UK.

Introduction: Neurodegenerative diseases are now the leading source of disability globally. According to the 2015 Global Burden of Disease, Injuries, and Risk Factors Study (GBD) analysis, the fastest growing neurological disorder, assessed by prevalence and disability, is Parkinson's disease (PD). The situation is particularly alarming as currently there is no cure for the disease, although medication can help control the symptoms, often for many years. Diagnosis for Parkinson's is often delayed due the lack of clinical biomarkers for the disease leading to diagnosis based upon the development of motor symptoms, which is often many years after non-motor symptoms have begun. Hence, identification of biomarkers and methods to detect these is a major goal.

Methods: We demonstrate the use of direct infusion of sebum from skin swabs using paper spray ionization coupled with ion mobility mass spectrometry (PS-IM-MS) to determine the regulation of molecular classes of lipids in sebum that are diagnostic of PD. A PS-IM-MS method for sebum samples that takes 3 min per swab was developed and optimized. The method was applied to skin swabs collected from 150 people and elucidated~4200 features from each subject, which were independently analysed. The data included high molecular weight lipids (>600Da) that differ significantly in the sebum of people with PD. Putative metabolite annotations of several lipid classes, predominantly triglycerides, and larger acyl glycerides, were obtained using accurate mass, tandem spectrometry, and collision cross-section measurements.

Keywords: Parkinson disease, biomarker classes, sebum, paper spray ionization, ion mobility, lipids.



Novel aspect: This work shows that human sebum can be used as a sampling biofluid for PSI-IM MS to diagnose Parkinson's disease.

Enzymatic biosynthesis of gold nanoparticle-α-amylase with different catalytic rates and sizes for rapid and sensitive classification of starch

<u>Prathu Raja Parmar</u>[1], Saurabh Dubey[2], Nafisa Arfa[1], Srijita De[2], Dipankar Bandyopadhyay*[1,2,3]

[1] Department of Chemical Engineering, Indian Institute of Technology Guwahati, Assam, India
[2] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Assam, India
[3] School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Assam, India

Email: dipban@iitg.ac.in

The enzymatic biosynthesis of gold nanoparticles (AuNPs) by directly using α-amylase as a reducing and linking agent. The α-amylase thiol group reduces the $AuCl_4{}^-$ ions and binds to the synthesized AuNPs. The biosynthesized AuNP-α-amylase has different catalytic rates and sizes. The enzymatic activity of AuNP-α-amylase and free α-amylase was determined rapidly and sensitively by Raman spectroscopy. Raman spectra of starch are dominated by three strong bands. Raman intensity decreases progressively with increased enzymatic activity at three different bands, pyranose ring skeletal modes (480 cm^{-1}), OH bend (1640 cm^{-1}), and C-H stretching mode (2910 cm^{-1}). The 6 mg mL^{-1} AuNP-α-amylase has the highest enzymatic activity than other biosynthesized AuNP-α-amylase and free α-amylase. The classification of starch after 5 minutes of hydrolysis by 6 mg mL^{-1} AuNP-α-amylase into rapidly digestible starch (RDS), slowly digestible starch (SDS), and resistant starch (RS) based on the amount of maltose produced. The amperometric measurement of maltose produced after hydrolysis using the screen-printed electrode (SPE). Maltose act as reducing sugar, which reduces $[Fe(CN)_6]^{3-}$ to $[Fe(CN)_6]^{4-}$. This conversion generates the current signal proportional to the amounts of maltose produced after starch hydrolysis. This method is a simple, fastest, reliable, portable, inexpensive, and powerful tool for the rapid classification of starch. The reported sensor can potentially be used in point-of-care testing to detect glycemic indices.

Keywords: Alpha-amylase; Gold nanoparticle; Starch; Maltose; Biosynthesis.

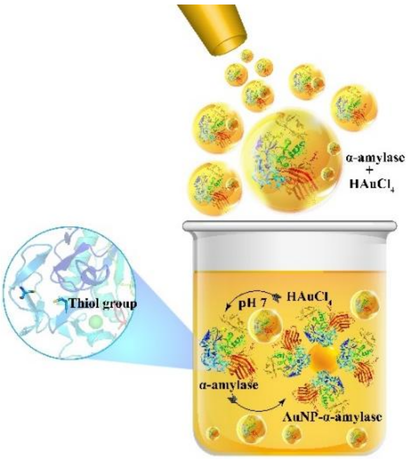


Figure 1. Schematic illustration of the biosynthesis of gold nanoparticle-α-amylase.

Shades of risk: delving into the mechanistic insight of azodyes toxicity and its nano-catalytic degradation using SnO_2-based heterostructure

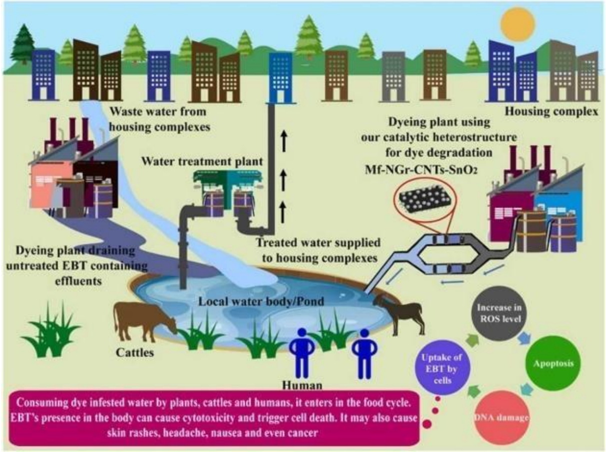
Indranil De[1], Mansi Pahuja[2], Dr. Kaushik Ghosh[2] and Dr. Manish Singh*[1]

[1] Chemical Biology Unit, Institute of Nano Science and Technology, Knowledge City-Sector 81, Mohali-140306, India
[2] Quantum Materials & Devices Unit, Institute of Nano Science and Technology, Knowledge City-Sector 81, Mohali-140306, India

Email: manish@inst.ac.in

Eriochrome Black T (EBT), a popular azodye is widely used in carpet and textile industries to render black/blue color to fabrics. EBT also finds its application in cosmetics, leather, and paper printing industries. Despite of the wide application of EBT, the toxicity of this dye is not reported yet. The present study aimed to assess the toxicity of EBT on C6 glial cells and also explored the mechanism behind the toxicity. Further the photocatalytic degradation of EBT was achieved using an innovative Mf-NGr-CNTs-SnO_2 heterostructure. To assess EBT's in vitro toxicity MTT assay, cellular morphological analysis and estimation of intracellular Reactive oxygen species (ROS) was performed. Also, in order to understand the mechanism behind the toxicity, Caspase 3/7 activity, FACS and confocal imaging was carried out. EBT exhibited a toxicity of upto 65% at the highest dose (800 μg/ml). Also, a permeability of 6.48 % across organ barriers was observed. A dose-dependent increase in ROS, Caspase 3/7 activity was noted for EBT and the same was confirmed through Confocal imaging and FACS analysis. EBT induced its' toxicity through ROS dependent activation of apoptosis. To address the harmful effect of EBT, an innovative approach was proposed using Mf-NGrCNTs-SnO_2 heterostructure for nano-photocatalytic degradation of the dye. The catalyst showed excellent dye degradation potential of upto 82% upon 2h of solar light irradiation. The rate of degradation is faster in case of catalyst as compared to bare SnO_2 and follows pseudofirst-order kinetics with a rate constant equivalent to 0.77249 min^{-1}. Interestingly, the degraded dye products showed a reduction in toxicity of upto 30%. This research promotes the development of sustainable and efficient techniques for the treatment of textile dye pollutants, thus advancing the goal of a cleaner and safer river health.

Keywords: Water pollution, Azo dyes, Eriochrome Black T (EBT), Photocatalyst, Tin (IV) oxide (SnO_2), Apoptosis.



Structural Characterization and Optimization of Enzymatic Hydrolysis of *Brassica oleracea* var. *botrytis* waste derived Cellulose through Different Statistical Tools

Upasana Medhi[1], Julie Bauah[2] and Eeshan Kalita*[1]

[1] Department of Molecular Biology and Biotechnology, Cotton University, Panbazar, Guwahati, Assam, India, 781001
[2] Department of Molecular Biology and Biotechnology, Tezpur University, Tezpur, India, 784028

*Email: eeshankalita@gmail.com

The world is leaning towards renewable energy sources, recycling vegetable waste and biomaterials for a greener nature, and extensive works have been done in recent years where lignocellulosic biomass is attracting researchers all around. Cellulose, being the most preeminent part of biomass has excellent biocompatibility, strong construction, is economical and environmental neutral. To generate biomass-derived fuels and chemicals at large scale, lignocellulosic biomass or their cellulose must be depolymerized into sugars in an environmentally friendly way. Several methods have been established by researchers to extract and isolate cellulose for this purpose that include chemical, biological, physical, and physicochemical methods. This work focusses on the extraction of cellulose from *Brassica oleracea* var. *botrytis* (Cauliflower) and its efficient conversion to glucose. Cellulose to glucose conversion was simulated using Response Surface Methodology (RSM) and the effects of enzyme concentration, substrate concentration, surfactant concentration and incubation time were studied. The maximum yield was found to be 90%. This was further optimized using artificial neural networks (ANN), and adaptive neuro-fuzzy inference system (ANFIS) modelling were to generate yields of 89.84% and 90% respectively. Subsequently, the in-depth analysis suggested that the isolated cellulose is a reinforcing ingredient in green composites and may be a forerunner for future waste-produced nanocellulose.

Keywords: Cauliflower; Cellulose; Enzymatic Hydrolysis; ANN; ANFIS.

Photocatalytic Degradation of Antibiotic Mixture using TiO_2-ZnO Nanocomposite

Arhama Tufail Ahd Ansari [1], **Soumyo Mukherji** [2], **Suparna Mukherji*** [1]

[1] Environmental Science and Engineering Department, Indian Institute of Technology, Bombay, Mumbai, India
[2] Department of Biosciences and Bioengineering, Indian Institute of Technology Bombay, Mumbai, India

Email: mitras@iitb.ac.in

In recent times, a large quantity of antibiotics is being administered to humans and animals for treating diseases and infections. This has increased the production of antibiotics and the generation of antibiotic-containing effluents. Many antibiotic contaminations are only partially removed in conventional wastewater treatment. Hence, novel approaches are continuously studied to supplement traditional wastewater treatment methods to achieve higher water quality, meet guidelines, and minimize the cost of treatment processes. TiO_2 is universally considered one of the most efficient photocatalysts for the abatement of several pollutants, including pharmaceuticals. The major disadvantage of TiO_2 is that it requires UV irradiation for photocatalysis. The addition of ZnO can cause narrowing of the bandgap and lead to a decrease in recombination, thereby increasing the lifetime of the reactive species. Studies have suggested that the photocatalytic degradation can be used to remove individual antibiotics. However, the ultimate aim for feasible photocatalytic processes would be to remove the mixture of antibiotics. Hence, in the present study, photocatalytic degradation of six selected antibiotics (azithromycin, erythromycin, linezolid, sulfamethazine, oxacillin, and enrofloxacin) in a senary mixture was tested using TiO_2-ZnO nanocomposite. TiO_2-ZnO nanocomposites with Ti: Zn molar ratio of 1:0.3 was prepared by sol-gel process followed by calcination at 600 ^{0}C. The removal of the antibiotic mixture by photocatalysis under UV and visible irradiation was studied with a 10 mg/L catalyst dose, the reaction volume was 500 mL, and the initial concentration of each antibiotic was 10 mg/L (total initial concentration of 60 mg/L). TiO_2-ZnO showed around 30 to 70 % transformation of the each selected antibiotics within 90-120 min under both UV and visible irradiation. The low concentration of nanocomposite (10 mg/L) possibly limited the degradation of the antibiotic mixture. It was observed that the highest extent of transformation occurred in case of enrofloxacin, followed by azithromycin, linezolid, erythromycin, oxacillin, and sulfamethazine. Mineralization behavior of antibiotics was also examined by following total organic carbon changes during photocatalysis. It was observed that although the antibiotics went through transformation at the end of 240 min, the % removal of TOC was lower than the transformation of antibiotics. TOC removal due to adsorption was around 16%, while it was around 35% due to photocatalysis.

Keywords: Antibiotics; Photocatalysis; TiO_2ZnO.

A packed bed Nickel/carbon nanofiber anchored activated carbon beads based efficient electrode for microbial fuel cell: Simultaneously generating electricity and wastewater treatment

Yashmeen Budania [a], Shraddha Mishra* [b] and Shiv Singh* [a]

[a] CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal
[b] Indian Institute of Technology, Kanpur

Email: shraddha2001@gmail.com; sshiv.singh@ampri.res.in; sshiviitk@gmail.com

Microbial fuel cells (MFCs) are economical, clean and renewable devices that generate energy and treat wastewater by degrading organic matter of wastewater at the anode and transferring generated electrons to the cathode to perform efficient oxygen reduction reactions. Development and modifications over the years have shown considerable efficiency in current density and power density. In this trend, carbon based electrodes have emerged as dependable electrode for MFCs, which are significantly inexpensive, easy to manage, hierarchically porous, electrically conductive and contains mass transfer channels. Current research proposes nickel dispersed carbon nanofiber based activated carbon beads (Ni/CNFACBs) as an efficient electrode material. Ni has been proven to be a great catalyst for oxygen reduction reaction at cathode and facilitates the electron transfer from microbes to anode. The CNFs provide biocompatibility/adhesiveness to the growth of biofilms and increase the electrical conductivity of the electrodes given to their graphitic nature. The biofilm analysis shows the uniform spatial distribution of bacteria and significant viability. Along that, packed bed Ni/CNF being at most mesoporous supports the adsorption at anode and congruently yields an excellent open circuit voltage of 0.7 V, current density of 7000 ± 100 mAm^{-3} and power density of 1000 ± 100 mWm^{-3} using mixed culture after only 3 days of MFC operation. The reported electrode material also harnesses the bridge between efficiency and environmental friendliness as Ni/CNF-ACBs based electrode is a fruitful alternative to the noble metal based electrode in MFC.

Keywords: Microbial fuel cell, Oxygen reduction reaction, Wastewater treatment, Electricity generation, Nickel/carbon nanofiber.

Antimicrobial resistance (AMR) to Penicillin G in India and photocatalytic degradation of Penicillin G using TiO_2 – Graphene oxide based nanocomposite

Ayush Ransingh and Suparna Mukherji*

Environmental Science and Engineering Department, Indian Institute of Technology Bombay, Powai, Mumbai (M.H.)

Email: mitras@iitb.ac.in

With Penicillin being the first ever discovered antibiotic in 1928, there has been a tremendous increase in antibiotic prescription and consumption for humans as well as animals. Penicillin G (PEN G) is one of the most consumed antibiotics for the treatment of bacterial infections. The poor absorption of PEN G in human body and inefficient wastewater treatment plants (WWTP) has resulted in appearance of residual PEN G in different matrices. Residual antibiotics have led to the development of antimicrobial resistance (AMR), AMR which is suspected as forth coming pandemic. Photocatalysis can prove to be a potential technique to overcome the concern of AMR pandemic.

In this work, a literature survey was conducted on antibiotic consumption in India, with special emphasis on PEN G consumption and development of antimicrobial resistance (AMR) due to PEN G. Further, Graphene oxide – Titanium di oxide (GOT) based nanocomposite was synthesized following modified Hummer's method. Characterization techniques such as XRD, FEG-SEM, FEG-TEM, TGA-DTA, FTIR showed successful synthesis of GOT nanoparticles. Solid phase extraction (SPE) was used as a sample preparation technique. LC-MS/MS was used for the detection of PEN G with LOD as 1.21 ppb, LOQ as 3.68 ppb and R^2 as 0.9986. Using synthesized GOT nanoparticles (150 mg/L), photocatalytic degradation of PEN G (10 mg/L) was carried out under UV and Visible light irradiation. The degradation of PEN G in photocatalysis studies was approximately 80%, while in photolysis studies it was approximately 12% during 180 minutes of irradiation. Probable photocatalytic degradation pathway was suggested for PEN G. Therefore, the synthesized GOT nanoparticles demonstrates commendable potential for the photocatalytic degradation of antibiotics.

Keywords: Heterogeneous Photocatalysis, Antimicrobial Resistance, Advanced Oxidation Process, Graphene oxide-TiO_2, QGIS.

The implications of spatial variation of soil erosion and sediment dynamics for the sustainable river management: A case study of the Siang Basin

Uma Narayan M*, Rishikesh Bharti and Archana M Nair

Earth System Science and Engineering, Department of Civil Engineering, Indian Institute of Technology Guwahati, Assam, India.

Email: uma18@iitg.ac.in

The distribution of the hillslope erosion process is a vital aspect to consider while studying the Himalayan Rivers. Siang River, a major tributary of the Brahmaputra River, flows downstream from the Tibetan plateau through the Namche Barwa massif, draining a considerable amount of sediments into the low-lying plains. Active tectonic features like Main Central Thrust, Lohit Thrust, the ongoing upliftment of Namche Barwa massif, and high rainfall contribute to this massive influx in sediments. Topographic relief and fault activity of an area can accelerate surface erosion. The fractures can diminish the rock strength and disintegrate the bedrock into finer particles. Besides, the steep slopes can facilitate the transport of these sediments into the river channel, resulting in rapid mass wasting, such as landslides. Thus, topography, surface erosion and transport capacity control the sediment dynamics in a watershed. Hence, understanding the spatial variation of erosion rates along the hillslope and around the fault zones is inevitable to tackle soil erosion problems. In the present study, the variation of the suspended sediment rate throughout the basin is investigated using stream power incision law. The trend followed by the sediment flux along the major tectonic features is evaluated. An attempt is made to correlate the morphological controls on erosion rate by active tectonics. This study can be a valuable input for the current advancement in nano-treated remedies for soil conservation and watershed management.

Keywords: Sediment dynamics; Erosion rate; Spatial Variability; Siang Basin.

Coalescing solar-to-chemical and carbon circular economy: Mediated by metal-free porphyrin and triazine-based porous organic polymer under natural sunlight

N. Saini, N. Sharma, D. K. Chauhan, R. Khurana and K. Kailasam*

Institute of Nano Science and Technology (INST), Mohali

Email: kamal@inst.ac.in

Harnessing renewable solar energy to valorize CO_2 has emerged as a promising and enduring solution to address energy and environmental challenges. However, achieving high efficiency and selectivity in the photocatalytic reduction of CO_2, without relying on metals, photosensitizers, or sacrificial agents, presents a formidable hurdle. In the continuing pursuit of a sustainable synthesis, in this study, we present the development of a novel metal-free photocatalyst, composed of porphyrin and a triazine-based porous organic polymeric network (TPT-prop) for the photocatalytic reduction of CO_2 coupled with oxidative benzylamine homocoupling under natural sunlight for the first time. Astonishingly, we achieved an exceptional CO production rate, reaching 1786 $mmolg^{-1}h^{-1}$, with an outstanding selectivity of >90% and selective oxidation of benzylamine, yielding N-benzylbenzaldimine with a conversion of 65% and selectivity exceeding 98% in 6 h of irradiation under natural sunlight. A remarkably high AQY of 9.34% (at $\lambda = 430$ nm) for CO production was attained in comparison to several other reported COFs. A series of controlled experiments, EPR studies, $^{13}CO_2$ labelling experiments, and DFT studies were employed to unravel the underlying mechanism of this dual photoredox process. In summary, our pioneering study opens up unprecedented avenues for the investigation of metal-free photocatalysts capable for dual photoredox processes and these findings offer tremendous potential for advancing the field of sustainable photocatalysis.

Keywords: Photocatalysis, solar fuels, CO_2 reduction, benzylamine homocoupling.

Unraveling the Environmental Impacts of Viscous Fingering and Dewetting Instabilities in Polymer Films on Porous Membranes

Saurabh Dubey[1], **Srijita De**[1], **Prathu Raja Parmar**[2] **and Dipankar Bandyopadhyay***[1, 2, 3]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Assam, India
[2] Department of Chemical Engineering, Indian Institute of Technology Guwahati, Assam, India
[3] Jyoti and Bhupat Mehta School of Health Sciences and Technology, Indian Institute of Technology Guwahati, Assam, India

*Email: dipban@iitg.ac.in

This article investigates the intricate phenomenon of viscous fingering within porous mediums, where a less viscous fluid displaces a more viscous one, resulting in the creation of intricate and irregular patterns. The focus is on processed polymer materials, shaped into films on porous membranes and widely applied in various industries. However, exposure of these polymer films to hot water induces viscous fingering instability and other dewetting instabilities, ultimately leading to the release of micro and nano plastic particles into the environment. The dewetting of stable films on physiochemically heterogeneous porous media triggers a cascade of events, culminating in the degradation of the once-stable film. Submicron patterns give rise to microplastics, while sub-nano patterns lead to nano plastics during the dewetting sequence. The release of these particles poses potential threats to ecosystems, as they may be ingested by aquatic organisms, entering the complex web of the food chain. The small size of these particles facilitates their permeation through diverse environmental matrices. Recognizing and mitigating these environmental impacts emerge as crucial facets of responsible material design and production. Researchers and industries are increasingly exploring sustainable alternatives and refining manufacturing processes to minimize the inadvertent release of microplastics into the environment. This study underscores the urgency and significance of comprehending these intricate interactions, fostering informed decision-making, and promoting environmentally conscious practices within the realms of material science and engineering.

Keywords: Viscous fingering, porous mediums, polymer films, dewetting instabilities, microplastics, nano plastics, environmental impact.

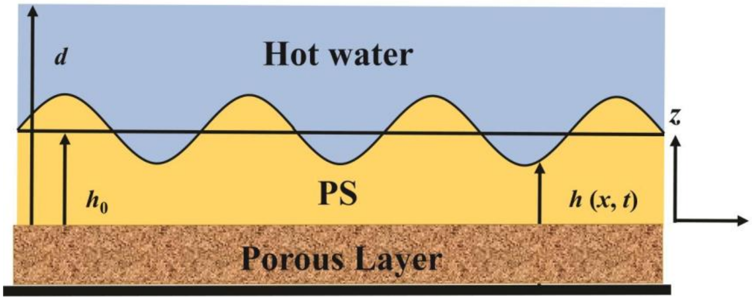


Figure 1: A schematic diagram of the experimental setup of the PS film resting on porous cellulose surface exposed to hot water.

Production of Biodiesel from Esterification of Fatty acid by a Surface Modified NiFe2O4 Nanoparticles

Manisha Pandey and **Kalluri V.S. Ranganath***

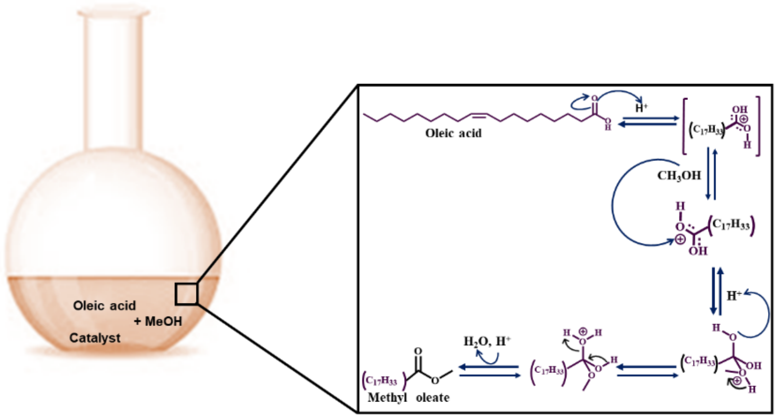
Department of Chemistry, Institute of Science, Banaras Hindu University, Varanasi, U.P. India, 221005

Email: ranganath.chem@bhu.ac.in

The current global environmental scenario is like not only concern with pollution but also moving towards the exhaustion of the fossil. Now in concern with this issue we most focus our research to sustainable development. The sustainable development refers to effective way of meeting of energy demands while using the natural asset as it can full fill the energy demand of next generation as well. In this context, there is requirement of great energy demand but such amount of supply of energy from the non-renewable resources is not possible, so to concern about this we must shifted our energy requirement need from this fossil fuel to some alternative sources and among the various alternative sources one of the alternative source is fatty acid and their esters.

In this paper we have reported the synthesis of Magnetic metal ferrites nanoparticles by coprecipitation method, and its surface modification with 4,4'biphenyldisulphuric acid (BPDSA), characterization have been performed are Powder XRD, FTIR, VSM, TGA, XPS, DLS and elemental analysis for studying the acidic site of the catalyst after surface modification. We have performed for esterification of fatty acid as Oleic acid The active catalyst was highly thermally stable, robust and recyclable in the esterification of oleic acid with methanol. The conversion of oleic acid was greater than 99% in a short period of time (3h,70 °C). The catalytic activity of different fatty acids such as linoleic acid, erucic and elaidic acids and methanol was also investigated. Based on the kinetic study, activation energy was calculated and found to be 60 kJ/mol. Besides, reusability of prepared catalyst was also studied. Further potentiality of our catalyst was also tested in the trans esterification of olive oil.

Keywords: Biodiesel, Esterification, BPDSA, Fatty acid, Activation energy.



Scheme: Mechanism of Esterification of oleic acid

Binder-free $CaMoO_4$ anchored polyaniline as an efficient and durable electrocatalyst for alkaline water oxidation reaction

Nitika Garg[a] and Ashok K Ganguli*[a,b]

[a] Department of Chemistry, Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016
[b] Department of Chemical Sciences, Indian Institute of Science Education and Research Berhampur, Ganjam, Odisha-760010

Email: ashokganguliiitd@gmail.com

Developing efficient and durable electrocatalysts for OER is pivotal to expediting the multistep four-electron transfer process and overcoming its sluggish kinetics.[1] Recently, efforts have been made to explore electrochemical property enhancement due to inorganic material/conductive polymer composite.[2] Polyaniline (PANI) can transport charge through the polymeric backbone, as carriers can hop between polymer chains.[3] Molybdenum containing mixed oxides, *i.e.,* $MMoO_4$, has been extensively used as the catalyst for water oxidation.[4] However, using $CaMoO_4$ as an electrocatalyst for water splitting has not been extensively studied.[5] During electrode preparation for electrochemical measurements, a polymer binder such as Nafion is used, which can impede diffusion as well as block the catalysts' active sites. The growth of a catalyst directly on a current collector, such as nickel foam (NF), can have certain intrinsic advantages, for example, durability, larger surface area, and high electroconductivity. In this work, we report the *in situ* growth of $CaMoO_4$ over electropolymerized PANI on nickel foam (PANI/NF). $CaMoO_4$/PANI/NF has an overpotential of 187 mV and tafel slope of 54 $mVdec^{-1}$ at a current density of 10 mA cm^{-2}, which is far better compared to that of pure $CaMoO_4$ and PANI as well as some noble metal-based catalysts. The higher catalytic efficiency of $CaMoO_4$/PANI/NF originates from low charge transfer resistance in the electrode-electrolyte interface, as indicated by the Nyquist plot. Further, a multistep chronopotentiometry curve was recorded for $CaMoO_4$/PANI/NF to confirm the excellent mass transportation, conductivity, and mechanical robustness of the catalyst electrode.

Keywords: Electrochemical Water Splitting, Oxygen Evolution Reaction, Inorganic material/conductive polymer composite.

References:

1. *ACS Catal.* 2018, 8, 10, 9765–9774.
2. *Inorg. Chem.* 2022, 61, 18, 7051–7059.
3. *Applied Surface Science*, 2020, 529, 147173.
4. *Chem. Commun.*, 2015, 51, 14361-14364.
5. *Chem. Commun.*, 2018, 54, 5066.

A Polyoxometalate-derived Noble Metal-free Electrocatalyst for Acidic Water Oxidation

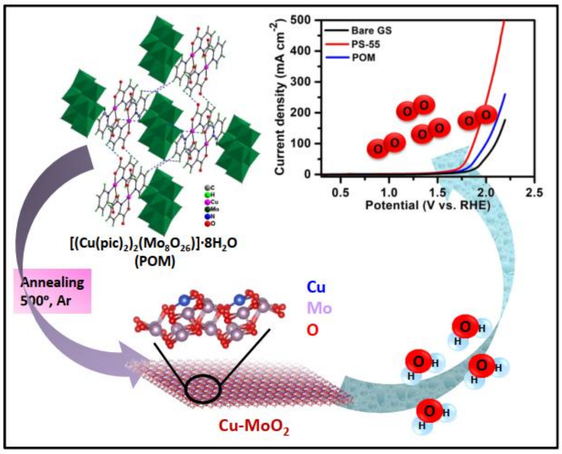
Parul Sood, Krishankant, Harshita Bagdwal, Arti Joshi, Krishna Kumar Yadav, Chandan Bera and Monika Singh*

Institute of Nano Science and Technology, Sector-81, Mohali, Punjab-140306

Email: monika@inst.ac.in

In the era of renewable energy, electrocatalytic water splitting has always shown considerable potential. Consequently, it is essential to develop electrocatalysts that are earth-abundant, affordable and durable for oxygen evolution. In this regard, polyoxometalates have been in the spotlight since the past few years because of their attractive properties. Herein, we report a ‘polyoxometalate-derived’ noble metal-free electrocatalyst for efficient oxygen evolution in ‘acidic’ medium for the very first time. An Octamolybdate POM, $[(Cu(pic)_2)_2(Mo_8O_{26})]\cdot 8H_2O$ was used as the precursor to obtain the electrocatalyst Cu-MoO_2 (PS-55) which gave the overpotential of 374 mV to reach the current density of 10 $mAcm^{-2}$ and tafel slope of 193 $mVdec^{-1}$, with the stability of 18 hours. To examine the electrochemically active site, density functional theory (DFT) was performed, which unveiled Mo as the most prominent active site in Cu-MoO_2. The projected density of states (PDOS) shows that the marriage between d orbitals of Cu-Mo and p orbitals of O, resulted in p-d mixing, which is responsible for proficient OER activity. This work opens up a wide avenue of research over the exploration of POM-derived electrocatalysts for acidic water oxidation.

Keywords: POM-derived, acidic water oxidation, Overpotential, Tafel slope, Density functional theory.



Enhancing light utilization efficiency of semi-transparent perovskite solar cells via tailored interfacial engineering

Bhavna Sharma and Soumitra Satapathi*

Indian Institute of Technology, Roorkee

Email: soumitra.satapathi@ph.iitr.ac.in

Semi-transparent perovskite solar cells (ST-PSCs) are increasingly recognized as appealing options for building-integrated photovoltaic (BIPV). Additionally, they exhibit significant potential for scaling up toward commercial viability, especially when used in tandem solar cell configurations. However, the interface between the perovskite layer and the carrier transport layers plays a pivotal role in causing substantial decreases in the power conversion efficiency (PCE) and contributing to the instability of semi-transparent perovskite solar cells (ST-PSCs). In this study, we present an innovative method for mitigating trap states by employing three distinct hydrochlorides of organic amine cations: specifically, 2-chloroethylamine-hydrochloride (CEAC), 3-chloropropylamine-hydrochloride (CPAC), and 4-chlorobutylamine-hydrochloride (CBAC). We utilize these compounds to modify the interface between the perovskite layer and the electron transport layer. These interface modifications exert a substantial impact on the dynamics of charge transfer, ultimately resulting in improved device performance and stability. This is achieved by reducing non-radiative recombination and enhancing the quality of the interfacial contact. Devices subjected to post-treatment with a CPAC layer exhibit the highest power conversion efficiency (PCE) at 14.11%, along with an open-circuit voltage (V_{oc}) of 1.23 V. Moreover, when subjected to storage for 1500 hours under a relative humidity of approximately 35%, the unencapsulated devices maintain approximately 89% of their initial PCE.

Keywords: semitransparent perovskite solar cells, building-integrated photovoltaic, tandem solar cell, trap states, interface engineering.

Optofluidic Microreactors with Pt-Modified CdS Nanowires for Efficient Photocatalytic Hydrogen Production: A Scalable and Cost-Effective Fabrication Approach

Ameer Suhail M[1], D Pamu[1,2] and Nageswara Rao Peela*[1,3]

[1] Centre for Nanotechnology, IIT Guwahati, Guwahati, 781039, India
[2] Department of Physics, IIT Guwahati, Guwahati, 781039, India
[3] Department of Chemical Engineering, IIT Guwahati, Guwahati, 781039, India

Email: peelanr@iitg.ac.in

The renewable energy landscape is seeing an increasing interest in photocatalytic hydrogen production, prompting the need for efficient and scalable systems. Central to our work is the development, characterization, and operation of a novel optofluidic microreactor system specifically tailored for photocatalytic hydrogen evolution. Employing a novel scalable fabrication method, microreactor plates were prepared from commercial glass sheets, featuring microchambers with complex geometric microstructures for enhanced light absorption and mass transfer.

The scalable fabrication method was carefully assessed using a range of analytical tools, including scanning electron microscopy (SEM) and profilometry, to evaluate surface roughness, microchamber dimensions, and the overall microchannel integrity. The microchamber bed was then subjected to a surface modification technique to ensure efficient immobilization of the catalytic material.

For carrying out the sacrificial photocatalytic hydrogen evolution experiments, CdS nanowires were synthesized using a solvothermal approach and were further modified by photodeposition of Pt. The Pt-CdS nanocomposite exhibited optimized optoelectronic properties, validated through characterization methods like UV-Vis absorption spectroscopy and X-ray diffraction (XRD).

Upon immobilization of Pt-CdS onto the reactor plates by a binder assisted spray coating, photocatalytic reaction experiments were conducted to optimize operational parameters, including reactant flow rates and catalyst layer thickness/loading. Performance evaluations employing gas chromatography confirmed notable efficiencies in hydrogen production.

Addressing the ever-pertinent issue of scalability, further discussions outline the extension of our fabrication methodology to large-area reactors, detailing considerations in material requirements, energy efficiency, and fabrication limitations.

This multi-faceted research describes not only the creation and fine-tuning of a novel optofluidic microreactor system but also its promising adaptability to large-scale applications. The work thus marks a significant advancement in the quest for scalable, efficient, and cost-effective hydrogen production technologies.

Keywords: Photocatalytic Hydrogen Evolution, Optofluidic Microreactors, Scalable Fabrication, Pt-Modified CdS Nanowires, Particle immobilization.

Metal nanoparticles decorated biochar supported anodes for high performance MFC

Anjana Ratheesh[1] **and S. M. A Shibli***[2,3]

[1] Department of Biotechnology, University of Kerala, Thiruvananthapuram
[2] Department of Chemistry, University of Kerala, Thiruvananthapuram
[3] Center for Renewable Energy and Materials, University of Kerala, Thiruvananthapuram

Email: smashibli@yahoo.com

Microbial Fuel Cell technology is a sustainable approach for generating electricity from chemical energy using microorganisms. Electrode-bacterial interaction is pivotal in the overall performance of an MFC. Special attention is given to modify the surface characteristics of anode as it is where bacteria adhere and function. In the present work, highly porous biochar was synthesized and tuned to provide more active microsites for efficient microbial actions. Metal nanoparticles have been known for enhancing electrical conductivity, surface area, electron transfer, adsorption capacity and catalytic activity. Furthermore, the stability and longevity of a suitable biochar can be improved while incorporating the nanoparticles. Transition based metal oxide nano particles are applied in the present work and their synergistic performance as MFC anode was evaluated in detail. The biochar nanoparticle composite exhibited improved microbial adhesion and electron transfer capabilities which is essential for a high performance MFC. Physical, physiochemical, and electrochemical factors have significant roles in bio-electrochemical systems. The electrochemical performance was appropriately correlated with their physiochemical features based on advanced sophisticated characterizations.

A typical DC-MFC used in this study constitutes the present anode, SS cathode, Proton Exchange Membrane and exoelectrogens, operated under controlled environment with electroconductive electrolytes aiding to bacterial growth. The details of the outperformed transition metal oxide-based anode and their sustained performance with a power density of 312Wm^{-2} and reactivation capability as high as 90 % is presented here.

Keywords: Microbial Fuel Cell, Anode, Biochar, Metal-nanoparticle, Exoelectrogens.

Synthesis and Electrochemical Study of Sponge-Like Nanosheet Cluster of β-Bismuth Oxide and Fabrication of Hybrid Supercapacitor with Activated Carbon

A. Buragohain and D. Mahanta

Gauhati University, Guwahati-781014, Assam, India

Email: debam@gauhati.ac.in

Supercapacitors have recently gained tremendous attention in the field of energy storage because of their eye-catching advantages such as long-term cyclic stability, high power, safety, etc. In our work, we have constructed a hybrid supercapacitor (HSC) by using a negative electrode made up of a sponge-like microsphere of Bi_2O_3 with a bio-derived hierarchically porous activated carbon as a positive electrode using an aqueous 0.5 M Na_2SO_4 electrolyte. A detailed study of the designed HSC was performed by applying cyclic voltammetry, chronopotentiometry, and electrochemical impedance spectroscopy techniques. The areal capacitance of the fabricated device was found to be 131.5 mF cm^{-2}, energy density 73.1 μW h cm^{-2}, power density 999.9 μW h cm^{-2} at 1 mA cm^{-2} current density. The cyclic stability of 97.8% after 10000 charge-discharge cycles suggests the good stability of the device. Moreover, 72.9% diffusion contribution at 5 mV s^{-1} to the total current of the device established its hybrid nature. In the end, the real application was also confirmed by lighting up an LED.

Keywords: Hybrid Supercapacitor, Bi_2O_3, electrochemical performance.

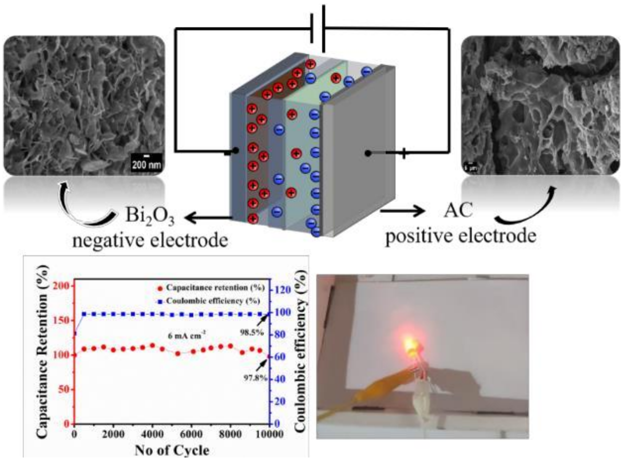


Figure: Graphical abstract

Hybrid Two-dimensional Porous Materials

Kolleboyina Jayaramulu*

Hybrid Porous Materials Lab, Department of Chemistry, Indian Institute of Technology Jammu, Jammu & Kashmir, 181221, India

Email: jayaramulu.kolleboyina@iitjammu.ac.in

Metal-Organic frameworks are crystalline materials that comprise metallic clusters and organic ligands with great potential for a diverse range of applications, including but not limited to gas separation and storage, electrocatalysis, water purification, batteries, and supercapacitors. However, their poor conductivity, inaccessible pores, and limited stability hinder their maximum utilization. To overcome these challenges, one solution to this problem is to integrate MOFs with two-dimensional (2D) layer materials to create emerging multifunctional hybrid two-dimensional porous materials. In my presentation, I will discuss our work in integrating 2D materials to create hybrid materials with improved electro and physicochemical properties, broadening their potential applications.

Keywords: Coordination Polymers, Energy, Environment, Hybrids, Two-dimensional Materials.

Design and simulation of semi-transparent Si-based solar cells using TCAD-Sentaurus for building integrated photovoltaic applications

Ashish Kumar Patel and **Pratima Agarwal***

Department of Physics, IIT Guwahati, Assam, 781039, India

Email: pratima@iitg.ac.in

There is emerging interest in developing flexible semi-transparent solar cells (SCs) that can serve as Building Integrated Photovoltaics (BIPV). This requires an optimum transmittance to be obtained without compromising efficiency. With this motivation, we have designed and simulated a *p-i-n* junction SC with ITO/a-Si:H(*p*)/a-Si:H(*i*)/a-Si:H(*n*)/ITO/Glass substrate using TCAD-Sentaurus simulator. The thickness of ITO, *p, i* and *n*-layers were fixed at 100 nm, 10 nm, 100 nm and 10 nm respectively. Keeping acceptor doping of the *p*-layer fixed N_a = 1019 cm^{-3}, the donor doping of the *n*-layer (N_d = 1016 to 1019 cm^{-3}) was varied and its effect on SC was thoroughly studied. The best performance was observed for N_d = 1019 cm^{-3} with fill factor (*FF*) = 84%, power conversion efficiency (*PCE*) = 7.95%, and average visible transmittance (*AVT*) of 46.42% in the wavelength range of 500-800 nm as shown in the figure. An increase in *PCE* is attributed efficient separation of photogenerated carriers due to the strengthening of the built-in electric field. Keeping N_d =1019 cm^{-3} fixed, the thickness of the *i*layer was varied (100 nm to 30 nm) to optimize *AVT* while keeping a reasonable *PCE*. Though in the process the *PCE* decreased as shown in the figure, still we managed to maintain V_{oc} > 1V and it is attributed to the decrease in the recombination probability of photogenerated carriers. The best result was observed in the thickness range of 40-70 nm, which showed *AVT* >50%, in the same wavelength range while keeping *PCE* ~5%. Overall, we conclude that a 40-70 nm thick *i*-absorber layer with the proposed design will be a feasible mode for semitransparent SCs for BIPV applications providing *AVT > 50%* in the 500-800 nm wavelength range.

Keywords: Semi-transparent solar cells, BIPVs, Amorphous Si solar cells.

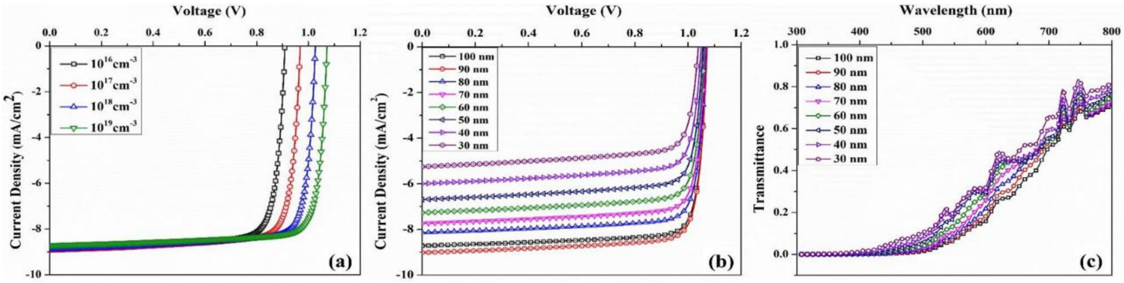


Figure: (a) J-V characteristics of the SCs with *p*-layer doping N_a=1019 cm^{-3} and varying *n*-layer doping N_d, **(b)** J-V characteristics and **(c)** transmittance of the SCs with *p*-layer doping N_a = 1019 cm^{-3} and *n*- layer doping N_d = 1019 cm^{-3} and varying *i*- layer thickness.

Experimental and theoretical investigations of *Brassica Napus* flower extract as a sensitizer dye for TiO_2 based DSSC

Abhilasha Tiwari and Pankaj Srivastava*

Department of Chemistry, Institute of Science, Banaras Hindu University, Varanasi-221005

Email: pankaj@bhu.ac.in

Sensitizers play a crucial role of solar light harvesting in dye-sensitized solar cells (DSSC). Natural dyes are the suitable choice as sensitizers since it imposes no hazardous impact on the environment. Here, a natural sensitizer extracted from *Brassica Napus* flowers in ethanol solvent has been used as a sensitized dye for TiO_2 based DSSC. UV-Vis absorption and FT-IR spectra were utilized to find out the presence of coloring pigment and anchoring groups. Mass spectrometry was used to identify the major chemical constituent present in *Brassica Napus* flowers. The HOMO-LUMO gap of key chemical constituents present in the extracted dye was estimated by using DFT. Various physicochemical properties of chemical constituents were also calculated and verified theoretically utilizing DFT/TD-DFT methods using a 6-31G(d,p) basis set. The photovoltaic performance of the dye-coated TiO_2 photoanode was performed and the output parameters were achieved as open-circuit voltage (V_{oc}) of 0.260 V, short-circuit photocurrent density (J_{sc}) of 0.453 mAcm^{-2}, fill factor (FF) of 0.525 and power conversion efficiency(η%) of 0.062% respectively as shown in **Fig.1.**

Keywords: DSSC, TiO_2, Natural dye sensitizer.

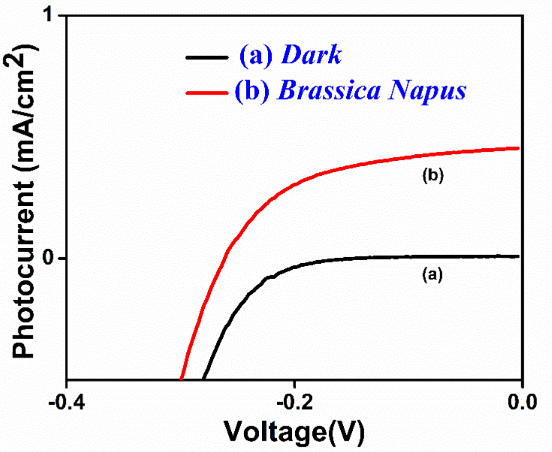


Fig.1. Characteristic current-voltage curves for DSSC (a) under dark condition (b) illumination condition

Multi-heteroatom doped vehicle exhaust diesel soot as an electrocatalyst for excellent oxygen reduction reaction

Manish Chauhan, Pradip Kumar* and Shiv Singh*

CSIR- Advanced Materials and Process Research Institute (AMPRI), Bhopal

Email: pkgangwar84@gmail.com* (Pradip Kumar) , Sshiv.singh@ampri.res.in* ,
sshiviitk@gmail.com*(Shiv Singh)

The depletion of fossil fuels and the essence of paramount energy leads researchers to seek out alternative sources of energy. Electrocatalytic reactions are the future of renewable and green energy. The oxygen reduction reaction is a sluggish kinetic reaction that is the heart of fuel cells and batteries. Traditionally Pt is considered as an ideal electrocatalyst for ORR. The economic burden and scarcity of Pt is a concern to proceed ORR. To counter this issue, we must look out for an abundant, economical and highly conductive electrocatalyst. Vehicle exhaust diesel soot, a major source of pollutants in India. The principle of waste to wealth, can be used in case of vehicle exhaust diesel soot that can be used as an electrocatalyst. Having morphological similarity with carbon black favors the conditions to use vehicle exhaust soot as an electrocatalyst for sluggish kinetics reaction of ORR. In this work, B, N, S, and O heteroatom doping is performed to diesel soot by providing a hot temperature. The synergistic effect of heteroatoms affects the half-wave potential and limiting current density of the electrocatalyst. Half wave overpotential of B-N-S-CNP showed 0.63595 V which is near to Pt (0.81932 V) at 1500 rpm and scan rate of 10mV/s.

Keywords: Vehicle exhaust diesel soot, Oxygen reduction reaction, Heteroatom doping.

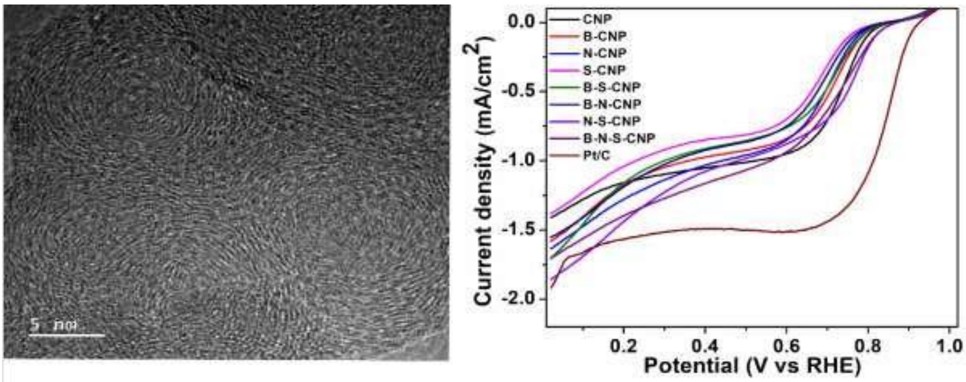


Figure 1. TEM image of CNP and LSV polarization curve of ORR performance.

Improving the electrochemical performance of industrial waste-based supercapacitor electrodes through the systematic modulation of initial precursor ratios

Pooja Yadav, Sushil Patel, Gangadhar Mahar and P. Abdul Azeem*

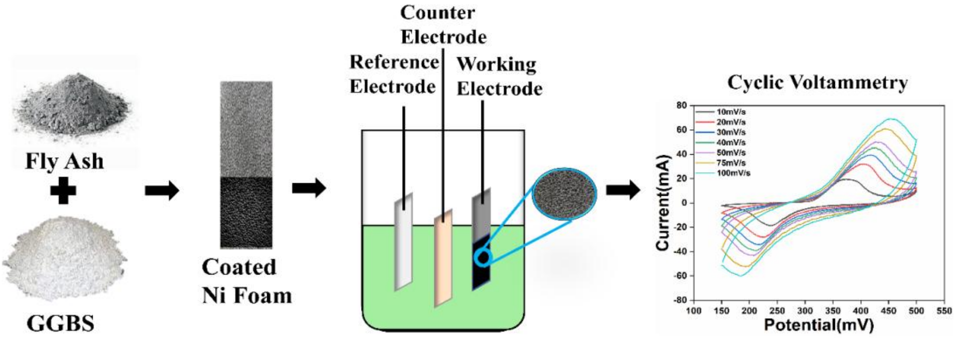
National Institute of Technology, Warangal- 506004 (TS)-India

Email: drazeem2002@nitw.ac.in

To solve the problems of waste management and environmental pollution from coal fly ash (FA) and ground granulated blast furnace slag (GGBS), it is necessary to develop a high-value and sustainable utilization technology. In this study, a sustainable utilization method for FA and GGBS to prepare transition metal silicate-based supercapacitors was proposed for the first time by modulating the initial precursors (FA and GGBS) ratios from 0.2 to 5. The X-ray diffraction (XRD), Brunauer–Emmett–Teller (BET) was used to analyze the structural, elemental, and surface properties of the prepared powders. The industrial biomass-based materials exhibit a specific surface area that lies between (2.1 to 89.25 m^2g^{-1}) and pores with a pore volume lie between (0.0002 to 0.0345 cm^3g^{-1}) composed of macropores. The electrochemical studies such as cyclic voltammetry (CV), galvanic charge-discharge (GCD), and electrochemical impedance spectroscopy (EIS) were performed by the three-electrode workstation. The cyclic voltammograms of the prepared electrodes exhibited a characteristic duck-shaped curve, indicative of their pseudo-capacitive behavior, attributed to the presence of inherently embedded transition metal oxides in initial precursors. The composition with an FA-to-GGBS ratio of 1 demonstrated a notably high specific capacitance of 1410.85 F/g when evaluated at a scan rate of 3 A/g. The difference in the capacitive values in the samples is mainly due to variations in the composition of the conductive metal oxides. This approach can effectively convert industrial residues into electrode materials, contributing to both environmental sustainability and high-value material utilization.

Keywords: Industrial Waste, Fly Ash, Ground Granulated Blast Furnace Slag, Supercapacitor, Energy Storage Application.

Figure/Scheme:



Ternary Metal Chalcogenide and Lead Halide Perovskite Heterostructure: Energy or, Charge Transfer?

S. H. Shah[1], T. Debnath*[1] and A. Chattopadhyay*[1,2]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati, Assam 781039, India
[2] Department of Chemistry, Indian Institute of Technology Guwahati, Guwahati, Assam 781039, India

Email: t.debnath@iitg.ac.in & arun@iitg.ac.in

Semiconductor heterostructures offer enhanced stability and better interfacial charge and/or energy transfer pathways which often plays an important role in a wide range of applications in optoelectronics, and photovoltaics. In this work, we fabricate a heterostructure of $CsPbX_3$ NCs (where X= Cl, Br and I) and $CuInS_2$ quantum dots (CIS QDs), a I-III-VI ternary metal chalcogenide, to investigate the energy transfer (ET) and interfacial charge transfer (CT) processes. The structural and morphological studies such as X-ray diffraction (XRD) and high-resolution transmission electron microscopy (HRTEM) revealed formation of the $CsPbX_3/CuInS_2$ heterostructure, retaining crystallinity of the individual phases. Steady state and time resolved PL measurements of $CsPbX_3/CuInS_2$ NCs shows >99.5% PL quenching for X= Br and I, while X=Cl shows only ~35% PL quenching. Considering the spectral overlap between $CsPbX_3$ donor and $CuInS_2$ acceptor, as well as thermodynamical energy level alignment, we argue the drastic PL quenching in X= I is solely due to the interfacial CT process, while for X= Br both CT and ET processes are active. In contrast, the minor PL quenching in X= Cl is possibly due to the ET process. Our halide dependent controlled regulation of CT and ET processes in these heterostructures may find promising optoelectronic applications.

Keywords: $CuInS_2$ quantum dots, $CsPbX_3$ nanocrystals, Interfacial charge transfer, Heterostructure, Energy transfer.

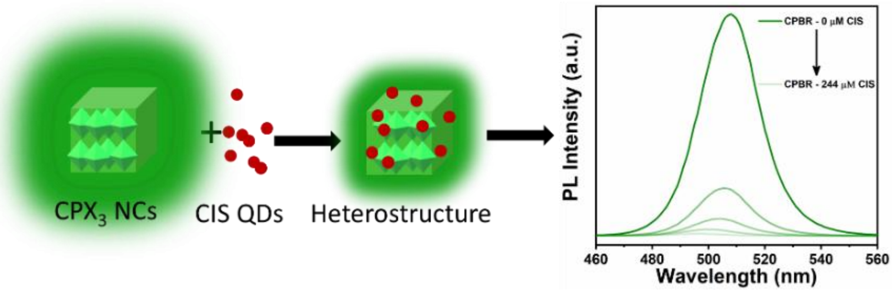


Figure 1. Schematic illustration of $CsPbX_3/CuInS_2$ heterostructure and the corresponding PL quenching result of $CsPbBr_3$ NCs upon increasing concentration of CIS QDs.

Modulating Buried Interface of the NiOX-based Inverted Perovskite Solar Cells

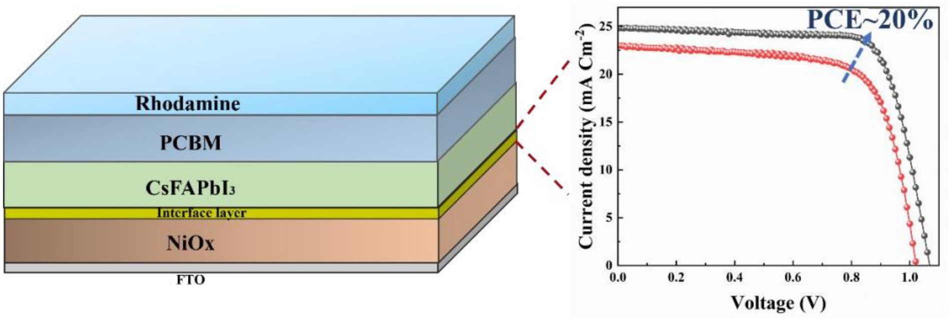
R. D. Adhikari [1] **and P. K. Iyer*** [1,2]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India
[2] Department of Chemistry, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India

Email: pki@iitg.ac.in

The poor interface quality between $CsFAPbI_3$ perovskite and the hole transport layer limits the stability and efficiency of $CsFAPbI_3$ perovskite solar cells (PSCs). In this study, we address this issue by employing a fluorine-containing small organic molecule as a bifacial defect passivator to refine the perovskite/NiOX interface. The comprehensive experiments demonstrate that the fluorine-containing molecule can not only optimize the conductivity, electron mobility, and energy band structure of the NiOX layer by passivation of the oxygen vacancy (V_O), and free-OH defects but also promote the yield of high-quality $CsFAPbI_3$ film by synergistic passivation of undercoordinated Pb^{2+} defects with the -C=O group and F atom, and limiting I-migration via F⋯I interaction. Benefiting from the above interactions, the 4ATFBA-modified $CsFAPbI_3$ device yields a champion power conversion efficiency (PCE) of 20.02% and an excellent open-circuit voltage (V_{OC}) of 1.07V. Meanwhile, the optimized $CsFAPbI_3$ PSC maintains 87.74% of its initial efficiency after aging 800 h in an air atmosphere.

Keywords: Nickle oxide, Interface modification, Defect passivation, Inverted Perovskite Solar cells.



Diamine assisted prolongation of hot carrier cooling in perovskite solar cells

Shivani Choudhary [a] and Soumitra Satapathi* [a]

[a] Department of Physics, Indian Institute of Technology Roorkee, Roorkee, Haridwar, Uttarakhand, 247667, India.

Email: soumitra.satapathi@ph.iitr.ac.in

The incorporation of 4,4'-diaminodiphenylmethane iodide salt (MDA) as an in-situ additive in the methylammonium lead triiodide ($MAPbI_3$) precursor aids in both enhancing crystallization and mitigating defects in organic-inorganic hybrid halide perovskites (HHPs). This defect passivation significantly reduces nonradiative recombination, ultimately resulting in improved photovoltaic performance and enhanced stability of the device. X-ray photoelectron spectroscopy (XPS) and nuclear magnetic resonance (1H NMR) spectroscopy were employed to elucidate the interaction between MDA and perovskites. To validate the passivation effect, inverted perovskite solar cells (PSCs) with a p-i-n architecture were fabricated, comparing cells with and without the MDA additive. The trap density decreased from 1.31×10^{16} to 8.50×10^{15} after passivation, leading to an 18% increase in power conversion efficiency (PCE) compared to the control device. The perovskite layer, post-defect passivation, demonstrated superior carrier dynamics, slowing down hot-carrier (HCs) cooling in the presence of the organic molecule, as evidenced by femtosecond transient absorption spectroscopy. Consequently, MDA modification accelerated carrier extraction while reducing charge-carrier recombination within the device. Additionally, steady-state studies and impedance analysis revealed that modified perovskite films exhibited improved charge transport and decreased recombination of photogenerated charges. This enhancement in charge dynamics translated to impressive ambient stability of the devices, retaining 80% of the initial PCE after 500 hours of storage in the dark at 60-70% relative humidity.

Keywords: Aromatic diamine, Passivation, Perovskite solar cells, Nonradiative Recombination, Ambient stability.

Tubular Nickel Hydroxide Embedded in Zeolitic Cobalt Oxide for Methanol Oxidation Reaction

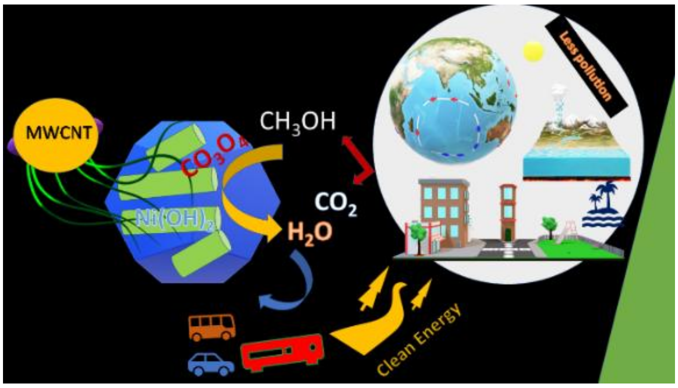
S. A. Khanam and K. K. Bania*

Department of Chemical Sciences, Tezpur University, Assam, India, 784028.

Email: kusum@tezu.ernet.in or bania.kusum8@gmail.com

Non-noble metal based electrocatalysts consisting of nickel (Ni) and cobalt (Co) metals have been synthesized by zeolitic imidazolate framework (ZIF) templation approach for effective electrochemical oxidation of methanol in basic medium. The application of such a method resulted in the decoration of tubular nickel hydroxides, $Ni(OH)_2$, in nano dimensions within zeolitic crystals of spinel cobalt oxides, Co_3O_4. At low onset potential, the mixed metal hydroxide and oxide, $Ni(OH)_2$-Co_3O_4, demonstrated good activity in electrochemical oxidation of methanol (CH_3OH) in 1M KOH. On modification with carboxylate functionalized multi walled carbon nanotube (COOH-MWCNT), the same material $Ni(OH)_2$-Co_3O_4 at similar conditions exhibited superior MOR (methanol oxidation reaction) activity showing maximum current density of 4.2 Amg^{-1}. The MWCNT modified catalyst, $Ni(OH)_2$-Co_3O_4-MWCNT also demonstrated good stability up to 500 cycles and 25000s without substantial reduction in current density. A diffusion-controlled MOR process has been indicated from the linear dependency of current density against the square root of the scan rate. A kinetically favorable MOR process was also predicted by the decrease in onset potential with increased scan rate. According to FTIR and Raman analysis, the MOR process involved the adsorption of methanol (CH_3OH) on the catalyst surface and its deprotonation, resulting in the formation of the methoxide ion (CH_3O^-), which eventually decomposed to CO_2 and H_2O. The Raman investigation further anticipated that the MOR was favoured not only by the oxidation of $Ni(OH)_2$ to NiOOH, but also by the change of Co^{2+} species in Co_3O_4 to CoOOH.

Keywords: Cobalt oxide, nickel hydroxide, nanotubules, electrocatalyst, methanol oxidation



Scheme: ZIF derived $Ni(OH)_2$-Co_3O_4-MWCNT electrocatalyst exhibiting good MOR activity

Reference:

Khanam, S.A.; Hoque, N.; Lee, S.; Park, Y.B.; Gogoi, G.; Bania, K.K. Tubular Nickel Hydroxide Embedded in Zeolitic Cobalt Oxide for Methanol Oxidation Reaction. *ACS Appl. Energy Mater.* **2022**, *5*, 12651-12662.

Molecular Welding of Delamination Resistant Metal Coordination Sites with Carbon Nitride Framework for Mimetic Artificial Photosynthesis

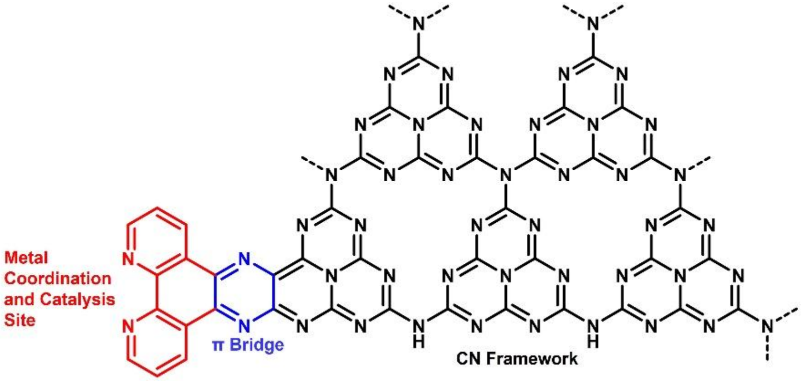
S. Bhowmik*[1] and P. K. Iyer[1,2,3]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Assam, India - 781039
[2] Department of Chemistry, Indian Institute of Technology Guwahati, Assam, India - 781039
[3] Jyoti and Bhupat Mehta School of Health Science and Technology, Indian Institute of Technology Guwahati, Assam, India – 781039.

Email: sbhowmik@iitg.ac.in

Graphitic carbon nitride (g-C_3N_4) has stood up as a highly potent photocatalyst for artificial photosynthesis, primarily due to its high chemical and thermal stability, low toxicity, cost-effectiveness, visible light absorption capacity and ingeniously tuneable synthetic routes as compared to other semiconductor platforms. Nevertheless, lower specific surface area, lesser electrical conductivity, fast recombination of photo triggered excitons and narrow visible light absorption window hinder the application of this catalytic material for practical photocatalytic utilization. To address the aforementioned issues and to modulate the photochemical and photophysical properties of g-C_3N_4, molecular doping has been a widely employed strategy. However, the inefficient methods of synthesis and the poor understanding of structure-property relationship in different molecularly doped carbon nitrides has hindered its practical implementation. Pristine carbon nitride suffers from radiative recombination losses and the drawbacks related to the radiative recombination of pristine g-C_3N_4 can be mitigated by disrupting the regular triazine and heptazine repeat units, by introducing disordered zones in the framework by the use of carefully chosen non triazine based molecular precursors. Anchoring of atomically precise metal sites in the form of a π-conjugated ligand heterostructure with proper coordination geometry enables reaction centers for catalysis, without the need of a classical heterojunction cocatalyst, thus bridging the gap between homogeneous and heterogeneous catalysis. As compared to the known homo-catalysts anchored on the carbon nitride photosensitizer-support through a weaker single σ-bond, molecularly welded (fused ring) ligand moieties with double (σ and π) bonds provide a stronger delamination free site with higher propensity of charge transfer through the π bridge and enhanced photo absorption capability due to the extension of conjugation. Added benefits of disruption of the triazine framework are also achieved through this method. This type of photocatalyst platforms pave the way for new generation classical heterojunction free photocatalysis with impact in artificial photosynthesis type applications.

Keywords: Artificial Photosynthesis, Carbon Nitride, Molecular Doping, π-conjugated Ligand Heterostructure.



Synthesis and characterization of transition metal derivativesMXene@NiP electroless coatings for boosting hydrogen evolution reaction

S. Sarika and S. M. A. Shibli*

Centre for Renewable Energy and Materials, University of Kerala, Thiruvananthapuram, Kerala, India.

Email: smashibli@yahoo.com

Hydrogen evolution reaction (HER) is a most feasible way to meet the urge for futuristic renewable and environment benign energy sources. An electrocatalyst with high activity, stability and economic viability is desirable to replace expensive bulk noble metal usage for electrocatalytic water splitting. Herein, we have developed a transition metal (TM) derivative embedded MXene modified NiP coating (TMMX@NiP) by facile electroless plating technique for HER application. The incorporation of TM on MXene enhances the morphology and effectively increases the surface area and active sites availability for HER. The physicochemical characteristics of TMMX@NiP were analyzed by XRD, AFM, XPS, SEMEDS and their electrochemical performance under various conditions were done using CV, EIS, Tafel polarization, LSV, OCP and CA studies. The TMMX@NiP coatings were found to have low b value, high I_0 and low η_{100}. The low R_{CT} value reveals its higher charge transfer rate as compared to bare NiP coatings. The long-term stability of was confirmed from OCP measurements. The higher area under CA plot indicates the higher extent of hydrogen adsorption. The present coating system exhibits unique performance due to the critical composite content and are promising in the respect of its application for large or irregular shaped electrodes that are actually required for industrial application.

Keywords: Electroless NiP coatings, MXene, HER, Electrocatalyst, Transition metals.

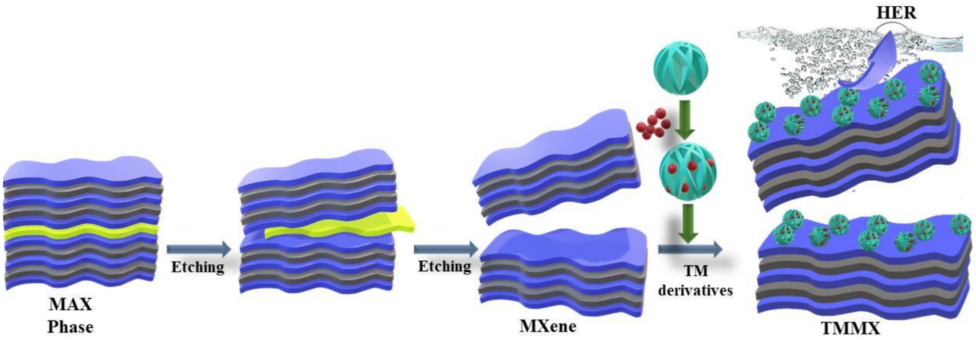


Fig. 1. Schematic representation of the synthesis route of TMMX for HER

ICANN2023 ID: PP153

A Broad Dual Emitter by Codoping Cr^{3+} ($\boldsymbol{d \rightarrow d}$) and Bi^{3+} ($\boldsymbol{s \rightarrow p}$) in $Cs_2Ag_{0.6}Na_{0.4}InCl_6$ Halide Double Perovskite

S. Saikia and A. Nag*

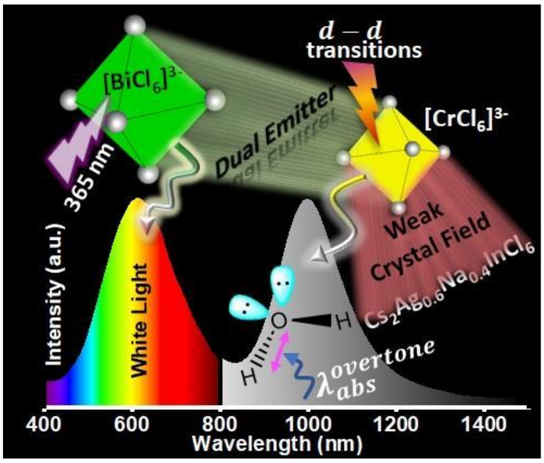
Indian Institute of Science Education and Research (IISER) Pune, 411008 (India)

Email: angshuman@iiserpune.ac.in

Materials that emit either white light or near-infrared (NIR) are known for indoor/ outdoor room lighting or NIR spectroscopic applications like food inspection, remote sensing, bioimaging etc. However, simultaneous white light and broad NIR radiation from a single material can provide both information viz. visual inspection (color/ overall appearance) and early signs of rotting of food products. The broad NIR emission near 1000 nm can effectively absorb by the vibrational overtones of water molecules (-OH) present in food items, providing the non-invasive image contrast to assess the food freshness. Upon single excitation a material that can provide dual emissions covering white light and broad NIR is desired and challenging to design. Here I will be discussing about our recently designed such broad dual emitter, Cr^{3+}-Bi^{3+}-codoped $Cs_2Ag_{0.6}Na_{0.4}InCl_6$.

Octahedral site of perovskites lattice is suitable for wide range of ions to dope and allows to tune optical pathways. Codoping Cr^{3+} and Bi^{3+}in the lattice of $Cs_2Ag_{0.6}Na_{0.4}InCl_6$ halide double perovskite can simultaneously emit warm white light and broad NIR (λ_{max} ≈1000 nm) radiation with quantum yield 27%. This dual emitter is designed by combining the features of s^2-electron (Bi^{3+}) and d^3-electron (Cr^{3+}) doping. Importantly, host lattice $Cs_2Ag_{0.6}Na_{0.4}InCl_6$ provides weak crystal field to Cr^{3+} enabling to get broadness in the NIR PL. Other hand, Bi^{3+} via $6s^2 \rightarrow 6s^1 6p^1$excitation allows to use a commercial 370 nm ultraviolet light-emittingdiodes (UV-LED), yielding both emissions. A fraction of the excited Bi^{3+} dopants emit warm white light, and the other fraction transfers its energy non-radiatively to codopants Cr^{3+}. Then the Cr^{3+} de-excites emitting broad NIR emission. Temperature dependent (6.4–300 K) photoluminescence in combination with Tanabe-Sugano diagram helps to understand the photophysics of the system. It reveals that Cr^{3+} experiences a weak crystal field ($D_q / B = 2 \cdot 2$), yielding the ${}^4T_2 \rightarrow {}^4A_2$ (d - d transition) NIR emission. As a proof of concept, we fabricated a panel of 122 phosphor-converted LEDs (pc-LEDs) with dimensions 22 × 17 cm^2, demonstrating its capability to inspect food products.

Keywords: Double perovskite, near infrared, d - d transition, pc-LED.



Phosphorus-Doped Nickel Oxide Micro-Supercapacitor: Unleashing the Power of Energy Storage for Miniaturized Electronic Devices

S. A. Siddiqui, S. Das, S. Rani, Mohd Afshan and K. Ghosh*

Institute of Nano Science and Technology (INST), Mohali

Email: kaushik@inst.ac.in

The miniaturization of electronic devices has facilitated the extensive integration of wireless sensor networks across various domains. In order to ensure an uninterrupted self-powered network, the requirement of miniaturized energy storage device is of utmost importance. In this study, we explore the potential utilization of phosphorus-doped nickel oxide (NiO) to design highly efficient durable micro-supercapacitors. The introduction of phosphorus as a dopant serves to enhance the electrical conductivity of bare NiO, leading to a remarkable 11-fold augmentation in volumetric capacitance to 841.92 Fcm^{-3} followed by significant enhancement of energy density and power density from 6.78 mWhcm^{-3} to 42.096 mWhcm^{-3} and 0.42 Wcm^{-3} to 1.046 Wcm^{-3}, respectively, demonstrating the device to be a highly promising contender for diverse range of energy storage applications. Simultaneously, the as-designed micro-supercapacitor (MSC) device demonstrates a facile integration with the photovoltaic system for renewable energy storage and smooth transfer to the external loads where charging with 4 V silicon solar cell helps to enlighten the blue LED for approximately 1 min. The research work also emphasizes the importance of cost-effectiveness by employing a nickel metal current collector instead of commonly used costly alternatives of Au/Ag-based current collectors. This deliberate choice of P-doped NiO/Ni system not only contributes to cost reduction but also ensures minimal lattice mismatch at the interface facilitating high durability up to 15 K cycles along with capacitive retention of ~100% and coloumbic efficiency of 93%, respectively. The optimized doping concentration of phosphorous in NiO matrix significantly induces the lattice strain as well as increases the electrical conductivity and thereby exhibits remarkable advancements in volumetric capacitance, energy density, and power density. Thus, the as-designed heterostructure unveils the possibilities of exploring miniaturized semi-transparent energy storage devices for renewable energy-driven portable electronics.

Keywords: Micro-supercapacitor, photolithography, miniaturized electronics, energy density.

Upcycling rust and plastic waste into an Fe MOF for effective energy storage applications: transformation of trash to treasure

R. Deka and S. M. Mobin*

Department of Chemistry, Indian Institute of Technology Indore, Khandwa Road, Simrol, Indore 453552, India.

Email: Phd1901231001@iiti.ac.in, xray@iiti.ac.in

The upcycling of waste into valuable chemicals has gained significant attention in recent years as a way to reduce waste and promote the circular economy. The transition to a circular economy that includes waste upcycling is crucial for addressing the global challenge of resource depletion and waste management. To that end, a Fe-based metal–organic framework material (**Fe-BDC(W)**) has been synthesized completely *via* the utilization of waste materials. The upcycling of rust gives the Fe salt, whilst the benzene dicarboxylic acid (BDC) linker has been derived from waste polyethylene terephthalate plastic bottles. Sustainable energy storage from waste materials seeks to produce environmentally benign and economically viable energy storage technologies. The prepared MOF has been deployed as an active material for a supercapacitor, which achieves a specific capacitance of 752 F g^{-1} at 4 A g^{-1}, comparable with the MOF produced from commercially available chemicals, Fe-BDC(C).

Keywords: Metal-Organic Framework, Polyethylene Terephthalate, Iron Rust, Supercapacitor.

Cu-Metal Organic Framework derived Multilevel Hierarchy as a Bifunctional Electrode for High-performance Supercapacitors and Oxygen Evolution Reaction

Z. Abbas[1], S. M. Mobin*[1]

[1] Department of Chemistry, Indian Institute of Technology Indore, Simrol, Khandwa Road, Indore 453552, India

Email: phd2001131017@iiti.ac.in, * xray@iiti.ac.in

The development of a MOFs-derived multilevel nanostructured in a single step still remains a challenging task. Herein, we have synthesized novel **Cu-MOF** via a slow diffusion method at ambient temperature and further utilized it as a precursor source for MOF-derived **Cu/Cu$_x$O@NC** (x = 1 and 2). The studies suggest that the organic ligands served as a source of an N-doped carbon matrix encapsulated with metal oxide nanoparticles which were confirmed by various characterization techniques, further BET analysis reveals a surface area of 178.46 m^2/g. The synthesized multilevel hierarchy was utilized as an electro-active material in a supercapacitor that achieved a specific capacitance of 546.6 Fg^{-1} at 1 Ag^{-1} with higher cyclic retention of 91.81% after 10,000 cycles. Furthermore, the ASC device was fabricated using **Cu/Cu$_x$O@NC** as the positive electrode and carbon black as the negative electrode and utilized to enlighten the commercially available LED bulb. The fabricated ASC device was further employed for a two-electrode study which achieved a specific capacitance of 68 Fg^{-1} along with a comparable energy density of 13.6 Whkg^{-1}. Furthermore, the electrode material was also explored for oxygen evolution reaction (OER) in an alkaline medium with a low overpotential of 170 mV along with a Tafel slope of 95 mVdec^{-1} having long-term stability. The MOF-derived material has high durability, chemical stability, and efficient electrochemical performance. This work provides some new thoughts for the design and preparation of a multilevel hierarchy (**Cu/Cu$_x$O@NC**) via a single precursor source in a single step and explored multifunctional applications in energy storage and energy conversion system.

Keywords: MOFs derived, Multilevel structure, Heteroatom doped, Bifunctional activity.

Interface-Engineered Porous Pt–PdO Nanostructures for Highly Efficient Hydrogen Evolution and Oxidation Reactions in Base and Acid

R. Samanta and S. Barman*

School of Chemical Sciences, National Institute of Science Education and Research (NISER), Homi Bhabha National Institute, Bhubaneswar, Orissa 752050, India
Homi Bhabha National Institute, Training School Complex, Anushakti nagar, Mumbai 400094, India.

Email: sbarman@niser.ac.in

The rising environmental concerns and global energy demand have provoked the scientific society to find a green and economy-friendly approach as an alternative to fossil fuel-based technologies. Although, there are several renewable energy technologies to overcome this problem, they are regional and seasonal. Therefore, energy conversion and storage is highly necessary. Electrolyzers and fuel cells have gained lot of attention for this purpose. Alkaline hydrogen oxidation/evolution reaction (HOR/HER) has great potential for commercializing fuel cells/electrolyzers. But, the poor activity of Pt-based-catalysts in base is main obstacle. The improvement of alkaline HOR/HER kinetics on electrocatalyst is paramount important for development of alkaline fuel cells/electrolyzers. In this work, an interface-engineered porous Pt–PdO–N-doped carbon (Pt–PdO/C) composite was synthesized for HER/HOR application in both the acidic and alkaline media. The catalyst required 29 and 16 mV overpotential to reach 10 mA/cm^2 HER current density in alkaline and acidic media with 36 and 22 mV/dec Tafel slope values, respectively. In addition, Pt–PdO/C showed excellent HOR performance in all pH solutions. The mass-specific exchange current density ($i_{0,m}$) of this catalyst was 463.8 mA/mg$_{metal}$ in 0.1 M KOH solution, which was ~5.5 times better than commercial Pt/C. We demonstrated that both the hydrogen binding energy and OH binding energy are equal descriptors for HER/HOR in the alkaline media. The excellent HER/HOR catalytic performance of Pt–PdO/C may be due to the interface engineering, strong synergistic interaction between the components, high electrochemical surface area, and porous morphology. We hope this work will provide an opportunity to design metal–metal oxide-based electrocatalysts for several renewable energy devices.

Keywords: Nonmaterial: Electrocatalysis; Hydrogen binding energy; Oxophilicity; Synergistic interaction.

Study on Hydrothermal Synthesis and Electrochemical Properties of $NiFe_2O_4$ Nanoparticles as Anode Material for Lithium-ion Batteries

Reshma Babu[1], **Prasad Gonugunta**[2], **Prasanth Ravi anusuyadevi***[2], **Peyman Taheri**[2], **Arjan Mol**[1], **V.V. Ravi Kanth Kumar**[1] **and N. Satyanarayana***[1]

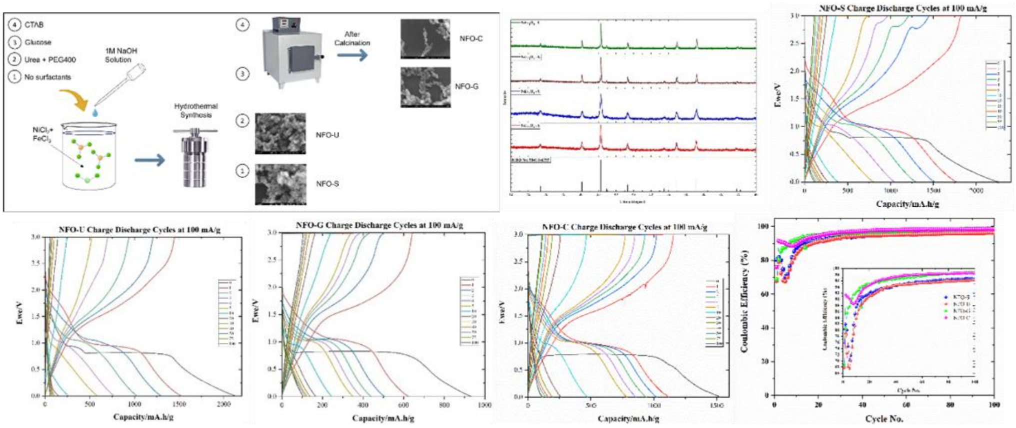
[1] Depertment of Physics, Pondicherry University, Puducherry 605 014, India,
[2] Materials Science and Engineering, Faculty of Mechanical, Maritime and Materials Engineering, Delft University of Technology, Mekelweg 2, 2628 CD, Delft, the Netherlands.

Email: nallanis2011@gmail.com

Nanoparticles of $NiFe_2O_4$ are synthesized through hydrothermal methods using different surfactants and synthesis conditions. The phase and morphology of four $NiFe_2O_4$ samples are confirmed from XRD and FESEM results, respectively. From the FESEM data, NFO-S and NFO-U have lesser particle sizes compared to NFO-G and NFO-C. The lithium storage performance of $NiFe_2O_4$ as an anode material in the lithium-ion battery is studied. Among the four samples, NFO-S showed the highest first discharge capacity of 2258mAh/g and a discharge capacity of 116mAh/g retained after 100 cycles at a current density 100mA/g. The synthesis conditions and characteristics of nanoparticles directly correlate with their electrochemical performance, where NFO-S and NFO-U, with lower particle size, give a very high initial capacity than others. At the same time, the samples with larger particles, NFO-G and NFO-C, showed better retention and high Coulombic Efficiency.

Keywords: $NiFe_2O_4$, Hydrothermal Synthesis, Nanoparticles, Lithium-ion Batteries, Energy Storage.

Figure/Scheme:



Dual hole transport layer facilitated efficient perovskite light emitting diode

Ramesh Babu Yathirajula,[1] Ritesh Kant Gupta,[1] Mohammad Adil Afroz,[2] Anwesha Choudhury,[1] Himangshu Baishya[1] and Parameswar Krishnan Iyer*[1,2]

[1] Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India.
[2] Department of Chemistry, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India.

Email: y.ramesh@iitg.ac.in

The luminescence and colour purity of solution processable perovskite materials have significantly improved, which makes them a promising candidate for high performance lighting technologies. In this paper, we present a straightforward method for fabricating dual hole transport layers (HTLs) in green-emitting perovskite light emitting diodes (PeLEDs), which significantly helps and charge balance in the emissive layer (EML). By achieving charge balance in the emissive layer, with well-matched energy levels, and lowered charge injection barrier of the transport layers, maximum radiative recombination can be obtained (HTLs). The varying HOMO levels of the HTLs used in the device are in alignment with the work function of the FTO and HOMO of the emissive layer. The PEDOT:PSS/NPD-based PeLED device showed outstanding performance with a maximum brightness of 19625 cd m^{-2}, the highest current efficiency of 19.2 cd A^{-1}, and turn-on voltage of 3.8 V among the all three HTL combination. The reason for these higher results was the well-match HOMO of PEDOT:PSS and NPD with both the anode and emissive layer facilitating better hole injection and charge balance. CIE coordinates (0.22, 0.74) for pure green emission are supported by studies utilizing photoluminescence and electroluminescence. The best film morphology and crystallinity with less pinholes were found in perovskite films made on top of PEDOT:PSS/NPD, which allowed for efficient charge transport.

Keywords: Perovskite LED; carrier injection; current efficiency; turn-on voltage; brightness.

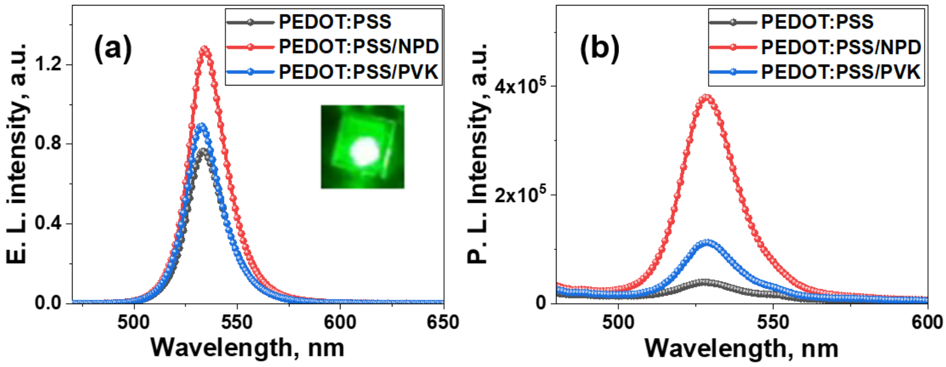


Figure. (a) & (b) EL and PL spectra for dual HTL Perovskite LEDs

Multifunctional Additive to Control Crystallization, Defect Passivation and Minimizing Ion-migration in $CsFAPbI_3$ perovskite solar cell

Himangshu Baishya,*[a] Deepak Yadav,[b] Parameswar K. Iyer*[a,b]

[1] Centre for Nanotechnology, Indian Institute of technology Guwahati, Guwahati-781039, Assam, INDIA
[2] Dept. of Chemistry, Indian Institute of technology Guwahati, Guwahati-781039, Assam, INDIA

Email: pki@iitg.ac.in

Formamidinium (FA) based halide perovskite material has got tremendous research interest as a replacement of MA counterpart in the 3D perovskite structure to improve the thermal stability. However, the serious phase instability issues and low defect formation energy of FA-based perovskite compromise the solar cells' long-term stability and efficiency. To increase the stability of the photo-active α-phase of the FA based perovskite structure, we have optimized the FA-based perovskite structure $Cs_{0.1}FA_{0.9}PbI_3$ by incorporating a small proportion of Cs cation to the perovskite structure. The defects at the surface and grain boundaries that serves as non-radiative recombination center originated during the crystallization of the perovskite phase reduces the mobility and life-time of the photo-generated charge carriers and hence Voc and FF of the solar cell devices. In order to improve the device efficiency and hence stability we have incorporated 4-((trifluoromethyl)thio)benzoic acid a small additive molecule that strongly combined with the uncoordinated ions in the perovskite structure that regulated the crystallization process and able to maintain large grain growth with less grain boundaries of the perovskite structure. As a result, the improvement of all photovoltaic parameters, the modified device exhibits an average PCE of 19.85% as compared to the 15.63% of the pristine device. The improved morphological, photophysical properties in the modified film has verified by FESEM, AFM, UV, PL study respectively. Further, the modified device has able to maintain a normalized PCE of 90% after 300 hours of ambient condition aging by keeping under dark condition at RH of 60-70%.

Keywords: Large grain, defect passivation, ion migration compositional engineering, phase stability, ambient stability.

Y-shaped Membraneless Methanol Fuel Cell using Co-laminar Flow for Instant Power Generation

Sarmistha Baruah[a], **Akshai Kumar**[a, b] **and Nageswara Rao Peela***[a, c]

[a] Centre for Nanotechnology, Indian Institute of Technology, Guwahati-781039, Assam, India
[b] Department of Chemistry, Indian Institute of Technology, Guwahati-781039, Assam, India
[c] Department of Chemical Engineering, Indian Institute of Technology, Guwahati-781039, Assam, India

Email: peelanr@iitg.ac.in

The growing demand for point-of-care microelectronics and lab-on-chip-based biochemical sensors requires fully integrated and dependable flexible power supply systems. In this regard, membraneless microfluidic fuel cells (MMFCs) represent a promising innovation in the field of sustainable energy conversion and storage. In comparison to the well-established chip-based battery and capacitor technologies, flexible MMFC offers a compact and efficient alternative by eliminating the requirement of an ion exchange membrane. They also provide distinct advantages such as easy integration, cost-effectiveness, portability, etc., and serving as an essential supplement for batteries over the last decade. In this work, we implemented a Y-shaped paper-based MMFC that utilizes methanol as a fuel. Two parallel anolyte and catholyte streams flow by capillarity in paper strips and react with the anode and cathode catalyst surface without the use of a separating membrane. Unlike, conventional microfluidic fuel cells, the current system does not require auxiliary pumps to function because reactants flow solely by capillary forces. The critical structural parameters such as fuel crossover, cell resistance, and textural properties of paper channels have been comprehensively investigated and optimized. The results reveal that the performance of MMFC is significantly influenced by the textural characteristics of the paper. The best results were obtained by utilizing an alkaline anodic stream and an acidic cathodic stream, thereby boosting the cell potential. This enhancement resulted in a maximum power density (MPD) of ~ 5 mW cm^{-2} for the paper-based co-laminar flow FC with methanol and $KMnO_4$ as fuel and oxidant, respectively at ambient temperature. This work highlights the potential opportunities of paper-based microfluidic fuel cells in portable electronics.

Keywords: Membraneless microfluidic fuel cells, Point-of-care, Co-laminar flow, Paper texture.

Surfactant induced variation in performance of $ZnCo_2O_4$ for electrochemical application

Garima Gupta*, Somnath C Roy

Indian Institute of Technology, Madras, India

Email: garima.gupta151@gmail.com

Renewable energy sources are the need of the current generation to suppress the adverse environmental impact of greenhouse gas. However, renewable sources are intermittent in nature and are not available all the time, therefore their storage is important. Supercapacitors with moderate energy density, high power density and excellent cycle life are excellent choices for this purpose. Co_3O_4 is a good redox active material for supercapacitors (electrode) application with theoretical capacitance of 3560 F g^{-1}. However, due to poor conductivity, theoretical capacitance can be achieved. Replacing some of the Co^{2+} ions with Zn^{2+} ions improves the conductivity. Therefore, $ZnCo_2O_4$ is a good choice. For any electrochemical performance surface area and conductivity plays a crucial role. Surfactants can interesting tune these properties. In this work, we have demonstrated the effect of surfactants in achieving urchin-like morphology and hexagonal sheet-like morphology. Urchin-like morphology shows higher surface area as well as conductivity and hence shows better performance. We have achieved 234 mA h g^{-1} capacity at 5 mV s^{-1} scan rate in case of urchin-like morphology which is higher than 100 mAh g^{-1} achieved in case of hexagonal sheet like morphology. Confirming that urchin-like morphology have better electrochemical performance we have also fabricated a coin cell with this sample. Fabricated device shows good capacity 72 mA h g^{-1} at 5 mV s^{-1} , high energy density (19 Wh kg^{-1}), higher power density (4125 W kg^{-1} and excellent Coulombic efficiency of 98%. Thus, it shows a good potential application in energy storage.

Keywords: Supercapacitor, Urchin-like morphology, Hexagonal sheet-like morphology, Surfactants effect, Zinc Cobalt oxide.

α-Fe_2O_3 nanorods@TiO_2 thin film heterojunction for enhanced photoelectrochemical water splitting

Govinda C. Behera*[1,2]; **J. K. Rath**[2] **and S. C. Roy**[1]

[1]Semiconducting Oxide Materials, Nanostructures, and Tailored Heterojunction (SOMNaTH) Lab, Department of Physics, IIT Madras, Chennai 600036, India
[2]Photovoltaic Lab, Department of Physics, IIT Madras, Chennai 600036, India

Email: gvndbhr143@gmail.com

Iron oxide based photocatalysts are not only environment safe but also highly suitable for solar water splitting using visible light. Particularly, α-Fe_2O_3 is an attractive material for its low band gap, readily availability on earth crust, relatively easy to synthesize, stable in harsh chemical environments e.g., basic solution. But the low electrical conductivity, short hole diffusion length hinders its successful applications in solar water splitting. Heterojunction formation with other material can help in charge separation with reduced recombination[1]. In this work we have synthesized vertically aligned Fe_2O_3 nanorods through single step chemical bath deposition method on Ti metal substrate. The heterostructure was characterized by XRD, FE-SEM, Uv-Vis-DRS, Raman, XPS, EDAX. The photoelectrochemical performance of the bare Fe_2O_3 ,TiO_2 and composite material were evaluated using three electrode photoelectrochemical cells. The composite one shows higher photo-current density as compared to bare Fe_2O_3 nanorods on FTO and bare TiO_2 on Ti metal substrate. Electrical impedance spectroscopy and Mott-Schottky plots were also studied, which shows low charge transfer resistance and better charge carrier density at the interface for TiO_2 thinfilm/Fe_2O_3 nanorods heterostructure sample. We have proposed an energy band diagram showing interfacial charge transfer mechanism, depending upon the device architecture and enhanced photocurrent.

Keywords: Composite material; heterojunction; iron oxide; titanium dioxide; nano-structure.

Reference:

1. G.C. Behera, S. Rani, N. Khatun, J.K. Rath, S.C. Roy, WS_2 nanosheets functionalized Fe2O3 nanorod arrays as a type II heterojunction for photoelectrochemical water splitting, Appl. Surf. Sci. Adv. 11 (2022) 100293. https://doi.org/10.1016/j.apsadv.2022.100293.

Novel Tetramethylethylenediamine Gemini Surfactant Gel-stabilized Palladium Nanocatalysts for One-pot Aqueous phase Reductive Acetylation Nitro-Aromatic Compounds at Room Temperature

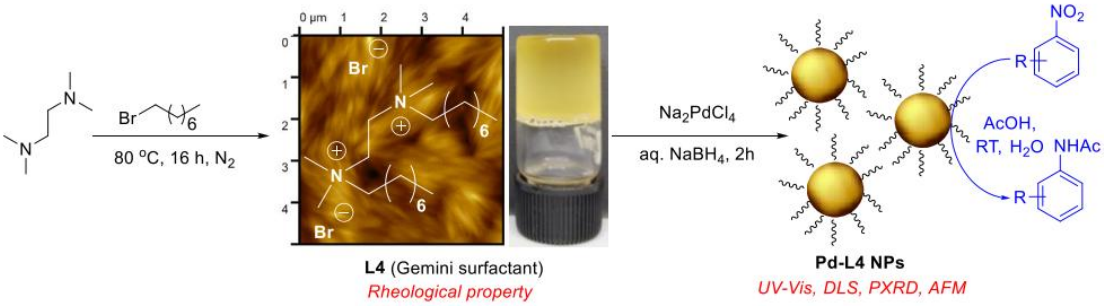
P. K. Gupta, A. Srivastava and K. V. S. Ranganath*

Department of Chemistry, Center of Advanced Study, Institute of Science, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India

Email: ranganath.chem@bhu.ac.in

Since the dawn of organic synthesis, the idea of reducing, reusing and recycling its toxic byproducts has been a matter of concern for green chemists. In this context, eradication of hazardous nitro-aromatic compounds by converting them to commercially valuable N-acetyl aromatic compounds that are used as synthons in several synthetic industries is a matter of great scientific interest. Conventional reducing agents demands stringent reaction conditions, prolonged reaction time and high temperature, and offer unsatisfactorily lower yields. Aqueous phase nanocatalysis could however, afford it without using carcinogenic solvents. Thereafter, multiple attempts for NaBH4 and electrophilic mild acetylating mediated nitro-aromatic reduction in presence of catalysts like heavy-metal powders, metal oxides, metal complexes although offered improved yields, but had poor catalyst recyclability under aqueous conditions. Gemini surfactant (GS)-stabilized semi-heterogeneous nanoparticles can achieve better dispersion of catalyst and reactant under water, thereby making them a suitable aqueous phase nanocatalyst. We attempted aqueous phase one-pot reductive acylation of nitro-aromatic compounds at room temperature in presence of Palladium nanocatalysts (Pd NPs) stabilized by N,N,N',N'- tetramethylethylenediamine (TMEDAn; n = 2-18) GS and found that active Pd NPs (particle size: 28 nm) stabilized by stabilized by TMEDA8 GS gel could actively afford it within 125 min, with ~ 99% yields and turnover number of 110, without any leaching, for up to 4 catalytic cycles. The possible mechanism for the reductive acylation has been proposed through semi-empirical PM6 computations, thereby deducing a possible role of surfactant's quaternary nitrogen in achieving nitro-aromatic to Pd NP interaction, thereby allowing its efficient reduction.

Keywords: Surfactant, Organogel, Palladium nanoparticles, Reductive N-acetylation, Recyclability.



Novel Urea organo-polymer decorated Palladium Nano-catalysts for speedy reduction of toxic Cr(IV) ions

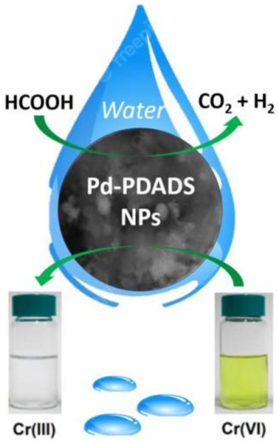
N. Kumar, P. K. Gupta and K. V. S. Ranaganath*

Department of Chemistry, Center of Advanced Study, Institute of Science, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India

Email: ranganath.chem@bhu.ac.in

The deleterious impacts of heavy metal toxicity over the biome, has been an alarming challenge for green chemist. In this context, scientists have coined a much greener approach of eradicating the toxic mutagenic/carcinogenic Cr(IV) ions from ground/wastewater, by reducing it to the less toxic Cr(III) ions under acidic conditions (i.e., formic acid) and precipitating it insoluble hydroxides under basic conditions, finally releasing CO_2 and H_2 as the sole by product. Numerous aqueous-tolerant nano-catalysts like metal (Fe, Sn, Zn) powders, nanomaterials (Ru, Ir, etc) or metal-organic frameworks, employed as ion exchangers, membrane filtration sieves have although secured quantitative Cr(IV) reduction, but over a long period of time, and with minimal catalyst recyclability. We hereby report highly dispersed polyurea organo-polymer stabilized Palladium nanoparticles as suitable nano-catalyst that could afford the reduction of 0.4 mM, 3 mL Cr (IV) ion solution in presence of formic acid, within 18 min under mild conditions. The reduction completion was mark by complete fading of yellow colour. The prepared Pd NPs were characterized through FTIR, DLS, SEM, PXRD and XPS analysis. The facile approach of fabricating metal NP-immobilized polymers offer high surface area to volume ratio, enhanced mechanical durability, and uniform NP distribution and can be extended to prepare different nano-catalysts for various applications in catalysis, sensing, environmental sciences.

Keywords: Heterogeneous, Polyurea, Palladium nanoparticles, toxicity, reduction, nanocatalyst.



Low Palladium Content Iron (III) Nanocatalyst Supported on Zeolite-NaY for Suzuki Miyaura Cross Coupling Reaction *via* C-Cl Bond Activation

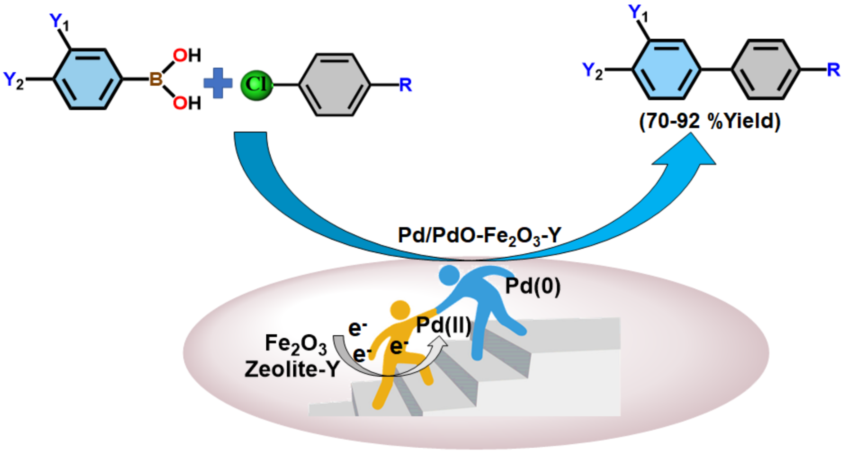
T. J. Bora and K. K. Bania*

Department of Chemical Sciences, Tezpur University, Napaam, Sonitpur, Assam, India-784028

Email: kusum@tezu.ernet.in

A heterogeneous nanocatalyst containing palladium (Pd/PdO) and iron (III) oxide (Fe_2O_3) in the dimension of 1-4 nm was synthesized using sodium exchanged zeolite-Y or zeolite-NaY as support matrix. The catalyst was found to behave as a true heterogeneous catalyst for the activation of the robust C-Cl bond of aryl chlorides in the Suzuki Miyaura Cross Coupling (SMCC) reaction. The catalyst with very low Pd loading (0.0037 mol%) exhibited high reactivity in the SMCC reaction with various derivatives of aryl chlorides (Ar-Cl). Biaryl products were obtained with upto 92% yield, high selectivity, and a good turn over number with this Pd/PdO-Fe_2O_3-Y catalyst. The reaction was found to be reliant on various parameters like solvent system, temperature, time, and catalyst amount. A small aliquot of water (H_2O) mixed with methanol (CH_3OH) dramatically brought a substantial improvement in the product yield of the desired biaryl product. The role of zeolite-NaY was also investigated by comparing the results with various other synthesized catalysts. The catalyst exhibited good thermal stability and was highly recyclable. The impact of Fe on the electronic structure and reactivity of Pd was analyzed through Density Functional Theory (DFT) calculation. The study provided a strong evidence for creation of negative (-ve) charge on Pd with increasing amount of Fe content and thereby favored the *in situ* transformation of Pd(II) to Pd(0) as required in the activation of the C-Cl bond.

Keywords: C-Cl bond-activation, iron-oxide, in situ, SMCC, zeolite-NaY.



Scheme: A Pd/PdO-Fe_2O_3-Y catalyst with low Pd loading for C-Cl bond activation reaction

Reference:

Bora, T.J.; Hazarika, N.; Gour, N.K.; Lee, S.; Park, Y.B.; Biswas, S.; Devi, A. and Bania, K.K. Low-Palladium-Content Iron (III) Nanocatalyst Supported on Zeolite-NaY for C–Cl Bond Activation. *ACS Applied Nano Materials*, **2023**, https://doi.org/10.1021/acsanm.3c03244

Utilization of methanol and ethanol for synthesis of 3,3'-bis(indolyl)methane through activation of peroxymonosulfate over copper catalyst

A. Devi and K. K. Bania*

Department of Chemical Sciences, Tezpur University, Assam 784028, India

Email: kusum@tezu.ernet.in or bania.kusum8@gmail.com

For the synthesis of biologically significant 3,3′-Bis(indolyl)methanes (BIMs), a simpler and greener catalytic system is developed, using C1 and C2 alcohols as the source of carbon for the bridging methylene group. The reaction took place under mild and environmental-friendly circumstances without the need for any hazardous solvents. The low-cost CuO-peroxymonosulfate (CuO-PMS) system makes the reaction to be highly efficient resulting in very good product yield.

Keywords: 3,3′-Bis(indolyl)methanes, alcohols, environment-friendly, CuO-peroxymonosulfate.

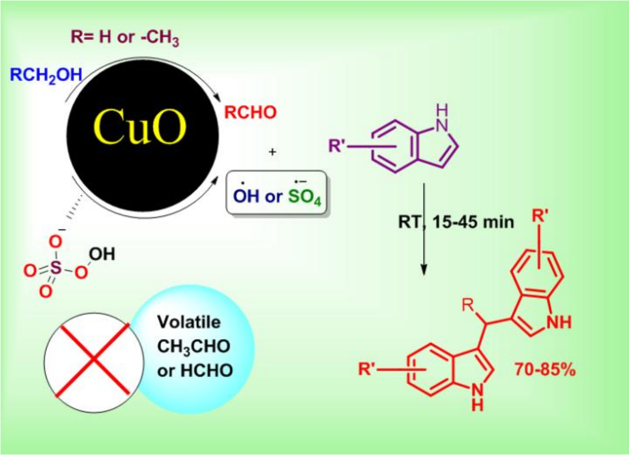


Figure: CuO-peroxymonosulfate as a catalytic system for the system of BIMs

References:

A. Devi, M. M. Bharali, S. Biswas, T. J. Bora, J. K. Nath, S. Lee, Y. B. Park, L. Saikia, M. J. Baruah and K. K. Bania, *Green Chem.*, 2023, **25**, 3443-3448.

Photosynthetic chalcogenide nanobiohybrids for enhanced photocatalytic activity and value added products

Uddandarao Priyanka*, Piet N.L. Lens

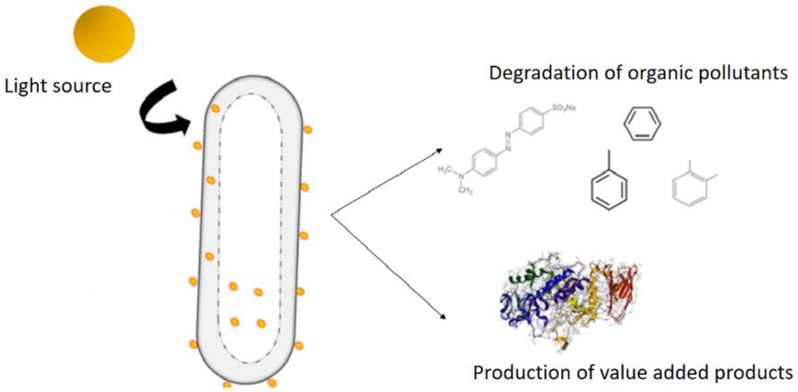
National Institute of Technology, Andhra Pradesh 534101.

Email: uddandaraopriyanka@gmail.com

Inorganic-biological hybrid systems have potential to be sustainable, efficient and versatile platforms by integrating the light-harvesting properties of semiconductors with the biosynthesis potential of biological cells. Coupling nanomaterials with microbes opens up a whole spectrum of new metabolic properties, where the nanomaterials can capture reducing equivalents in the presence of light sources, these equivalents are provided to the cellular metabolism of the microbes, thereby enhancing their metabolic properties. This mechanism is exploited for the treatment of pollutants and production of the value added products. Chalcogenide semiconductor nanoparticles II–VI ZnS NPs and I-VI CuS NPs are integrated with *Aspergillus niger* to form nanobiohybrids. Further, these nanobiohybrids are used for the degradation of methyl orange dye and petrochemical compounds such as benzene, xylene and toluene in the presence of the UV light source and for the enhanced production of value added products such as enzymes and amino acids in the presence of a visible light source.

Relevance and impact: With the rapid population growth globally, large amounts of wastewater containing organic pollutants from various industries are being discharged into the environment. These emerging contaminants are persistently released into the waterbodies majorly from manufacturing industries, consumer utilities and effluent treatment plants. Further, there is an extensive use of industrial enzymes and amino acids. Many of these find numerous applications in various industrial sectors such as food, detergent, paper and textile industries. In these aspects, nanobiohybrids can serve as efficient tools for wastewater treatment and production of industrial biocommodities.

Keywords: Amylase, *Aspergillus niger* , methyl orange, nanohybrid, nanoparticles.



***Aspergillus niger*-Chalcogenide nanobiohybrids**

$CuFe_2O_4$ catalyzed cascade synthesis of phenoxypyrimidines from arylboronic acids and chloropyrimidines

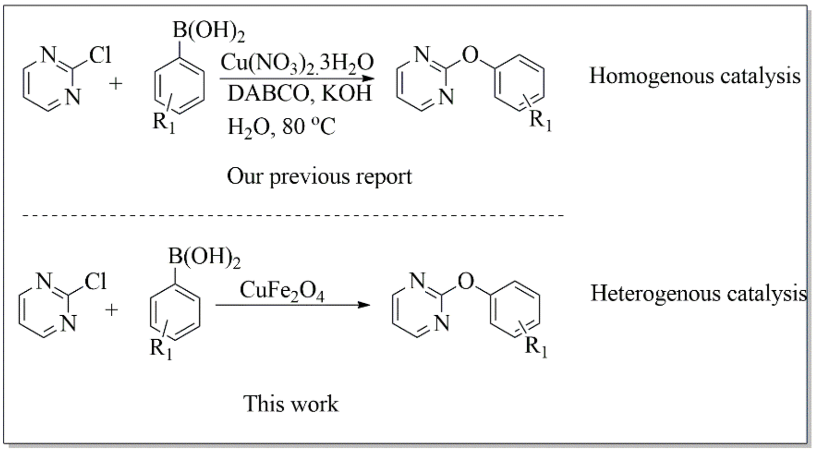
R. Star, A. J. Bhuyan and L. Saikia*

Department of Chemistry, Rajiv Gandhi University, Rono Hills, Doimukh-791112, Arunachal Pradesh, India.

Email: lakhinath.saikia@rgu.ac.in

The importance of diaryl ethers can be understood from their frequent incorporation in many biologically active molecules, comprising several natural products, pharmaceutical, agricultural and polymer industries.[1] Various pathways have been developed for the synthesis of ethers via C-O bond formation namely Ullmann reaction, Buchwald-Hartwig coupling, Chan-Lam coupling, Williamson ether synthesis, S_NAr reaction etc.[2] In a recent development, our research group developed a synthetic methodology for the synthesis of phenoxypyrimidines via C-O bond formation starting from an unconventional substrate pairs, viz. chloropyrimidines and arylboronic acids adopting a homogenous catalytic procedure.[3] The methodology was successful to deliver as many as 32 numbers of phenoxypyrimidines in good to excellent yields. The current work describes our efforts to develop a heterogenous catalytic methodology for the same transformation. During the process, we prepared $CuFe_2O_4$ nanoparticles adopting co-precipitation technique. Four different catalytic ($CuFe_2O_4$) systems were prepared, which were then checked for their catalytic properties for the purpose.

Keywords: Aryl boronic acid, chloropyrimidine, phenoxypyrimidine, nanoparticles, co-precipitation.



Scheme: General reaction scheme

References:

1. Khalili *et al.*; *Microporous and Mesoporous Materials* **2019,** *287*, 254-263.
2. Kikelj *et al.*; *Synthesis* **2006,** *14*, 2271-2285.
3. Bhuyan et al. *The Journal of Organic Chemistry* **2022,** *87* (17), 11846-11851.

Gold coated iron oxide core shell nanostructures for oxidation of indoles and synthesis of uracil-derived spirooxindoles

S. B. Gohain,[a,c] P. K. Boruah,[b] M. R. Das[b] and A. J. Thakur*[a]

[a] Department of Chemical Sciences, Tezpur University, Napaam, Assam, 784028, India,
[b] Advanced Materials Group, Materials Sciences and Technology Division, CSIR-North East Institute of Science and Technology (NEIST), Jorhat 785006, Assam, India, [c]Dimoria College, Khetri, Kamrup (M), Assam, India

Email: shivanee.chem@gmail.com

Encapsulated iron oxide (Fe_3O_4) based nanoparticles (NPs) with Au NPs hold promising scope for catalysis in organic synthesis, which overcomes the hindrance of the inherent hydrophilic surface of iron species and facilitates easy separation of colloidal Au NPs. As such, iron oxide based NPs were encapsulated by Au NPs as core-shell structures (Fe_3O_4/Au NPs) and followed further immobilization on *in-situ* synthesized reduced graphene oxide (rGO) as Fe_3O_4/Au NPs-rGO for increased stability. Fe_3O_4/Au NPs-rGO were evaluated for oxidation of NH-free indoles to synthesize isatins, potential precursors of SARS CoV 2 protease inhibitors. Furthermore, the application of isatin was explored with Fe_3O_4/Au NPs-rGO catalysed synthesis of uracil based spirooxindoles (potential precursors of anti-cancer compounds) *via* mild reaction conditions and shorter reaction time with high yields.

Keywords: Gold nanoparticles, core-shell, NH-free indoles, spirooxindoles.

Visible light-driven photocatalytic thiol–ene/yne reactions using anisotropic 1D Bi_2S_3 nanorods: a green synthetic approach

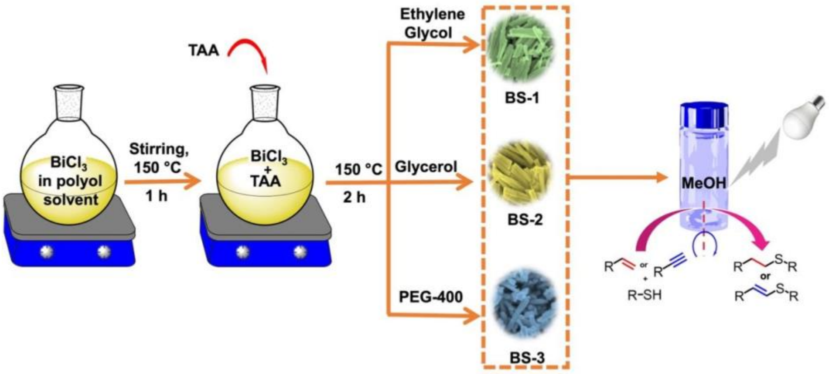
Haider Ali, **Bhagirath Mahto, Ashok Barhoi and Sahid Hussain***

Department of Chemistry, Indian Institute of Technology Patna, Patna 801103, Bihar, India.

Email: sahid@iitp.ac.in

Thiol–ene/yne click reactions play a significant role in creating carbon–sulfur (C–S) bonds, and there has been a growing interest in using visible-light photoredox catalysis for their formation. In this study, anisotropic 1D Bi_2S_3 nanorods were prepared using a simple polyolassisted reflux method, and they were used as catalysts for the thiol–ene/yne click reactions under visible light irradiation. The developed protocol is highly compatible and tolerant to various substrates with excellent product yields. Also, thiol–ene and –yne reactions achieved maximum TONs of 93 and 95, respectively. Detailed mechanistic studies were conducted and supported by NMR studies, radical trapping utilizing TEMPO, and ESI-MS product analysis. The ability of Bi_2S_3 nanorods to catalyze thiol–ene/yne reactions is primarily due to the creation of photoexcited holes, which aid in the formation of thiyl radicals. This method can be scaled up to the gram-scale synthesis of benzyl styryl sulfide with an excellent chemical yield of 90%. The 1D Bi_2S_3 nanorods also demonstrated structural and morphological stability throughout five reaction cycles while maintaining a favorable photocatalytic activity. The developed methodology had the advantages of broad substrate scope, mild reaction conditions, scaled-up synthesis, and nonrequirement of free radical initiators.

Keywords: Bismuth sulphide, 1D nanorods, Photocatalyst, Click reaction and Thiol ene/yne reaction.



Scheme: Schematic diagram for synthesizing BS-1, BS-2, and BS-3 and their use as catalysts for visible-light-driven thiol–ene/yne click reactions.

Design, Synthesis and Metal Ion Sensing Novel Utilizing NIR Sensitive Symmetrical Squarine Dye-Probes

*Sushma Thapa, Shekhar Gupta, Safalmani Pradhan, and Shyam S. Pandey

Graduate School of LSSE, Kyushu Institute of Technology, 2-4, Hibikino, Wakamatsu, Kitakyushu 808-0196, Japan
Email: sushmathapa858@gmail.com

Metal ions such as Cu^{2+}, Zn^{2+}, Ca^{2+}, Na^{+}, K^{+} etc. play a vital role in controlling the physiological processes in living beings, where Cu^{2+} is 3rd most abundant metal in the human body. Especially, the presence of excess amounts of heavy metal ions like Pb^{2+}, Cd^{2+}, Hg^{2+}, As^{3+} etc. have been reported to induce diseases like anaemia, neurological disorders, memory loss and kidney disorders. This necessitates the determination of metal ions in biological and environmental samples to monitor environmental pollution and diagnosis of clinical disorders. Monitoring the spectral changes in the near-infrared (NIR) wavelength region alleviates the prior processing of the biological samples owing to the least auto-fluorescence by other biological components making them highly suitable for bio-sensing applications. In this work, novel NIR-sensitive squaraine dyes having terminal functionalities that possess specific binding affinity toward Cu^{2+} ions have been successfully synthesized, and their metal-sensing properties were investigated using UV-visible absorption and emission spectroscopy.

The chemical structure of the newly designed sensing probes is shown in Fig. 1 (inset), which were synthesized and characterized. Absorption and emission spectra of probe-1 shown in **Fig. 1** reveal that the absorption maximum ranged from 668 nm - 681 nm, and the maxima fluorescence wavelength ranged from 686 nm to 700 nm. The very small Stokes shift of about 20 nm represents the conformational stability of probes in the excited state. In acetonitrile solution, Probe-1 exhibits a blue colour and becomes completely colourless in the presence of Cu^{2+} ions. Interestingly, under similar conditions, there was no colour change in the presence of metal ions such as Li^{+}, K^{+}, Ag^{+}, Cs^{+}, Co^{2+}, Zn^{2+}, Ca^{2+}, Mg^{2+}, Ni^{2+}, Cd^{2+}, Fe^{2+}, Al^{3+} and Cr^{3+} ions demonstrating Probe-1 to be a selective chemosensor for Cu^{2+} ions. The Job's plot and Benesi-Hilderbrand analysis revealed that Probe 1 and Cu2+ ions interact with 1:1 molecular stoichiometry.

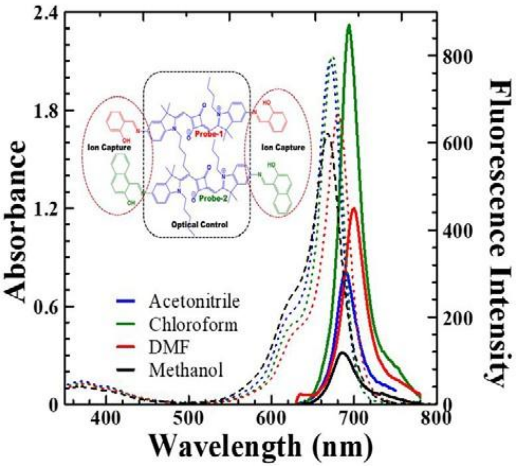


Fig. 1. Absorption (dotted line) and emission (solid line) spectra of sensing probe-1 in different solvents. Chemical structure of sensing probes is shown in inset.

Keywords: Squaraine dyes, NIR, Chemical sensor, Metal ion-sensing, Competitive interaction

The possibility of metabolism in extracellular vesicles: An FASN point of view

Namita. N. Kashyap and Dinesh. Upadhya*

Centre for Molecular Neurosciences, Kasturba Medical College, Manipal Academy of Higher Education, Manipal-576104.

Email: dinesh.upadhya@manipal.edu

Background: Extracellular vesicles (EVs) are nanoparticles loaded with carbohydrates, lipids, proteins, and cellular metabolites, secreted by the cells into the interstitial space. These circulatory nano-messengers are known to establish cell-cell communication, thereby influencing the microenvironment of the target cells. Enzymes, catalysing biochemical reactions, are important constituents of EVs. Fatty acid synthase (FASN), an enzyme involved in the synthesis of fatty acids is one among the top hundred proteins present in EVs. In the current investigation, we seek to comprehend the role of FASN in the EVs with varied exogenic concentrations of glucose.

Methodology: EVs were isolated from conditioned media of HEK293T cells. Following that, the EVs were resuspended in sterile phosphate buffer. These EVs were characterized by transmission electron microscopy (TEM), immunoblotting, and nanoparticle tracking analysis (NTA). Since glucose is an upstream substrate of fatty acid synthesis, EVs were treated with varying concentrations of glucose and protein levels of FASN were relatively quantified by immunoblotting.

Results: NTA characterization of the preparation showed optimal size and concentration of EVs. They were further validated using existing EV markers- CD63, TSG101 and HSP90β1. TEM imaging confirmed their spheroidal morphology. When EVs were supplemented with increasing concentrations of glucose, FASN protein concentration was found to decrease.

Conclusion: Our study shows that EVs possess metabolically active FASN whose protein levels are influenced by glucose. Understanding the role of FASN in EVs could help us to better understand metabolic diseases like diabetes. Further studies are warrantied.

Keywords: Extracellular vesicles, metabolism, fatty acid synthase.

Synthesis of Porphyrin appended Single walled carbon nanotube and its Electrocatalytic Application

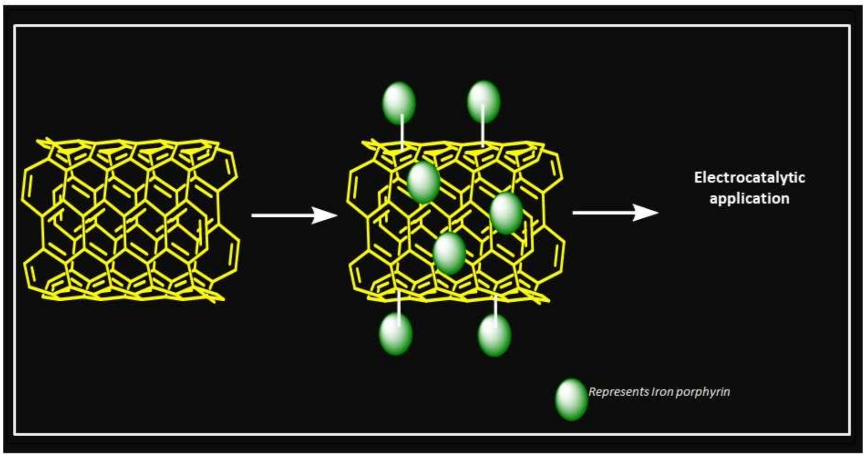
A. Srivastava[a], V. Bhardwaj[b] and M. Sankar* [a,b]

[a] Center for Nanotechnology, Indian Institute of Technology Roorkee, Roorkee-247667, India
[b] Department of Chemistry, Indian Institute of Technology Roorkee, Roorkee-247667, India

Email: m.sankar@cy.iitr.ac.in

Porphyrins are naturally occurring colored compounds that play many vital roles in fundamental biological processes. Tetrapyrrole macrocycle is naturally found as heme in hemoglobin, chlorin in chlorophyll, corrin in vitamin B_{12} etc. Chemically, porphyrins are aromatic tetrapyrrolic macrocycles having 18 π-conjugated electronic system. An A_3B type metalated iron porphyrin was synthesized because of its biological importance such as it serves as prosthetic group in myoglobin, hemoglobin, peroxidase and various other heme proteins. Later, this metalated porphyrin moiety was conjugated with single-walled carbon nanotube (SWCNT) by covalent interaction. Carbon nanotubes possess important properties such as- lightweight, high conductivity, high tensile strength etc, which makes it a useful material in various applications. Synthesis of nanoconjugate was followed by its characterization which was done by various techniques such as UV-Visible spectroscopy, IR spectroscopy, SEM and TEM analysis, powder XRD and TGA so as to confirm its composition. The resulting synthesized nanoconjugate exhibits high surface area, high electrical conductivity and enhanced stability which was utilized for electrocatalytic application. Therefore, the electrocatalytic activity of porphyrin-SWCNT nanoconjugate was evaluated for oxidation reduction reaction (ORR). As a result of which, nanoconjugate showed excellent ORR activity with better stability. The enhanced electrocatalytic activity of nanoconjugate is evident of the synergistic effect between Fe-Porphyrin and SWCNT which increased the electron transfer and catalytic activity of the material. In summary, this nanoconjugate shows great potential for various electrochemical applications such as sensors, fuel cells etc.

Keywords: Single walled carbon nanotube, porphyrin, electrocatalytic activity, oxidation-reduction reaction.



Synthesis of CuO nanoparticles and study of its different characteristics for application in visible light photocatalysis

M. Sarma* [1], **Manju Kumari Jaiswal**[2], **Biswajit Choudhury**[2], **A. R. Pal**[2] **and S. Karmakar**[1]

[1] Dept. of Instrumentation and USIC, Gauhati University, Guwahati-781014, Assam.
[2] Physical Sciences Division, IASST, Paschim Boragaon, Garchuk, Guwahati-781035

Email: sarmamintu9@gmail.com

Copper oxide nanoparticles (CuO-NPs) are the emerging semiconductor-based photocatalysts that can be used the organic dye degradation under visible light irradiation. In this work, we synthesized three samples of CuO-NPs having molarity of 0.01M,0.02M, and 0.03M and denoted them as A1, A2, and A3 respectively. These samples were synthesized using the required amount of copper acetate monohydrate ($Cu(CH_3COO)_2.H_2O$) and Sodium hydroxide (NaOH) by the wet chemical method. The synthesized samples of CuO-NPs were confirmed by XRD and their intrinsic characteristics were also studied. The diffraction peaks seen in XRD patterns and their corresponding planes revealed the crystalline characterization having monoclinic phase of CuO-NPs. The FESEM and TEM images showed that CuO-NPs are highly prone to agglomeration. The photocatalytic behavior of CuO-NPs was studied in the degradation of methylene blue (MB) dye solution under visible light irradiation. The band gap energy of samples A1, A2, and A3 were found to be 1.38 eV,1.65 eV, and 1.72 eV respectively and their respective photocatalytic efficiencies were found to be 71.57%, 70.52%, and 68.42% respectively.

Keywords: nanoparticles, photocalyst, degradation, visible light

References:

1. K. Sahu, J. Singh, and S. Mohapatra, “Catalytic reduction of 4-nitrophenol and photocatalytic degradation of organic pollutants in water by copper oxide nanosheets,” *Opt. Mater. (Amst).*, vol. 93, pp. 58–69, Jul. 2019, doi: 10.1016/j.optmat.2019.05.007.
2. P. K. Mondal, R. Ahmad, and R. Kumar, “Adsorptive removal of hazardous methylene blue by fruit shell of Cocos nucifera,” *Environ. Eng. Manag. J.*, vol. 13, no. 2, pp. 231–240, 2014, doi: 10.30638/eemj.2014.026.
3. B. T. Sone, A. Diallo, X. G. Fuku, A. Gurib-Fakim, and M. Maaza, “Biosynthesized CuO nano-platelets: Physical properties & enhanced thermal conductivity nanofluidics,” *Arab. J. Chem.*, vol. 13, no. 1, pp. 160–170, 2020, doi: 10.1016/j.arabjc.2017.03.004.

Value addition of lignin to Zingerone using recyclable $AlPO_4$ and Ni/LRC catalysts

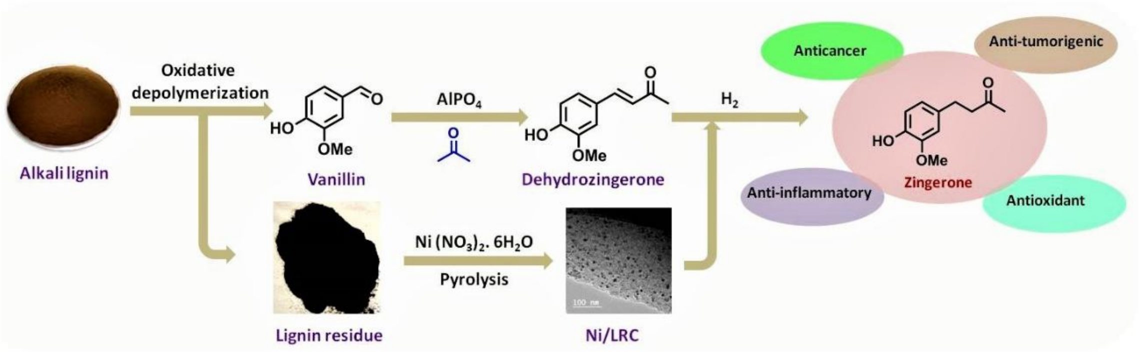
Baint Singh, Ganesh Naik, Kishore Natte and Anand Narani*

CSIR-Indian Institute of Petroleum
Haridwar road, Mohkampur, Dehradun, 248 005 India

Email: naranialr1@gmail.com

Value-addition of lignin to chemicals and medicinal compounds is highly desirable for bio-refineries and chemical industries. We present a simple and intriguing two-step method for synthesizing zingerone from vanillin. The first step was to make dehydrozingerone via aldol condensation of vanillin and acetone in the presence of an $AlPO_4$ catalyst. At 120 °C for 24 h, this catalyst showed outstanding activity, with 99% selectivity of dehydrozingerone. Second, utilizing lignin residual carbon assisted Ni nanocatalyst (Ni/LRC), the dehydrozingerone was transformed into targeted zingerone by selective hydrogenation of the C–C double bond. The reaction parameters significantly influenced the formation of both dehydrozingerone and zingerone. The Physico-chemical properties of both the catalysts (AlPO4 and Ni/LRC) were thoroughly investigated by NH_3 and CO_2 TPD, Py-FTIR, XRD, N2 adsorption–desorption, ^{27}Al, and ^{31}P MAS NMR and FT-IR analysis. Interestingly, both $AlPO_4$ and Ni/LRC catalysts were effectively recovered and reused for 10 cycles without apparent loss in catalytic activity for their respective reactions. Zingerone was eventually synthesized directly from lignin for the first time, with yields of 9.25 wt% on initial lignin intake.

Keywords: Lignin, Value addition, Vanillin, Dehydrozingerone, Zingerone.



Enhanced Catalytic Activity for Electro-Oxidation of Methanol and Ethanol with Homogeneous 3d-Metal based Anodic Electro-catalysts in an Alkaline Media

N.Tanwar; H.Narjinari and A. Kumar*

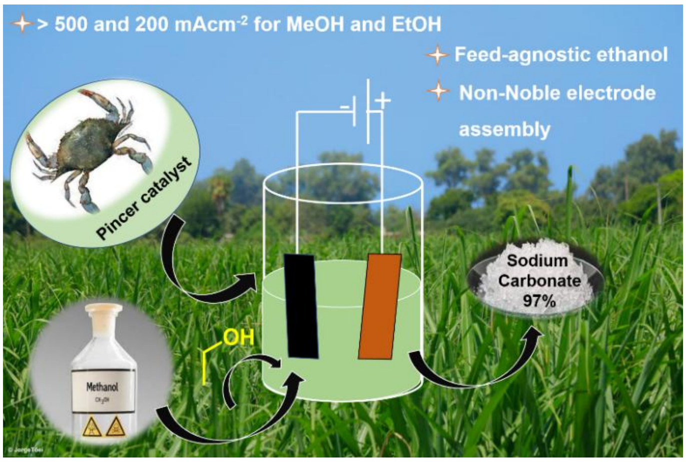
Indian Institute of Technology, Guwahati, Assam, India

Email: akshaikumar@iitg.ac.in

The high efficiency of fuel cells for conversion of chemical energy into electrical energy has led an upsurge interest of the researchers to explore the perquisites of alcohol fuel cell technologies due to their low cost, environment friendliness and high energy density particularly in ethanol and methanol-based fuel cells. In view of this, homogeneous electro-catalytic systems with inexpensive base metal Ni, Co and Cr have been attempted for the electro-oxidation of alcohols (methanol and ethanol) constituting a key half-cell component of direct alcohol fuel cells (DAFCs). The methanol and ethanol tolerance of different catalysts were evaluated using various electrochemical studies (CV, LSV, CA) with and without argon purging in a homogeneous solution of aqueous electrolyte containing alcohol and base along with the catalyst.

A complete carbon-based working as well as counter electrode half-cell assembly was employed and it was found to give remarkable results for both methanol as well as ethanol electro-oxidation. Ni/Co/Cr metal salts and their pincer complexes have been used as homogeneous anodic electro-catalysts for the alcohol half-cell reactions. Amongst them, catalytic systems based on Co outperformed the corresponding systems based on Ni and Cr for both the methanol [5 M] electro-oxidation (> 500 mA cm^{-2}) and for the ethanol [5 M] electro-oxidation (>200 mA cm^{-2}). The optimized catalytic condition was proficient enough to completely oxidize alcohol to carbon dioxide which readily reacts with the aqueous alkaline electrolyte to form the corresponding alkali carbonate (up to 96% yield) which holds commercial applications for industrial purposes along with mitigation of any possible hazards of greenhouse gas emission. The cell-assembly operating with non-noble working and counter electrodes with catalytic system based on earth-abundant, base metal salt/complex which not only results in good half-cell current densities for high-energy power-source DAFCs but also generates high-value sodium carbonate offers exciting avenues.

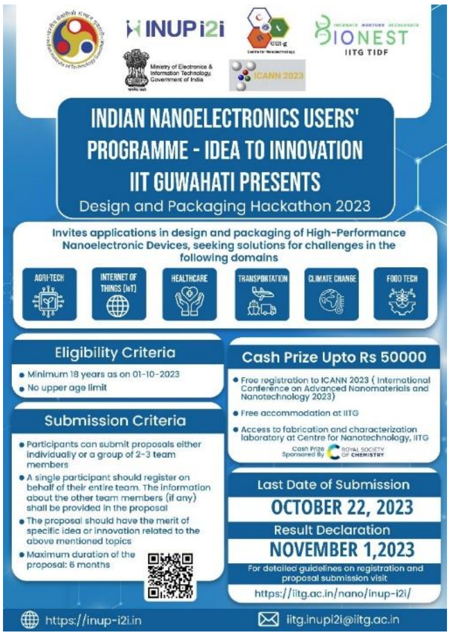
Keywords: Direct Alcohol Fuel Cells, Methanol Electro-oxidation, Ethanol Electro-oxidation, Electro-Catalysis, Non-Noble Electrode Assembly.



HACKATHON on 5G & 6G Technologies
and
Design and Packaging

INUP i2i

IIT Guwahati is organizing a Hackathon on the themes, “5G & 6G Technologies” and “Designing & Packaging”, under the programme of Indian Nanoelectronics Users Programme – Idea to Innovation, supported by Ministry of Electronics and Information Technology, Govt. of India. The grand challenge Hackathon is in collaboration with BioNEST, IIT Guwahati and ICANN (IIT Guwahati). The cash prize is sponsored by the Royal Society of Chemistry (RSC). It is open nationwide to all (individual or team) above 18 years who want to come up with an innovative solution in the domains of Agri-tech, IoT, Healthcare, Transportation, Climate Change and Food tech. For the theme, “Design and Packaging”, the focus is given on the development of high-performance nanoelectronic devices. Furthermore, using the theme, “5G & 6G technologies” with areas in materials, sensors, transmitter and receivers, applicants are expected to aim at solving the domains as mentioned earlier. 12 participants are shortlisted for the final pitching on 30 November 2023 as a part of ICANN 2023.
For further details, visit (https://www.iitg.ac.in/nano/inup-i2i/index.html).



INDIAN NANOELECTRONICS USERS' PROGRAMME - IDEA TO INNOVATION
IIT GUWAHATI PRESENTS
Design and Packaging Hackathon 2023

Invites applications in design and packaging of High-Performance Nanoelectronic Devices, seeking solutions for challenges in the following domains

Eligibility Criteria
- Minimum 18 years as on 01-10-2023
- No upper age limit

Submission Criteria
- Participants can submit proposals either individually or a group of 2-3 team members
- A single participant should register on behalf of their entire team. The information about the other team members (if any) shall be provided in the proposal
- The proposal should have the merit of specific idea or innovation related to the above mentioned topics
- Maximum duration of the proposal: 6 months

Cash Prize Upto Rs 50000
- Free registration to ICANN 2023 (International Conference on Advanced Nanomaterials and Nanotechnology 2023)
- Free accommodation at IITG
- Access to fabrication and characterization laboratory at Centre for Nanotechnology, IITG

Cash Prize Sponsored By ROYAL SOCIETY OF CHEMISTRY

Last Date of Submission
OCTOBER 22, 2023
Result Declaration
NOVEMBER 1,2023
For detailed guidelines on registration and proposal submission visit
https://iitg.ac.in/nano/inup-i2i/

https://inup-i2i.in
iitg.inupi2i@iitg.ac.in

INDIAN NANOELECTRONICS USERS' PROGRAMME - IDEA TO INNOVATION
IIT GUWAHATI PRESENTS
5G & 6G TECHNOLOGIES HACKATHON 2023

Invites applications in Sensors, Transmitters and Receivers using 5G and 6G Technologies, seeking solutions for challenges in the following domains

Eligibility Criteria
- Minimum 18 years as on 01-10-2023
- No upper age limit

Submission Criteria
- Participants can submit proposals either individually or a group of 2-3 team members
- A single participant should register on behalf of their entire team. The information about the other team members (if any) shall be provided in the proposal
- The proposal should have the merit of specific idea or innovation related to the above mentioned topics
- Maximum duration of the proposal: 6 months

Cash Prize Upto Rs 50000
- Free registration to ICANN 2023 (International Conference on Advanced Nanomaterials and Nanotechnology 2023)
- Free accommodation at IITG
- Access to fabrication and characterization laboratory at Centre for Nanotechnology, IITG

Cash Prize Sponsored By ROYAL SOCIETY OF CHEMISTRY

Last Date of Submission
OCTOBER 22, 2023
Result Declaration
NOVEMBER 1, 2023
For detailed guidelines on registration and proposal submission visit
https://iitg.ac.in/nano/inup-i2i/

https://inup-i2i.in
iitg.inupi2i@iitg.ac.in

Centre for Nanotechnology @iit-g

इलेक्ट्रॉनिकी एवं सूचना प्रौद्योगिकी मंत्रालय
MINISTRY OF ELECTRONICS AND INFORMATION TECHNOLOGY

ICANN 2023

BIONEST IITG TIDF

ICMR INDIAN COUNCIL OF MEDICAL RESEARCH
Serving the nation since 1911

DOCTOR'S CONCLAVE

8th International Conference on Advanced Nanomaterials and Nanotechnology ICANN 2023

(29TH NOVEMBER TO 1ST DECEMBER, 2023)

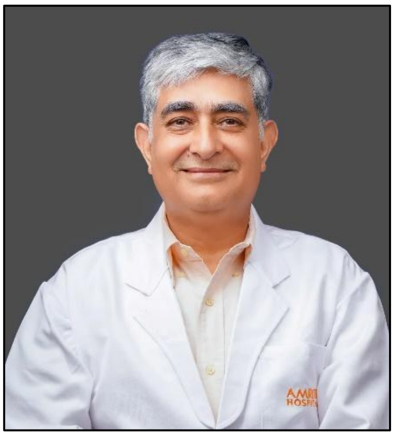
Dr. Puneet Dhar
Dr. Arjun Alva
Dr. Amit Haldar
Dr. Girish Menon Ramachandran
Dr. Leslie Edward S Lewis
Dr. Sunip Banerjee
Dr. Neeraj Siddharthan
Dr. Srikanth Moorthy

Organized By
Centre for Nanotechnology
IIT Guwahati

SPONSORED BY

ROYAL SOCIETY OF CHEMISTRY
ChemDist
ACS Chemistry for Life
JEOL
ऑयल इंडिया लिमिटेड
Oil India Limited
molbiogen

Dr Puneet Dhar
Professor and Head GI Surgery and Chief Administrator Surgical Services,
Amrita Hospital Faridabad and Amrita School of Medicine Faridabad



Gastrointestinal and Hepatopancreatobiliary Surgery

Current

- Professor and Head GI Surgery and Chief Administrator Surgical Services
- Amrita Hospital Faridabad and Amrita School of Medicine Faridabad

Immediate Past

- Prof and Head GI HPB Surgery and Organ transplant
- Dean UG Research and Dean Students Welfare AIIMS Rishikesh

Special Interests

- Pancreas, Neuroendocrine Tumours, Antimicrobial Stewardship, Surgical Education

Extra-curricular interests

Bird Photography, Music and Travel

Dr. Neeraj Siddharthan

General Medicine, DNB (General Medicine), DM (Clinical Hematology)

Blood and Marrow Transplantation, Clinical Haematology & Stem Cell Transplantation

Current

- Associate Professor, Department of Clinical Hematology and Stem-cell Therapy, Amrita Institute of Medical Sciences, Kochi

Special Interests

- Bone Marrow Transplant for malignant and non-malignant disorders
- Paediatric Leukemias
- Acute Myeloid Leukemias
- Myelomas
- Relapsed Lymphomas
- Hemophilia
- Flow Cytometry

Achievements

- Tamilnadu MGR Medical University medal in Clinical Hematology for the year 2010.
- Professor T. K. Raman Memorial Gold Medal for the best postgraduate student in General Medicine in 2005, University of Kerala, Thiruvananthapuram.

Dr. Vimal Bharadwaj D MD, Fellowship (Critical Care Medicine)

Critical Care

Current

- Intensivist at Narayana Health City, Bangalore. Managing cardiac ICU, Post heart/ heart-lung transplant care and managing Hospitalist course.
- Director of Ikannekt Biomedical Research Pvt Ltd.

Field of Expertise:

- Critical care
- Ventilatory Management of ARDS
- Critical Care Ultrasound
- Toxicology
- Sepsis with multi organ failure

Awards & Achievements:

- EDIC from ESICM
- Medicine topper in Med School
- Guest faculty in various CME and Conferences
- Four (4) patents

About:

A POCUS enthusiast and passionate about venous congestion and Right ventricular function; has conducted multiple workshops on VExUS in India and abroad. A staunch believer in bridging gap between biomedical engineer and medical profession for development of cutting edge technologies.

Dr. Sunip Banerjee
DM, MD, Fellowship Society for Cardiovascular Angiography and Interventions, Fellowship American College of Cardiology

Paediatrics & Neonatology

Current

- Chief, Ruby General Hospital, Kolkata.

Immediate Past

- Professor, PGI Chandigarh.
- Senior Consultant, RTIICS.
- Principal Supervisor of academic courses at the Medica Institute of Cardiac Sciences

Special Interests

- Radial Intervention & Primary Angioplasty Radial angioplasty
- Primary angioplasty
- Peripheral angioplasty (Carotid& Peripheral)
- Various clinical trials Heart failure cases
- FFR (Fractional Flow Reserve)
- Cardiac resynchronization therapy (CRT)

About

Dr. Banerjee is among the pioneers in interventional cardiology, radial intervention and primary angioplasty in eastern India. He is reputed as a cardiac surgeon to perform complex interventions including primary angioplasty, radial angioplasty, primary angioplasty, peripheral angioplasty, cardiac resynchronisation therapy and treating heart failure cases.

Dr. Girish Menon Ramachandran
DNB Neurosurgery, MCh, FRCS, DHM, PGDMLE

Neurosurgery

Current

- Professor and Head Neurosurgery, Kasturba Medical College, Manipal, Manipal Academy of Higher Education

Immediate Past

- Professor Neurosurgery, Sri Chitra Tirunal Institute for Medical Science & Technology

Recognition

- Neuroendoscopy fellowship Germany 2006
- H index (Scopus) 18; I 10 (Google scholar): 40

Special interests

- Cerebrovascular surgery, Epilepsy surgery, Sellar/suprasellarr tumours

Dr. Leslie Edward S Lewis

DCH, DNB (Paediatrics), Neonatology – Childrens Westmead Hospital Australia

Paediatrics & Neonatology

Current

- Professor and Head, Paediatrics & Neonatology, Kasturba Medical College, Manipal, MAHE
- Faculty of Medical Education Unit, MAHE
- **Over 20 years of research experience**

Special Interests

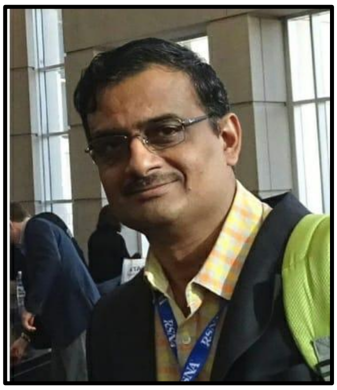
- Developed NICU at KMC equipped to handle neonatal cardiac surgeries
- Inborn errors of metabolism, neonatal sepsis, gut microbiome, perinatal asphyxia and preterm complications

Awards & Recognitions

- Recipient of prestigious India Giani Fund (Yale University, Connecticut)
- Certified NRP/PALS trainer (max number of NRP in 2014 (India)
- Best UG teacher for 3 consecutive years

H-index – 20; i-10 index – 40; Publications – 212

Dr. Srikanth Moorthy MD, PDCC



Radiology-Imaging-Interventional Radiology

Current

- Professor and Head of Department, Interventional Radiology, Amrita Institute, Cochin

Special Interests

- Hepatobiliary intervention, Benign biliary strictures, Budd Chiari syndrome, Pancreatic pseudoaneurysm IR management

Dr. Soumik Goswami
DM(Endocrinology), MD(Medicine)

Endocrinology & Diabetes

- Assistant Professor at the Dept. Of Endocrinology, NRS Medical College, Kolkata.
- Consultant Endocrinologist, Manipal Hospital, Salt Lake and AMRI, Mukundapur
- Treasurer, Endocrine Society of Bengal.

Awards & Achievements:

- Awarded Gold Medal in Physiology and Gold Medal for Dissertation work in MD (Medicine)
- Placed 1st in Medical College Calcutta, 2nd in the University in the Final MBBS examination and 2nd in the University in DM (Endocrinology) examination.
- Awarded the BC Roy Memorial medal, Dr. Nilmadhab Sarkar Memorial Award Medal, Dr. Sailen Sen & Dr. Sunil Sen Award Medal, Kunja Kumar Scholarship, Karalipada & Adyashakti Sarkar Memorial Silver Medal, Arijit Banerjee Memorial Award and AV Gandhi Award for Excellence in Endocrinology – Best Clinical Acumen in 2014.
- Awarded the Inspiring Diabetologist & Endocrinologist of India award at The Economic Times Doctors' Day Conclave 2019 at New Delhi on 29th June 2019.

Publications:

- 78 publications till date in peer-reviewed indexed national and international journals.
- Co-author of several chapters on Endocrinology in several textbooks.

ICANN 2023

Invited Talks

Industry Academia Partnerships for Technology Translation & Sustainable Development Goals

Speakers

Dr. Nandakumar Jairam
Chairman, Medica Synergie

Dr. Alok Nikhil Jha
IIIT Delhi

Ramesh Kumar V
Co-Founder
Grahaa Space

Vivek Mishra
Founder & CEO
FibroHeal Woundcare

CONTACT US

☎ 0361 2910391
www.iitg.ac.in/bionest/
bionest.iitg@gmail.com

Dr. Nandakumar Jairam
Chairman Medica Synergie, Shyamrad

Dr Nandakumar Jairam currently is Chairman Medica Synergie, Shyamrad and an advisor Sheares India and an independent Health care advisor for a number of health care related organizations. He was the Chairman, CEO and Group Medical Director for Columbia Asia Hospitals in India. He was associated with Columbia Asia through its journey in India. He continues as member of the board for Columbia Pacific communities. He is a Board member of VST tractors and tillers and of Medica Synergi hospitals. He holds the position of President for the RBANMS trust. He serves on the Board of ACESO a non-profit organization for global health initiative. He serves on the Board of Aditya Birla health insurance co ltd. He has been inducted on the Boars of Portea. He is the Prseident of GAPIO. He was the Chairman of the NABH under the auspices of QCI (Quality Council of India), and Past Chairman of the health services committee of FICCI. He was a member of the Health insurance forum of IRDA and FICCI. He is the founder member of NATHEALTH and Secretary of GAPIO as well as the founder trustee for Terry Fox foundation Bangalore until its existence. He founded Krishna charitable trust. Till recently, Dr. Jairam was also a Consultant Colorectal and General Surgery for Columbia Asia. He is also responsible for the development of the self -help group for Ostomy patients, and was the Vice President of Ostomates, India until 2007. He was the Chairman, Health CII institute of quality from 1999 for a period of two years. He also led the delegation of health professionals as its Chairman, to England under the Indo UK partnership treaty. From 1996 to 1998 he was the Medical director of Mallya Hospital, Bangalore. He was secretary of a charitable hospital the Dhanavanthri Hospital between 1997 and 2000. Between 1980 and 1994, he served at St John’s Medical College and Hospital firstly as lecturer, later as assistant professor, associate professor, Professor and head of Surgery and member of the Board of administration of SJMCH. Dr Nandakumar Jairam is trained in colorectal and Minimally Invasive Surgery. He is an alumnus of Bangalore Medical College, National College, Basavanagudi and Bishop Cottons School, Bangalore, India. He has several papers including publications in the prestigious British journal of Surgery and presentations to his credit. He was awarded the FRCS in 2017, awarded as the health care personality of India by FICCI in 2017 and the life time achievement award by ALERT in 2019. He is the recipient of the health care award of Medgate 2021 and the life time achievement award of FICCI in healthcare 2021.

Dr. Alok Nikhil Jha
Head-Development, Innovation & Resources, IIIT Delhi

Dr. Alok Nikhil Jha, the dynamic head of the Development and Resource Generation Office at IIIT Delhi. With a keen eye for fostering innovation, Dr. Jha plays a pivotal role in steering technology and research towards creating tangible value for industries, startups, government entities, and corporations.Dr. Jha's impactful journey includes spearheading the establishment and growth of technology incubation and startup ecosystems. His past role as the Chief Operating Officer at the Innovation Center at IIIT Delhi and Coordinator of Incubation and IPR at Innovation Center Delhi University showcases his commitment to nurturing entrepreneurial ecosystems. Notably, he played a significant part in conceptualizing and setting up the incubator for Ryerson University Canada in India as early as 2012. Beyond his organizational endeavors, Dr. Jha has been a part of India's entrepreneurship landscape at a national level. His contributions as a member of the Advisory Group to the Honorable Prime Minister during the formulation of entrepreneurship guidelines for India underscore his commitment to shaping the country's entrepreneurial framework. With his startups in both India and Canada in the realms of technology and social impact, Dr. Jha brings a wealth of experience. His entrepreneurial spirit is further exemplified by his role in leading the startup framework of Delhi on behalf of the Delhi Industrial Department.

A seasoned professional, Dr. Jha has accumulated nearly two decades of experience in technology design, development, and strategy. His journey includes significant roles with renowned Corporates such as Adobe Systems, Statestreet, Wipro, and teaching and research in IIIT Delhi, IIT Delhi, University of Delhi, Delhi Skill University and DTU and also led ICT Interventions & eGovernance at Ministry of Agriculture for Government of India. An alumnus of IIT Delhi, Dr. Jha's interdisciplinary expertise in technology and entrepreneurship is a testament to his passion for research and innovation. With his experience he fills up the gaps from lab research to a comemrcial business usecase of technology. Currently, he sits on the research and advisory boards of several startups, incubators, and research institutions, supporting them in building the impact and to foster growth and excellence.

LinkedIn profile: http://linkedin.com/in/aloknikhil

Vivek Mishra
Founder & CEO, FibroHeal Woundcare

A techno commercial management professional, Worked in various industries and capacities in the field of medical devices, pharmaceuticals, food, and nutrition, Agri and seed business). He started his current venture in the year 2017 which is based on silk protein derived wound management solutions called FIBROHEAL WOUNDCARE PVT LTD. Fibroheal is working to address various types and stages of wounds and become a comprehensive wound management company from India addressing various types of acute, chronic, traumatic and post operative wounds through their IP protected technology and have more than half a dozen patents to its name.

Fibroheal is 1st company from India to have commercialized **silk proteins to heal different types of wounds.**

Fibroheal is supported by CCAMP (Centre for Cellular & Molecular platforms), BIRAC, Dept of Information technology, biotechnology and science and technology, Govt of Karnataka, KITVEN Funds – Venture fund arm of Karnataka Govt, BIRAC – Dept of Biotechnology, Govt of India and EXIM Bank (Export Import Bank of India under "UBHARTE SITARE" program.

Vivek also serves as panelist on various committee including BIRAC, IIT Guwahati and various others BioNest and life sciences incubators and help ground breaking ideas take shape and come to the market.

Under Vivek's leadership, Fibroheal won titles of: -

1) **Winner of Elevate 100** – One of most innovative biotech start-ups organised by Dept of IT, BT & ST, Govt of Karnataka.
2) Winner of **"Start-up of the year"** under Smart Bio Award 2020 during Bengaluru Tech Summit 2020
3) **Winner of National Technology award 2020** for start-up organised by Technology Development Board, a statutory body under DST.
4) **Winner of "Best IP Managed Medtech Start-up"** during BIOPHARMA world IE 2021 Bio start- up awards.
5) Finalists of "National Start-up awards 2020".

Ramesh Kumar V
Co-Founder Grahaa Space

Ramesh is the Co-Founder & CEO of Grahaa Space - a pioneering spacetech startup based out ofBangalore, working on designing and developing an advanced constellation of nano satellites. GrahaaSpace was the only spacetech startup to receive the coveted South Australian innovation grant in 2022funded by Government of South Australia through the Innovation and Collaboration Center at theUniversity of South Australia, Adelaide. Grahaa Space has also received the Startup India Seed Fundearlier this year. Prior to Grahaa Space, he was part of a student satellite mission which was launchedinto low earth orbit through PSLV C-44 in 2019.

Ramesh co-lead the spacetech subgroup as part of the B20 - Technology, Innovation and R&D task forceat the recently concluded G20 Summit under India's presidency. The policy recommendations proposedby the taskforce has been published in the Communique. Based on the collaborative efforts withAustralian space ecosystem and for the contributions to the emerging commercial space sector in India, Grahaa Space has also been featured in the "Compendium of best practices of G20 nations" - released byMr.Kris Gopalakrishnan and his team at the B20 India Summit. As part of the budding spacetech startupecosystem, he has also contributed for the National Remote Sensing Policy, Space policy and the Deeptech policy. As a technology advocate, he is currently working with a startup developing a nano satellite basedmicrogravity lab to test food and medicine in space. He has presented and published technical papers innational and international conferences related to nano satellites and interplanetary exploration.

He is a non-resident Director at the Center for Emerging Technologies based out of Adelaide - that focuson research and development activities related to emerging and futuristic technologies. He is also partof the Society for Space Education, Research and Development (SSERD) - a non-profit organisationworking towards space education and research. An electrical engineer by profession, he holds an MBAfrom Manipal University. He is also a fellow of Start-up Leadership program and is also affiliated with anumber of organisations including Space Generation Advisory Council, The Planetary Society, ISRO, CII, FICCI, BCIC, TiE, International Centre for Theoretical Sciences, Barcamp, and International Associationfor Human Values.

Food & Medicine for Interplanetary Exploration: Challenges and Research Opportunities

Ramesh Kumar V

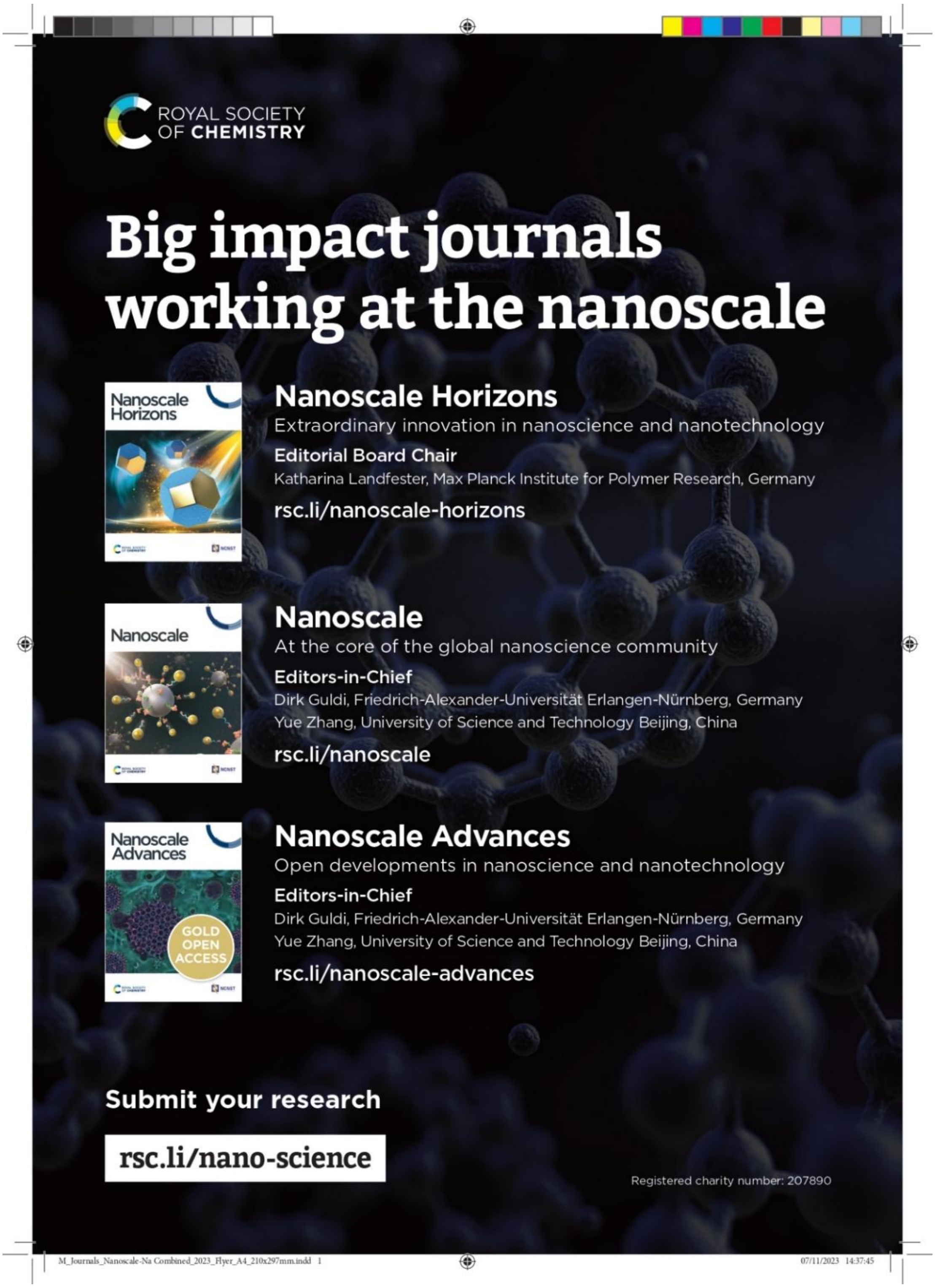
Space exploration involving humans presents unparalleled challenges, foremost among them beingthe sustenance and health of astronauts. Ensuring the well-being of astronauts is paramount forlong haul space missions, interplanetary exploration and long-term off-earth habitation in theabsence of re-supply from earth.

The diet of the astronauts is to be meticulously planned to provide optimal nutrition within limitedresources. Nutrient-dense, shelf-stable, easily preparable and palatable foods are vital to ensureastronauts receive essential vitamins, proteins, and minerals necessary for their physical and mentalwell-being. In addition, food serves as a psychological anchor, providing astronauts with a sense ofnormalcy and comfort amid the isolation of space. Shared meals and culturally familiar foodscontribute significantly to crew cohesion, mental health, and overall morale. Addressing thepsychological aspects of food consumption is crucial for maintaining crew dynamics and preventingemotional stress during lengthy missions.

Equally important is maintaining the health of the astronauts and it's important to ensure that theastronauts are protected from muscle atrophy, bone density loss, and radiation exposure. Microgravity also alters the human body's physiological processes, necessitating specialisedmedical interventions. Precision medicine tailored to individual astronauts' genetic predispositionsand health profiles, is also a promising avenue for personalised healthcare in space.

The convergence of food science, pharmacology, nanotechnology and biomedicine is drivinginterdisciplinary research to create synergistic solutions. Technologies involving pulsed electricfield, high pressure processing, micronisation, accelerated freeze drying and nano-engineered drugmanufacturing and delivery systems are revolutionizing space food and medicine respectively. Moreover, these innovations are not only vital for astronauts' well-being but also lay the groundworkfor future space colonization and sustainable habitation on extraterrestrial bodies like moon andmars.

Based on personal experiences from successfully realising a nano satellite bus and platform as part of translational research from astudent satellite mission, supporting the development of nano satellite based microgravity lab to test food and medicine inspace, exposure to analog space missions, insights from international collaborations related to plants for space (P4S) and Deep Space FoodChallenge, this session underscores the various challenges and opportunities in addressing food and medicinerequirements in the context of space exploration.



Nanoscale Horizons
Nanoscale
Nanoscale Advances
GOLD OPEN ACCESS

PROMPTECH INSTRUMENTS PVT. LTD.

Authorized Channel Partner of:-

Tektronix KEITHLEY A Tektronix Company Anritsu Advancing beyond MICROTEST We Make T & M Easier and Better

Greetings from Promptech Instruments Pvt Ltd!

We are pleased to introduce ourselves as authorized Channel Partners of Tektronix, Keithley, Anritsu, Microtest, Tabor Electronics, and Everbeing Probe Station.

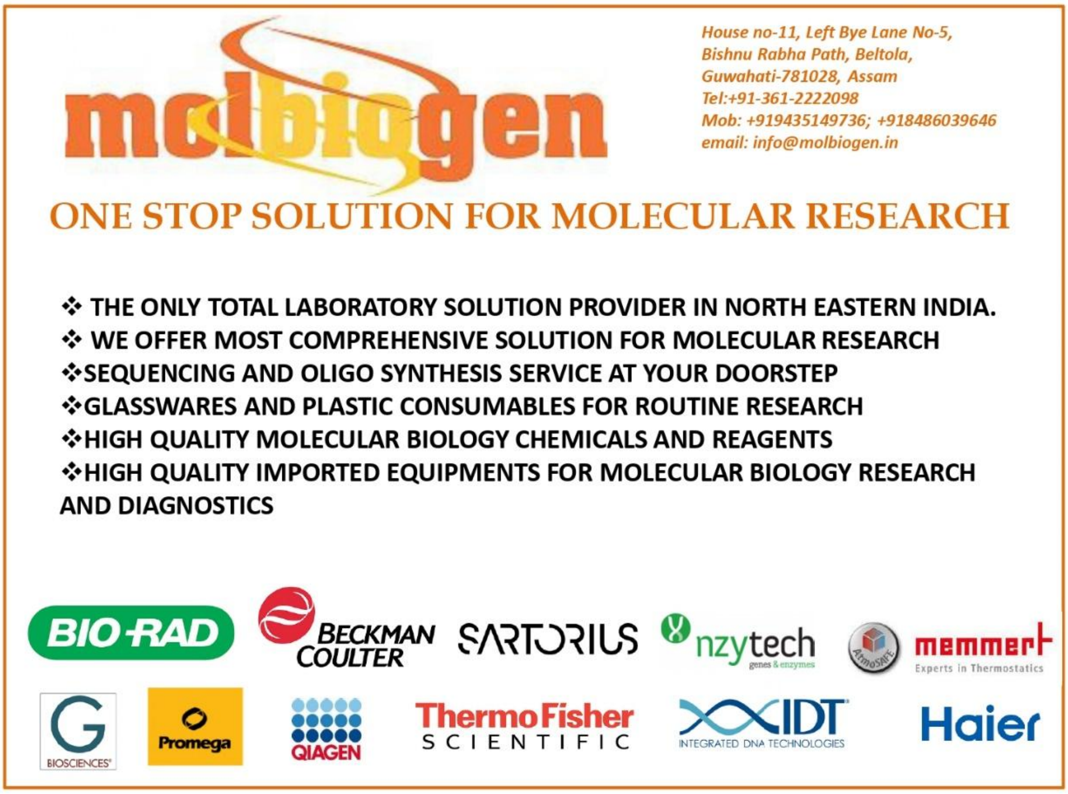
Promptech Instruments Private Limited is a leading provider of test and measuring instruments. With a commitment to precision and innovation, we specialize in delivering high-quality equipment designed to meet the diverse needs of industries ranging from electronics and telecommunications to manufacturing and research.

Our extensive range of test and measuring instruments encompasses cutting-edge technologies that empower businesses to ensure the accuracy, reliability, and performance of their products and processes. From oscilloscopes and spectrum analyzers to multimeters and programmable electronic loads, our portfolio is meticulously crafted to meet the stringent demands of today's dynamic and competitive market.

At Promptech Instruments Private Limited, we pride ourselves on not only providing top-notch products but also offering exceptional customer service. Our team of experts is dedicated to assisting clients in selecting the right instruments for their specific applications and ensuring seamless integration into their workflows.

We deal in Test and Measuring instruments -

- Oscilloscopes and Probes
- Waveform Generator
- Digital Multimeter
- Power Supply
- Power Analyzer
- Real-Time Spectrum Analyzer
- Vector Signal Generator
- Vector Network Analyzer
- Source Measure Unit
- Nanovoltmeter
- PicoAmmeter
- Electrometer
- Precision Current Source
- Semiconductor Parameter Analyzer
- Frequency Counters
- Optical Modulation Analyzer
- Data Acquisition System
- Solar Array Simulator
- AC/DC Power Supply
- AC/DC Electronic Load
- PCB Design Software
- PCB Prototype Machine
- DC and RF Probe Station
- LCR Meter & Impedance Analyzer


molbiogen
BIO-RAD
BECKMAN COULTER
SARTORIUS
nzytech genes & enzymes
AtmoSAFE
memmert Experts in Thermostatics
G BIOSCIENCES
Promega
QIAGEN
ThermoFisher SCIENTIFIC
IDT INTEGRATED DNA TECHNOLOGIES
Haier

JALDHARA & COMPANY
Guwahati Office : Pink Arcade, K. C. Sen Road, Paltan Bazar, Guwahati-781008 (Assam)
Jorhat Office : Mariani Road, Rajabari, Opp. Maruti Show Room, Jorhat-785014 (Assam)
E-Mail : jaldharaco@gmail.com, M: 9435090514, 9085081802
GSTIN/UIN : 18ABSPJ6886E1ZZ
GeM Seller Id: 691F180000337798
CHEMICALS-GLASSWARE-PLASTICWARE-SILICAWARE-INSTRUMENTS

Authorized Distributors:

1. HiMedia Laboratories Pvt. Ltd., Mumbai
2. Sigma Aldrich Chemicals Private Limited, Bangalore
3. Tarsons Products Pvt. Ltd., Kolkata
4. Imperial Life Sciences Pvt. Ltd., Gurgaon
5. Axiva Sichem Biotech, Delhi
6. GCC Biotech (India) Pvt. Ltd., New Delhi
7. Star Micronic Devices, New Delhi
8. Promega Biotech India Pvt. Ltd., New Delhi
9. Agile Lifescience Technologies India Pvt. Ltd., Maharastra
10. Allied Scientific Products, Kolkata
11. Avra Synthesis Pvt. Ltd., Hyderabad
12. High Purity Chemicals Pvt. Ltd. (HPLC), Mumbai
13. International Trade Links Instrumentation Pvt. Ltd., Mumbai
14. Jain Scientific Glass Works, Ambala Cantt.
15. Bioserve Biotechnologies (India) Pvt. Ltd., Hyderabad
16. Biotechno Labs, New Delhi
17. Rescholar Equipment, Haryana
18. Genetix Biotech Asia Pvt. Ltd., New Delhi
19. DSS Takara Bio India Pvt Ltd., New Delhi
20. Finar limited, Ahmedabad
21. Avantor Performance Materials India Limited, Gurugram
22. ZELLE Biotechnology Pvt. Ltd., Thane
23. Biotech Desk Pvt. Ltd., Hyderabad
24. IKON Instruments, Delhi
25. Hyclone Life Sciences Solutions (I) Pvt. Ltd., Kolkata
26. Centyle Biotech Pvt. Ltd., Uttarakhand
27. Topclass Enterprices LLP, New Delhi
28. Genaxy Scientific Pvt. Ltd., New Delhi
29. Secure Diagnostics Pvt. Ltd., Bhopal
30. REMI Sales and Engineering Ltd., Kolkata
31. Redcliffe Lifesciences Pvt. Ltd., Noida(UP)
32. ACS Chemicals, Ahmedabad
33. Nice Chemicals Private Limited, Ernakulam, Kerala
34. FILTROS (UK) Ltd., (A Unit Of Neeraj Exports), Jaipur
35. Microlit India, Lucknow etc

Solutions for Innovation

NEOARM

"NEOARM" / JEM-ARM200F comes with JEOL's unique cold field emission gun (Cold FEG) and a new Cs corrector (ASCOR) that compensates for higher order aberrations. The combination of a Cold FEG and ASCOR enables atomic-resolution imaging at not only 200 kV accelerating voltage, but also a low voltage of 30 kV.

"NEOARM" is also equipped with an automated aberration correction system that incorporates JEOL's new aberration correction algorithm for automatic fast and precise aberration correction. This system enables higher-throughput atomic-resolution imaging.

Furthermore, a new STEM detector that provides enhanced contrast of light elements is incorporated as a standard unit. Contrast enhancement of light elements is achieved by a new STEM imaging technique (e-ABF: enhanced ABF), facilitating observation of light-element materials, even at low accelerating voltages.

The microscope room is separated from the operation room to respond to a remote operation. In addition, JEOL products' new concept colors of "pure white" and "JEOL silver" are adopted, leading to a sophisticated exterior design of "NEOARM".

Learn more at: http://www.jeol.co.jp/in/
Send an enquiry: JEOL INDIA PVT. LTD.
Delhi, Kolkata, Mumbai, Bengaluru, Chennai, Hyderabad ,
(E)info@jeolindia.com

INCUBATE NURTURE ACCELERATE
BIONEST
IITG TIDF

Symbica

Meditio™
POWERED BY GETTHRILLS

FULONI

JSV INNOVATIONS
innovations for life

JR Ngurie
Work To Care

ALTANOSTICS
LABS PRIVATE LIMITED

BIHANGAM INDIA LLP
Diverse Vision of Life

KUMSHUNG

icmr INDIAN COUNCIL OF MEDICAL RESEARCH Serving the nation since 1911 | Department of Health Research Ministry of Health and Family Welfare Government of India | BENGALURU TECH SUMMIT | MDMS MEDICAL DEVICE & DIAGNOSTICS MISSION SECRETARIAT, ICMR *Nurturing Medtech Ecosystem*

mobilab™

By Primary Healthtech

Mobile Based Portable Lab

Mobilab™, is a portable clinical chemistry analyzer for a wide range of parameters. The Device can test 25 parameters related to the diagnosis of chronic diseases of **Kidney, Liver, Heart, Pancreas** and **Blood** among others.

20x Reduced Cost

100% Unlimited Storage

21+ Indian Languages

50x Light Weight

50x Low Powered

ISO 9001:2015 13485:2016

EMI/EMC
ESD - IEC 61000-4-2:2008
ESD - IEC 61000-4-8:2009

Drugs License
D/OL/KMP/22934 & D/OL/KMP/22935

MFG/IVD/2023/000083

GeM Government e Marketplace
Efficient • Transparent • Inclusive

Profiles of Diagnosis

- Pancreatic Profile
- Heart Profile
- Kidney Profile
- Liver Profile
- Haemogram

Supported By

Deployments and Events

PRIMARY HEALTHTECH PRIVATE LIMITED

R&D & Manufacturing Office
202A, Research Building, IIT Guwahati,
North Guwahati, Assam - 781039, India
Corporate Identity Number: U33301DL2018PTC333152
Mobile: +919315824671

Scan to Visit our Website

www.primaryhealthtech.com
info@primaryhealthtech.com

ICANN 2023

8th International Conference on Advanced Nanomaterials and Nanotechnology

भारतीय प्रौद्योगिकी संस्थान गुवाहाटी • Indian Institute of Technology Guwahati •

Serpentine Lake at IIT Guwahati

ACS Chemistry for Life®

JEOL

ROYAL SOCIETY OF CHEMISTRY

ChemDist

ऑयल इंडिया लिमिटेड
(भारत सरकार का उद्यम)
Oil India Limited
(A Government of India Enterprise)

molbiogen

MAYURI FURNITURE
DESIGN DEVELOP DELIVER

cnt @iit-g
Centre for Nanotechnology

November 29 – December 1, 2023

Organized by Centre for Nanotechnology, IIT Guwahati

इलेक्ट्रॉनिकी एवं सूचना प्रौद्योगिकी मंत्रालय
MINISTRY OF ELECTRONICS AND INFORMATION TECHNOLOGY
सत्यमेव जयते

INCUBATE NURTURE ACCELERATE
BIONEST
IITG TIDF

ICMR
INDIAN COUNCIL OF MEDICAL RESEARCH
Serving the nation since 1911

INUP i2i