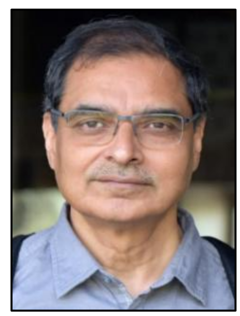
Sectional Committee -III

Chemistry

Chair
Prof. Amitava Das, FNA



Amitava Das obtained his Ph.D. from Jadavpur University, Kolkata, in 1989, followed by postdoctoral research at the Universities of Birmingham and Bristol, UK. He began his independent career at CSIR–CSMCRI in 1993, later serving as its Director and Distinguished Professor of AcSIR until 2019. He was Chief Scientist at CSIR–NCL (2013–2016) and is currently Visiting Professor at IISER Kolkata, where he was Senior Professor (2020–2025). A Fellow of all three Indian Science Academies, he has received several honours, including the ANRF–J. C. Bose Fellowship and CRSI Bronze and Silver medals. His research focuses on supramolecular chemistry, biomolecular recognition, and nanostructured therapeutics. He is an academic editor of iScience.

INSA Distinguished Lecture

Development of energy harvesting molecules: From structure to function

Surya Prakash Singh

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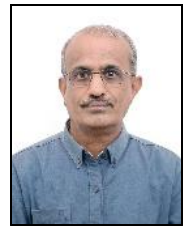
Energy is a crucial factor in driving social, economic, and industrial progress. Our daily energy consumption continues to rise gradually. In recent decades, rising energy demand has increased reliance on fossil fuels such as coal, petroleum and natural gas, releasing CO2 and contributing to global warming. Small organic molecules with suitable photophysical and electronic properties have garnered attention in advanced technology applications, especially in photonic devices such as dye-sensitized solar cells, organic solar cells, emissive displays like OLEDs; electronic materials such as organic semiconductors, and security printing. Organic photovoltaics are gaining popularity as a cost-effective, color-tunable, and mechanically flexible renewable energy technology. Numerous research endeavors aim to develop novel organic materials and enhance their efficiency and durability. Our research group is focussing on producing stable organic molecules for diverse applications. In the upcoming event, I will present our progress on developing hole-transport materials for perovskite solar cells. The presentation will commence with a brief introduction to solar cells, followed by an exploration of industrial applications and the commercialization potential of dye molecules.

Speaker's Profile

Dr. Surya Prakash Singh, is currently working as a Senior Principal Scientist at CSIR-Indian Institute of Chemical Technology (IICT), Hyderabad. He has been involved in the design and synthesis of materials and molecules for photonic devices. He has published over 250 research papers. BODIPY-based dyes for mitochondrial tracking developed by him have been commercialised by TCI (Japan). He is a recipient of several prestigious awards, like MRSI Medal, the CRSI-bronze Medal, Young Scientist Award, AVRA Young Scientist Award. Dr. Singh is a Fellow of the Telangana academy of sciences and Associate Fellow of the AP academy of sciences and INSA.

INSA New Fellow Lecture

Shock tube investigations reveal potential carrier for diffuse interstellar band λ5450



Elangannan Arunan

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Astrophysical shocks can contribute to the chemical evolution of the interstellar medium. Only a few studies on the shock processing of cosmic analogues have been conducted so far. These have been done using the shock tube facilities established at the Indian Institute of Science, which has been extensively used in pyrolysis[1] and combustion[2] studies previously. Recently, we investigated the shock processing of coronene. This talk will highlight the results from shock tube experiments with post-shock analysis of the gaseous products and solid residues using various techniques coupled with molecular dynamics simulation.[3] Analysis of the emission spectrum indicates the presence of C_2 emission, a black-body radiation and a band around 540-550 nm. This band centered at 545 nm could originate from C_nH and it coincides with one of the bands in the diffused interstellar band (DIB) listed as λ5450.

Speaker's Profile

Prof. Elangannan Arunan had his BSc in Chemistry from The American College, Madurai and M.Sc. in Chemistry from IIT Madras. He did an M.Tech in Chemical Analysis from IIT Delhi before going to Kansas State University for his Ph. D. After a postdoctoral stint at the University of Illinois at Urbana-Champaign, he joined IIT Kanpur in November 1994. He moved to the Department of Inorganic and Physical Chemistry at the Indian Institute of Science in June 1997 where he is continuing as a professor now after serving as Chair from 2018-24. He built a pulsed nozzle Fourier transform microwave spectrometer, first and only one in India. Experimental results from his lab eventually led IUPAC to change the definition of hydrogen bond through a task group formed and chaired by him. In collaboration with Aerospace Engineering Department at IISc, he built shock tube facilities for both fundamental and applied research, of relevance to ISRO and DRDO

INSA New Fellow Lecture

Discovery of Sustainable Organocatalytic Reactions

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The discovery of *in situ* generated novel reactive primary catalytic species like enamines, iminium ions, dienamines, trienamines and aminoenynes from the reaction of variety of carbonyls with catalytic amount of chiral primary- or secondary amines or amino acids will be discussed. Their direct applications in a variety of selective green bond formations to furnish the chiral functionalized molecules, drugs, drug-like molecules, natural products, and pharmaceuticals will be discussed.

Speaker's Profile

Ramachary graduated with M.Sc. degree in School of Chemistry from University of Hyderabad and obtained Ph.D. in synthetic organic chemistry from Indian Institute of Science, Bangalore in 2001. He subsequently held postdoctoral position at the Scripps Research Institute for Catalysis, prior to joining University of Hyderabad in January 2005, where presently he is senior professor of organic chemistry.He is a recipient of many awards including Fellow of the National Academy of Sciences, Allahabad-2021, Fellow of the Royal Society of Chemistry, London-2020 and Fellow of Indian Academy of Sciences, Bangalore-2018. He has guided 22-PhD students, 14 PDFs and out of them, 5-PhD's got Eli Lilly & Company Asia Outstanding Thesis Awards 2011, 2012, 2013, 2014 and 2021. Prof. Ramachary serving as a reviewer for many national and international reputed journals and member in many committees of national funding body, DST, SERB. Prof. Ramachary published more than 125 research papers in both national and international reputed journals, two books on emerging organocatalysis area and few chemical reactions are named after him. Prof. Ramachary delivered more than 170 lectures in both national and international conferences.

Towards Life-Like Behavior in Supramolecular Polymers

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Supramolecular polymers—dynamic, non-covalent analogues of conventional macromolecular polymers—have emerged as powerful platforms for the development of adaptive, responsive, and multifunctional soft materials. Despite significant progress, a key challenge remains: achieving precise spatial and temporal control over molecular organization to impart complex functionality. While recent advances in bio-inspired, kinetically regulated assembly strategies have opened exciting avenues, synthetic supramolecular systems still fall short of the intricacy and dynamic capabilities characteristic of biological matter.

Nature exemplifies the remarkable ability to self-organize, evolve, and perform sophisticated functions such as self-regulation, repair, and adaptive response. Mimicking such life-like features in synthetic materials could enable the creation of next-generation soft-materials capable of dynamic responsiveness, motility, and autonomous behavior. Achieving this, however, requires breakthroughs in multicomponent molecular organization, compartmentalized self-assembly, liquid–liquid phase separation, motility, oscillatory behaviors, and precise regulation of self-assembly in dynamic and crowded environments.

Driven by these challenges and opportunities, our laboratory is actively engaged in bridging the current gaps by designing supramolecular polymers that structurally mimic biological complexity and operate away from equilibrium, thereby exhibiting lifelike traits. This talk will present our recent efforts in this direction, from a chemist's perspective, highlighting how these materials are advancing toward the next frontier of adaptive soft materials.

Speaker's Profile

Subi George leads the Supramolecular Chemistry Group at the New Chemistry Unit, JNCASR, Bangalore, where he also serves as Dean (Faculty) and Associate Editor of Chemical Science (RSC). His research focuses on functional supramolecular polymers, living and non-equilibrium supramolecular polymerization, supramolecular chirality, and organic phosphors. He received the Shanti Swarup Bhatnagar Prize in Chemical Sciences (2020), the Swarnajayanti Fellowship (2017), and the CNR Rao National Prize (2021), among other recognitions. Elected Fellow of the Indian Academy of Sciences (2019) and NASI (2023), he was also honored with the G. D. Birla Award for Scientific Research in 2024

.INSA New Fellow Lecture

Extraction of critical minerals by metal–organic frameworks (MOFs) and related advanced porous materials for sustainable future

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Critical minerals (CMs) are those minerals that are essential for economic development and national security. In 2025 Indian government have launched the National Critical Mineral Mission (NCMM) to establish a robust framework for self-reliance in the critical mineral sector, and identified a list of 30 critical and strategic minerals. These are essential for the advancement of many sectors, including high-tech electronics, telecommunications, transport, and defence. Currently extraction or processing of CMs are happening in a few geographical locations in the world, which may lead to supply chain vulnerabilities and even disruption of supplies. For that there is an urgent need for development of sustainable and efficient extraction technologies of CMs in our country. Recycling of CMs from secondary sources such as e-waste, lithium-ion battery scrap, and end-of-life vehicle parts is also strongly encouraged with incentive scheme under the NCMM. Advanced function porous materials—like metal–organic frameworks (MOFs), related porous materials, have recently emerged as transformative platforms for efficient extraction technologies of different metal ions, due to their tuneable pore environments, high surface areas, and ion-exchange properties. In this lecture I will talk about some of the examples of MOFs and related porous materials, developed in our laboratory, which can efficiently extract some of the critical minerals from solution, demonstrating, potential use of the materials for extracting critical minerals from primary and secondary sources.

Speaker’s Profile

Sujit is currently a Professor of Chemistry at IISER Pune, India. Before joining IISER in 2009 he did his postdoctoral work with this year’s one of the Chemistry Nobel prize winners, Prof. Susumu Kitagawa, Japan. His research interest is metal–organic frameworks (MOFs) and related porous materials for extraction of critical minerals, sustainable environment and safe drinking water. He has published >175 papers with average IF ~8, with total citations > 18000 and h-index-68. Recently he got selected for "The Distinguished Lectureship Award" by the Chemical Society of Japan (CSJ), Friedrich Wilhelm Bessel Research Prize by the Humboldt Foundation, Germany.

Stabilization of Diboranes and Bn Rings (n = 3-6) on Transition Metal Templates

Sundargopal Ghosh

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The fascinating aspect of metallaborane chemistry is that several classic organometallic complexes that defined fundamental structural and bonding paradigms are mimicked by many isoelectronic metallaborane analogues. In this context, we have synthesized and structurally characterized a bimetallic diborane(4) which mimics Cotton's dimolybdenum-alkyne complex $[\{CpMo(CO)_2\}_2C_2H_2]$. Also, we have isolated the first classical diborane (5) $[B_2H_5]^-$, in which the sp^2-B center is stabilized by the electron donation from tantalum. Unlike carbon, boron does not usually form ring compounds due to its electron deficiency-driven affinity towards polyhedral geometries. Although the smaller B_3 and B_4-rings are mostly isolated as individual species, larger B_5 and B_6-rings are stabilized by transition metals, depending on the ring size and electronic requirements of the rings. For example, we have isolated the first examples of a nearly planar $[B_6H_6]$ unit, stabilized as a part of $[(Cp^*Ti)_2(\mu\text{-}\eta^6{:}\eta^6\text{-}B_6H_6)(\mu\text{-}H)_6]$, where significant electron delocalization was observed from the Ti–Ti bonding orbital to the μ-H atoms and B_6 skeleton. Furthermore, we have synthesized and structurally characterized tetraborane $[B_4H_8]^{2-}$, pentaborane $[B_5H_{10}]^-$ and hexaborane $[B_6H_{11}]^-$ ring stabilized by monometallic Os-templates in η^4, η^5, η^6-fashions which mimics $[C_4H_4]^{2-}$, $[C_5H_5]^-$, and $[C_6H_6]$ rings, respectively. The selection of transition metals mostly depends on their diffuse orbitals, valence electrons, and ring sizes, while the bridging hydrogens balanced the electron deficiency of the boron rings.

Speaker's Profile

Prof. Sundargopal Ghosh obtained his B.Sc. and M.Sc. degrees from the University of Calcutta, followed by Ph.D. from the Indian Institute of Technology Bombay in 1998. He then pursued postdoctoral research at University of Notre Dame, USA. His research focuses on the chemistry of transition metal-boron compounds. He has authored more than 300 scientific publications in leading international journals. Prof. Ghosh received the CRSI Bronze Medal and the Institute Research and Development Award (IRDA) from IIT Madras in 2014. He was an elected Fellow of the Indian Academy of Sciences (FASc, 2017), Fellow of the National Academy of Sciences (FNASc, 2017), and Fellow of the Indian National Science Academy (INSA). Over his career, Prof. Ghosh has guided 36 Ph.D. students, many of whom hold positions at reputed institutions in India and abroad.

INSA New Fellow Lecture

Molecular Flasks

Partha Sarathi Mukherjee

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Chemical and physical properties of chemical entities in confined nanospace are expected to be different from their bulk behavior due to restricted motions. Such restricted motions along with other interaction/s may allow stabilization of unusual conformations of compounds in confined space of molecular cavity. Moreover, reactivity and reaction pathways in confined space may become different from traditional bulk reactions leading to the formation of unusual product/s. In this regard, chemists have been trying to design artificial molecular vessels to perform chemical reactions in their confined nanospace. My lecture will focus on the unusual behavior of photochromic spiropyrans in the confined cavities of molecular flasks that are made of Pd(II) and hydrophobic aromatic donors. Separation of hydrophobic aromatic isomers using a molecular flask by simple aqueous extraction will also be presented.

Speaker's Profile

Prof. Mukherjee is currently a professor of chemistry at IISc (Bangalore). He works on self-assembled discrete molecular architectures including their use in catalysis, sensing, biology, and light-harvesting. He has extensively used barrel shaped molecular architectures as molecular vessels for photocatalysis, separation of isomers, and chiral recognition. Prof. Mukherjee is a J. C. Bose fellow. He is a recipient of the NASI-SCOPUS young scientist award, INSA-Medal, S. S. Bhatnagar prize, TWAS young affiliateship and Swarnajayanti fellowship. He is an elected fellow of the TWAS, the Indian Academy of Sciences, and the INSA. He is currently serving as an Associate Editor of Inorganic Chemistry.

INSA New Fellow Lecture

Towards the end of two century years of suffering: The Phase II human clinical trials and the future of Parkinson`s care

Diwan S Rawat

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To address the drug resistance issue and improve a drug molecule's ADME properties, the concept of molecular hybridization was put forward, wherein two or more distinct pharmacophores are covalently linked into a single molecule. This approach has resulted many drug candidates with improved activity profiles, and some of these compounds are in clinical trials. We have utilized this concept in designing antimalarial molecules, and later, a massive multi-institutional collaboration was started, and over 700 new molecules were studied for Nurr1 activation, a potential target for the Parkinson's disease model. Fifteen hit molecules were identified during this study. One of the molecule ATH 399A activates the Nurr1 enzyme, which is essential for the survival of the dopamine neurons, stops the aggregation of α-synuclein protein in the brain, and promotes autophagy demonstrating the potential of being a perfect drug candidate for Parkinson treatment. Systematic studies demonstrated that these compounds can cure the Parkinson-induced mice model at 5 mg/kg body weight without any toxicity. Phase I trials showed that ATH-399A was well tolerated with no major safety issues in any of the 76 participants and PK results support once a day dosing and the molecule has moved to phase II trials and two molecules are in pre-clinical stage of development, one for Lewis body dementia and other for autoimmune disease.

Speaker's Profile

Prof. Rawat is the Vice Chancellor of Kumaun University, Nainital. After obtaining his Ph.D. from Central Drug Research Institute, Lucknow and he worked with pharma industry followed by postdoctoral work from Indiana University and Purdue University, USA and joined Delhi University in 2003. He has published over 175 research papers, authored a book, the book was forwarded by Nobel Laureate Sir DHR Barton, he authored 7 book chapters, and 22 patents to his credit. His research work has been cited over 7850 times with impressive h-index of 52 and i-10 index of 139. Prof Rawat is the follow of INSA and NASI.

INSA New Fellow Lecture

Nanosized ceria-based catalysts for energy and environmental applications

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Environmental issues, including air pollution, water pollution, and the overconsumption of natural resources, continue to be among the greatest challenges facing humanity today. Recent advances in nanoscience and nanotechnology are playing a crucial role in addressing some of these challenges. The choice of material and its synthetic methodology ultimately determines the success or failure of a nanostructured material in its application, as its physicochemical properties are heavily influenced by the synthesis process. Ceria (CeO_2), an abundant rare-earth metal oxide, has garnered significant research interest recently due to its wide range of applications in environmental and energy-related fields. The importance of ceria comes from its notable Ce^{4+}/Ce^{3+} redox couple and excellent oxygen storage/release capacity (OSC). Ceria acts both as a promoter and as an active catalyst in three-way catalytic converters, reducing hazardous exhaust emissions. Additionally, the catalytic activity of ceria for soot combustion has recently been studied and proven to be a promising material. However, a major limitation of pure ceria is its poor thermal stability, which results in loss of surface area and OSC, leading to decreased catalytic performance. A key challenge is to develop efficient and thermally stable ceria–based catalysts that meet increasingly demanding requirements. Two promising strategies for improving CeO_2 properties are doping it with suitable rare-earth or transition metal ions and reducing ceria particle size into nanoscale. Our recent investigations, to be discussed in this presentation, have shown that incorporating an appropriate dopant into the nano-ceria matrix significantly boosts its redox properties and chemical reactivity.

Speaker's Profile

B.M. Reddy is a senior professor emeritus in the Department of Chemistry at BITS Pilani, Hyderabad Campus. He earned his PhD at CSIR-IICT in 1986 and served the same organisation in various capacities until 2017. Later, he was a DAE Raja Ramanna Fellow at the same institute. Reddy has received international fellowships from JSPS, DAAD, CNRS, Brain Pool, and NSF, allowing him to work across multiple countries. He has authored over 350 research articles, two books, five monographs, 13 book chapters, and 12 reviews, and holds eight patents. His Google Scholar h-index is 84 with over 21,200 citations. He has supervised 40 PhDs and more than 35 BTech/MTech/MSc dissertations. He serves on the editorial boards or as a guest editor for journals, including the Journal of CO2 Utilisation, Catalysis Today, Discover Catalysis, Industrial & Engineering Chemistry Research, and others. A special issue of Molecular Catalysis was published in his honour on his 60th birthday.

He has received various awards and honours, including CSIR Young Scientist Award and Catalysis Society of India (CSI) Young and Eminent Scientist Award, as well as an Associateship from TWAS. His accolades also include Sir C.V. Raman Fellowship from CSIR, Gold Medals from SMC and ABAP, as well as a Bronze Medal from CRSI. He has been an elected fellow of INSA, INAE, NASI, RSC, and Telangana Academy of Sciences (TAS). He has served as a Council Member of the International Association of Catalysis Societies and the Asia-Pacific Association of Catalysis Societies, and held positions including Honorary Secretary of CSI and Honorary Treasurer of TAS. His research focuses on catalysis and physical chemistry, with a special emphasis on emission control catalysts and CO2 utilization technologies.

INSA Associate Fellow Lecture

Evolution of Co (III)-Catalysis in Asymmetric C-H Bond Functionalizations

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Since Murahashi's pioneering work on cobalt-catalyzed C-H bond carbonylation in 1955, the field of C-H bond functionalization has made significant strides, particularly with the development of low-valent cobalt systems. While the use of in situ-generated or isolated cobalt (III) catalysts for C-H activation was seldom explored until the independent studies by Matsunaga and Daugulis in 2014, recent advancements have shed light on the intricate coordination environment around cobalt and the mechanisms driving these catalytic cycles. In this talk, I will review the progress made over the past decade in Co (III)-catalyzed C-H bond functionalization, focusing on both mono- and bidentate directing groups, and the role of spectator ligands in the latter. I will also discuss how replacing these spectator ligands with external chiral ligands can induce chirality at the metal center through an enantio-determining C-H activation step, and how these factors impact the efficiency and selectivity of asymmetric transformations. Additionally, I will highlight our systematic efforts to replace Mn (II) with photocatalystsor oxygen as sole oxidants, thereby eliminating the need for stoichiometric metal oxidants in asymmetric C-H bond annulations using the Co/Salox catalytic system.

Speaker's Profile

Dr. Basker Sundararaju, born in Mettuppalayam, a small town in Tamil Nadu, earned his M.Sc. (2008) and Ph.D. (2011) from Université de Rennes, France, followed by an AvH postdoctoral fellowship with Prof. Alois Fürstner at the Max-Planck Institute (2011–2013). He joined IIT Kanpur in 2013, becoming Professor in 2022. His research focuses on base-metal catalysis using [Fe], [Co], and [Mn] systems for C–H activation, CO_2 valorization, and asymmetric synthesis. Author of 90 papers (H-index 41), he received awards including the Merck Young Scientist Award (2019), CRSI Bronze Medal and Fellow of Royal Society of Chemistry (2023) and now currently being elected for an INSA Associate Fellow (2025). He served as Associate Editor, J. Heterocyclic Chem. (2019–24) and early career advisory board member of ACS Catalysis (2018-20).

Non-equilibrium self-assembly for living matter-like properties

Dibyendu Das

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Life's soft and wet machinery arose from spatially confined assemblies of biomolecules capable of replication, integrated with metabolic reaction cycles that function far from equilibrium. By methodically synthesizing and integrating these key elements, i.e. replication, metabolism, and confinement under non-equilibrium conditions, we can begin to explore how chemically constructed systems might acquire life-like, evolving properties. This ambitious goal lies at the heart of systems chemistry. In this talk, I will outline recent insights into how reaction networks, self-reproduction, and compartmentalization can be brought together under non-equilibrium settings. I will also delve into the interplay between reaction dynamics and transient compartmentalization, and explore the development of self-replicating systems capable of sustained operation in far-from-equilibrium conditions.

Speaker's Profile

Dibyendu is an Associate Professor of Chemistry at IISER Kolkata. He earned his Ph.D. from IACS, India, postdoc at Emory University, USA. He leads an interdisciplinary lab on systems chemistry, chemical evolution, and adaptive materials, emphasising non-equilibrium self-assembly and peptide catalysis. He is awarded the Shanti Swarup Bhatnagar Award (RVP-YVSSB-2025) and Swarnajayanti award (2020), and elected Chair (2028) of the Gordon Research Conference on Systems Chemistry. Dr. Das was featured in "75 under 50 Scientists Shaping Today's India" by Vigyan Prasar.

INSA Associate Fellow Lecture

Cascade transformations promoted by sulfoxonium ylides for the rapid creation of skeletal complexity

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The Corey-Chaykovsky reagent [dimethyloxosulfonium methylide (DOSM)] is typically employed for the preparation of cyclopropanes from electron-deficient olefins. However, we employed DOSM in an unconventional manner, as a nucleophilic trigger to initiate cascade reactions. This approach resulted in the formation of novel classes of fused- and spirocyclopropanes, generating multiple carbon-carbon bonds and stereocenters. We refer to this process as the interrupted Corey-Chaykovsky reaction (Figure 1). In my talk, I will describe how we entered this field serendipitously.

Speaker's Profile

Ramasastry obtained Ph.D. in Chemical Sciences in 2005 from the Department of Organic Chemistry, Indian Institute of Science, Bangalore (India), under the supervision of Prof. A. Srikrishna. He then pursued postdoctoral studies with Prof. Carlos F. Barbas, III, at The Scripps Research Institute, San Diego (USA). He joined the Department of Chemical Sciences, IISER Mohali, as an Assistant Professor in 2011. Since 2023, he has been a Professor in the same department. His research interests include the development of sustainable and atom economic reactions via organophosphine catalysis, palladium-catalyzed allylic alkylation reactions and cascade transformations employing sulfur ylides.

Carbene Mimics from Strained Rings

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Ring-strain in organic molecules is a powerful driving force that promotes reactivity through strain-release, allowing the facile construction of a myriad of useful scaffolds via ring-opening or ring-expansion reactions. Carbene chemistry has been extensively studied, leading to numerous applications in organic synthesis, including X–H insertions (where X can be C, Si, N, O, etc.), cyclopropanations, ylide formations, and 1,2-migrations. Due to their high reactivity, carbenes are particularly well-suited for initiating cascade sequences, which results in the rapid generation of structural complexity. The most common method for generating carbenes involves highly reactive diazoalkanes, typically using metal catalysts or photoirradiation. Alternative precursors for carbenes include substituted triazoles or alkynes combined with pyridine *N*-oxides, often utilizing transition metal catalysts. Generating carbenes through the activation of C−C bonds presents significant advantages, as it offers unique opportunities for constructing the backbones of organic molecules. However, this process is challenging due to the inertness of C−C bonds and the lack of metal-carbon bond interactions. In this context, the ring strain energy in small organic molecules has been effectively utilized to promote the activation of these difficult C−C bonds. In this lecture, I will first discuss how we generate carbene mimics from bicyclo [1.1.0] butane using Rh-catalysis for the synthesis of skipped dienes. Next, I will present our approach to utilizing ring strain in [1.1.1] propellane to access carbenes for [2,3]-sigmatropic rearrangements and skeletal editing of ketones.

Speaker's Profile

D. P. Hari completed his M.Sc. at IIT Madras and earned his PhD from the University of Regensburg under the supervision of Prof. Burkhard Koenig. He was a postdoctoral fellow at EPFL with Prof. Jerome Waser and was a Marie Curie research fellow in the Aggarwal group at the University of Bristol. Since April 2021, he has been an Assistant Professor at IISc Bangalore. His research primarily focuses on discovering new reactivities of strained molecules. He has received several awards, including the INSA Young Associate Award, the Thieme Chemistry Award, the Infosys Young Investigator Award, and the IISc Award for Excellence in Teaching.

INSA Young Associate Lecture

Electrochemical synthesis of green ammonia, green urea & nitric acid under ambient conditions: Fundamental and translational Components

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There are numerous varieties of fertilizers that primarily contain macronutrients such as nitrogen, phosphorus, and potassium. Fixed nitrogen frequently serves as the limiting factor for plant development, rendering the synthesis of nitrogen-based fertilizers—such as ammonia, nitrate, and urea—essential. In the present Indian scenario, the demand for these fertilizers is rapidly increasing due to agricultural expansion and food security needs. However, most of these fertilizers depend on imported raw materials and fossil fuels, leading to economic and environmental challenges. Hence, promoting important import substitutes chemicals like ammonia, urea, nano-fertilizers, and nitric acid is vital. India is emphasizing self-reliance (Atmanirbhar Bharat) by developing indigenous technologies for sustainable fertilizer production. The adoption of renewable energy-based chemical processes can significantly reduce carbon emissions, energy consumption, and import dependency, ensuring long-term agricultural productivity and environmental sustainability for the nation's growing population.

In our laboratory, we have developed sustainable electrocatalytic methods for producing green ammonia, green urea, and nitric acid under ambient conditions using metal phthalocyanine based electrocatalysts. These innovative processes are protected by appropriate intellectual property rights (IPR). Field trials for green ammonia and green urea synthesis have been successfully completed, demonstrating high efficiency and environmental sustainability. We have also completed technology transfer and licensing for pilot-scale green ammonia production in collaboration with a multinational company. Additionally, we have initiated technology licensing process for green urea production through CO_2 utilization in partnership with industry, supporting India's vision of clean, self-reliant, and energy-efficient chemical manufacturing.

Speaker's Profile

Dr. Uttam Kumar Ghorai is currently working as an Assistant Professor in Ramakrishna Mission Vidyamandira, Belur Math, India. He has made significant research contributions to the development of sustainable processes and products. The major emphasis of his research includes the synthesis of green ammonia, green urea, and nitric acid under ambient conditions using electrochemical pathways. He recently completed a technology licensing agreement for his electrocatalytic green ammonia synthesis process with a multinational company under royalty terms. His contribution to electrocatalytic CO2 capture and conversion to green urea technology aligns with the crucial contemporary challenge of carbon capture and utilization (CCU).

INSA Young Associate Lecture

Precision Engineering of Nanoclusters: Advancing Structural and Functional Properties

Indranath Chakraborty

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Atomically precise metal nanoclusters consist of a well-defined metal core and a ligand shell. Generally, the diversity in ligand types is rare for most NCs except for a few gold NCs (e.g., Au_{25}) reported so far. This is primarily because the ligand contributes significantly to determining the atomicity of the resulting NCs. Metal–ligand interactions during the NC formation are particular to individual metals and kinetic parameters used in the synthesis. For example, Ag_{25} NC was reported to be synthesized only with 2,4-dimethylbenzenethiol (DMBT), while Au_{25} NCs are reported with a wide variety of ligands, although both the NCs have identical crystal structures. Both secondary and primary ligands and their functionalities play a significant role in their optical properties, especially in photoluminescence. These examples indicate that NC's properties, like molecules, can be tunable via surface modification, ligand engineering, doping, or hybridization with other materials. This talk will explain how precision engineering will allow researchers to manipulate nanoclusters' structural and functional properties, such as stability, catalytic activity, and photoluminescence, increasing their usefulness in a wide variety of fields, including health care, electronics, and manufacturing.

Speaker's Profile

Prof. Indranath Chakraborty is an Assistant Professor at the School of Nano Science and Technology, Indian Institute of Technology Kharagpur. His research specializes in atomically precise nanomaterials, focusing on molecular-level synthesis, structure-property correlations, and applications in catalysis, sensing, and healthcare. His group pioneers the development of atomically precise metal nanoclusters and their nanohybrids to explore unique optical and catalytic properties. Prof. Chakraborty earned his PhD from IIT Madras and conducted postdoctoral research in the USA and Germany, including a fellowship from the Alexander von Humboldt Foundation. His achievements include the Malhotra Weikfield NanoScience Fellowship, the J.C. Bose Patent Award, and the IIT Kharagpur Faculty Excellence Award.