



XXXXV
ANNUAL CONFERENCE
INDIAN
COUNCIL OF CHEMISTS

30th OCTOBER to 01st NOVEMBER, 2026



**Department of Chemistry and
Chemical Biology**
IIT (ISM) Dhanbad-826004, Jharkhand



ABSTRACTS BOOK - 2026

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Prof. Sangita Sharma

Department of Chemistry, Hemchandracharya North Gujarat University,
Patan, Gujarat

SYMPOSIUM ON "CRITICAL MINERALS AND RARE EARTHS: CATALYST FOR TECHNOLOGY AND INDUSTRY TRANSFORMATION FOR VIKSIT BHARAT"

Prof. Dhruva Kumar Singh

Department of Fuel, Minerals and Metallurgical Engineering,
IIT(ISM), Dhanabdh-826004

INDIAN COUNCIL OF CHEMISTS



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XXXXV ANNUAL NATIONAL CONFERENCE 2026 ABSTRACTS BOOK



Department of Chemistry and
Chemical Biology
IIT (ISM) Dhanbad-826004, Jharkhand

30th Oct. to 01st Nov., 2026

"This Conference is dedicated to the memory of
Late Dr. Greesh Chandra Saxena (1940–2026), Founder and
Architect of the Indian Council of Chemists."

Message from the Secretary

Dear Delegates, Distinguished Guests, Scientists, and Researchers,

It gives me immense pleasure to welcome you to the XXXXV Annual National Conference of the Indian Council of Chemists (ICC) being hosted at IIT (ISM), Dhanbad.

The pursuit of scientific knowledge thrives through dialogue, collaboration, and the free exchange of ideas. This conference brings together eminent academicians, researchers, industry professionals, and young scientists on a common platform to share their findings and explore new avenues of scientific advancement.

I am confident that the technical sessions, keynote lectures, and scholarly interactions scheduled during the conference will provide stimulating opportunities for learning and professional growth. Equally important, these interactions will strengthen the bonds within our scientific community and inspire future collaborations.

I convey my sincere appreciation to all participants, speakers, session chairs, and organizers whose contributions have made this event possible.

I wish you fruitful deliberations, engaging discussions, and a pleasant stay in Dhanbad.

With warm regards,

Prof. Rajesh Dhakarey

Secretary

Indian Council of Chemists (ICC)

PROVISIONAL PROGRAMME

Friday, October 30th, 2026

08.00 to 09.30 am	Registration
09.30 to 01:00 pm	Inauguration, keynote address
01:00 to 02:00 pm	Lunch
02:00 to 02:30 pm	Sectional Presidents address in respective sections
02:30 to 05:30 pm	Invited lectures and paper presentations
05:30 to 07:30 pm	Poster presentations and Executive Meeting
07:30 to 08.45 pm	Cultural programme
08:45 pm onwards	Dinner

Saturday, October 31st, 2026

09:00 to 1:00 pm	Symposium on "Critical Minerals and Rare Earths: Catalyst For Technology and Industry Transformation for Viksit Bharat" (common to all delegates)
01.00 to 02.00 pm	Lunch
02:00 to 06:00 pm	Invited lectures and paper presentations
06:00 to 07:30 pm	Poster presentations
07:30 to 08:30 pm	ICC General Body Meeting (To be attended by fellows only)
08:30 pm onwards	Dinner

Sunday, November 1st, 2026

09:00 to 01:00 pm	Invited lectures and paper presentations
01:00 to 02:00 pm	Lunch
02:00 to 04:00 pm	Invited lectures and paper presentations
04.00 to 06.00 pm	Valedictory Function

The detailed programme of each day and each section shall be circulated in the Conference.

ADVISORY COMMITTEE

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Chairman, BOG, IIT (ISM) Dhanbad

Patron

Prof. Sukumar Mishra

Director IIT (ISM) Dhanbad

Co-Patron

Prof. Sarat Kumar Das

Deputy Director IIT (ISM) Dhanbad

Conference Chair

Prof. Sagar Pal

HoD

Prof. D. D. Pathak

Convenor

Prof. Mahendra Yadav

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Prof. Somnath Yadav

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Jt. Secretary

Prof. Hari Pada Nayek

Prof. Swapan De

Cultural Secretary

Prof. Madhulika Gupta

Prof. Sourav Kumar Dey

Prof. Rashmi Madhuri

Local Section Coordinators

a. Analytical and Environmental

Chemistry Section:

Prof. Rashmi Madhuri

b. Inorganic Chemistry Section:

Prof. Asmita Singha

c. Organic Chemistry Section:

Prof. Sunil Pulletikurti

d. Physical Chemistry Section:

Prof. Ananya Banik

e. Symposium :

Prof. B. Rajasekhar Reddy FMME

Local Organizing Committee

All faculty members of the Department of
Chemistry and Chemical Biology

Instructions for the Preparation of Poster Presentation

The poster should be displayed as per the poster board number given in the abstract book. Posters will be displayed during the Poster Sessions and must be mounted from the start of sessions and removed upon conclusion of sessions on the scheduled day. Authors are requested to stand next to their poster boards during the Poster Sessions.

- You should be printing and bringing your poster to the conference.
- The dimensions of poster **should NOT exceed 90 cm wide × 120 cm high.**
- Please prepare your poster to fit the dimensions specified. It is recommended that poster be prepared on one sheet. Alternatively presenters may display their material on several smaller sheets.
- Allocate the top of the poster for the title and authors as stated on the submitted abstract.
- The text, illustrations, etc. should be bold enough to be read from a distance of two meters.
- Double sided tape and technical equipment will be available for the mounting of posters. Staff will also be available to assist you.
- DO NOT write or paint on the poster boards. DO NOT use nails, push pins, screws, or any tools that will puncture the poster boards.
- Please use the board that displays the same number assigned to you.

For any help kindly contact the concerned **Sectional President**.



Tribute to the Founder

The Indian Council of Chemists (ICC) proudly acknowledges the vision and pioneering leadership of Late Dr. Greesh Chandra Saxena (1940–2026), eminent educationist, distinguished inorganic chemist, and revered science writer in Hindi. Recipient of Atmaram Award (2017), Honored by President of India.

Dr. Saxena, who served as Vice Chancellor of Dr. Ram Manohar Lohia Avadh University, Faizabad (1998–2001) and Dr. Bhimrao Ambedkar University, Agra (2001–2004), was the founder and principal architect of ICC. His tireless efforts in structuring the Council since its inception in 1981 laid the foundation for a vibrant national forum of chemists.

Through his scholarship, administrative acumen, and lifelong dedication to chemical sciences, Dr. Saxena nurtured ICC into a premier body that continues to unite researchers, teachers, and industry professionals across India. His legacy of academic excellence, democratic spirit, and commitment to science communication will forever inspire the fraternity.

From the President's Desk

The Indian Council of Chemists is achieving a new milestone with the holding of its XXXXV Annual Conference this year and, welcoming distinguished scientists, participants and guests to this 3 day event at the historic IIT-ISM, Dhanbad. Our young scientists shall again have ample opportunities of rubbing shoulders with leading stalwarts in their fields of interest in four concurrent scientific sessions in the Inorganic, Organic, Physical and Analytical & Environmental Chemistry Sections and those sessions will be besides a special Symposium on "Critical Minerals and Rare Earths: Strategic Enablers of Technology and Industrial Transformation for Viksit Bharat". The theme has been chosen so as to align it with one of our national priorities. The ₹34,300 Cr National Critical Mineral Mission has been launched as an important component towards achieving national target of Vikshit Bharat 2047 by providing exciting inputs for high tech industries, electronics, defense and clean, efficient energy requirements. In this book, advance abstracts of papers and lectures have been given to facilitate participants to choose sessions and explore feasibility of collaboration etc. It is for the second time that this ICC has reached this institution.

This Conference is dedicated to its Founder, the Founding Secretary of ICC and veteran Inorganic Chemist, author and exceptionally visionary Dr Girish Chandra Saxena (1940-2026) who organised first organisational meeting of ICC involving Chemistry leaders from across the country to work out a wider platform for chemistry teachers and researchers. He served as Vice Chancellor of Agra (Dr Bhimrao Ambedkar) University BRABU and Awadh (Dr RM Lohia) University and was honoured with Atmaram Award by President of India in 2017.

In 2024, ICC started celebrating annually, the 2nd of August-the birthday of Acharya P. C. Ray (August 2, 1861 – June 16, 1944) as the National Chemistry Day. Acharya Ray who is revered as the "Father of Indian Chemistry" was a true inspiring patriotic and motivational chemist with rare entrepreneurship, research and organizational skills. He was also the first Indian scientist whose research paper was published in modern times on the basis of work carried on in India. This year too, the Chemistry Day (NCD- 2025) was celebrated like a movement in Universities, Colleges and Schools on August 2, 2026 across the length and breadth of the country. Some other organizations have also started taking up the celebrations. ICC is making efforts for declaration of this day as the "National Chemistry Day. Best performing institutions are being recognized by ICC.

"I wish the conference a grand success.

Ranjit K Verma
President, ICC

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ABBREVIATIONS

AEIL	- Analytical Invited Lecture
AEO	- Analytical Oral
AEP	- Analytical Poster
IIL	- Inorganic Invited Lecture
IO	- Inorganic Oral
IP	- Inorganic Poster
OIL	- Organic Invited Lecture
OO	- Organic Oral
OP	- Organic Poster
PIL	- Physical Invited Lecture
PO	- Physical Oral
PP	- Physical Poster
CYSA	- Contestant for Young Scientist Award
SYM-SP	- Symposium

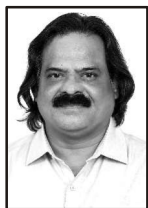
AWARDEE 2026



Prof. (Dr.) Jabali Jayakrishna Vora
Life Time Achievement Awardee



Prof. (Dr.) Goutam Brahmachari
Prof. W.U. Malik Memorial Awardee



Prof. (Dr.) C. V. Yelamaggad
Dr. S.P. Hiremath Memorial Awardee



Dr. Pranjal Chandra
Dr. Arvind Kumar Memorial Awardee



Dr. Meena Bisht
Prof. Kaza Somsekhara Rao Awardee



Prof. (Dr.) T. Maiyalagan
Prof. S.T. Nandibewoor Awardee



Prof. Akella Sivaramakrishna
Dr. S.M.L. Gupta Memorial Awardee



Dr. M.A. Quraishi
Dr. P.N. Sharma Memorial Awardee

SECTIONAL PRESIDENTS



Prof. Dhruv Kumar Singh

Symposium on
"Critical Minerals and
Rare Earths: Catalyst for Technology
and Industry Transformation for Viksit Bharat"



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Inorganic Chemistry Section



Prof. Ajay Kumar Srivastava
Organic Chemistry Section



Prof. Sangita Sharma
Physical Chemistry Section



Dr Nagaraj P Shetti
Analytical and Environmental
Chemistry Section

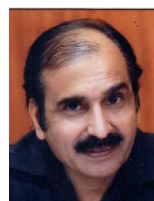
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Secretary, ICC
Ex. Vice Chancellor
Maharaja Surajmal Brij University
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Prof. M.K. Rawat
Treasurer, ICC
Principal, Meerut College,
Meerut-250 001 (U.P.)



Prof. Ajay Taneja
Zonal Secretary, ICC
Vice-Chancellor
Khwaja Moinuddin Chishti Language
University (KMCLU), Lucknow



Dr. S.C. Goyal
Joint Secretary, ICC
Former Head, Department of Chemistry
Agra College, Agra-282002



Prof. Vinod Kumar
Joint Secretary, ICC
Department of Chemistry,
Agra College, Agra-282 002

Life Time Achievement Awardee Lecture

Joyful Journey and Soulful Snippets

Jabali Vora

*Former Vice Chancellor, Former Head, Department of Chemistry,
Hemchandracharya North Gujarat University, Patan – 384265.
E-mail : jabali_vora@hotmail.com*

Thanks giving for ICC as it is indeed a humungous platform of learning. Chemistry: Research, Teaching, Administration and Innovation. If one looks at books of abstracts of various years, all branches and subject areas in chemistry are seen there. The focus of this talk will be on the work done by our group along with important principles of learning. Focus will be the Zen-G youth. Initially, work was done on amino acids and their coordination compounds. One important molecule is S-methyl methionine. The other name is Vitamin-U. The molecule is useful in ulcer prevention and some gastric problems. Infection occurs due to *Helicobacter pylori* bacteria. A student with wrong information had to return back. The other student, with an unsafe laboratory, had developed gastrointestinal infections and ultimately left. Then some work was carried out regarding dental enamel. A study on the effect of sour substances before brushing was conducted. But the work had to be stopped due to theft of data. This is another type of safety that is also important in research.

The importance of publication of research papers is to be understood by the well-known interaction of Bohr and Rutherford. Bohr explained his theory to Ernest Rutherford for hours, but to no avail. Anyhow, Rutherford, being referee for the paper, showed broad-mindedness and tolerance. He recommended that paper for publication. He knew that science could not survive without broad-mindedness and tolerance. Regarding quantum mechanics, Einstein used to say, "Do you think God ever plays dice?" Later on, he (age 68) said one cannot regard a concept as senseless. Later on, he wrote

to de Broglie, "I must have seemed an ostrich..." The importance of hypothesis has its own significance. Uhlenbeck and Goudsmit's initial enthusiasm was dampened when they found that the electron surface would move with a velocity much greater than that of light. However, the editor sent it for publication and said, "You are young enough to make a folly or two." But this blunder fetched the Nobel for them. Why should research papers of other scientists or other work be seen? Albert Einstein once said, after reading the paper by young Pauli...

With this, I am concluding by once again thanking ICC dignitaries and best wishes for growing scientific community of ICC.

**To be presented After
Key Note Address**

Prof. W.U.Malik Memorial Awardee Lecture

Sustainable Strategies in Coumarin Chemistry: Innovative Synthetic Approaches

Goutam Brahmachari

Laboratory of Natural Products & Organic Synthesis, Department of Chemistry, Visva-Bharati (A Central University), Santiniketan-731235, West Bengal

*E-mail : brahmg2001@yahoo.co.in; brahmg2001@gmail.com;
goutam.brahmachari@visva-bharati.ac.in*

Synthetic organic chemistry is foundational to building the material basis of a sustainable society. This reality demands a proactive shift in how we design chemical products, moving away from traditional methods toward eco-friendly, energy-efficient processes. Today, the integration of green tools and novel methodologies goes beyond merely mitigating hazardous waste; it is unlocking unprecedented organic transformations that remain entirely unfeasible under conventional conditions.

For almost two decades, our research group has been deeply engaged in advancing green chemistry. We focus on designing sustainable approaches for biologically promising organic small molecules, including the fruitful application of green energy tools to implement complex chemical reactions. This presentation will highlight our recent efforts in this area, with a specific focus on utilizing these innovative, sustainable methodologies to drive highly effective transformations in coumarin chemistry.

**To be presented in
Organic Chemistry**

Prof. S.P. Hiremath Awardee Lecture

**Quantum Dots in Liquid Crystal Science and
Technology: Advanced Explorations**

C. V. Yelamaggad

*Centre for Nano and Soft Matter Sciences (CeNS)
1Arkavathi, Survey No.7, Shivanapura, Dasanapura Hobli,
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Quantum dots are semiconductor nanocrystals, typically a few nanometres in size, whose optical and electronic properties are strongly influenced by quantum confinement. Integrating QDs with liquid crystals (LCs) creates an interesting nano-soft-matter hybrid platform that combines the self-organization, anisotropy, and responsiveness of LCs with the size-dependent optical/electronic properties of QDs. Given this background, systematic studies carried out in our laboratory have examined the fluorescence (photoluminescence, PL) characteristics of several organic/hybrid composites realized by dispersing organic dyes and quantum dots (QDs) in the host fluorescent columnar liquid crystal (Col LC) phase exhibiting the excited-state intramolecular proton-transfer (ESIPT) phenomenon. Specifically, we prepared binary mixtures by doping organic dyes such as methyl red/rubrene and carbon QDs/perovskite (CsPbBr₃) QDs into the fluorescent (ESIPT) Col LC, namely, phasimdic bis(N-salicylideneaniline) (PBSAN-14). Three condensed states, viz., solid, LC, and liquid states, and their solutions have been subjected to photophysical characterization. The composites derived from organic dyes and Col LC do not emit light, implying that the host PL is quenched; Stern-Volmer profiles revealed combined dynamic and static quenching mechanisms. The Col LC-QD composites exhibit intense emission that covers almost the entire visible wavelength region. The CIE chromaticity diagram shows a wide range of color tuning achieved by varying the nature of additives. Thus, this investigation provides a clear insight into the effect of organic dyes and QDs on the condensed states of fluorophores.

**To be presented in
Analytical Chemistry Section**

Dr. Arvind Kumar Memorial Awardee Lecture

Smart NanoBio-Analytical Platforms for Next-Generation Personalized Healthcare Diagnostics

Pranjal Chandra

*Laboratory of Bio-Physio Sensors and Nanobioengineering, School of
Biochemical Engineering, Indian Institute of Technology (BHU),
Varanasi, Varanasi - Uttar Pradesh 221005*

Robust, reliable, and quantitative detection of harmful target analytes at ultra-low concentrations is of profound significance in modern clinical diagnostics. Smart nano-bio-analytical platforms have emerged as a transformative class of integrated technologies that combine functional nanomaterials, bioreceptors, advanced analytical methodologies, and digital data processing to enable sensitive and real-time point of care disease detection. These next-generation analytical platforms offer various advantages over conventional laboratory-based diagnostics, which are both time-consuming and not suitable for point-of-care/onsite diagnosis. The bioreceptors embedded in these analytical chips, including antibodies, aptamers, enzymes, bio-bodies, etc., are important for analyte detection by generating the analytical signals. A revolution in the understanding and synthesis of nanomaterials in the last few decades has also contributed significantly to the development of remarkable analytical sensor systems in terms of sensitivity, catalytic activity, biocompatibility, robustness, etc. Such platforms have tremendous promise in detecting various analytes, including disease biomarkers, free radicals, and chemical compounds in diverse matrices. Dr. Chandra has made significant contributions to the rapidly evolving domain of analytical chemistry by developing various cutting-edge nano-bio-analytical platforms for point-of-care sensing of diverse analytes, including disease biomarkers, free radicals, and other chemical compounds, hence providing a pertinent solution for modern healthcare diagnostics.

One of his notable innovations is an eco-friendly and affordable laser-engraved flexible paper microelectrode for electrochemical sensing of multiple model analytes; it is an alternative to commercial existing electrodes. He has also developed several smartphone-enabled nano-engineered analytical sensing platforms which hold the potential for real-time biomarker detection, thereby promoting digital health monitoring. Furthermore, he has developed a novel signal-transduction strategy based on a redox-active chemical probe that provides a highly sensitive and versatile analytical platform for disease diagnosis. These translational nano-bioanalytical devices/models hold significant promise for widespread applications in public healthcare and clinical laboratories.

**To be presented in
Organic Chemistry Section**

Prof. Kaza Somsekhar Rao Awardee Lecture

**Ionic Liquids and Deep Eutectic Solvents
as Efficient Media for Enhancing Enzyme
Activity and Stability**

Meena Bisht

*Department of Chemistry, Sri Venkateswara College,
University of Delhi, Dhaula Kuan, New Delhi 110021*

There is considerable interest in the use of structurally stable and catalytically active enzymes, in the pharmaceutical and fine chemicals industries. However, harsh process conditions, such as temperature, pH, and the presence of organic solvents, are the major barrier to the effective use of enzymes in biocatalysis. Cholinium-based ionic liquids (ILs) and deep eutectic solvents (DESs) and found as potential media for proteins and enzymes to improve their stability and activity. ILs and DESs-assisted enzymes showed significantly higher activity and stability against several external stimuli, such as high temperature (120°C), oxidative stress, high pH range and biological (trypsin) and chemical denaturants (GuHCl and urea,) compared to the native enzyme. These results are highly useful tools for improving the biocatalytic and extraction processes. Based on the observed results, the most efficient ILs/DESs were further chosen to extract various proteins (collagen) directly from sustainable biomass sources (fish industry waste). Compare to the conventional method, DES-extracted proteins were found with higher yield and purity. The observed results support the suitability of these solvents as efficient and green media for improving protein packaging, biorefinery, biocatalysis and drug delivery applications.

**To be presented in
Physical Chemistry Section**

Prof. S. T. Nandibewoor Awardee Lecture

Earth Abundant Electrocatalysts for Sustainable and Affordable Green Hydrogen Production

T. Maiyalagan

*Electrochemical Energy Laboratory, Department of Chemistry,
SRM Institute of Science and Technology, Kattankulathur, 603203
E-mail : maiyalagan@gmail.com*

Electrochemical water splitting has emerged as a promising and sustainable approach for large-scale hydrogen production with near-zero direct carbon emissions when powered by renewable energy. However, sluggish reaction kinetics, high energy requirements, and the reliance on expensive precious-metal-based catalysts remain significant challenges for the practical and commercial deployment of water electrolysis technologies. Consequently, considerable research efforts have been devoted to developing low-cost, highly active, and durable electrocatalysts for the hydrogen evolution reaction (HER), oxygen evolution reaction (OER), and overall water splitting.

In our research, we have developed a range of noble-metal-free electrocatalysts for HER, OER, and overall water-splitting applications. An ideal electrocatalyst should simultaneously exhibit (i) intrinsically active catalytic sites, (ii) abundant and readily accessible active surface sites, (iii) efficient electron and mass transport pathways, (iv) excellent chemical and structural stability, and (v) economically viable and scalable synthesis. Although substantial progress has been made in catalyst development, many reported studies primarily focus on electronic-structure modulation while giving comparatively less attention to the simultaneous optimization of activity, active-site accessibility, transport properties, durability, and scalability.

This presentation will highlight our recent progress in the design and development of noble-metal-free electrocatalysts for HER, with particular emphasis on molybdenum-based materials, including MoO_2 , MoS_2 , and Mo_2C . These earth-abundant materials offer attractive catalytic properties, good

structural stability, and cost advantages, making them promising candidates for sustainable hydrogen production. Strategies for enhancing their electrocatalytic performance will be discussed, including carbon-composite formation, heteroatom doping, defect engineering, and heterostructure construction to promote synergistic catalytic effects, improve electrical conductivity, increase the accessibility of active sites, and facilitate charge and mass transport. Finally, the presentation will address the key challenges associated with catalyst activity, long-term durability, synthesis scalability, and integration into practical electrolyzer systems. Future perspectives for translating advanced Mo-based electrocatalysts from laboratory-scale studies toward scalable and economically viable green hydrogen production will also be discussed.

**To be presented in
Physical Chemistry Section**

Dr. S.M.L. Gupta Memorial Awardee Lecture

Molecular Design and Functional Coordination Chemistry: From Phosphoryl to Terpyridine-based Metal Complexes

Akella Sivaramakrishna

*Department of Chemistry, School of Advanced Sciences, Vellore
Institute of Technology (VIT), Vellore 632014, Tamil Nadu
Email: asrkrishna@vit.ac.in*

The progress of functionalized ligands and their metal complexes through rational design represents a vital frontier in contemporary chemistry, involving fundamental coordination chemistry with applications in catalysis, sensing, materials science, separation science, and biology. This lecture presents an outline of the research contributions by highlighting the synthesis, coordination behavior, structure–property relationships, and functional applications of phosphoryl and terpyridine-based ligand systems. The phosphoryl group containing molecules (e.g. phosphine oxides, phosphinates, phosphonates, α -aminophosphonates, and aminophosphine oxides) will be discussed with a particular attention to understanding how donor-atom properties, steric factors, and electronic effects influence metal–ligand interactions, stability of complexes, ligand-exchange behavior, and the selective extraction of lanthanides and actinides. The development of functionalized materials for metal-ion separation further illustrates the potential of molecular coordination chemistry in addressing challenges associated with nuclear fuel-cycle chemistry and catalysis reactions.

Also, the versatile coordination chemistry of functionalized terpyridine ligands provides opportunities for developing catalytic systems, fluorescent and chemical sensors including supramolecular architectures, and biologically relevant metal complexes. These studies demonstrate how ligand modification and control of coordination environments can be used to modify

molecular properties and explore new functions. By bringing together fundamental synthesis, structural characterization, mechanistic understanding, and application-oriented research, this lecture will emphasize the importance of interdisciplinary collaboration and molecular innovation in advancing chemistry, which can lead to development of advanced materials, sustainable catalysis, selective metal-ion recovery, and bioinorganic chemistry.

**To be presented in
Inorganic Chemistry Section**

Dr. P. N. Sharma Memorial Awardee Lecture

Designing Sustainable Corrosion Inhibitors for Industrial Applications: A Green Chemistry Approach

M.A. Quraishi

Current: Adjunct Professor, Centre for Green Chemistry and Sustainability, AKS University, Satna, MP, Former Professor and Head, Department of Chemistry, IIT (BHU), Varanasi

Corrosion poses a significant threat to global industrial infrastructure, resulting in substantial economic losses and environmental challenges. While corrosion inhibitors offer a practical and cost-effective solution, stringent environmental regulations are driving the need for sustainable alternatives. This presentation outlines recent progress in designing green corrosion inhibitors guided by Green Chemistry principles. The focus is on synthesizing novel inhibitors using eco-friendly methods that feature safer reaction conditions, renewable feedstock's, reduced waste, and energy efficiency. The crucial relationship between molecular structure, adsorption behaviour, and inhibition mechanisms is examined. A key aspect is the integration of experimental work with Density Functional Theory (DFT) and Molecular Dynamics (MD) simulations to understand inhibitor-metal interactions and predict performance. The combined use of electrochemical techniques, surface analysis, and computational modelling has enabled the rational creation of highly effective and environmentally compatible inhibitors. Examples include green-synthesized heterocyclic compounds, ionic liquids, Schiff bases, and amino acid derivatives for acidizing, pickling, and petroleum industry use. The discussion also addresses challenges and future prospects for transitioning these green technologies from research to industrial practice, demonstrating that Green Chemistry offers a robust pathway for developing next-generation inhibitors that are both high-performing and sustainable.

**To be presented in
Inorganic Chemistry Section**

**GLORIOUS RECORD OF ICC PAST CONFERENCES
WITH SECTIONAL PRESIDENTS IN THEIR RESPECTIVE SECTIONS**

Conf.	Date/Year	Local Organiser
1st	20-21 Sept., 1981	Indian Council of Chemists at Hotel Clarks Shiraz, Agra
	Inorganic	Prof. T. N. Srivastava, Lucknow University, Lucknow
	Organic	Prof. P. R. Singh, IIT, Kanpur
	Physical	Prof. S. P. Srivastava, Roorkee University, Roorkee
2nd	06-08 Nov., 1982	Kashmir University, Srinagar (J & K)
	Inorganic	Prof. M.M. Taqui Khan, Director, CSMCRI, Bhavnagar
	Organic	Prof. M. S. R. Naidu. S.V. University, Tirupati
	Physical	Prof. Aizaz Baig, Aligarh Muslim University, Aligarh
3rd	28-30 Oct., 1983	Karnataka University, Dharwad
	Inorganic	Prof. L. D. Dave, Bhavnagar University, Bhavagar
	Organic	Prof. P. R. Singh, IIT, Kanpur
	Physical	Prof. H. C. Gaur, Delhi University, Delhi
4th	30-31 Dec., 1984 & 1 Jan., 1985	Gorakhpur University, Gorakhpur
	Inorganic	Prof. S. S. Sandhu, G.N.D. University, Amritsar
	Organic	Prof. S. C. Palerashi, Indian Institute of Chemical Biology, Jadavpur, Kolkata
	Physical	Prof. E. S. Jayadevappa, Karnataka University, Dharwad
	Anal.& Env.	Prof. S.G. Tandon, R.S. University, Raipur
5th	27-29 Dec., 1985	Central Fuel Research Institute (CFRI), Sindri, Dhanbad
	Inorganic	Prof. G.K.N. Reddy, Bangalore University, Bangalore
	Organic	Prof. D. Natsepuri, Indian Institute of Chemical Biology, Jadavpur, Kolkata
	Physical	Prof. M. L. Lakhadpal, Panjab University, Chandigarh
	Anal.& Env.	Prof. S.G. Tandon, R.S. University, Raipur
6th	27-29 Dec., 1986	Madurai Kamraj University, Madurai
	Inorganic	Prof. P. P. Singh, Bareilly College, Bareilly
	Organic	Prof. M. M. Bokadia, Vikram University, Ujjain
	Physical	Prof. Y. K. Gupta, Rajasthan University, Jaipur
	Anal.& Env.	Prof. S.M. Khopkar, IIT, Mumbai
	Bio-Chemistry	Prof. D.T. Jayaraman, Madurai Kamaraj Univ., Madurai

7th	Dec., 1987	Jiwaji University, Gwalior
	Inorganic	Prof. G. K. Chaturvedi, G. B. Pantnagar University, Pantnagar
	Organic	Prof. J. P. Saxena, Jodhpur University, Jodhpur
	Physical	Prof. B. Sethuram, Osmania University, Hyderabad
	Anal. & Env. Bio-Chemistry	Prof. Y.K. Agrawal, M.S. University, Baroda Prof. Rattan Singh, Punjab Agriculture Univ., Ludhiana
8th	1988	Sri Venkateshwara University, Tirupati
	Inorganic	Prof. D.V. Jahagirdar, Marathwada University, Aurangabad
	Organic	Prof. S. P. Hiremath, Gulbarga University, Gulbarga
	Physical	Prof. K. N. Mehrotra, Agra University, Agra
	Anal. & Env. Bio-Chemistry	Prof. B.K. Pal, Jadavpur University, Kolkata Prof. A.M. Siddiqui, Aligarh Muslim University, Aligarh
9th	1990	Gulbarga University, Gulbarga
	Inorganic	Prof. K. N. Munshi, Nagpur University, Nagpur
	Organic	Prof. J. N. Srivastava, Bhagalpur University, Bhagalpur
	Physical	Prof. R. C. Srivastava, B.H.U., Varanasi
	Anal. & Env. Bio-Chemistry	Prof. J. Rama Reddy, S.V. University, Tirupati Prof. T. Ramasarma, Indian Inst. of Science, Bangalore
10th	28–30 Oct., 1991	Goa University, Goa
	Inorganic	Prof. M. L. Dhar, Jammu University, Jammu
	Organic	Prof. G. K. Trivedi, IIT, Mumbai
	Physical	Prof. P. C. Nigam, Manipur University, Imphal
	Anal. & Env.	Prof. S.N. Tandon, Roorkee University, Roorkee
11th	12–14 Mar., 1993	Bihar University, Muzaffarpur
	Inorganic	Prof. K. C. Satpathy, Sambhalpur University, Burla
	Organic	Prof. V. K. Saxena, Dr. H.S. Gaur University, Sagar
	Physical	Prof. K. C. Nand, Jiwaji University, Gwalior
	Anal. & Env.	Prof. K.G. Varshney, Dr. Z.H. College of Engg. & Tech., Aligarh
12th	Dec., 1993	Kakatiya University, Warangal
	Inorganic	Prof. A. S. R. Murthy, Andhra University, Guntur
	Organic	Prof. D. Bhaskar Reddy, S.V. University, Tirupati
	Physical	Prof. S. I. Ali, Jamia Millia Islamia, New Delhi
	Anal. & Env.	Prof. B.M. Schinde, Inst. of Science, Mumbai
13th	1994	Jammu University, Jammu (J & K)
	Inorganic	Prof. R. R. Naidu, S. V. University, Tirupati
	Organic	Prof. S. C. Sharma, H.P. University, Shimla
	Physical	Prof. R. K. Prasad, L. S. College, Muzaffarpur
	Anal. & Env.	Prof. P.A. Puja, Gulbarga University, Gulbarga

14th	28–30 Dec., 1995 Inorganic Organic Physical Anal. & Env.	The Institute of Science, Mumbai Prof. N. K. Jha, IIT, Delhi Prof. S. Shivasubramanian, Madurai University, Madurai Prof. N. K. Sharma, University of Jammu, Jammu Prof. R.T. Sane, R.H. Ruia College, Mumbai
15th	24-26 Oct., 1996 Inorganic Organic Physical Anal. & Env.	Dr. B.R. Ambedkar University, Aurangabad (M.S.) Prof. P. G. Ramappa, Mysore University, Mysore Prof. P. S. Kalsi, Punjab Agricultural University, Ludhiana Prof. V. Ananta Raman, Andhra University, Vishakhapatnam Prof. S.P. Mathur, M.D. University, Ajmer
16th	Oct., 1997 Inorganic Organic Physical Anal. & Env.	Mangalore University, Mangalore Prof. K. C. Patel, Indian Institute of Science, Bangalore Prof. S. Y. Ambekar, Mysore University, Mysore Prof. S. C. Ameta, M. L. Sukhadia University, Udaipur Prof. Mrs. S.K. Menon, Gujarat University, Ahmedabad
17th	26-28 Nov., 1998 Inorganic Organic Physical Anal. & Env.	Madras University, Chennai Prof. S. F. Patil, North Maharashtra University, Jalgaon Prof. A. K. Singh, IIT, Mumbai Prof. Bharat Singh, Allahabad University, Allahabad Prof. T.S. Pal, IIT, Kharagpur
18th	27–29 Dec., 1999 Inorganic Organic Physical Anal. & Env.	North Maharashtra University, Jalgaon Prof. M. C. Chakraborty, IIT, Kharagpur Prof. M. M. Salunkhe, Institute of Science, Mumbai Prof. (Mrs) Surekha G. Devi, M. S. University, Baroda Prof. S.M. Khopkar, IIT, Mumbai
19th	27-29 Nov., 2000 Inorganic Organic Physical Anal. & Env.	Kuvempu University, Shimoga Prof. R. C. Maurya, R. D. University, Jabalpur Prof. (Mrs.) Sujata V. Bhat, IIT, Mumbai Prof. B. Thimme Gowda, Mangalore Univ., Mangalore Prof. V.K. Gupta, R.S. University, Raipur
20th	22-24 Dec., 2001 Inorganic Organic Physical Anal. & Env.	Mysore University, Mysore Prof. B. L. Khandelwal, D.M.S.R.D.E., Kanpur Dr. V. S. Ekkundi, CIBA India Pvt. Ltd., Mumbai Prof. M. K. Mishra, IIT, Mumbai Prof. Syed Akeel Ahmad, Mysore University, Mysore
21st	24-26 Oct., 2002 Inorganic Organic Physical Anal. & Env.	Rani Durgavati University, Jabalpur (M.P.) Prof. P. K. Bhattacharya, M.S. University, Baroda Prof. H. M. Chawla, IIT, New Delhi Prof. B. L. Thembe, IIT, Mumai Prof. K.K. Verma, R.D. University, Jabalpur

22nd	17-19 Oct., 2003 Inorganic Organic Physical Anal. & Env.	Indian Institute of Technology, Roorkee Prof. Ranjeet K. Verma, Magadh University, Bodh-Gaya Prof. S. S. Talwar, IIT, Mumbai Prof. A. K. Jain, IIT, Roorkee Prof. P.K. Padmanabhan, BARC, Mumbai
23rd	29-31 Oct., 2004 Inorganic Organic Physical Anal. & Env.	K.C. College, Churchgate, Mumbai Prof. Lallan Mishra, B. H. U., Varansi Prof. N. S. Prakasa Rao, Nagarjuna University, Nagarjunanagar Prof. S. K. Dogra, IIT, Kanpur Prof. K.S. Pitre, Dr. H.S. Gaur Univ., Sagar
24th	16-18 Dec., 2005 Inorganic Organic Physical Anal. & Env.	Birla Institute of Technology, Mesra, Ranchi Prof. S. K. Roy, Vinoba Bhave University, Hazaribagh (Jharkhand) Prof. K. R. Desai, South Gujrat University, Surat Prof. Girjesh Govil, TIFR, Mumbai Prof. Kaza Somasekhara Rao, Acharya Nagarjuna Univ., Nuzvid
25th	27-29 Dec., 2006 Inorganic Organic Physical Anal. & Env. Pharmaceutical	Birla College of Arts, Science & Com., Kalyan (M.S.) Prof. R. C. Srivastava, Lucknow University, Lucknow Prof. K. S. Rangappa, Mysore University, Mysore Prof. M. K. Mahanti, North-Eastern Hill Univ., Shillong Prof. H.S. Rathore, Z.H. College of Engg. & Tech., AMU, Aligarh Prof. Anamik Shah, Saurashtra University, Rajkot
26th	26-28 Feb., 2008 Inorganic Organic Physical Anal. & Env. Pharmaceutical	Dr. H.S. Gour University, Sagar (M.P.) Prof. P. Indrasenan, Univ. of Kerala, Tiruvanthapuram Prof. S. Kabilan, Annamalai University, Annamalai Nagar Prof. Ashok Kumar Sharma, Devi Ahilya University, Indore Prof. A.D. Sawant, Mumbai University, Mumbai Dr. P.M.S. Chauhan, CDRI, Lucknow
27th	26-28 Dec., 2008 Inorganic Organic Physical Anal. & Env. Pharmaceutical	Gurukul Kangri Vishwavidyalaya, Haridwar Prof. C. P. Bhasin, HNG University, Patan Prof. Balakrishna Kalluraya, Mangalore University, Mangalore Dr. L. Gomithi Devi, Bangalore Univ., Bangalore Dr. Rakesh Kumar, NEERI, Worli, Mumbai Prof. M.P.S. Ishar, Gurunanak Dev University, Amritsar

28th	07–10 Nov., 2009 Inorganic Organic Physical Anal. & Env. Pharmaceutical	Hem North Gujarat University, Patan (Gujarat) Dr. A. S. Aswar, SGB Amravati University, Amravati Prof. B. H. M. Mritunjaya Swami, Gulbarga University, Gulbarga Prof. A. K. Srivastava, Allahabad Univ., Allahabad Prof. G. Rama Krishna Naidu, Sri Venkateswar University, Tirupati Prof. C.S. Mahela, Kumaun University, Nainital
29th	19–21 Dec., 2010 Inorganic Organic Physical Anal. & Env. Pharmaceutical	Panjab University, Chandigarh Prof. A. K. Manihar Singh, Manipur University, Imphal Prof. D. Ashok, Osmania University, Hyderabad Prof. S. T. Nandibewoor, Karnatak University, Dharwad Prof. K.S. Gupta, University of Rajasthan, Jaipur Prof. M. Himaja, VIT University, Vellore
30th	28–30 Dec., 2011 Inorganic Organic Physical Anal. & Env. Pharmaceutical	Osmania University, Hyderabad Prof. A. K. Singh, IIT, Delhi Prof. M. V. Basaveswara Rao, Krishna University, Machilipatnam, A.P. Prof. S. A. Chimatadar, Karnataka Univ., Dharwad Prof. A.K. Singh, IIT, Delhi Dr. P.M.S. Chauhan, CDRI, Lucknow
31st	26–28 Dec., 2012 Inorganic Organic Physical Anal. & Env. Pharmaceutical	Saurashtra University, Rajkot Prof. H. P. S. Chauhan, Devi Ahilya University, Indore Prof. N. C. Desai, M.K. Bhavnagar Univ., Bhavnagar Prof. S. K. Mehta, Panjab Univ., Chandigarh Prof. I. Ajit Kumar Reddy, NIT Warangal Prof. Naveen B. Patel, VNSG University, Surat
32nd	28–30 Nov. 2013 Inorganic Organic Physical Anal. & Env. Pharmaceutical	Karnataka University, Dharwad Prof. A. P. Mishra, H. S. Gour University, Sagar Prof. D. Channe Gowda, Mysore University, Mysore Prof. M. B. Halli, Gulbarga Univ. Gurbarga Prof. J.J. Vora, H.N.G. University, Patan Dr. Anil Kumar Dwivedi, CDRI, Lucknow
33rd	15–17 Dec., 2014 Inorganic Organic Physical Anal. & Env. Pharmaceutical	Indian School of Mines, Dhanbad Prof. Shivraj, Osmania University, Hyderabad Prof. C. Venkata Rao, Sri Venkateswara Univ., Tirupati Prof. M. M. Singh, BHU, Varanasi Prof. Sanjoy Mishra, Ranchi University, Ranchi Prof. N.S. Rajurkar, Pune University, Pune
34th	26–28 Dec., 2015 Inorganic Organic Physical Anal. & Env. Pharmaceutical	UKA Tarsadia University, Bardoli, Surat Prof. D. D. Pathak, ISM, Dhanbad Prof. Kotha Sambasiva Rao, IIT Bombay Prof. Ali Mohammad, AMU, Aligarh Dr. V.S. Srivastava, G.T.P. College, Nandurbar Prof. Shailesh Shah, UKA Tarsadiya Univ., Bardoli, Surat

35th	22–24 Dec., 2016	Haribhai V. Desai College Pune & College of Engg., Pune
	Inorganic Organic Physical Anal. & Env. Pharmaceutical	Dr. R. K. Agrawal, Lajpat Rai P.G. College, Sahibabad Prof. Balakrishna Kalluraya, Mangalore University, Mangalore Prof. R. Sambasiva Rao, Andhra Univ., Visakhapatnam Prof. S.K. Pardeshi, Pune University, Pune Prof. K. Sathiyarayanan, VIT University, Vellore
36th	26–28 Dec., 2017	Andhra University, Visakhapatnam
	Inorganic Organic Physical Anal. & Env. Pharm. & Bio-Chemistry	Prof. Sushil K. Pandey, University of Jammu, Jammu Prof. Vommuna V. Sureshbabu, Bangalore Univ., Bangalore Prof. Krishnaiah Abburi, Tirupati Prof. Prafulla K. Sahoo, Utkal University, Bhubaneswar Prof. P. Vani, Andhra University, Visakhapatnam
37th	12–14 Dec., 2018	National Institute of Technology Karnataka, Surathkal, Karnataka
	Inorganic Organic Physical Anal. & Env. Pharm. & Bio-Chemistry	Prof. B. Narayana, Mangalore University, Mangalore Prof. J. J. Vora, HNG University, Patan Prof. Puttaswami, Bangalore Univ., Bangalore Prof. R.K. Dubey, Allahabad University, Allahabad Prof. J. Saravanan, PES College of Pharmacy, Bangalore
38th	26–28 Dec., 2019	Jaipur National University, Jaipur
	Jaipur Organic Physical Anal. & Env. Pharm. & Bio-Chemistry	Prof. B. K. Rai, Muzaffarpur Prof. Bhaskar S. Dawane, Marathwada University, Nanded Prof. Harsh Manchanda, NIT, Jalandhar Prof. Pradeep Kumar Sharma, J.N.V. Univ., Jodhpur Prof. D. Ashok, Osmania University, Hyderabad
39th	10–11 Apr., 2021 (Online)	Veer Narmad South Gujarat University, Surat
	Inorganic Organic Physical Anal. & Env. Pharma.	Prof. R. N. Patel, A.P.S. University, Rewa Prof. M. Vijulatha, Osmania University, Hyderabad Prof. Amalendu Pal, Kurukshetra Univ., Kurukshetra Prof. Pranav Srivastava, Gujarat Univ. Ahmedabad Prof. K.H. Chikhalia, VNSG University, Surat
40th	29-30 Dec., 2021 (Online)	Satavana University, Karimnagar, Telangana
	Inorganic Organic Physical Anal. & Env. Pharma.	Prof. Shivadhar Sharma, Magadh University, Bodh-Gaya Prof. Panaganti Leelavathi, Osmania University, Hyderabad Prof. Pannuru Venkatesu, University of Delhi, Delhi Prof. Satish K. Pardeshi, S.P. Pune University, Pune Dr. Hitesh D. Patel, Gujarat Univ., Ahmedabad

41st	27-29 Dec., 2022	Institute of Basic Sciences, Dr. B. R. Ambedkar University, Agra Inorganic Dr. Abhay Nand Sahay, TM Bhagalpur Univ., Bhagalpur Organic Prof. A. Jaya Shree, J.N. Technological Univ., Hyderabad Physical Prof. P. Venkatesu, Delhi University, Delhi Anal.& Env. Dr. A.S. Aswar, S.G.B. Amravati University, Amravati
42nd	20-22 Dec., 2023	University of Kota, Kota, Rajasthan Inorganic Prof. G. S. Gugale, H. V. Desai College, Pune Organic Prof. Kishore Chikhalia, VNSG University, Surat Physical Prof. Pradeep K. Sharma, JNV, Jodhpur in place of Prof. M.Y. Karidurganavar, Karnatak Univesity, Dharwad Anal.& Env. Prof. Jaya Dwivedi, Banasthali University, Banasthali
43rd	26-28 Dec., 2024	Modern College of Arts, Science & Commerce, Pune & H. V. Desai College, Pune Inorganic Prof. R. N. Patel, Rewa in place of Dr. R. N. Jadeja, M. S. University, Baroda Organic Prof. Beeraiah Baire, IIT Madras, Chennai Physical Prof. Dilip H. Dagade, Shivaji Univ., Kolhapur Anal.& Env. Prof. Tamal Banerjee, IIT,Guwahati
44th	22-24 Dec., 2025	KLE Technological Univ., Hubballi, Karnataka Inorganic Prof. V. K. Sharma, Lucknow University, Lucknow Organic Prof. Arun M. Isloor, NIT Karnataka, Surathkal Physical Prof. Ramesh L. Gardas, IIT Madras, Chennai Anal.& Env. Prof. Annamalai Senthil Kumar, Vellore Institute of Technology University, Tamil Nadu

**SYMPOSIUM ON
“CRITICAL MINERALS AND RARE EARTHS:
CATALYST FOR TECHNOLOGY AND INDUSTRY
TRANSFORMATION FOR VIKSIT BHARAT”**

Sectional President’s Welcome Address

Dhruva Kumar Singh

Convenor

*Department of Fuel, Minerals and Metallurgical Engineering,
IIT(ISM), Dhanabdh-826004*

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Distinguished guests, eminent speakers, colleagues from industry and academia, and dear young researchers,

It is my privilege to welcome you to IIT (ISM) Dhanbad for the National Symposium on “Critical Minerals and Rare Earths: Strategic Enablers of Technology and Industrial Transformation for Viksit Bharat.” The symposium is held under the aegis of the Indian Council of Chemists, in association with TEXMiN, during the centenary year of this great institution. The Indian School of Mines has served the nation’s mineral sector for a hundred years, and it is fitting that its second century begins with the minerals that will shape India’s future.

Critical minerals and rare earths are no longer specialised commodities. They underpin clean energy, electric mobility, electronics, defence, space and nuclear technologies. Yet the world’s processing capacity remains highly concentrated, and supply has become a matter of strategic security. The National Critical Mineral Mission recognises this, and its success will depend on how well we connect geology, processing, materials and manufacturing into a single national value chain.

I have spent more than three decades at the Bhabha Atomic Research Centre and the Homi Bhabha National Institute working on hydrometallurgy, solvent extraction, ion exchange and membrane separations. That work involved developing process flowsheets for critical, atomic and rare earth metals from both primary and secondary sources. It taught me one enduring lesson: a mineral deposit becomes a national asset only when we can process it. Exploration identifies

the resource, but beneficiation, separation, purification and metal production turn it into strength. Developing the indigenous technology for neodymium metal for NdFeB magnets, and supplying gadolinium nitrate as moderator poison for the Kakrapar Atomic Power Project, showed me that Indian science can deliver when laboratories, industry and government work towards a shared goal.

This symposium has been built around that conviction. Over the course of the day you will hear from policymakers at NITI Aayog, scientists from DAE, CSIR, DRDO and C-MET, leaders of public-sector and private industry, and innovators building start-ups in recycling and magnet manufacturing. The themes cover the full chain: exploration, ore characterisation and beneficiation, hydrometallurgy and separation, urban mining and the circular economy, scale-up and technology transfer, and policy and supply-chain security. The dedicated industry session and the panel discussion with the World Resources Institute are meant to turn ideas into partnerships.

I especially encourage our students and young researchers to engage fully. India's critical mineral mission needs process engineers, separation chemists, metallurgists and entrepreneurs who can take technologies from the laboratory to the plant. Many of you will build that future.

I am deeply grateful to the Chief Guest, Prof. Gobardhan Das, Hon'ble Member, NITI Aayog; to our Patrons and the leadership of IIT (ISM) Dhanbad; to the Indian Council of Chemists; to TEXMiN; to our sponsors; and to every speaker and panelist who has given time to be with us. My sincere thanks also go to the Symposium Convenor, Prof. B. Rajasekhar Reddy, and the organising team for their tireless effort.

Let us use this day not only to share knowledge but to build collaborations that endure, so that India moves from resource security to technology leadership and becomes self-reliant in critical minerals and rare earths.

SIL-01 : Critical Materials and Supply-Chain Security: NFC Enabling India's Nuclear Energy Vision

Dinesh Srivastava

Former Distinguished Scientist and Chief Executive, Nuclear Fuel Complex, Hyderabad

India's nuclear energy vision depends on indigenous technologies, assured nuclear fuel and secure access to critical materials. Uranium fuel and zirconium alloys are particularly important for sustaining reactor operation and expanding nuclear power capacity. Established in the early 1970s, the Nuclear Fuel Complex (NFC), a constituent unit of the Department of Atomic Energy (DAE), has played a pivotal role in developing India's indigenous capabilities in uranium fuel fabrication, zirconium-alloy processing and manufacturing of critical reactor components. Its products include pressure tubes, calandria tubes, garter springs, reactivity mechanism assemblies and BWR square channels, while its expertise has also supported advanced reactor programmes including the FBTR and PFBR.

As India expands its nuclear programme, strengthening the supply chain for uranium, zirconium alloys and other strategic materials, along with advanced processing, manufacturing, recycling and quality-assurance technologies, is essential for energy security and technological self-reliance. This talk highlights NFC's role in fulfilling critical materials and development of strategic nuclear technologies, strengthening India's nuclear supply-chain resilience and supporting the nation's journey towards a secure, self-reliant and sustainable nuclear-energy future.

SIL-02 : Critical and Strategic Minerals: Strengthening India's Resource Security through Exploration and Sustainable Resource Utilisation

Dheeraj Pande

*Director, Atomic Minerals Directorate for Exploration and Research (AMD), DAE, Hyderabad 500 016
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Critical and strategic minerals have emerged as indispensable strategic resources underpinning the global transition towards clean energy, advanced manufacturing, digital technologies and defence applications. Their growing strategic importance, coupled with concentrated global supply chains, underscores the need to strengthen India's indigenous resource base and develop a resilient rare earth ecosystem.

India possesses considerable geological potential for REEs in carbonatites, alkaline complexes, granitic and pegmatitic systems and beach sand placer deposits. Atomic Minerals Directorate for Exploration and Research (AMD) has contributed substantially in identifying and evaluating these resources through integrated geological, geophysical, geochemical and mineralogical investigations. Notable achievements include the delineation of hard-rock hosted REE-Nb-Zr deposit at Ambadungar Carbonatite Complex, Gujarat and Siwana Ring Complex, Rajasthan. The growing complexity of mineral exploration necessitates integrated, mineral-system-based approaches for identifying both exposed and concealed mineralisation. Application of airborne and ground geophysical surveys, remote sensing, advanced geochemical techniques, structural interpretation and three-dimensional geological modelling, coupled with multidisciplinary data integration, can significantly enhance mineral prospectivity assessment, target identification and resource delineation.

Beyond conventional exploration, reassessment of mine tailings, legacy mining wastes and other secondary mineral resources offers additional opportunities for recovering critical minerals while promoting resource efficiency and sustainable utilisation. A comprehensive strategy integrating advanced exploration technologies, systematic resource evaluation and collaborative research will be pivotal in augmenting India's critical mineral inventory, strengthening resource security and supporting the objectives of the National Critical Mineral Mission 2025 and vision of Viksit Bharat@2047.

SIL-03 : Critical and Strategic Mineral Systems in India: Integrating Metallogenic Provinces, Predictive Exploration, Resource Discovery and Metal Recovery

Deepak Kumar Sinha

Chief Executive Officer, GMRICS / GMDC

Former Director, AMD, DAE

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India is endowed with Archaean (H⁴by) to Recent (< 1 Ma) geological environments and rich metallogenic provinces which are considered prospective for the critical-mineral supply chain. Indian studies have comparatively limited integration of geological environments and metallogenic provinces for forecasting exploration, resource characterisation, geometallurgy, and metal recovery. This talk presents a mineral-systems-based framework that links ore-forming processes, exploration targeting, resource delineation, and metal extraction within a common evaluative structure.

Conventional exploration in India has depended primarily on geological mapping, geochemical surveys, geophysical investigations, and shallow (< 300 m) drilling-based resource evaluation. These approaches have contributed substantially to identifying mineral occurrences. Still, their effectiveness may be limited when targeting blind, buried, or in terms of structure complex mineral systems beyond 300m. Integrating tectonic reconstruction, metallogenic analysis, ppb/ppt-level geochemical signatures, advanced surface/subsurface geophysical techniques, high-resolution remote sensing, localised mineral chemistry, and three-dimensional geological modelling provides a basis for constructing mineral-system models that can help identify favourable geodynamic settings, mineralisation pathways, and depositional sites. Such datasets may contribute to prospectivity assessment, target prioritisation, and evaluation of exploration uncertainty.

India's geological framework contains Archean cratons, Proterozoic mobile belts, alkaline-carbonatite complexes, granitic pegmatite provinces, sedimentary basins, mafic-ultramafic complexes, and coastal placer systems that host a variety of critical-mineral occurrences. A significant group of critical minerals, including Li, Be, Sn, Ta, Nb and REE, is closely associated with evolved granitic systems, pegmatites, carbonatites, and alkaline igneous complexes. Li and Be predominantly occur in pegmatitic environments, whereas Nb and Ta are concentrated in rare-metal pegmatites, alkaline complexes, and carbonatite-hosted pyrochlore deposits. Tin mineralisation is characteristically related to highly differentiated peraluminous granites and occurs within greisens, skarns, hydrothermal veins, and placer deposits. Similarly, REE mineralisation is hosted by carbonatites, alkaline intrusions, ion-adsorption clays, and monazite-bearing placers. The principal challenges for resource identification of these commodities include low concentrations and the requirement for advanced beneficiation and metallurgical techniques. Predictive exploration of pegmatite belts, alkaline complexes, carbonatite provinces, and concealed granite-related mineral systems deliver substantial opportunities to expand domestic resources, with a strong background in beneficiation and metallurgical requirements. Energy-transition minerals such as graphite, Co, Ni, V, Ga and Ti are essential for battery technologies, renewable-energy storage systems, and advanced industrial applications. Co and Ni are primarily associated with magmatic sulfide deposits, lateritic profiles, and mafic-ultramafic complexes, while graphite is predominantly formed through metamorphism of carbonaceous sedimentary rocks. V occurs principally within titanomagnetite-bearing layered intrusions, black shales, and

sandstone-hosted deposits. In contrast, Ga is dispersed within bauxite and zinc deposits and recovered as a by-product during Al and Zn processing. Ti mineralisation is concentrated in heavy-mineral placers and anorthosite-associated magmatic deposits. Several strategically important technology metals, including In, Cd, Se, Te, Rh and Mo, occur mainly as trace constituents within larger ore systems. In and Cd are mostly associated with sphalerite-rich zinc deposits, Se and Te with porphyry copper systems, and Rh with Mo-bearing porphyry Cu-Mo deposits. Because these metals are generally recovered as by-products, their production depends on the mining and processing of host metals rather than dedicated extraction operations. Consequently, supply is strongly influenced by fluctuations in primary metal demands. The main challenge is their extremely low concentrations, which require sophisticated processing technologies and efficient recovery circuits. Nonetheless, substantial opportunities exist through improved recovery from zinc-processing streams, copper-refining anode slimes, molybdenite concentrates, mine waste, and recycling pathways, therewith enhancing resource efficiency and domestic availability. Predictive exploration and mineral discovery, however, meet challenges because primary metal ore bodies are often deep-seated. The layering of mineral phases at various levels (depth) during mineralisation processes provides a good opportunity to discover and recover trace critical elements in primary mineralised bands. Other economically significant critical minerals, including phosphate, K, Zr, W, and PGEs, occur in a wide variety of geological settings. Phosphate resources are principally hosted in sedimentary phosphorites and carbonatite-associated apatite deposits, whereas potash is associated with evaporitic sequences and glauconitic sedimentary formations. Zircon is mainly concentrated in heavy-mineral placer deposits derived from the weathering of zircon-bearing igneous rocks. Tungsten occurs in skarns, greisen, veins, and porphyry systems related to granitic magmatism. PGEs are commonly associated with mafic-ultramafic layered intrusions and magmatic sulfide deposits. Predictive PGE exploration, based on high-resolution geophysical and geochemical targeting, process mineralogy, and sustainable extraction technologies, offers considerable scope for resource expansion.

The above concepts have been utilised in the Singhbhum Shear Zone, one of India's mineral-rich belts, which has produced copper since 1930. This zone is interpreted as an important metallogenic corridor containing Cu, Mo, U, REE and Th mineralisation associated with prolonged tectonic reactivation, hydrothermal fluid circulation, and lithological controls. The recent recognition of serpentinitised peridotite-hosted U-Cr-Ni-Mo-REE mineralisation in the Kudada-

Turamdih area has shifted perceptions, with additional metallogenic environments discovered that contain a variety of critical metals. The resumption and expansion of Rakha Copper Mine in 2025 have opened a new era in which resource discovery and critical-element metal recovery are likely. Similar approaches are being attempted in another mineral-rich province, the South Aravalli-Delhi-Copper Belt, where early successes in Gujarat-Rajasthan show encouraging evidence from > 300 m depth, targeting the Ambaji Copper Mine in the Ambaji-Deribasantgarh belt for many Cu-Zn-Pb-sulphide-hosted critical elements. The Singhbhum and Aravalli-Delhi provinces therefore indicate the potential utility of process-based exploration approaches in mature exploration terrains, with geo-metallurgy in the background.

The important aspect of the proposed framework is integrating geo-metallurgical characterisation into exploration and resource-definition workflows. Geological resources do not necessarily correspond directly to recoverable metal inventories because mineralogical composition, ore texture, grain-size distribution, mineral associations, liberation behaviour, and deleterious phases can notably control beneficiation and extraction performance. Geo-metallurgy seeks to define quantitative relationships between orebody geology and metallurgical response through integrating geological, mineralogical, geochemical, and processing datasets into predictive systems of ore behaviour. Such approaches facilitate the definition of geo-metallurgical domains and allow assessment of spatial variability in ore characteristics and processing response. In critical-mineral deposits, where economically important elements commonly occur within mineralogically complex and comparatively low-grade ores, metal deportment may strongly influence recoverability. REE deposits, for example, may contain multiple REE-bearing minerals exhibiting different beneficiation and leaching characteristics. In contrast, Li, Nb-T, Ni-Co, graphite and V deposits commonly display mineralogical heterogeneity that could influence process performance. Early incorporation of automated mineralogy, mineral chemistry, liberation analysis, and metallurgical testing into predictive exploration may improve resource and metal discovery.

SIL-04 : Advances in Sustainable Processing of Critical Mineral Values from Primary Resources

T. Sreenivas

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The scramble for securing control of both supply- and value-chain

of critical minerals (CM) is fuelled by push for clean energy transition, widespread digital transformation and national security. However the green transition is noted to be mineral intensive and further analysis indicated that such a scale of demand carries a heavy irony in the sense that extracting and processing the CM - whether from primary resources or of recycled origin, inflicts massive environmental and energy penalties. In view of this industry stakeholders must pivot immediately to cleaner, actionable production strategies before these ecological damages worsens. A review of contemporary technologies in the mid-stream stage of the value chain of CM values from different resources indicate the importance of mineral beneficiation, hydro-, pyro- and electro-metallurgy in significantly reducing the damage to environment. Multiple steps like adoption of advanced ore sorting methods, energy efficient comminution techniques, enhanced recovery of mineral fines by kind of centrifugal separators or high gradient magnetic separators or by adopting selective surface-chemical separation methods using biodegradable mining chemicals are some examples of re-invented advancements in mineral beneficiation. The field of extractive metallurgy too came out with aggressive R & D on plant or bio derived organic acids, DES, more eco-friendly solvents, gas and electrochemical based reductants for precipitation, to name a few. Trials of using renewable energy for energy-intensive steps are also in pipe-line. Modelling of scenarios wherein utilization of waste heat of small nuclear power plants in energy-intensive mineral processing unit operations too gave encouraging indications of reduction in CO₂ emissions. This presentation makes an attempt on showcasing some of the aforementioned advancements in processing of CM values from primary resources.

SIL-05 : Resource Efficiency and Circular Economy through Urban Mining: Challenges and Opportunities

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With the rapid advancements in technology innovation and digital product marketing strategies allure replacement of the electronic gadgets at a faster pace resulting in ever-increasing generation of waste electrical and electronic equipment (WEEE) or otherwise known as e-waste. More than 62 million tonnes of electronic waste are generated annually worldwide, which could bring serious risks to the human health and the environment. India is the second largest e-waste generator in Asia and the third largest generator in the world.

The unscientific disposal of e-waste leads to leaching of heavy metals and flame retardants into soil and thereby contaminating the ground water. Urban mining offers a transformative approach converting e-waste into valuable resources towards environmental sustainability. Recent studies show that the anthropogenic stock of some of the precious materials are equal to or greater than that of known natural deposits. Hence, urban mining provides immense potential for mitigating environmental impacts associated with primary mining such as land degradation, water pollution and greenhouse gas emissions.

The printed circuit boards (PCBs) are the basic building block on which microelectronic components such as semiconductor chips, multilayer capacitors, inductors etc. are mounted. PCBs provide the electrical interconnections between components and are found in virtually all EEE products. Recycling of waste PCBs is an important subject not only from the treatment of waste point of view but also from the recovery of valuable resources for further manufacturing. Due to its complex composition, PCB recycling requires a multidisciplinary approach to extract assorted value chains through environmentally benign processing methodologies. However, rudimentary methods are being employed for the processing of PCBs especially in the informal sector. Most of the participants in this sector are unaware of the risks involved and associated environmental pollution leading to health hazards. A state-of-the-art Centre of Excellence (CoE) on E-waste Management is established at C-MET, Hyderabad on Public Private Partnership (PPP) Model for the development of cost-effective e-waste recycling technologies and dissemination of the same to private industries for the safe and efficient recovery of secondary resources. CoE on e-waste Management promotes recycling solutions for End-of-Life (EoL) Printed Circuit Boards, Li-Ion batteries, Si Solar cells and Permanent Magnets and thereby ensure resource efficiency and circular economy in the country. Such innovations enable the empowerment of informal E-waste recyclers in the country, recovery of precious and critical metals from E-waste, strengthening of current engineering ecosystem to improve the process efficiency and vanquish the export of seventh resources.

SIL-06 : Energy Sransition Metals : Supply and Demand Dynamics in a Geopoliticised Market and Role of CSIR-NML

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The global shift towards low-carbon energy systems has significantly

increased the strategic importance of minerals such as lithium, cobalt, nickel, copper, manganese, graphite and rare earth elements. Previously regarded as relatively specialized commodities, these resources now play a crucial role in determining the direction of climate action, national industrial policies and relations between countries. This review examines the changing dynamics of supply and demand for minerals essential to the energy transition by drawing on scholarly publications, government statistics, legal and regulatory documents, and recorded market developments. Particular emphasis is placed on the growing interaction between geopolitical interests and mineral-market operations.

The expansion of electric mobility, energy storage capacity and electricity transmission infrastructure has contributed to annual demand growth of approximately 10%. According to International Energy Agency projections, total demand for these minerals could increase to nearly twice its current level by 2040 under existing policy commitments and rise to almost four times that level under a net-zero emissions scenario. Nevertheless, technological developments may substantially alter the outlook for individual commodities.

Recycling represents an important means of reducing dependence on newly extracted resources, although its present contribution remains relatively modest. Secondary supply is routinely invoked as the structural answer to both the volume and the concentration problems, but its present contribution is modest and uneven. Looking forward, the IEA estimates that recycling could supply 20–30% of lithium, nickel and cobalt demand and nearly 40% of copper demand by mid-century under announced pledges, reducing required.

In the presentation, CSIR-NML’s activity will be presented on the recycling of various secondary and tertiary resources towards self-reliance of our nation on these metals.

SIL-07 : Beyond Mining: Unlocking India’s Critical Minerals from Secondary and Unconventional Resources

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Critical minerals are strategic enablers of clean energy, advanced manufacturing, defence and emerging technologies. With growing global demand and concentrated supply chains, securing reliable access has become a national priority. India’s National Critical Mineral Mission

provides a framework for strengthening domestic capabilities; however, long-term resource security requires exploring opportunities beyond conventional mineral deposits. India generates substantial quantities of mine overburden, beneficiation tailings, red mud, metallurgical residues, spent catalysts and end-of-life products. These materials may contain recoverable critical and strategic elements, including rare earths, titanium, zirconium, vanadium, gallium and nickel. Traditionally considered waste, they represent potential alternative resources for domestic mineral production while addressing environmental challenges.

Unlocking this potential requires integrated resource characterisation, mineralogical assessment, selective beneficiation and innovative extraction technologies. Hydrometallurgical, biohydrometallurgical and hybrid processing routes offer promising opportunities, particularly for complex and low-grade resources. However, variable feedstock composition, selective recovery, product purity and process economics remain significant challenges. The transition from laboratory research to commercial production requires pilot-scale validation, technology readiness, assured feedstock availability, multiproduct recovery and industrial partnerships. This is High time India should examine opportunities for recovering critical minerals from unconventional resources, identify technological and commercialisation barriers, and discuss pathways for developing economically viable indigenous technologies.

India’s critical-mineral security will depend not only on discovering new deposits but also on transforming overlooked resources and industrial wastes into valuable strategic materials, thereby strengthening resource security, promoting circularity and advancing the vision of Viksit Bharat.

SIL-08 : India’s Nuclear Energy Programme Towards 2047: Role of Rare Earth Elements in Modern Nuclear Reactor Design

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India’s nuclear-energy programme is poised for substantial expansion as the country seeks to achieve 100 GW of installed nuclear power capacity by 2047, in support of the Amrit Kaal vision of Viksit Bharat@2047. Realization of this ambitious objective through the progressive deployment of PHWRs, PWRs, Fast Breeder Reactors (FBRs) and advanced thorium-based systems will require continued advances in reactor physics, particularly in neutron economy, fuel

utilization, reactivity management, power distribution, and core safety margins. In this context, Rare Earth Elements (REEs) with favourable neutron-interaction characteristics offer important role for advanced reactor-physics applications.

REE isotopes, particularly those of gadolinium, samarium, erbium, europium, and dysprosium, exhibit high neutron-absorption properties and strong energy-dependent absorption characteristics. These properties make them attractive as burnable neutron absorbers for controlling initial excess reactivity and regulating its evolution during fuel depletion. Proper optimization of REE absorber concentration and spatial distribution can influence reactivity, reactivity swing, neutron-flux distribution, radial and axial power peaking, fuel-cycle length, and fuel utilization. Some of these elements (europium and dysprosium), are utilized in the form of control rods which are used to regulate and shut down nuclear reactors.

Rare earth elements in the form of burnable absorbers are used in a many of Indian nuclear reactor designs such as Pressurized Water Reactors, Boiling Water Reactors and innovative reactor concepts. In PWRs, burnable absorbers are suitably placed in fuel assemblies to balance reactivity and optimize fuel utilization over a reactor cycle. BWRs employ similar strategies to manage power distribution and control reactivity. Additionally, emerging reactor concepts, such as molten salt reactors and fast reactors, also use burnable absorbers to alter neutron spectra and improve safety margins.

SIL-09 : Development of Hydrometallurgical Processing Route to Recover High Pure Nd-Pr Oxide from NdFeB Magnet Scrap

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Rare earth supply is highly concentrated. China accounted for about 60% of mined magnet rare earths and 91% of refined output in 2024, and for 94% of sintered magnet production. Recycling of rare earths has remained within 1%, even though magnets take roughly a fifth of rare earth oxide demand. End-of-life NdFeB magnets from computer hard disk drives are a rich secondary source, with about 28% Nd-Pr compared with about 0.03% in beach sand monazite.

The present work shows a complete scrap-to-oxide process developed at BARC. Magnets recovered from discarded NdFeB scrap are demagnetised, pulverised and acid leached. Rare earths are precipitated as double sulphates, which separates them from iron and

boron, then converted to hydroxides and oxalates and calcined to mixed rare earth oxide. The flowsheet was run at 10 kg scrap per batch and demonstrated to IREL at the Rare Earth & Titanium Theme Park, Bhopal, with the technology transferred to IREL in 2020.

Two separation steps then give the final product. In first use case where HREE content was found to be low < 500 ppm, Dysprosium, Terbium and other HREE along with Fe is removed from the mixed rare earth solution with D2EHPA-encapsulated polyethersulfone beads. These beads avoid hazardous diluents, lose only about 2–3% of extractant over 30–50 cycles, and were produced at kilogram scale. Treating 100 L of leach solution with 1 kg of beads gave Dy_2O_3 of more than 99.2% purity at over 98% recovery, with over 97% of the Nd-Pr recovered having purity over >99%. Alternatively, Nd-Pr is upgraded from High HRE content mixed RE (obtained after NdFeB magnet reprocessing) and iron by developing counter-current solvent extraction, giving Nd-Pr oxide of more than 99% purity.

Combining precipitation, polymeric bead extraction and counter-current solvent extraction gives a scalable route that turns electronic waste into separated, high-purity rare earth oxides.

SIL-10 : Metal–Organic Frameworks (MOFs+) for Selective Extraction and Recovery of Critical Minerals: Emerging Opportunities

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Critical minerals (CMs) are indispensable to modern technologies and national security, yet their extraction and processing remain geographically concentrated, creating vulnerabilities in global supply chains. This is not only a national concern but a pressing global issue, as disruptions can affect industries worldwide. Recognising this challenge, the Government of India launched the National Critical Mineral Mission (NCMM) in 2025, identifying 30 strategic minerals essential for sectors spanning high tech electronics, telecommunications, transport, and defence. In addition to primary extraction, the NCMM strongly promotes recycling from secondary sources such as e waste, lithium ion battery scrap, and end of life vehicles.

Advanced porous materials—particularly metal–organic frameworks (MOFs) and related architectures (collectively referred to as MOFs+)—have emerged as transformative platforms for critical mineral recovery.

Their tunable pore environments, high surface areas, and ion exchange properties enable selective extraction of valuable metal ions from complex matrices. In this lecture, I will present examples from our laboratory demonstrating how MOFs+ can efficiently recover critical minerals from primary ores and secondary waste streams. These findings highlight the potential of MOFs+ technologies to advance sustainable resource management and resilient supply chains at both national and global scales.

SIL-11 : Placer Beach Sand Minerals to Rare Earths: Processing Experience, Technological Challenges and the Road Ahead for India

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India hosts a number of multi-mineral shoreline placer deposits occurring as beach and dune sand, inland sand bodies/palaeo beach ridges and teris/red sediments. Favourable geological and geomorphological conditions coupled with tropical to sub-tropical climate and intricate drainage pattern have resulted in formation of these placer deposits of varied dimensions and concentrations. The heavy mineral suite in these placer deposits essentially comprises ilmenite, rutile, leucoxene, monazite, zircon, garnet, sillimanite in various proportions and are classified as heavy minerals because they have densities greater than 2.9 g/cm³. Among these, monazite, a phosphate mineral rich in light rare earth elements (LREEs), contains notable concentrations of cerium, lanthanum, neodymium, samarium represents an important indigenous resource of rare earth elements (REEs). It is radioactive due to presence of both thorium and uranium. India's beach placer deposits in Kerala, Tamil Nadu, Odisha, and Andhra Pradesh contain monazite and associated minerals.

The processing route from beach sand to rare earth products involves several stages such as mining, physical concentration, mineral separation, monazite recovery, chemical cracking, rare-earth dissolution, purification, solvent extraction/ion exchange and production of individual rare-earth oxides, metals and downstream materials. Generally, units involving gravity, magnetic, electrostatic, and flotation-based separation are integrated in BSM beneficiation, with particle size distribution, mineralogical associations, and equivalent mineral properties as the principal factors controlling separation efficiency. The major technological challenges include beneficiation of lean and complex placer deposits, presence of undesired minerals, fineness of feed, efficient recovery of key economic minerals like Ilmenite, rutile,

zircon and monazite from multi-mineral assemblages, reduction of reagent and energy consumption, management of radioactive residues, separation of closely associated rare earths, solvent-extraction circuit optimisation, treatment of low-grade and variable feed materials, and achieving consistently high purity at commercial scale. Efficient conversion of this mineral resource into high-purity rare earth products is therefore strategically important for India's critical-mineral security, clean-energy technologies and advanced manufacturing. Development of environmentally sustainable processes with minimum liquid and solid waste, water recycling and improved residue utilisation is equally essential.

Although considerable technological capability has been established in India till now for beach placer mining to rare earths production, further stronger integration of mineral processing, process mineralogy, hydrometallurgy, solvent extraction, materials science and magnet manufacturing would bring transition from resource availability to technological advancement and integration across the complete value chain. Moreover, the balance between strategic extraction, restoration, and coastal ecosystem management can also bridge the gap between resource ambition and real ecological responsibility.

SIL-12 : From Resource Security to Technology Sovereignty: Accelerating India's Critical Minerals Value Chain

Shri Prasanna Kumar Motupalli

Former CMD, NLC India Limited | Former MD, GSECL | Former Executive Director, NTPC

India's journey towards Viksit Bharat requires a fundamental shift in the way critical minerals and rare earths are viewed. They are not merely geological resources; they are strategic enablers of technology and industrial transformation, supporting clean energy, electric mobility, advanced manufacturing, aerospace and defence, electronics and energy storage.

This address argues that mineral security must evolve into value-chain security. India must connect exploration and responsible mining with beneficiation, extraction, separation, refining, advanced materials, component manufacturing and recycling. The strategic challenge is not geological scarcity alone, but concentration of processing capability, technological dependence and weak links between resources and high-value products.

A complementary opportunity exists in India's existing coal, lignite and ash ecosystem. Evidence presented in the accompanying analysis

indicates encouraging rare-earth concentrations in selected materials, including reported Neyveli fly-ash samples. However, these are limited data points rather than a national resource estimate. The proposed principle is therefore “extract before you embed”: systematically assay secondary resources before permanently dispersing them into construction applications, and recover valuable minerals wherever technically, environmentally and economically justified.

The presentation proposes an integrated roadmap: faster digital exploration; domestic processing and separation; mission-oriented technology demonstration; common-user refining hubs; strategic market and offtake mechanisms; recycling and urban mining; diversified international partnerships; and multidisciplinary talent and programme leadership.

The central message is aspirational but execution-oriented: India need not compete only by finding more mines. It can build resilience by processing intelligently, recovering resources already mined, developing indigenous technology, manufacturing higher-value products and creating a circular mineral economy.

The address concludes that India’s strategic opportunity is to convert minerals into knowledge, knowledge into technology, technology into industry and industry into national capability—making critical minerals a foundation of a secure, sustainable and prosperous Viksit Bharat.

SIL-13 : Sustainable Recovery of Rare Earth Elements from NdFeB Magnets

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Recovering rare earth elements (REEs) from waste resources extends mine life, reduces supply criticality, and supports sustainability. This presentation discusses resource- and energy-efficient processes for recovering REEs from end-of-life NdFeB magnets while overcoming the limitations of conventional direct leaching, which requires large amounts of acid and generates significant waste. A smelting-based approach selectively oxidizes REEs using Fe_3O_2 and B_2O_3 , achieving over 99% recovery, followed by acid leaching to recover rare earths as double sulfates and boron as boric acid. A selective leaching process was also developed that dissolves only rare earths, significantly reducing acid consumption, reagent use, and waste generation. Furthermore, an integrated hydrometallurgical process for the selective recovery

and purification of rare earth elements enables the production of high-purity rare earth compounds (>99%) with high recovery efficiencies while minimizing chemical consumption and liquid effluent generation. The process has been successfully demonstrated at pilot scale, highlighting its scalability and industrial applicability. In addition, a novel synergistic recycling strategy integrates NdFeB magnet recycling with lithium-ion battery processing by reusing waste ferrous sulfate generated during magnet leaching as a reductive agent for battery cathodes, enabling recovery efficiencies above 95% for REEs, Li, Co, Ni, and Mn. Overall, the proposed approaches provide scalable, resource-efficient, and circular solutions for sustainable recovery and purification of rare earth elements from secondary resources.

ANALYTICAL AND ENVIRONMENTAL CHEMISTRY SECTION

Sectional President's Address

Advances in Electrochemical Sensing Platforms for Sensitive Detection of Agrochemicals

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The uncontrolled influx of toxic contaminants into aquatic and terrestrial ecosystems poses significant global environmental and public health risks. Synthetic pesticides, including carbendazim, 4-chlorophenoxyacetic acid (PCPA), 2,4-dichlorophenoxyacetic acid (2,4-D), diuron, and dichlone, extensively accumulate in agricultural soils and water bodies via non-target runoff, necessitating reliable, sensitive, and rapid analytical tools for on-site monitoring. Conventional chromatographic methods, while standardized, are often constrained by complex preprocessing and centralized instrumentation, creating an urgent demand for simplified electroanalytical protocols. Nano-engineered electrochemical sensor assemblies offer transformative avenues to address these analytical bottlenecks. By integrating advanced carbon matrices with transition metal-based nanomaterials onto electrode surfaces, these platforms achieve superior electrocatalytic activity, elevated conductivity, and rapid interfacial electron-transfer rates. Implementing pulse voltammetric techniques, particularly Square Wave Voltammetry (SWV) alongside Cyclic Voltammetry (CV), enables trace-level quantification and clear delineation of interfacial redox pathways. Systematic optimization of operational parameters including pH, accumulation time, modifier loading, scan kinetics, and thermodynamic variables ensures exceptional analytical performance, resilient selectivity, and low

detection limits in complex sample matrices. The validated electroanalytical sensors effectively monitor recalcitrant pesticide residues across real environmental soil and water samples with high precision and reproducibility. Ultimately, this presidential address highlights how the convergence of nanomaterial engineering and dynamic electroanalysis drives scalable, cost-effective environmental remediation and robust agricultural safety compliance.

AEIL-01 : Cyclic Voltammetry at Modified Carbon Paste Electrode for Bioactive Molecules

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Cyclic voltammetry (CV) is a powerful electrochemical technique for investigating the redox behavior, reaction mechanisms, and analytical determination of bioactive molecules. In the present study, a modified carbon paste electrode (MCPE) is proposed as a sensitive and versatile working electrode for the electrochemical characterization of biologically important compounds. Modification of the carbon paste surface with suitable nanomaterials, conducting polymers, metal nanoparticles, or other electrocatalytic materials can significantly enhance electron-transfer kinetics, increase electroactive surface area, and improve the sensitivity and selectivity of detection. The electrochemical responses of selected bioactive molecules are investigated using cyclic voltammetry under optimized experimental conditions. The effects of scan rate, pH, concentration, and electrode composition on the oxidation and reduction peak currents and potentials are evaluated to understand the charge-transfer process. The modified electrode is expected to exhibit enhanced peak currents, lower overpotentials, and improved reproducibility compared with an unmodified carbon paste electrode. The obtained voltammetric parameters provide useful information regarding the electrochemical mechanism and analytical performance of the sensor. Such modified carbon paste electrodes offer advantages including low cost, simple preparation, renewable surface characteristics, and good sensitivity. Therefore, cyclic voltammetry using MCPEs provides a promising approach for the electrochemical detection and quantitative determination of bioactive molecules in pharmaceutical, biological, and environmental samples.

AEIL-02 : Next Generation Molecular Engineering of 2D Carbon Nitride for Efficient Solar CO₂ to CH₄ Conversion

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Tuning the optical and electronic properties of two-dimensional

(2D) graphitic carbon nitride (g-C₃N₄) is a promising strategy for enhancing photocatalytic performance. In this study, the optoelectronic properties of g-C₃N₄ were systematically engineered through sulfur self-doping using thiosemicarbazide. Further molecular engineering was achieved by incorporating 2,6-diaminopyridine (DAP) into the sulfur-doped carbon nitride (SCN) framework, significantly modifying its electronic structure and optoelectronic characteristics. The incorporation of DAP establishes a donor- π -acceptor (D- π -A) architecture within the conjugated carbon nitride network, where the electron-rich amino groups facilitate electron donation into the p-conjugated backbone, while the pyridine nitrogen centers act as effective electron-accepting sites. This molecular-level polarity promotes directional charge transfer and spatial separation of photogenerated charge carriers, thereby suppressing electron-hole recombination, as confirmed by photoluminescence (PL) analysis. Moreover, DAP incorporation extends δ -conjugation and broadens the optical absorption range, enabling more effective utilization of the solar spectrum. The optimized DAP-doped SCN exhibited excellent photocatalytic CO₂ reduction under natural solar-light irradiation, achieving a CH₄ production rate of 217.28 ppm g⁻¹ h⁻¹, corresponding to 0.13686 μ mol g⁻¹ h⁻¹. This performance represents approximately a five-fold enhancement compared with pristine bulk carbon nitride (BCN) and a 1.5-fold improvement over pristine sulfur-doped carbon nitride (SCN). The enhanced photocatalytic activity is attributed to the synergistic effects of molecular doping and optimized electronic structure, including accelerated charge-carrier dynamics, broadened light absorption, and favorable catalytic energetics. The D- π -A molecular configuration provides an effective pathway for promoting charge-transfer processes and enhancing CO₂ conversion efficiency. These findings demonstrate that molecular level engineering offers a rational and powerful approach for designing next-generation carbon nitride photocatalysts. Overall, the developed DAP doped SCN shows significant potential for sustainable solar-driven CO₂ conversion and carbon-neutral fuel production.

AEIL-03 : Chemical, Microbiological and Geological Aspects of Acid Mine Drainage and its Control Aspects

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Acid mine drainage (AMD) is one of the most persistent environmental pollution problems which occurs world-wide in the

mining regions. AMD refers to the distinctive type of wastewater that originates from the weathering and leaching of sulphide minerals present in coal and metalliferous ore bodies. More insidious effects of AMD water pollution include the fish kills, loss of other aquatic life; corrosion of mining equipment and structures such as barges, bridges concrete materials etc. The AMD problem is presently much more severe as a result of increasing activity of the mining industry coupled with the challenging task of its mitigation to comply with the regulatory requirements.

The AMD problem is intensely localised in the North Eastern Coalfields of India where ecology of the surrounding areas is badly disrupted apart from the usual environmental problems being encountered. This study reflects typical nature of AMD which consists of geological occurrence of pyrite types, pyrite forms including morphology, chemical and microbiological aspects of AMD formation. Various chemical, geological and microbiological aspects of AMD control are also presented. At source bactericidal control of AMD has been observed as a most suitable measure to abate and mitigate AMD for overall environmental compliance.

AEIL-04 : Nanomaterials at the Forefront of Analytical Chemistry: From Surface Engineering to Ultrasensitive Sensing

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Recent years have witnessed a remarkable technological renaissance in nanomaterials, driving significant advances in biosensing and biomedical research. The exceptional physicochemical properties of carbon nanotubes, fullerenes and graphene have positioned carbon-based nanomaterials at the forefront of modern analytical and biomedical applications. Their integration into analytical platforms has opened new opportunities in medical diagnostics, multimodal drug delivery, bioimaging, environmental monitoring and biocatalytic sensing. The convergence of electrochemistry and nanotechnology has emerged as a versatile, sustainable and powerful platform for developing advanced sensing technologies. In our research, nanomaterial-engineered electrochemical sensors have been developed for the sensitive detection of non-steroidal anti-inflammatory drugs, antihypertensive agents, antiviral drugs and natural alkaloid associated with hepatocellular carcinoma. The developed sensors demonstrated enhanced analytical performance, including improved sensitivity and reliable detection, highlighting the potential of nanomaterials to impart

novel functionality to electrochemical sensing platforms. These advances provide promising opportunities for rapid and accurate molecular detection and have considerable potential in clinical diagnostics and biological research. This emerging synergy between nanotechnology and electrochemistry represents a compelling frontier for next-generation sensing, diagnostics and personalized medicine.

**AEIL-05 : Biodiversity of Medicinal Plants of Nepal-
A Health Care Overview**

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Nepal, renowned for its ecological diversity, is home to over 700 species of medicinal plants, many of which are endemic to the region. Spread across diverse ecosystems, from the tropical lowlands to the alpine Himalayas, these plants play a vital role in traditional and modern health care systems. Medicinal plants like Neem, Yarsagumba, Jatamansi, and Tulsi are widely used in Ayurveda, Amchi medicine, and folk remedies, addressing ailments ranging from infections to chronic diseases.

Traditional knowledge, passed through generations, continues to be the foundation of primary health care for many rural communities. Additionally, medicinal plants contribute significantly to pharmaceutical research and natural product development worldwide. However, challenges such as overharvesting, habitat destruction, and lack of systematic documentation threaten this biodiversity. Conservation efforts through protected areas, community forests, and cultivation programs are underway to ensure the sustainable use of these valuable resources.

This overview underscores the need for integrating traditional knowledge with scientific research and implementing sustainable practices to preserve Nepal’s rich medicinal plant biodiversity, which is crucial for global health care advancements and the well-being of local communities.

**AEIL-06 : Recent Advances in Electrochemical
Sensors for Pesticide Residue Detection**

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The use of nanoparticles for developing an electrochemical sensing platform for the sensitive, rapid and cost effective detection of pesticide

residues found in food, water, soil and biotic samples with the highest level of efficiency. The nanomaterials such as metal nanoparticles, metal oxides, carbon-based nanomaterials and nanocomposites, greatly enhances the electrochemical performances of carbon paste electrodes due to their increase in effective surface area, enhancement in electron-transfer kinetics and catalytic activity. Such properties allow the specific detection of extremely low levels of organophosphate, carbamate, organochlorine and pyrethroid pesticides using techniques like differential pulse, square-wave voltammetry and amperometry. The modification of the surface lead to increased selectivity and lower detection limits, good results in terms of reproducibility and stability. These sensors in environmental samples can be beneficial for fast assessment of pesticide contamination; in food and biological matrices, they can help to ensure a better food safety and public health protection. Despite the benefits, problems remain with the issues of fouling, matrix, stability, aggregation and selectivity in complex samples to be addressed. The further development of the carbon paste electrode will be accompanied by more effective functionalization of the surface and the development of portable electrochemical devices, which are expected to facilitate the practical monitoring of pesticides for applications in health and environment.

AEO-CYSA-01 : Integrated Analytical Characterization and Source Attribution of Atmospheric Black Carbon: Linking Particle Chemistry, Morphology and Atmospheric Deposition

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Black carbon (BC) is a strongly light-absorbing component of fine particulate matter whose climatic and environmental impacts depend on its concentration, emission sources, and transfer to the Earth's surface. This study presents an integrated assessment of BC dynamics at a suburban site in Agra, located in the central Indo-Gangetic Basin, by combining continuous AE-33 aethalometer observations with PM size-fraction measurements, aerosol optical properties, FESEM–EDX characterization, meteorological analysis, source identification, dry-deposition estimation, and machine-learning prediction. BC

concentrations ranged from approximately 1.5 to 18.0 $\mu\text{g m}^{-3}$, with an annual mean concentration of about $9.1 \pm 5.6 \mu\text{g m}^{-3}$ and pronounced enhancements during winter and post-monsoon periods. Source analysis indicated a strong influence of local fossil-fuel combustion and traffic emissions during morning and evening periods, while elevated post-monsoon BC concentrations were associated with biomass-burning activities. FESEM–EDX analysis revealed carbon-rich, chain-like soot aggregates containing elements such as K, S, and Fe, providing chemical evidence for combustion-derived BC, while the presence of mineral particles and quartz indicated a concurrent influence of dust. The estimated dry-deposition fluxes ranged from approximately 8 to 35 $\mu\text{g m}^{-2} \text{ day}^{-1}$, demonstrating substantial atmospheric-to-surface transfer of BC. Furthermore, machine-learning models incorporating atmospheric and meteorological predictors explained approximately 72–81% of the observed variability in BC concentrations. Overall, the integrated findings reveal distinct seasonal variations in BC sources and deposition behavior and provide a quantitative basis for developing targeted strategies to mitigate black carbon pollution in the Indo-Gangetic Basin.

AEO-CYSA-02 : A Multi-Metallic Amorphous Electrocatalyst for Effective Overall Water Splitting in Basic Medium

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The global impact of industrial growth resulted in a rapid elevation in consumption of gas and electricity, while corporations continued to produce excess amounts of gas and oil but still insufficient to meet the energy demands worldwide. Resultantly, research on electrochemical water splitting has become central due to its renewable and environmentally favorable qualities. However, high overpotential and noble metal-based state-of-art catalysts are major bottleneck of these reactions. Thus, development of an extremely stable, cheap and effective bi-functional catalysts is essential for its application on a large scale. In the present work, a simple, eco-friendly and scalable co-precipitation method was used to synthesize a highly amorphous electrocatalyst for overall water splitting in basic medium. The synergistic effect between Fe, Ni and Co is believed to be one of the prime reasons which led to its exemplary electrocatalytic activity towards both HER and OER. The obtained η_{10} for alkaline electrolyzer in a two-electrode cell was 1.59 V which surpasses many reported

similar kinds of catalysts till date. These findings indicate a viable pathway for water electrocatalysis by using cost effective amorphous electrocatalysts that are abundant on earth and can be used for future applications.

AEO-CYSA-03 : A Promising Method to Sense Uric Acid Inhibition by Piroxicam through an Innovative Electrochemical Study

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Uric acid (UA) is a metabolic waste product formed during the metabolism of purines and nonpurine bases. Elevated UA concentrations can adversely affect human health, leading to inflammation and gout. Several drugs are available to treat the effects of elevated UA levels. One such drug is Piroxicam (PRX), an NSAID that can help alleviate inflammation and gout caused by elevated UA levels. The interaction between PRX and UA was studied using an innovative electrochemical method, specifically cyclic voltammetry (CV). The pH study indicated that changes did not significantly influence the inhibitory effect. The scan-rate study demonstrated that the interaction between PRX and UA altered UA's current and potential. Furthermore, the effect of increasing PRX concentration in the presence of UA was also examined.

AEO-CYSA-04 : Electrochemical Detection of Dichlorophene Using MoS₂-Integrated P-doped Activated Carbon Derived from Benincasa Hispida Peel

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An environmentally sustainable electrochemical sensor was developed for the sensitive determination of dichlorophene (DCP) using a phosphorus-doped activated carbon/MoS₂ composite (P-AGC/MoS₂) derived from ash gourd (Benincasa hispida) peel. P-AGC was prepared through thermal carbonization followed by phosphoric acid activation, and MoS₂ nanosheets were subsequently integrated by a hydrothermal route. The resulting composite was characterized by XRD, FTIR, Raman spectroscopy, FE-SEM, TEM, and EDS, confirming its structural and morphological features. The composite-modified carbon paste electrode

(P-AGC/MoS₂/CPE) exhibited enhanced electrochemical activity and improved electron-transfer characteristics compared with the bare CPE, as demonstrated by CV, SWV, and EIS. Under optimized conditions, the sensor provided a linear response toward DCP from 0.5 to 5.0 μ M, with a limit of detection of 31.7 nM. Electrochemical studies indicated a diffusion-controlled oxidation process involving two protons and two electrons. The sensor showed good tolerance toward common coexisting substances and potential interferents. Its applicability was validated for the determination of DCP in water, soil, and food samples, yielding recoveries of 94.77-101.27% with low relative standard deviations. The developed P-AGC/MoS₂/CPE therefore provides a sustainable and sensitive platform for electrochemical monitoring of DCP in environmental and related samples.

AEO-CYSA-05 : MMT/MgCoAl LDH-incorporated PES Hollow Fiber Ultrafiltration Membrane for Sustainable Environmental Remediation of Agrochemicals, Dyes, and Heavy Metals Rejection

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The contamination of water bodies with agrochemicals, heavy metals, and textile dyes poses a significant challenge to environmental integrity. This study fabricated a montmorillonite-functionalized MgCoAl layered double hydroxide (MMT@MgCoAl LDH) incorporated thin-film composite hollow fiber membrane by interfacial polymerization on a polyetherimide/polyethersulfone membrane substrate, tailored for removing hazardous water pollutants. The incorporation of MMT@MgCoAl LDH into the polyamide layer escalated the pure water permeability from 5.23 to 9.5 Lm⁻²h⁻¹bar⁻¹. The optimal TM-2 membrane exhibited superior pollutant rejection, achieving heavy metal rejection of 99.1% for lead, 86.8% for arsenic, 86% for cadmium, and 80.2% for mercury, dye rejection of 99.4% for Reactive red 120, 99.2% for Crystal violet, 95.5% for Reactive orange 16, and 88% for Reactive black 5, and agrochemical rejection of 80.2% for chlorpyrifos, 66.1% for 2,4-dichlorophenoxy acetic acid, 64.4% for atrazine, and 70% for paraquat dichloride. This work offers a novel MMT@MgCoAl LDH-embedded PES membrane for wastewater that eliminates potentially harmful agrochemicals, heavy metals, and textile dyes.

AEO-CYSA-06: F/Cl Co-Doped Carbon Dot/Biochar Hybrids for Sustainable Metal-Free Electrocatalysis toward Overall Water Splitting

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The widespread use of transition and precious metal-based electrocatalysts for water splitting highlights the need for sustainable, cost-effective, and metal-free alternatives. Herein, we develop an F/Cl co-doped carbon dot/biochar hybrid (FC-ACDs/B) derived from coconut shell and ovalbumin through a facile hydrothermal strategy. The synergistic integration of carbon dots with the conductive biochar framework, coupled with F/Cl-induced electronic modulation, generates abundant defect-rich active sites and favorable charge-transport characteristics. The resulting metal-free FC-ACDs/B/NF electrode exhibits efficient bifunctional electrocatalytic activity, delivering an OER overpotential of 344 mV at 50 mA cm⁻² and a HER overpotential of only 77 mV at 10 mA cm⁻² in alkaline medium. Notably, it also achieves 102 mV at 10 mA cm⁻² for HER in acidic medium, demonstrating its versatile electrocatalytic behavior. The activity observed on glassy carbon further supports the intrinsic catalytic contribution of the metal-free carbon framework. The enhanced performance is attributed to synergistic halogen-induced electronic modulation, defect engineering, improved conductivity, and increased accessibility of active sites. This work establishes biomass-derived F/Cl-engineered carbon hybrids as promising metal-free platforms for sustainable electrochemical hydrogen production.

AEO-CYSA-07 : Tailoring Interfacial Charge Separation through a Direct Z-Scheme NiAl-LDH/MoSe₂ Heterojunction for Sustainable Solar-Driven Photocatalysis

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Photocatalysis is a promising green approach for wastewater remediation and hydrogen production; however, rapid charge-carrier recombination limits its practical application. Herein, a NiAl-LDH/MoSe₂ heterojunction was rationally designed by anchoring amorphous MoSe₂ onto flower-like NiAl-LDH microspheres. NiAl-LDH provides a

tunable layered framework, abundant active sites, and a suitable conduction-band potential, while MoSe₂ offers broad visible-to-near-infrared light absorption and favourable charge-transport properties. Composites with different NiAl-LDH and MoSe₂ weight ratios (3:1, 1:1, and 1:3) were synthesized and systematically characterized. Among them, 31LMS (3:1) exhibited the highest photocatalytic activity, achieving ~96% Congo red degradation with a kinetic rate constant of 0.01713 min⁻¹ and a synergy factor of 2.284. The enhanced performance was attributed to the proposed direct Z-scheme charge-transfer pathway, promoting charge separation while preserving strong redox potentials. TOC, COD, and HRMS analyses confirmed mineralisation and provided insights into the degradation pathway. The catalyst retained good activity over five cycles and efficiently removed other organic contaminants. Moreover, 31LMS produced 11.68 μmol g⁻¹ H₂ in 20 h. These results demonstrate its potential for sustainable wastewater treatment and solar-driven hydrogen evolution.

AEO-CYSA-08 : Development of a Sustainable Fish Scale-Derived Activated Carbon Electrode for Electrochemical Environmental Monitoring

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The 2,4,6-Trichlorophenol (TCP) is an isomer of trichlorophenols, a class of chlorophenols used for various purposes, including the manufacturing of fungicides, herbicides, and insecticides. Current research focuses on the estimation of TCP in various environmental matrices. This study introduces a highly sensitive electrochemical sensor for the detection of TCP, utilizing a carbon paste electrode (CPE) modified with fish-scale-derived activated carbon (FAC) in a 0.2 M phosphate buffer saline (PB) solution. Samples of fruits, vegetables, soil, and water contaminated with TCP pesticide were analyzed using the square wave voltammetry technique in PB of pH 6.0. The developed sensor demonstrated significantly higher TCP oxidation currents than a standard carbon paste electrode. Characterization techniques, including SEM, TEM, XRD, AFM, FTIR, and Raman, were employed to assess the material's crystallinity, functional groups, morphology, and structural attributes. The development FAC/CTAB/CPE displayed enhanced electrocatalytic activity, good selectivity in the presence of common interfering species, and satisfactory operational stability. These results demonstrate the potential of fish scale-derived activated carbon as a low-cost and sustainable electrode material for the electrochemical monitoring of 2,4,6-TCP in environmental samples.

AEO-CYSA-09 : Magnetic Molecularly Imprinted Polymer-Enabled Nanoelectronic Platform for Sensing and Separation of Enrofloxacin in Environmental Sample

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Enrofloxacin (ENR) is a synthetic fluoroquinolone (FQ) widely used as antibacterial agent in animals. Overuse of this drug causes numerous health complications like gastrointestinal, nervous and immune system damage and leakage into the environment which is extremely dangerous for other animals including humans. Non-covalent transient binding of ENR to DNA gyrase/topoisomerase complex IV inhibits the DNA replication in bacterial cell. Magnetic molecularly imprinted polymer (MMIP) is an emerging material studded with numerous artificial cavities which can be employed as a highly efficient, selective and sustainable sensing probe. It opens plethora of future possibilities for magnetic separation of various target analytes from diverse sources. In this work, we have synthesized MMIP for real-time sensing of ENR in environmental matrices. Synthesized MMIP has been thoroughly characterized both physically and electrochemically. It shows excellent sensing ability with good LOD of 161 fM and wide LDR of 100 pM to 10 mM. MMIP can be thus considered as a novel material with effective magnetic separation and specific recognition ability of target analyte.

AEO-CYSA-10 : Advanced Technology Engineering of Poly(VBC-co-VI) Nanoparticle-Integrated Thin-Film Nanocomposite Membranes for Sustainable Agro-Industrial Wastewater Treatment

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Wastewater from industries poses significant environmental challenges, carrying water-soluble reactive dyes and high salt concentrations. Conventional treatment methods often fail to efficiently remove these pollutants, leading to major threats to aquatic ecosystems and increasing demand for freshwater. Membrane technology provides a sustainable solution for large-scale water

purification without producing secondary pollutants. Nanofiltration is particularly effective at removing dyes and salts at low operating pressures, thus reducing energy consumption compared to other membrane types that require higher energy inputs. This research addresses thin-film composite (TFC) membranes fabricated via interfacial polymerization on a polysulfone (PSf) substrate. A novel feature of this approach is the incorporation of ionic polymeric poly(VBC-co-VI) nanoparticles (NPs) into the dense polyamide (PA) layer. The NPs were synthesized through a one-step quaternary precipitation polymerization involving the monomers 1-vinyl imidazole (VI) and 4-vinylbenzyl chloride (VBC), initiated by azobis(2-methylpropionitrile) (AIBN) in acetonitrile. Experimental results showed a dye rejection rate of 98% for Reactive Black 5 and over 95% for Sunset Yellow FCF at 100 ppm. Salt rejection tests at 1000 ppm showed 36% for NaCl, over 50% for MgCl_2 , and 85% for both Na_2SO_4 and MgSO_4 . The integration of these NPs enhanced membrane performance by increasing water permeability and pollutant rejection, and this research advances emerging trends in circular agricultural technologies and protects the global environment.

AEO-CYSA-11 : Development of a $\text{FeSe}_2/\text{Fe}_2\text{O}_3$ – Based Electrochemical Sensor for Trace-Level Determination of Thymol in Water and Soil Samples

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Thymol, a naturally occurring monoterpenoid phenolic compound derived from thyme and related plants, is often employed in insecticidal formulations. Although these formulations are generally considered less hazardous than many synthetic pesticides, their improper or excessive use can be hazardous to aquatic life, human health and the environment. It has several side effects; hence, it is essential to detect it in low concentrations. The current work reports the synthesis of a $\text{FeSe}_2/\text{Fe}_2\text{O}_3$ nanocomposite-modified electrochemical sensor employed for thymol-sensitive detection. The FeSe_2 and Fe_2O_3 were synthesised via pyrolysis and hydrothermal methods, respectively, followed by ultra-probe sonication to obtain their heterostructure nanocomposite. The synthesised compound was characterized using TEM, EIS, SEM, FTIR, XRD, and Raman. The electrochemical sensor behaviour of the material was evaluated using voltammetric techniques, such as DPV and CV. The fabricated electrode shows a linear response over 5-50 μM , with a low limit of detection (LOD) of 17.6 nM and a

limit of quantification (LOQ) of 58.7 nM, and remarkable selectivity over interfering compounds, excellent reproducibility, and stability. The fabricated electrode was employed for the environmental applications; real samples, including soil and water, were analysed, which yielded good recovery values of 95-100%. The outcomes of these analyses revealed the practical viability of the developed sensor, FeSe₂/Fe₂O₃/CPE, for environmental monitoring. Development of a FeSe₂/Fe₂O₃ – Based Electrochemical Sensor for Trace-Level Determination of Thymol in Water and Soil Samples.

AEO-CYSA-12 : Electropolymerized Poly (Allura Red) Detection for Amaranth and Indigo

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As the food sector develops substantially, it encompasses a growing range of specialized items with unique qualities, including appearance, taste, color, scent, texture, consistency, etc. Employing a (GCE) glassy carbon electrode surface and the cyclic voltammetric method (CV), Allura Red was effectively electropolymerized. At phosphate buffer solution (0.2 M PBS) with pH 7.0, amaranth (ARN), along with indigo carmine (ICN), was detected voltammetrically using CV and DPV methods at a poly (Allura red)-modified MGCE. The lower LOD for both ARN and ICN was found to be 0.21 µM and 0.09 µM, individually, using the DPV technique. The designed poly (AR-red/MGCE) proved synchronous division of the analytes in a binary mix through applying both CV and DPV methods. The findings demonstrate that the electrode goes through a diffusion-controlled process.

AEO-CYSA-13: Engineering of NiZnFe, O,, / Polyethersulfone Hollow Fiber Membranes for Sustainable Remediation of Arsenic-Contaminated Agro-Environments

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Aquatic arsenic [As(V)] contamination threatens ecosystems, agricultural soils, and food security through bioaccumulation.

Conventional treatment methods can be costly and energy-intensive, and may create secondary contamination. This study examines a sustainable approach to agro-water purification using a polyethersulfone (PES) hollow-fibre membrane (HFM) incorporating NiZnFe, O₂, nanoparticles (NPs). Structural and surface analyses—including FTIR, thermogravimetric analysis, BET analysis, SEM-EDS, AFM, and contact-angle measurements—showed that nanoparticle incorporation improved membrane hydrophilicity, water absorption, surface properties, and charge characteristics. In filtration tests, the optimized membrane, NZF-2, performed better than the unmodified NZF-0 membrane. Its contact angle fell from 88° to 75.1°, while pure-water flux increased from 28.7 to 91.6 L·m⁻²·h⁻¹. Arsenic [As(V)] removal also rose from 46.32% to 56.05%. These results suggest that NiZnFe, O₂, -modified PES HFM may offer a promising option for treating irrigation water and reducing exposure of agricultural ecosystems to toxic contaminants.

AEO-CYSA-14 : Voltammetric Investigation of Folic acid, Paracetamol and Ascorbic acid at Iron Oxide Poly (Titan yellow) Modified Carbon Paste Electrode

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The present work reports the synthesis of iron oxide nanoparticles using a simple co-precipitation method, followed by characterization through XRD, SEM and EDS analysis. The synthesized nanoparticles were employed to modify a carbon paste electrode for the electrochemical sensing of antibacterial and antimalarial drugs. The resulting poly titan yellow-iron oxide modified carbon paste electrode (PTYFe₂O₃MCPE) exhibited excellent sensitivity toward the electrochemical determination of folic acid (FA) and paracetamol (PA) using cyclic voltammetry (CV) and differential pulse voltammetry (DPV) techniques. The effects of experimental parameters such as pH and sweep rate were systematically studied to optimize detection conditions. The developed PTYFe₂O₃MCPE further enabled the simultaneous determination of FA and PA, achieving detection limits of 0.0877 µM

and 0.033 μM , respectively. Interference studies were also carried out using the DPV technique to evaluate the electrode's selectivity.

AEO-CYSA-15: Cr-Fe Co-Engineered Spinel High-Entropy Oxide Nanoparticles for Efficient and Durable Oxygen Evolution Electrocatalysis

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Developing highly active and durable electrocatalysts for the oxygen evolution reaction (OER) is essential for sustainable hydrogen production. Herein, a Cr-Fe co-engineered spinel high entropy oxide, $(\text{Mn}_{0.2}\text{Ni}_{0.2}\text{Co}_{0.2}\text{Cu}_{0.2}\text{Zn}_{0.2})(\text{Cr}_{0.5}\text{Fe}_{0.5})_2\text{O}_4$, was synthesized via a low temperature hydrothermal method (200 °C) followed by calcination at 400 °C, producing uniformly dispersed nanoparticles with an average size of ~ 5nm. The prepared materials were studied for physiochemical properties via various material characterization techniques such as XRD, HRTEM, FESEM, and XPS. In 1.0 M KOH, the optimized catalyst exhibits outstanding OER performance, delivering a low overpotential of 236 mV at 10 mA cm⁻², a Tafel slope of 41.7 mV dec⁻¹, and excellent stability over 48 h, outperforming commercial RuO₂ and the corresponding Cr and Fe containing spinel catalysts. The superior electrocatalytic performance is attributed to the synergistic interaction of multiple transition metals, which optimizes the electronic structure, increases the number of active sites, and accelerates charge transfer kinetics. This work provided a simple and effective strategy for developing high-performance spinel high-entropy oxide electrocatalysts for alkaline water oxidation.

AEO-CYSA-16: Biomass-Derived Activated Carbon Decorated with MoSe₂ for Sensitive Electrochemical Determination of Uric Acid

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A sustainable electrochemical sensing platform for the sensitive determination of uric acid (UA) was developed using a biomass-derived activated carbon/MoSe₂ nanocomposite. Cardamom peel-derived activated carbon (CP-AC), prepared through phosphoric acid-assisted

carbonization, was integrated with MoSe₂ nanosheets via a hydrothermal method to fabricate the CP-AC/MoSe₂ nanocomposite. The synthesized material was employed as an efficient modifier for a carbon paste electrode, enhancing electron-transfer kinetics and electrocatalytic activity. The successful formation of the heterostructure was confirmed by FE-SEM, EDS, TEM, FTIR, XRD, Raman spectroscopy, and electrochemical impedance spectroscopy (EIS), revealing improved conductivity and abundant electroactive sites. Electrochemical studies using cyclic voltammetry, square-wave voltammetry, and EIS demonstrated a significantly enhanced oxidation response toward UA at the modified electrode compared with the bare CPE. The developed sensor exhibited excellent analytical performance, achieving a low detection limit of 20.5 nM and a linear response over the concentration range of 0.5-10 µM. In addition, the sensor showed high selectivity against common interfering species, excellent reproducibility, and good long-term stability. Its practical applicability was successfully demonstrated by the determination of UA in human saliva and urine samples, providing satisfactory recoveries of 96.60-101.00% with low relative standard deviations. The proposed biomass-derived CP-AC/MoSe₂ sensing platform offers a simple, cost-effective, and environmentally sustainable strategy for sensitive electrochemical determination of UA with promising potential for analytical and environmental monitoring.

AEO-01 : Enantiomeric Analysis and Separation of Three Chiral Carboxylic Acids via Derivatization using Chiral Pure Derivative

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An indirect high-performance liquid chromatographic (HPLC) method was developed for the enantiomeric analysis of three pharmaceutically relevant chiral carboxylic acid drug candidates. The enantiomeric analytes were converted into the corresponding diastereomeric anhydrides through activation of the carboxyl functional group using suitable coupling reagents. A twofold molar excess of the chiral derivatizing reagent was employed to ensure quantitative derivatization while minimizing the possibility of kinetic resolution during the derivatization process. The resulting diastereomeric derivatives were efficiently separated using reversed-phase HPLC with an appropriate aqueous buffer–organic modifier mobile-phase system. A linear gradient of acetonitrile from 25 to 75% over 45 min at a flow rate of 1.0 mL min⁻¹ provided baseline resolution, enhanced peak

symmetry, and shorter analysis times compared with methanol-based mobile-phase systems. The developed method demonstrated good linearity over the concentration range of 25–250 ng mL⁻¹, with correlation coefficients (R^2) $\geq$ 0.97. The method also exhibited satisfactory precision, with relative standard deviation (RSD) values ranging from 2.6 to 5.4%, and acceptable accuracy, with recoveries ranging from 89.5 to 101.6%. Overall, the proposed indirect HPLC method offers reliable, sensitive, and reproducible enantiomeric discrimination and is well suited for the routine assessment of enantiomeric purity in chiral carboxylic acid drug candidates.

AEO-02 : Methionine Polymerized Chitosan Composite Sensor for the Sensitive detection of Azithromycin

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The present study aimed to design an electrochemical sensor for the analysis of azithromycin (AZ) by modifying the bare chitosan composite paste electrode (BCPE) surface using methionine (MT) in 0.2 M of phosphate buffer solution (PBS). Cyclic voltammetry (CV) was employed for fabricating poly methionine modified chitosan composite paste electrode (PMT/CSCPE) and the surface morphology was studied by applying electrochemical impedance spectroscopy (EIS) and linear sweep voltammetry (LSV). Various parameters such as pH, scan rate, accumulation time and potential were employed to evaluate the efficiency of the developed electrode to detect AZ. The impact of AZ concentration variation on the oxidation peak current was assessed using CV and LSV in the linear range of 2.0 to 80.0 μ M with the limit of detection (LOD) of 0.621 μ M and 0.335 μ M respectively. Moreover, PMT/CSCPE demonstrates excellent sensitivity and selectivity in detecting AZ, even in the presence of other interferents. The PMT/CSCPE was effectively used for the analysis of real samples.

AEO-03 : Climate Change and Ozone Interactions: Emerging Chemical Challenges and Green Chemistry Pathways

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Stratospheric ozone is controlled by a dynamic interplay of photochemical production, catalytic destruction, atmospheric transport,

and radiative processes. Although the Montreal Protocol has reduced ozone-depleting substances and initiated recovery of the ozone layer, this recovery is unfolding under rapidly changing climatic conditions. Rising greenhouse-gas concentrations, stratospheric cooling, altered circulation, increasing water vapour, and changes in heterogeneous chemistry can significantly influence ozone distribution and recovery rates. This study examines the two-way relationship between ozone chemistry and climate change, focusing on molecular reaction pathways involving chlorine, bromine, nitrogen, and hydrogen oxide radicals. Polar ozone depletion is considered as a model system for understanding temperature-dependent heterogeneous reactions and radical-driven catalytic cycles. The contrasting roles of CO₂, CH₄, N₂O, CFCs, and HFCs further illustrate the interconnected effects of atmospheric composition on ozone and climate. A major emerging concern is the uncertain prediction of regional and vertical ozone recovery under changing greenhouse-gas led atmospheric perturbations. This highlights the need to integrate atmospheric observations, chemistry–climate modelling and molecular-level reaction studies. The study further explores Green Chemistry as a preventive strategy, focusing on the design of chemicals with low ozone-depletion potential, low global-warming potential, benign degradation pathways and reduced environmental persistence. Such integration could advance the transition from controlling environmentally harmful chemicals to designing inherently sustainable atmospheric chemistry.

AEO-04 : Eco-Friendly Defect-Engineered Ceria-based Nanocatalysts for Green Hydrolytic Degradation of Persistent Phosphoester Pollutants

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Phosphate esters, extensively used as organophosphate pesticides, plasticizers, and flame retardants, are chemically robust pollutants that resist natural hydrolytic breakdown, causing bioaccumulation, eutrophication, and reduced dissolved oxygen in aquatic ecosystems, alongside neurotoxic and endocrine-disrupting effects in humans. Addressing this environmental burden calls for catalytic systems that are efficient, low-cost, biocompatible, and reusable, avoiding the instability and secondary waste generated by conventional molecular catalysts. This study presents biocompatible, non-toxic cerium oxide (CeO₂) nanocatalysts synthesized through three green and energy-

efficient routes, hydrothermal, solution-combustion, and co-precipitation, to enable selective phosphoester hydrolysis under mild, ambient, aqueous conditions without harsh reagents. Co-precipitated CeO₂, with high surface area (~82 m² g⁻¹) and elevated oxygen vacancy density (~52%), delivered the best pollutant-degradation performance, converting p-nitrophenyl phosphate and real-world organophosphate contaminants (paraoxon, parathion) into non-toxic products via a recyclable, enzyme-mimetic Ce³⁺ /Ce⁴⁺ redox cycle. Mechanistic FT-IR and XPS studies confirmed surface-hydroxyl-mediated ligand exchange with minimal environmental footprint. This work offers a sustainable, low-energy, reusable oxide-catalyst platform for remediating organophosphorus water pollutants, supporting cleaner and safer aquatic environments.

AEO-05 : Interannual Variability and Seasonal Control of Culturable Bioaerosols Associated with PM₁₀ and PM_{2.5} in a Semi-Arid Urban Environment

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Atmospheric bioaerosols represent an important biological component of particulate matter, but their variability is not necessarily governed by particulate mass alone. This study examined four-year variability in PM₁₀, PM_{2.5} and associated culturable microorganisms at Dayalbagh, Agra, a semi-arid suburban site in the Indo-Gangetic Plain. Measurements obtained during 2012-2015 were evaluated for interannual and seasonal variability using two-way ANOVA. PM₁₀ decreased from 218.4 ± 95.1 µg m⁻³ in 2012 to 127.4 ± 66.6 µg m⁻³ in 2015, while PM₁₀-associated total microbial concentration increased from 2170.6 ± 1224.4 to 3673.1 ± 1844.4 CFU m⁻³. Similarly, PM_{2.5} declined from 118.4 ± 50.6 to 60.5 ± 38.8 µg m⁻³, whereas associated microbial concentration increased from 1201.3 ± 595.9 to 2177.2 ± 684.9 CFU m⁻³. Seasonal effects were considerably stronger than interannual effects, with PM_{2.5} F-ratios of 35.60 and 0.97, respectively. Selected bacterial isolates were further characterised by 16S rRNA sequencing. The contrasting trajectories of particulate mass and microbial abundance demonstrate that bioaerosol variability is influenced by biological and seasonal atmospheric processes beyond particle loading alone.

AEO-06 : Punica Granatum Peel-Derived ZnO/rGO/ Surfactant Composites for Sensitive Electrochemical Detection of para-Hydroxyacetophenone

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We propose a cost-effective protocol for developing a sensor platform using a green-synthesized composite of ZnO and reduced graphene oxide derived from Punica granatum peel (ZnO/pg-rGO) to modify a carbon paste electrode (ZnO/pg-rGO/CPE) for detection of para-Hydroxyacetophenone (p-HAP). Raman spectroscopy, TEM, FE-SEM, and XRD were used to confirm the successful formation of ZnO/pg-rGO composite and corresponding surface characteristics. Electrochemical impedance spectroscopy (EIS) demonstrated a drop in charge-transfer resistance at ZnO/pg-rGO/CPE, resulting in a three-fold amplification of the anodic peak current relative to the unmodified CPE. Optimization studies suggested that the peak current output for ZnO/pg-rGO/CPE was maximum at pH 3.0 (PBS) in the presence of 0.5 μ M sodium dodecyl sulphate (SDS) (ZnO/pg-rGO/SDS/CPE). The LOD and LOQ obtained were 19 nM and 60 nM. The fabricated ZnO/pg-rGO/SDS/CPE sensor demonstrated excellent selectivity and minimal cross-reactivity (< 3%) in the presence of co-existing metal ions and pharmaceutical excipients. The sensors' validation for real-world applications was tested using spiked samples of cosmetics (cream and lotion), lake water, and biological fluids (human urine and saliva), with satisfactory recovery rates with good operational stability (up to 14 days).

AEO-07 : Bio-Waste-Derived Graphene Nanomaterials for Sustainable Control of Ambient Bioaerosols: Synthesis, Characterization and Antimicrobial Assessment

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Airborne biological particles typically known as bioaerosols, are an important component of atmospheric particulate matter and include bacteria, fungi, spores and other biological materials. The persistence of viable microorganisms in ambient air can affect environmental air quality and may pose potential risks to human health. Therefore,

sustainable and environmentally compatible methods for reducing airborne microbial loads are of increasing scientific interest. Graphene-based nanomaterials have attracted considerable attention as antimicrobial materials because of their two-dimensional structure, high surface area, tunable surface chemistry and ability to interact with microbial cells. The present study focuses on the synthesis and characterization of bio-derived graphene nanomaterials and their potential application for inhibiting microbial growth in ambient aerosols. Coconut shell was selected as a sustainable, carbon-rich agricultural waste precursor. The major objective was to convert this low-value biomass into functional graphene-based materials and evaluate their antimicrobial activity against airborne bacterial and fungal populations.

AEO-08 : From Exposure Sources to Blood Lead Burden: A Multi-Media and Age-Resolved Assessment using AALM and IEUBK in Kolkata

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Lead (Pb) is a potent developmental neurotoxicant, with adverse effects reported even at low childhood blood lead levels (BLLs), emphasizing the need for locally resolved exposure assessment. Present study integrated primary Pb measurements in food, ambient air, and soil from Kolkata with published Kolkata/West Bengal data. ICP-MS analysis yielded Pb concentrations of 0.008–0.139 µg/g in rice, 0.002–0.018 µg/g in pulses, 0.02–1.89 µg/g in spices, and 0.020–3.882 µg/g in dried vegetables (moisture-corrected to fresh-weight equivalents). Primary and literature data were harmonized, and median concentrations parameterized the U.S. EPA All-Ages Lead Model (AALM) and Integrated Exposure Uptake Biokinetic (IEUBK) model. For children aged 0.5–7 years, AALM and IEUBK yielded comparable BLL predictions of 3.2 µg/dL (sex-averaged) and 2.9 µg/dL (duration-weighted), respectively. Vegetables dominated total Pb intake (60.8%), followed by rice (20.4%) and air (11.3%). AALM was extended to adolescence. For three males aged 13, 14, and 17 years, the mean age-matched prediction (4.07 µg/dL) closely agreed with experimentally measured pilot mean BLL (4.12 µg/dL). The pilot mean exceeded the current CDC reference value of 3.5 µg/dL, highlighting continued Pb exposure beyond early childhood. This analytical–modelling framework bridges environmental measurement and biological prediction, strengthening region-specific Pb-risk assessment.

AEO-09 : 3D-Tetra Metallic Dendrite-Based Non-Enzymatic Sensor Coupled with a Smartphone Interface for GSH Quantification in Biological Fluids and Ex-Vivo Rat Models

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Glutathione (GSH) is an important antioxidant that protects against cellular damage. The depleted levels of GSH indicate stress and illness. GSH detection relies on highly fragile and costly natural enzymes. Herein, in this paper, we developed a rapid, enzyme-free sensor utilizing a unique tetra-metallic (Au, Co, Bi, Cu) dendritic nanostructure. Fabricated on an electrode in just 15 minutes, this highly sensitive platform achieves a broad linear dynamic range of 0.05 to 200,000 nM and an impressive detection limit of 0.02 nM. The sensor was successfully validated in complex real samples, including human blood serum, rat plasma, and rat liver tissues. Furthermore, it accurately tracked the time-dependent decline of GSH in rats exposed to a stress-inducing chemical. To enable point-of-care use, we integrated the sensor with a custom Android application, "GLUT Sense." The app automatically processes data, displaying simple green or red warning lights to signal whether GSH levels are safe or dangerously low, providing a portable tool for rapid, on-the-go health monitoring.

AEO-10 : pH-Dependent Lead Sequestration by Estuarine Biofilms: Uptake, Desorption and Stabilisation

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Intertidal biofilms regulate Lead (Pb) mobility in estuaries, yet the effects of acidification on Pb sequestration remain unclear. Biofilms from the Indian Sundarbans were exposed to environmentally relevant Pb concentrations in filtered, autoclaved seawater within continuous stirred-tank reactors. Seawater pH remained unregulated in the ambient treatment, whereas the acidified treatment was maintained at pH 7.4 (projected by 2300) using a pH/CO₂ controller. Dissolved and biofilm-associated elemental concentrations, anion availability, extracellular-polymeric substance (EPS) composition, MnO_x formation,

metallothionein (MT) and antioxidant enzymes were quantified, while FTIR and PHREEQC modelling evaluated EPS-Pb binding and mineral saturation indices. Under ambient-conditions, biofilms removed ~77% of dissolved Pb within 21days. Pb immobilisation occurred primarily through biogenic MnO_x formation and incorporation into phosphate-bearing phases (pyromorphite) within EPS matrix. Under acidified-conditions, rapid uptake lowered aqueous-Pb till day2, followed by net desorption from biofilm-associated binding sites. Competitive cation exchange at loosely bound EPS sites by $\text{Ca}^{+2}/\text{Mg}^{+2}$ likely facilitated Pb^{+2} -release, whereas uronic acid-rich EPS sites sustained stronger binding. Early increase in MnO_x , MT and anti-oxidant enzyme activities indicate rapid detoxification, while phosphate depletion and pyromorphite supersaturation supported continued Pb stabilisation. Thus, acidification shifted the role of biofilms from sustained Pb-sinks towards transient accumulators, although phosphate mineralisation maintained partial long-term stabilisation.

AEO-11 : Electrochemical Determination of Sulfadiazine by Fabricated Carbon Paste Electrode with Poly-Aniline and Tin Oxide Nanocomposite

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The consumption of pharmaceutical drugs has increased considerably in recent years, largely due to the growing incidence of various diseases. However, excessive and indiscriminate use of medicines can lead to serious health-related concerns. Sulfonamide compounds, commonly known as sulfa drugs, include sulfadiazine (SDZ), an extensively used antimicrobial agent in both humans and animals. It is an antibiotic employed for the treatment of various bacterial infections by interfering with folic acid synthesis, an essential nutrient required for bacterial growth and multiplication. Sulfadiazine can be electrochemically oxidized at the $-\text{NH}_2$ group and reduced at the $-\text{SO}_2\text{NH}-$ group. Owing to concerns over the electroanalytical determination of sulfa drugs, methods using both oxidation and reduction reactions have been reported.

The present study focuses on the electrochemical detection of sulfadiazine using a carbon paste electrode modified with a composite of poly(aniline) (PANI) and tin oxide nanoparticles. Electrochemical measurements were performed using an electrochemical analyzer, and the modified electrode exhibited significant electrochemical

performance. A phosphate buffer solution with a pH of 7.4 was employed throughout the investigation. The effect of scan rate on the electrochemical response of sulfadiazine was examined using the modified electrode over the range of 0.04–0.52 V s⁻¹, and the effective surface area of the electrode was determined. The effect of sulfadiazine concentration was investigated over the range of 0.02–0.40 mL, while the influence of pH was evaluated between 5.5 and 8.0. Differential pulse voltammetry (DPV) was employed for the electrochemical analysis.

Interference study was carried with some chemical compounds. And the real samples analysis was also done. The reproducibility of modified electrode was checked and results were good. Simultaneous study was also carried out.

AEO-12 : Sustainable Flexible Packaging: A Research Review on Environmental Impact, Waste Reduction, Resource Conservation, and the Promotion of a Circular Economy

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This research perspective synthesizes eight contemporary studies peer-reviewed journal articles, university dissertations, and industry white papers published between 2008 and 2025 to examine the environmental performance of flexible packaging and the strategies being deployed to make it sustainable. The review is organized around four pillars drawn from the source topic (1) environmental impact, (2) waste reduction, (3) resource conservation, and (4) circular economy promotion. Across the reviewed literature, a consistent finding emerges flexible packaging’s greatest environmental burdens occur upstream in raw material extraction and production rather than at end of life, contradicting dominant media and consumer narratives focused on disposal and recycling. Life Cycle Assessment (LCA) emerges as the most valued assessment tool among packaging professionals, while recycled-content incorporation (up to 75%) proves more impactful than switching to renewable energy alone. Key barriers to sustainability include the multilayer construction of flexible films, cost premiums of alternative materials, inadequate recycling and composting infrastructure, inconsistent transposition of regulation, and the attitude behavior gap among consumers. The review concludes that meaningful progress requires a combination of material reduction (lightweighting and source reduction), mono-material and modular design, high recycled content, supply chain integration, harmonized Extended Producer Responsibility (EPR) policy, and sustained consumer engagement.

AEO-13 : High-Purity Biodiesel from Spirogyra Algal Oil using NiO Nanoparticles: GC-MS Assessment and Process Variable Optimization

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Nickel oxide nanoparticles (NiO NPs) were employed as heterogeneous catalysts for biodiesel production from Spirogyra algal oil via methanol-based transesterification. The FTIR spectrum of the NiO catalysed product showed a prominent ester C=O band at ~1740 cm⁻¹, strong aliphatic C-H stretching at ~2925 and 2850 cm⁻¹, and CH₂ bending bands near 1435–1460 cm⁻¹, together with intense absorptions in the 1160–1200 cm⁻¹ region assigned to C-O and C-O-C ester vibrations, confirming FAME formation and successful transesterification. GC analysis revealed a simple chromatographic profile with three well-resolved peaks in the 10.6–12.7 min window, dominated by one major FAME peak (~92.2% area) and minor esters, typical of high purity biodiesel. The narrow elution range and absence of significant late eluting peaks suggest minimal residual triglycerides and partial glycerides. These findings demonstrate that NiO nanoparticles promote the formation of chemically clean biodiesel with a high FAME content, satisfying fuel grade quality criteria and offering an efficient heterogeneous route for algal biodiesel production.

AEO-14 : Electrochemical Determination of Sunset Yellow using poly-LEV/MCPE

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Sunset yellow is the most widely used synthetic food dye. Food items usually face the risk of adulteration, which can lead to serious health consequences. One of such food adulterant is addition of synthetic azo dye sunset yellow. This study reports the fabrication of electrochemical sensor for the detect of sunset yellow at poly-LEV modified carbon paste electrode. The developed carbon paste electrode demonstrated optimal detection of sunset yellow using cyclic voltammetry. The limit of detection (LOD) was calculated to be 0.3µM with a linear detection range of 2µM to 20µM. From the results

obtained, it is concluded that, the designed sensor can be a great tool for detecting sunset yellow in food samples.

AEO-15 : Electrochemical Sensing of Ciprofloxacin Using Poly (L-arginine) Modified Graphite Paste Sensor

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In this current work, Cyclic Voltammetry (CV) method was employed to swiftly detect and analyze Ciprofloxacin (CF) using an electro polymerized poly (L-arginine) modified graphite paste sensor (PLMGPS). CF is an antibiotic that belongs to the class of drugs called quinolone and is widely used against bacterial infections. It is effective in preventing the bacterial growth or killing the disease-causing bacterial population. The excessive use of CF causes various mild and severe side effects like nausea, diarrhea, muscle weakness, renal failure etc. The surface morphology of the bare graphite paste sensor (BGPS) and PLMGPS was assessed through scanning electron microscopy (SEM) and electrochemical impedance spectroscopy (EIS). At optimal experimental conditions, the fabricated sensor exhibited a significantly low limit of detection (LOD) and showed high sensitivity towards CF in the presence of certain metal ions and organic interferents. Concurrent determination of CF with paracetamol (PT) was performed to authenticate the selectivity of CF and the outcome was observed to an acceptable extent without causing any hindrance for CF analysis. These experimental data specify that the designed sensor is able to detect CFX with appreciable results.

AEO-16 : Electrochemical Determination of Allura Red using Poly Diethyl Carbamazine Modified Sensor

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The development of sensitive and reliable electrochemical sensors for food dye detection is of significant importance due to their potential health hazards. In this study, we report the electrochemical determination of Allura Red using a poly(diethyl carbamazine) modified carbon paste electrode (PDEC-CPE). The modified electrode was fabricated via electropolymerization, providing enhanced sensitivity

and stability compared to the bare electrode. The electrochemical behavior of Allura Red was systematically investigated under varying experimental conditions, including analyte concentration, solution pH, and scan rate. The modified electrode exhibited well-defined redox responses with linear dependence on concentration, demonstrating its suitability for quantitative analysis. The detection performance was evaluated, and the sensor displayed a limit of detection (LOD) of 4.2 μ M, highlighting its high sensitivity. Additionally, the electrode showed good reproducibility and stability, indicating its potential for practical application in food safety monitoring. Overall, this work establishes PDEC-CPE as a promising platform for the electrochemical sensing of synthetic food colorants, with scope for extension to other azo dyes of regulatory concern.

AEO-17: Influence of Linear Vs Star-Shaped Donors on the Photovoltaic Properties of D- π -A Dye Sensitizers for DSSCs : A DFT Investigation

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Organic π -conjugated materials as photosensitizers have attracted significant attention for applications in DSSCs since the DSSC performance can be fine-tuned by modifying the photosensitizer's architecture. The organic photosensitizer/dye has a basic D- π -A structure in which D, π and A stand for donor, π -bridge and acceptor respectively. Thus, the choice of donor, π -bridge and the acceptor is very crucial while designing the dye's architecture. In the present work, the influence of linear Vs star shaped donors, acceptor and π -spacer in the D- π -A structure of organic dye has been investigated. Geometry, charge transfer and photovoltaic properties of the D- π -A molecules have been studied. Further, the dyes were adsorbed on the nanocrystalline surface of the semiconductor (TiO_2). Theoretical evaluation of various parameters has been executed using density functional theory (DFT) and time dependent density functional theory (TD-DFT). Overall power conversion efficiency (PCE) of the designed molecules has been simulated by using all the photovoltaic parameters. The dyes with star shaped donor show superior PCE than linear donor containing D- π -A dyes. Thus, this study shows that variation of donor group of dye can be helpful in fine-tuning the overall performance of a DSSC.

AEO-18: Design and Synthesis of (2-amino-5-nitrophenyl)(phenyl)methanone-Based Azo Dyes for Selective Ni²⁺ Sensing and Anticancer Activity

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A series of azo dye derivatives (3a–3e) derived from 2-amino-5-nitrobenzophenone were synthesized and structurally characterized. Density functional theory (DFT) calculations were performed to understand the electronic properties of the synthesized molecules. The sensing behaviour of selected compounds (3c–3e) toward divalent metal ions was investigated. Among them, compound 3d exhibited a distinct and selective response toward Ni²⁺ ions, accompanied by the formation of a new absorption band, indicating complex formation. Spectroscopic studies established a 2:1 ligand-to-metal stoichiometry with a high association constant ($K_a = 2.97 \times 10^5 \text{ M}^{-1}$), along with a low detection limit of $1.40 \times 10^{-7} \text{ M}$. In addition, biological evaluation against HepG2 cells demonstrated significant cytotoxic activity for compound 3d ($\text{IC}_{50} = 40.65 \text{ }\mu\text{g/mL}$). These results demonstrate that azo-based compounds exhibit strong potential for selective metal ion sensing and biological activity, providing an efficient approach for applications in environmental monitoring and biomedical research.

AEO-19 : Biosensing of Brucine at a poly (L-tryptophan) Modified CNT Paste Electrode: Analytical Performance Evaluation

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Assessing food safety and keeping an eye on human health depend on the development of a rapid, sensitive, and affordable brucine toxicity detection system. In this study an innovative electrochemical sensor was fabricated for the sensitive and selective determination of brucine (BC), based on a carbon nanotube paste electrode (BCNTPE) surface were improved by the electropolymerization of poly (L-tryptophan) (PTMCNTPE). This modified electrode enhances the electrochemical response of the examining molecule. The study was conducted using a cyclic voltammetry technique in phosphate buffer saline of

physiological pH 3.0 at a scan rate of 0.1 V/s. The developed electrode possesses increased conductance and declined overpotential for the determination of BC. At the optimized conditions, the peak current responses were examined as a function of several variables, including pH, scan rate, the number of deposition cycles, and selectivity. The linear dynamic ranges were found to be 10 μM – 170 μM for BC. The limits of detection (LOD) and quantification (LOQ) were 0.065 μM and 0.21 μM . The PTMCNTPE was successfully applied to determine BC in real samples with percentage recoveries were found to be in the ranges of 95.3 % – 98.5 %.

AEO-20 : Smart Hydro Water Bottle with Bio-Based Filtration, UV-C Disinfection, and IoT-Enabled Water Quality Monitoring

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Providing safe, point-of-use drinking water remains a global challenge. Existing portable purification devices are limited to either filtration, disinfection or water-quality sensing, but not an integrated system. Here, we present the design of a Smart Hydro Water Bottle that incorporates bio-based depth filtration, UV-C disinfection, and real-time water-quality monitoring into one reusable device. The filtration unit is composed of a replaceable capsule containing depth-filtration layers of mycelium around an acid washed biochar core. This core is produced by slow pyrolysis (400–550°C) of agricultural biomass and treated with citric acid to neutralise surface pH and to remove ash and alkaline residues, allowing adsorption of organic contaminants, chlorine by products, and select heavy metals. The filtered water is then disinfected with UV C (265-280 nm). Dose delivery is quantified by integrating the irradiance measured by photodiodes and safety interlocks ensure activation only when sealed and lid-closed conditions are verified. On-device sensors offer real-time pH, TDS/conductivity, and temperature readings with automatic temperature compensation and are displayed on device and transmitted via Bluetooth Low Energy. The planned characterisation will evaluate the adsorption capacity of the biochar (BET surface area, leaching of metals), UV C microbial log reduction efficiency and filtration performance against turbid and contaminated water sources. The objective of this work is to develop a comprehensive sustainable chemistry-based approach for water quality assurance and point of use purification.

AEO-21 : Quinazolin-4-one Ionic Liquid as a Fluorescent NH₃ Sensor

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A novel quinazolin-4-one-based ionic liquid, 1-(3-aminopropyl)-3-methyl-4-oxo-3,4-dihydroquinazolin-1-ium bromide (QIL), was synthesized and characterized using ¹H NMR, ¹³C NMR, FTIR, and HRMS techniques. QIL was developed as a rapid and selective fluorescent sensor for the detection of dissolved ammonia (NH₃) in aqueous media. Upon reaction with NH₃, QIL undergoes a transformation accompanied by a significant fluorescence response, with excitation and emission maxima at 250 and 436 nm, respectively. The sensor exhibited a high binding affinity toward NH₃, with a binding constant of $6.43 \times 10^8 \text{ M}^{-1}$ and a remarkably low detection limit of $0.73 \times 10^{-8} \text{ M}$. The fluorescence response was observed within seconds and showed excellent selectivity against various potentially interfering cations, anions, organic compounds, and amino acids. QIL demonstrated efficient sensing performance over a broad pH range of 3–14. Density functional theory calculations supported the proposed sensing mechanism. Furthermore, the sensor showed good reversibility and reusability in the presence of ctDNA. Its practical utility was demonstrated through NH₃ imaging in *Drosophila* larval gut tissue and the development of a convenient test-strip kit. These results establish QIL as a promising platform for rapid NH₃ detection in environmental and biological applications.

AEO-22 : Acetylene-Linked Conjugated Microporous Polymers for CO₂/ Photoreduction to Methanol: Influence of Acceptor and ð-Bridge Engineering

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The development of efficient, metal-free photocatalysts for solar-driven CO₂ reduction to methanol offers a promising route toward sustainable carbon utilization. However, achieving high selectivity and conversion efficiency without sacrificial agents or co-catalysts remains challenging. In this work, a series of acetylene-linked donor-acceptor (D-A) conjugated microporous polymers (CMPs) with tunable

electronic structures were developed for visible-light-driven CO_2 reduction in aqueous NaOH. Among them, the optimized TTT-DEBP, incorporating an electron-accepting triazine unit and an extended π -conjugated diethynyl biphenyl (DEBP) moiety, exhibited a CH_3OH production rate of $30.8 \mu\text{mol g}^{-1}\text{h}^{-1}$, with 90.3% selectivity and excellent recyclability. Experimental and theoretical studies revealed that the synergistic contribution of triazine, biphenyl, and acetylene units lowers the exciton binding energy, facilitates charge separation and transfer, and suppresses charge recombination. These features collectively enhance the photocatalytic reduction of CO_2 to methanol, highlighting the potential of metal-free conjugated porous polymers for solar-driven CO_2 utilization.

AEO-23 : Thermophysical and Spectroscopic Studies of Green Solvent Mixture (Ethyl Lactate + γ -Valerolactone) for Environmentally Benign Industrial Applications

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The present study is an investigation involving the thermodynamic and transport properties to understand the molecular interactions of an environmentally benign bio-based green solvent mixture of ethyl lactate (EL) and γ -valerolactone (GVL) to reduce industrial solvent-associated pollution and improve sustainable chemical processing. The current study includes volumetric, viscometric and FTIR spectroscopic analysis. Densities (ρ) and viscosities (η) of the mixtures were measured across the entire composition range at various temperatures. Excess molar volume (V_M^E), excess coefficient of thermal expansion (α_p^E), deviation in viscosity ($\Delta\eta$) and excess Gibbs free energy of activation of viscous flow (ΔG^{*E}) reveal the non-ideal mixing behavior. The negative V_M^E and α_p^E values indicate presence of strong heteromolecular interactions and efficient molecular packing, mainly near equimolar composition. The positive and negative values of α_p^E and ΔG^{*E} of the liquid mixture confirm the composition dependent behavior over the entire range of composition. Predictive viscosity (η) models were applied to the EL-GVL mixture across 293.15–318.15 K. The combined thermodynamic and spectroscopic results provide molecular-level insights useful for the rational design of sustainable solvent systems for environmentally safer extraction, separation and chemical manufacturing processes.

AEO-24: Traditional Ecological Knowledge of Forest-Dwelling Communities : Implications for Environmental Protection and Sustainability

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Forest dwelling communities are considered as the original custodians of forests. Their livelihood is intrinsically linked with the forest ecosystem, which has developed a deep sense of co-existence and conservation ethics among them. Forest dwellers depend on forest resources for their life sustaining system, still they are the natural protector of this ecosystem. Uses of NTFPs and their harvesting, sacred grove conservation, use of organic manure, protection of water resources, bio fencing, traditional pest control, honey and Mohua collection are directly or indirectly linked with conservation of the natural resources. Different tribal practices play a crucial role in maintaining the chemical balance of the ecosystem. Regarding soil chemistry conservation they use herbal pesticides, herbicides, use of leaf litter ash and cow dung maintaining the soil pH. Moreover, the tribal knowledge is not just culture, it is a scientifically, valid system of environmental management. Their lifestyle represents a model of low chemical sustainable living system.

Therefore, integration of Traditional Ecological Knowledge (TEK) with modern environmental chemistry, monitoring and inclusion of the tribals in Joint Forest Management is essential for achieving sustainable development goals and environmental protection.

AEP-CYSA-01 : Graphitic Carbon Nitride (g-C₃N₄)-Based Electrochemical Sensor for Sensitive Determination of the Antiviral Drug Acyclovir

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Acyclovir (ACR) is a widely prescribed antiviral drug whose excessive release into the environment can adversely affect aquatic organisms and humans; therefore, its accurate monitoring is essential. In this work, graphitic carbon nitride (g-C₃N₄) was synthesized and used as an electrocatalytic modifier for a carbon paste electrode (g-C₃N₄/CPE). The material was characterized by XRD, Raman spectroscopy, FT-IR spectroscopy, EDX, and FESEM, while

electrochemical impedance spectroscopy confirmed improved charge-transfer properties compared with the bare electrode. The analytical performance of g-C₃N₄/CPE for ACR determination was investigated using square wave voltammetry. The modified electrode exhibited a linear response over the concentration range of 10–80 µM. The sensor achieved a low limit of detection (LOD) of 3.52 nM and a limit of quantification (LOQ) of 11.72 nM, indicating high sensitivity. Its selectivity was evaluated in the presence of common interfering species at 100 µM concentrations, with negligible interference observed. The effects of key electrokinetic parameters on ACR oxidation were examined, and a probable electrochemical oxidation mechanism was proposed. The developed sensor was successfully applied for quantitative determination of ACR in human blood serum and urine samples, demonstrating its reliability and potential for real-sample analysis.

AEP-CYSA-02 : Ionic Liquid: Green Solvent for The Synthesis of Cellulose/Guar Gum/PVA Biocomposite

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In recent years, the development of clean, efficient and environmentally friendly chemical processes using less hazardous chemicals has been one of the main goals of researchers. Green chemistry and sustainability are directing the development of the next generation of biocomposite materials and products. Herein, the authors use the ionic liquid 1-butyl-3-methylimidazolium chloride ([BMIM]Cl) as a green solvent for the synthesis of biodegradable, biocomposite materials from cellulose (microcrystalline cellulose (MCC)), guar gum (GG) and poly(vinyl alcohol) (PVA). The effect of GG and PVA composition with MCC was evaluated by comparing the physical, chemical and mechanical characteristics of the produced biocomposite films with those of the regenerated cellulosic film. The tensile strength and hardness of biocomposite films is superior to that of the regenerated cellulosic film. In this method, [BMIM]Cl has been used as a solvent to dissolve and synthesize the MCC/GG/PVA biocomposite material. [BMIM]Cl is removed from the biocomposite material by washing it with ethanol and recovered by using a rotary evaporator. The synthesized biocomposite is an advanced biomaterial with several potential applications in packaging and other fields.

AEP-CYSA-03 : Facile Synthesis of Nitrogen-Doped α -Fe₂O₃ nanoparticles as a Highly Efficient Electrocatalyst for Oxygen Evolution Reaction during Water Splitting in Alkaline Medium

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The rapid growth of the population and industries has adversely affected the environment. Researchers have focused on generating fuels from renewable energy sources to minimize pollution. Electrochemical water splitting is one of the most efficient methods for producing Hydrogen energy. Developing Electrocatalysts to accelerate water splitting, which involves the Hydrogen Evolution Reaction (HER) and the Oxygen Evolution Reaction (OER), is important. The anodic half-cell Oxygen Evolution Reaction (OER) exhibits sluggish four-electron-transfer kinetics and high overpotential, thereby inhibiting energy conversion efficiency. Therefore, the synthesis of low-cost transition metal oxides as electrocatalysts is essential for OER. In the present study, α -Fe₂O₃ (Hematite) and Nitrogen-Doped α -Fe₂O₃ were synthesized using the hydrothermal method and were confirmed using X-ray Diffraction (XRD), X-ray Photoelectron Spectroscopy (XPS), etc. Electrochemical Studies in 1M KOH showed that α -Fe₂O₃ reached an overpotential of 327 mV at 10 mA/cm². Whereas N-Doped α -Fe₂O₃ exhibited a low overpotential of 278 mV at 10 mA/cm² in comparison to α -Fe₂O₃. N-Doped α -Fe₂O₃ exhibited a higher Electrochemically Active Surface Area (ECSA) than α -Fe₂O₃. The long-term stability of N-Doped α -Fe₂O₃ was studied for 39 hours using Chronopotentiometry.

AEP-CYSA-04 : Development and Characterization of PVA-TEOS Crosslinked Membranes Incorporated with Green Synthesized Silver Nano-particles using Trigonella Foenum Graecum Leaf Extract for Supercapacitor Application

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Speedy growth of flexible electronics such as roll-up displays, hand-held portable devices and sensor networks has promoted the requirement of low-cost, light weight and environmentally friendly

energy storage devices. In order to achieve these, sincere effort was made to develop electrically conductive flexible nanocomposite membrane by incorporating an optimum amount of silver nanoparticle into a cross-linked poly(vinyl alcohol) (PVA). The physico-chemical properties of developed composite crosslinked membranes and were characterized using different analytical techniques including Fourier transform infrared (FT-IR) spectroscopy, wide-angle X-ray diffractometry (WAXD). The surface morphology of the developed membranes was studied using scanning electron microscope (SEM). Electrochemical properties of the composite membranes were studied employing CH-Electrochemical workstation. Among the developed membranes 5 mass% silver nano-particles incorporated PVA-TEOS crosslinked membrane exhibited an excellent conductivity value 2.1 S cm^{-1} and specific capacitance of 275.9 F g^{-1} at 5 mV s^{-1} in $1 \text{ M H}_2\text{SO}_4$ electrolyte. These results indicate that the developed 5 mass% silver nano-particles incorporated TEOS crosslinked PVA membrane could be a very good candidate for supercapacitor applications.

AEP-CYSA-05 : Green Solvothermal synthesis of Moringa Oleifera-derived Carbon material to stabilize Immunoglobulin (IgG)

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The use of water and two deep eutectic solvent (DES) systems, L-proline with Glycerol (Pro:Gly) and choline chloride with Ethylene glycol (ChCl:EG) for the conversion of raw powder of Moringa oleifera / Moringa (MO) to a water and DES derived carbon material. IgG was stabilized on the surface of carbon material and storage of IgG was also studied. Remarkably, structure of protein was maintained in the presence of DES-derived material. The thermal stability of Immunoglobulin G (IgG) is increased by 10.07°C in case of Pro:Gly DES-derived carbon material. The interaction of IgG with raw Moringa biomass and DES-derived materials was evaluated using spectroscopic and biophysical techniques, including UV-visible spectroscopy, fluorescence spectroscopy, Fourier-transform infrared spectroscopy, circular dichroism, and dynamic light scattering. The DES-derived materials demonstrated improved compatibility with IgG compared with untreated biomass, while maintaining the characteristic spectroscopic features of the protein. Overall, this study demonstrates the potential of Moringa oleifera-derived DES-treated biomass as a sustainable, low-cost, and biocompatible platform for protein stabilization, with promising applications in the storage and formulation of therapeutic antibodies.

AEP-CYSA-06 : Manganese-Nickel Layered Double Hydroxides as Bifunctional Electrocatalysts for Water Splitting

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The design of efficient, low-cost, and sustainable electrocatalysts greatly benefits the improvement of the overall water splitting performance. In this work, we prepared manganese nickel-layered double hydroxide (MnNi-LDH) through a simple and eco-friendly mechano-chemical grinding process and explored it as a bifunctional electrocatalyst for the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) in an alkaline medium. The as-prepared MnNi-LDH exhibits a multilayer nanosheet morphology, rich electrochemical active sites, fast electron transport, and enhanced electrolyte diffusion. Structural, morphological, and surface physicochemical characterization confirmed the successful synthesis of the MnNi-LDH structure. The electrochemical tests showed good catalytic activity with low overpotentials of 225 mV for HER and 187 mV for OER at 10 mA/cm². The catalyst showed excellent long-term stability with almost no loss of activity after 50 h of continuous operation. The improvement of electrocatalytic activity is attributed to the synergistic effect between Mn and Ni in the layered hydroxide structure, which leads to a favorable electronic structure and improved reaction kinetics. The results show that MnNi-LDH is an efficient, abundant, and promising bifunctional electrocatalyst for alkaline water splitting, a sustainable way for hydrogen production.

AEP-CYSA-07 : Ni/Co Layered MOF-Based Nanoelectronic Sensor with Smartphone Integration for Real-Time Nitrite Detection

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Metal–organic frameworks (MOFs) are the three-dimensional porous materials with large surface area, porous structure, and catalytically active metal centers. Hence, MOFs are appealing options for the designing of electrochemical sensing platforms, especially for environmental monitoring. In this work, a Ni-based MOF and a Co-

based MOF were progressively integrated to create a bilayer MOF-based sensing interface, which was then functionalized with gold nanoparticles for the electrochemical measurement of nitrite ions (NO_2^-) in environmental water samples. Nitrite is a common preservative in many industries and is found naturally in soil, but too much of it can lead to the production of possibly cancer-causing substances and endanger human health and the environment. The electrocatalytic oxidation of NO_2^- to NO_3^- at a distinctive oxidation potential form the basis of the sensing mechanism. A simple and quick electrodeposition method was used to create the GCE/NiMOF/CoMOF electrode. With a low detection limit of 4.2 nM and a broad linear response over the concentration range of 0.01-1000 μM , the developed sensing platform showed outstanding analytical performance. The sensor demonstrated its potential for very sensitive and speedy nitrite detection in environmental water samples with an average reaction time of less than 1.5 seconds. A smartphone-based application is also integrated to make the on-site analysis easier. This would enable the real-time estimation of the nitrite concentration from a single input generated from the test sample.

AEP-CYSA-08 : Sustainable Synthesis of Heteroatom-Doped Activated Carbon derived from Melaleuca Viminalis Seed-Pods for Trace Electrocatalytic Sensing of Isoxsuprine Hydrochloride

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Isoxsuprine hydrochloride (ISXP) is a β -adrenergic agonist commonly used to treat peripheral vascular disease and pre-term labour and must be monitored in pharmaceutical and biological samples. In this study, a novel biowaste precursor, Melaleuca viminalis seed pods, was utilized for the synthesis of a sustainable N-doped activated carbon (N-AC), which was then used as a modifier in the preparation of a CPE. The current response toward ISXP oxidation increased, while the oxidation overpotential decreased on the N-AC modified electrode upon the addition of SDS. Under optimized conditions (pH 6.0 PBS containing 5 mM SDS), square wave voltammetry revealed two linear detection ranges of 0.1-0.4 μM and 0.5-16 μM with limits of detection and quantification of 32.5 nM and 98.8 nM, respectively. The sensor demonstrated satisfactory recovery in pharmaceutical

formulations, including commercial tablet samples, and in biological samples such as human and cow urine and saliva, in addition to its good selectivity, stability, and reproducibility. These conclusions highlight the potential of the proposed sensor for real-time applications in pharmaceutical quality control and biological monitoring.

AEP-CYSA-09 : Development and Evaluation of a WO₃/rGO Enhanced Carbon Sensor for Improved Electrochemical Detection of Triclosans

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Triclosan (TCS) is a bactericidal agent recognized as a pollutant with potential endocrine-disrupting properties. Current research focuses on estimation of TCS in various biological and environmental matrices. This study introduces a novel sensor designed for the detection and analysis of TCS, utilizing a carbon paste electrode modified with tungsten oxide (WO₃) nanorods and reduced graphene oxide (rGO) nanocomposite in 0.2 M phosphate buffer solution (PB). Samples of fruits, vegetables, soil, and water contaminated with TCS pesticide were analyzed using square wave voltammetry in a phosphate buffer at pH 9.2. The developed sensor demonstrated significantly higher TCS oxidation currents than a standard carbon paste electrode. The nanostructured WO₃ enhanced the electrochemical response, leading to clearer peaks in the data. This research involved synthesizing a 1-D WO₃ nanostructure to facilitate TCS analysis. Characterization techniques, including SEM, XRD, TEM, and XPS, were employed to assess the material's crystallinity, morphology, and structural attributes. The synthesized 1-D WO₃ displayed a monoclinic crystal structure characterized by oxygen vacancies within its lattice. The study explored electrokinetic parameters such as the temperature effect, heterogeneous rate constant, scan rate, accumulation time, activation energy, pH levels, thermodynamic factors, and the number of electrons involved in the electro-oxidation of TCS.

AEP-CYSA-10 : IgG N-Glycan Profiling for Early Stratification of Dengue Disease Severity

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Dengue presents a major diagnostic and clinical challenge because

patients with initially non-specific febrile symptoms may subsequently develop warning signs and severe manifestations. Early identification of patients at risk of disease progression is therefore essential for timely clinical management. Conventional clinical and laboratory parameters may not fully capture the underlying molecular changes occurring during early disease. Our study investigated IgG N-glycan profiles as potential molecular biomarkers for early stratification of dengue disease severity. Serum samples from healthy controls, dengue fever (DF), and dengue with warning signs (DFWS) were included for comparative analysis. IgG was isolated from serum, followed by enzymatic deglycosylation, fluorescent labeling, and UPLC-based N-glycan profiling. Glycan profiles were comparatively characterized across clinical groups, followed by statistical and multivariate analysis to identify disease-associated glycan features and evaluate their potential utility for severity stratification. This study is intended to establish an analytical framework for identifying IgG N-glycan signatures associated with dengue disease progression and to provide a foundation for the development of glycan-based biomarkers for early clinical decision support.

AEP-CYSA-11 : Rapid Lead Detection in Ganga River Water using A Software-Assisted Chemo-Nano Microchip

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Lead is a high-density heavy metal ion usually present in environmental samples including the Ganga River water. Exposure to lead-contaminated water potentially causes numerous health complications including the cardiac and nervous systems. Thus, ultrafast and point of care monitoring of these contaminants in natural resources including the Ganga River are crucial for the betterment of human health. In this direction, we have developed a novel software-integrated chemo-nanosensor chip for lead detection in real-world scenarios. The fabricated chip was engineered using highly conductive gold nanoparticles and metal complex nanohybrids, and confirmed by both electrochemical and physical characterization. Integrated promoter complex probes showed a highly specific coordinative ion exchange for lead ions, facilitating the highly selective lead ions detection in real-world settings. The developed chip showed a broad two-fold dynamic

range of 0.006-0.25 μ M and 20-150 μ M with a low limit of detection (LOD) of 1.72 ($\pm$ 0.01) nM (0.35 ppb). The reported LOD lies within the limit set by the United States Environmental Protection Agency (EPA) (<15 ppb/0.072 μ M) and the World Health Organization (WHO) (<10 ppb/0.048 μ M). We have integrated this nanoengineered flexible chip with indigenously coded, smartphone-assisted decision-making application for hassle-free and user-friendly result.

AEP-CYSA-12 : Mass Spectroscopy Based Proteomic Analysis of Different Regions of the Rat Brain

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Proteomic analysis of the brain offers a comprehensive standpoint on the intricate molecular landscape that underlies the functional complexity and regional specialization of the central nervous system. The study aims to characterize the proteomic profiles of different regions of the rat brain, including the cerebellum, pons, and medulla. Understanding the regional variation in protein expression and post-translational modifications within the brain can provide valuable insights into the specialized functions and unique characteristics of the brain structures. The research methodology includes the procurement of normal rat brain samples and dissection of the cerebellum, pons, and medulla regions. Protein extraction from the brain tissue samples, digestion into peptides, and mass spectrometry-based proteomic analysis to identify and quantify the proteins present in each brain region. Bioinformatic analysis, including functional annotation, was conducted to examine the differences in biological processes, cellular components, molecular functions, and post-translational modifications across the brain regions. Functional analysis revealed distinct differences in the proteins involved in various cellular processes. The cerebellum had a higher representation of proteins related to stress response, glucose metabolism, and cytoskeletal components. The pons showed a greater abundance of proteins involved in sodium/potassium transport and cell membrane-associated functions. The medulla exhibited a higher prevalence of proteins related to acetylation, hydrolase activity, and amino acid metabolism. The comprehensive proteomic profile generated in this study is a valuable resource for further research on the structural and functional heterogeneity of the rat brain, and can serve as a baseline for comparative analysis with disease conditions.

AEP-CYSA-13 : Engineering Synergistic CuWO₄/NiS₂ Heterojunctions for High-Efficiency Photocatalytic Water Splitting

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Photocatalytic hydrogen (H₂) generation represents a promising and environmentally benign strategy for the production of green hydrogen. Nevertheless, the advance of efficient semiconductor materials that exhibit both high activity and long-term stability remains a significant challenge. In this study, we report the synthesis of a broadband-gap, UV light-responsive Cu-WO₄/NiS₂ nanocomposite via a straightforward impregnation method. The photocatalytic presentation of the hybrid system was comprehensively evaluated using microscopic, spectroscopic, and photophysical characterization techniques. Under light irradiation, the optimized CuWO₄/NiS₂ heterostructure achieved a remarkable H₂ evolution rate of 28.2 mmol h⁻¹ g⁻¹, which is approximately 2.71 and 3.28 folds higher than that of pristine Cu-WO₄ (10.4 mmol h⁻¹g⁻¹) and NiS₂ (8.6 mmol h⁻¹g⁻¹), correspondingly. The improved presentation is attributed to the synergistic interaction between the coupled semiconductors, which facilitates the formation of a Type-II heterojunction. This configuration promotes effective charge carrier separation and suppresses electron-hole recombination. Moreover, the Cu-WO₄/NiS₂ composite exhibited a significantly higher photocurrent density than that of pristine CuWO₄ and NiS₂, respectively. This improvement is attributed to the increased density of catalytically energetic sites and the enhanced absorption of solar radiation. These findings highlight the considerable potential of CuWO₄/NiS₂ as a noble-metal-free photocatalyst for sustainable hydrogen generation.

AEP-CYSA-14 : An Analytical Approach to Mapping Glycan Heterogeneity in Monoclonal Antibody

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Glycan heterogeneity presents an analytical challenge in the structural characterization of therapeutic monoclonal antibodies. This study investigated glycoform diversity and glycosylation-site localization in a monoclonal antibody using liquid chromatography-mass

spectrometry (LC-MS) at intact, subunit, and peptide levels. Intact-mass analysis revealed multiple molecular species consistent with glycoform heterogeneity. Subunit analysis localized the detected glycosylation to the Fc-derived fragment, with no glycosylation detected in the light-chain or Fd' fragments under the analytical conditions used. Peptide mapping identified glycosylation at Asn303 in the analyzed heavy-chain sequence and revealed multiple glycoforms associated with this site. Together, these complementary analyses connected whole-antibody mass heterogeneity with fragment-level localization and site-specific glycosylation. The findings demonstrate the value of multilevel LC-MS for characterizing antibody glycan heterogeneity and provide a basis for future comparative characterization of glycoengineered antibody preparations. Functional studies are further required to establish the biological consequences of the observed glycoform diversity.

AEP-CYSA-15 : Decoding the IgG N-Glycome as a Systemic Driver of Heavy Metal-Induced Neuroinflammation and Neurodegeneration

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Neurodegenerative disorders affect approximately three billion people worldwide and constitute the leading cause of global disability, yet tools for early, non-invasive diagnosis remain scarce. Environmental heavy metals such as lead, cadmium, and mercury are increasingly implicated as silent drivers of neurodegeneration, crossing the blood-brain barrier and triggering oxidative stress, mitochondrial dysfunction, and neuroinflammation. Our study explores peripheral immunoglobulin G (IgG) N-glycosylation as a systemic biomarker linking chronic heavy metal exposure to neuroinflammatory and neurodegenerative outcomes. Rat models exposed to low and high doses of Pb, Cd, and Hg showed dose-dependent brain metal bioaccumulation by ICP-MS. Serum IgG N-glycan profiling revealed clear dose-dependent remodeling, with PCA showing distinct group separation (PC1: 94.31% variance) driven by altered galactosylation, sialylation, fucosylation, and bisection traits. Histopathology (H&E, Thioflavin S, Congo red) confirmed dose-dependent neuronal degeneration and amyloid deposition, while shotgun proteomics identified differentially expressed brain proteins mapped to oxidative stress, apoptosis, and cytoskeletal pathways. Elevated peripheral markers indicated astrocyte dysfunction and neurovascular damage. Together, these findings establish IgG N-glycan signatures

as an early, minimally invasive biomarker panel for tracking heavy metal-induced neurodegeneration and reveal a mechanistic glycan-neurovascular axis linking systemic immune remodeling to neuroinflammation.

AEP-CYSA-16 : Electrochemical Investigation of Anticancer Drug Epirubicin Using Silver-Doped Cobalt Oxide Modified Carbon Paste Electrode: A Voltammetric Study

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In this present work, a Cobalt Oxide (Co₃O₄) and Silver-doped Cobalt Oxide (Ag@Co₃O₄) modifiers were added to unmodified carbon paste electrode (CPE) for the simultaneous electrochemical determination of Epirubicin (EP), an anticancer drug, and Sulfadiazine (SDZ), a sulfonamide antibiotic using Cyclic Voltametric (CV). To investigate the Green-synthesized nanoparticles derived from Ocimum tenuiflorum Leaf Extract, both Co₃O₄ and Ag@Co₃O₄ nanoparticles were characterized using X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Diffraction (EDS) techniques. Both modified carbon paste electrodes (Co₃O₄/MCPE and Ag@Co₃O₄/MCPE) were showed significant electrochemical activity for both EP and SDZ in that Ag@Co₃O₄/MCPE demonstrated superior performance. Many variables were studied, such as effect of pH, scan rate, concertation. The simultaneous determination of EP in the presence of SDZ was studied. Furthermore, the electrode exhibited good electrochemical stability with negligible current loss. The limit of detection (LOD) and Limit of quantification was calculated for EP. This green synthesized nanoparticle as a modifier for the CPE exhibits excellent selective and sensitive electrochemical detection of EP.

AEP-CYSA-17 : Isomer-Level Profiling of Serum IgG N-Glycans by HILIC-HPLC-FLD Reveals Hypogalactosylation as an Early Molecular Signature of Parkinson's Disease

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Parkinson's disease (PD) is diagnosed only after substantial

neuronal loss, creating a need for analytically robust molecular markers that report earlier cellular stress. Immunoglobulin G (IgG) N-glycosylation is a sensitive readout of systemic inflammatory status and is well suited to quantitative chromatographic analysis. In this pilot case-control study, serum IgG was affinity-purified from three PD patients and 41 healthy controls from a North Indian (Varanasi) population, and released N-glycans were fluorescently labelled and resolved by hydrophilic interaction liquid chromatography with fluorescence detection (HILIC-HPLC-FLD), which provided isomer-level separation of closely related glycan structures. Relative abundances were compared between groups. PD samples showed significantly lower FA2G2 (12.21% vs 17.13%, $p = 0.010$) and M5 (0.69% vs 1.19%, $p = 0.005$), reduced FA2[6]G1, and elevated A2G2S1 and A2BG2S1/FA2G2S2, indicating hypo-galactosylation together with an increase in high-mannose and sialylated species. The same shift toward agalactosylated, pro-inflammatory glycoforms was observed in a parallel rat model of neurodegeneration, supporting cross-species consistency of the measurement. This work demonstrates that isomer-resolved HILIC-HPLC-FLD glycan fingerprinting can discriminate PD serum and identifies hypo-galactosylated IgG as a candidate early biomarker for validation in larger longitudinal cohorts.

AEP-CYSA-18 : Fabrication of CaO modified carbon paste electrode for Bisphenol-A in the presence of Tartazine

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This study is used for fabrication and development of electrochemical performance of a Bisphenol-A sensor using a Calcium Oxide (CaO) as modified carbon paste electrode in presence of Tartrazine. The modified electrode was made to enhance the electrochemical response and sensitivity towards BPA using Voltammetric techniques. The conductivity was significantly improved by surface modification with CaO on carbon paste electrode. The electrochemical behavior of BPA at the CaO/CPE was investigated using cyclic voltammetry (CV) for pH scan rate, simultaneous study and differential pulse voltammetry (DPV) for concentration effect and interference study. pH study shows that electrons and protons are equally shared in the reaction. And scan rate study indicates the reaction is adsorption controlled. The presence of Tartrazine, a

commonly used food dye, which was found to influence the electrochemical oxidation of BPA, by modifying the peak currents and potentials in this study. The present sensor exhibited a low detection (LOD) and quantification limit (LOQ), high sensitivity, and good reproducibility, makes it a promising competitor for environmental and pharmaceutical applications. Further, Bisphenol-A sensor has given good stability and selectivity even in the presence of potential interfering species. This study provides a comprehensive understanding of the synergistic effect of CaO modification and the presence of Tartrazine in the electrochemical sensing of Bisphenol-A, Further this developed sensor was applied for analysis of different water samples successfully.

AEP-CYSA-19 : Population-specific IgG Fc N-Glycosylation Signatures in Healthy Indian Population : Towards a Glycan-based Platform for Preventive Health Screening

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Non-communicable diseases account for ~61% of deaths in India, yet healthcare remains largely episodic, and modifiable lab-based biomarkers that flag biological change before disease onset are lacking. The immunoglobulin G (IgG) N-glycome, which tunes antibody effector function and closely tracks aging, is a strong candidate, but reference data derive largely from Western cohorts which cannot be accurate for Indian cohort. We established an IgG N-glycan profiling workflow and applied it to a healthy Indian cohort (n = 100). IgG was affinity-purified in a high-throughput format from ~15 µL plasma/serum (purity confirmed by SDS-PAGE), and released N-glycans were resolved by UPLC-FLD. The Indian N-glycan data compared with reported Western data (Pucic et al, 2016), the Indian cohort showed lower core fucosylation (83.9% vs ~96%), higher galactosylation (G0 32.4% and G2 24.8% vs ~35–37% and ~19–20%), lower sialylation (16.3% vs ~20%; disialylated 0.24% vs ~2.0–2.3%) and higher neutral bisecting GlcNAc (24.5% vs ~18%). Arm preference and bisection effects were conserved across populations. Age was associated with rising G0 and declining G2, indicating pro-inflammatory glycan remodeling, with pronounced inter-individual variation in sialylated glycans. These findings provide a population-specific IgG glycomic baseline and support UPLC-FLD based glycan profiling for preventive health screening in India.

AEP-CYSA-20 : Copper Oxide Nanoparticle Modified Carbon Paste Electrode Sensor for Uric acid and Ascorbic acid: A Voltammetric Study

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Copper oxide nanoparticles (CuO/NPs) were prepared by chemical combustion and co-precipitation method and observed the humidity sensing property. The CuO/NPs were characterized under X-Ray Diffractometer (XRD), Energy dispersive spectroscopy (EDS), and Scanning electron microscope (SEM) spectroscopic methods. Uric acid (UA) and Ascorbic acid (AA) analytic solutions were sensed using a carbon paste electrode modified using CuO nanoparticles (NPs). The cyclic voltammetry results suggest that CuO NPs possess superior electrochemical properties due to a lower value of the difference between oxidation and reduction potential (E_O-E_R). The CV techniques were detected the good linearity of UA and AA concentration from 10 to 100 μ M with a detection limits were observed 0.216 μ M for UA and 0.281 μ M for AA, the limit of quantifications were found to be 0.648 μ M for UA and 8.826 μ M for AA. Respectively, the electrochemical behaviour indicates that CuO/NPs is a promising electrode material for sensing molecules such as Uric acid (UA) and Ascorbic acid (AA).

AEP-CYSA-21 : Synergistic Integration of Ragi Straw-Derived N, S-Doped Activated Carbon and WSe₂ Nanoparticles for Sensitive Bisphenol F Detection

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In the present work, ragi-straw was used as a precursor to produce activated carbon, further doped with N and S, producing N, S-doped activated carbon (N, S-AC). Further, a nanocomposite of N, S-AC and WSe₂ nanoparticles (N, S-AC/WSe₂) was synthesized via a hydrothermal process. CPE electrode was modified with synthesized nanocomposite (N, S-AC/WSe₂/CPE) to detect Bisphenol F (BPF) in water and soil samples. XRD, Raman, SEM, and TEM were used for morphological investigation. The electrode kinetic studies using EIS suggested higher charge-transfer resistance for the bare CPE compared to the modified

CPE. A significant threefold enhancement in anodic peak current was observed at the N,S-AC/WSe₂/CPE than to the bare CPE. The LOD and LOQ were determined to be 1.0134×10^{-9} M and 3.04×10^{-10} M, using the differential pulse voltammetric technique. Furthermore, the developed sensor demonstrated excellent stability, reproducibility and high selectivity for detecting BPF in real samples, highlighting its potential for practical environmental monitoring applications.

AEP-CYSA-22 : Harnessing Solar Energy for Rhodamine B Degradation: FeOOH Quantum Dots Engineered Kaolin Nanocomposites for Enhanced Photocatalysis

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The integration of naturally abundant clay minerals with efficient semiconductor Quantum Dots offers a promising strategy for developing sustainable photocatalysts for wastewater remediation. In this study, a series of Kaolin/FeOOH Quantum Dots (x-KF) nanocomposites were synthesised by incorporating 5–15% (wt%) of FeOOH Quantum Dots onto Kaolin via an in situ co-precipitation method to improve its ability to utilise sunlight for the degradation of Rhodamine B (RhB). The structural, morphological, and optical properties of the as-synthesised composites were elucidated by various techniques including XPS, PL, UV-DRS, FESEM, and BET surface area measurements. The optimised 10% KF nanocomposite exhibited enhanced photocatalytic activity, at a catalyst loading of 0.5 g L⁻¹, achieving 95.7% RhB degradation within 140 min, with an apparent rate constant of 0.01521 min⁻¹ and a synergy factor of 1.25. The effects of pollutant concentration, catalyst dose, and pH on the photoactivity were accordingly studied. TOC analysis confirmed 51.6% mineralisation, while scavenging studies identified superoxide and hydroxyl radicals as the primary reactive species. HRMS analysis identified the degradation intermediates, and post-cycle characterisation confirmed structural stability over three cycles. A comparison with previously reported photocatalytic materials further demonstrates the effectiveness of the Kaolin/FeOOH Quantum Dots nanocomposites, highlighting the advantage of integrating FeOOH Quantum Dots with naturally abundant Kaolin for solar-driven environmental remediation.

AEP-01 : Green Synthesis of Nitrogen–Sulfur Co-Doped Palmyra Palm Male Flower Spike-Derived Activated Carbon for Enhanced Supercapacitor Performance

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The increasing demand for sustainable energy-storage technologies has encouraged the exploration of renewable biomass as a source of inexpensive and environmentally friendly electrode materials. In this work, Palmyra palm male flower spikes (PPF) were employed as a carbon precursor for developing activated carbon electrodes for supercapacitor applications. The biomass was converted into activated carbon through carbonization followed by KOH-assisted chemical activation. Subsequently, nitrogen and sulphur heteroatoms were introduced into the carbon framework to improve its electrochemical characteristics. The physicochemical properties of the resulting carbon materials were examined using structural, morphological, and surface characterization techniques. Their electrochemical behaviour was investigated in a 3 M KOH aqueous electrolyte by cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), and electrochemical impedance spectroscopy (EIS). The pristine PPF-derived activated carbon delivered a specific capacitance of 78 F g⁻¹, while the N, S co-doped activated carbon achieved a substantially higher value of 115 F g⁻¹. This enhanced performance can be associated with the presence of N and S functional sites, which may improve electrolyte accessibility and surface wettability while facilitating ion diffusion and charge-transfer reactions. The obtained results highlight the potential of N, S co-doped PPF-derived activated carbon as a sustainable and cost-effective electrode material for supercapacitor devices and demonstrate an effective route for converting renewable biomass waste into value-added energy-storage materials.

AEP-02 : Synergistic Chromium Incorporation and Oxygen-Vacancy Engineering in NiFe-LDH for Oxygen Evolution Reaction

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The oxygen evolution reaction (OER) is an essential anodic reaction in electrochemical water splitting; however, its sluggish four-electron reaction mechanism and poor electrical conductivity can significantly reduce the efficiency of hydrogen production. Nickel–iron layered double hydroxides (NiFe-LDHs) are promising OER electrocatalysts owing to their favourable catalytic properties and low cost. Nevertheless, their practical performance is restricted by limited accessible active sites, inefficient charge transport, and slow reaction kinetics. In this study, oxygen-vacancy-engineered Cr–NiFe-LDH was successfully synthesized using a hydrothermal method to enhance its electrocatalytic properties. The introduction of oxygen vacancies generated additional active sites and improved electron transport within the LDH structure, while chromium incorporation modified the electronic environment of the catalyst. These synergistic effects significantly enhanced the OER activity of the synthesized material. The Cr–NiFe-LDH electrocatalyst exhibited a lower overpotential, low Tafel slope, and reduced charge-transfer resistance, confirming favourable reaction kinetics and efficient electron-transfer characteristics. Moreover, the catalyst showed high durability, retaining its catalytic performance during prolonged electrochemical operation. The enhanced activity and stability demonstrate that oxygen-vacancy-engineered Cr–NiFe-LDH is an effective electrocatalyst for OER and a promising material for efficient and sustainable electrochemical water-splitting applications.

AEP-03 : Linker-Directed Lanthanide based MOF as Multifunctional Platforms for Fluorescence, Electrochemical Sensing and Ester Hydrolysis

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The development of multifunctional materials capable of chemical sensing and catalytic transformation is important for analytical and environmental chemistry. In this work, linker-directed lanthanide metal-organic frameworks (Ln-MOFs) were explored to understand their structure-property-function relationships in fluorescence sensing, electrochemical detection, and phosphoester hydrolysis. Ln-TMA demonstrated a selective fluorescence turn-on response toward ascorbic acid (AA), attributed to AA-induced $\text{Ln}^{4+} \rightarrow \text{Ln}^{3+}$ reduction, oxygen-vacancy generation, and modulation of the electronic environment. The same material was also employed for electrochemical determination of AA using a modified glassy carbon electrode (GCE),

exhibiting good analytical sensitivity. The fluorescence-based sensing approach was further evaluated using orange extract as a representative food matrix, showing results comparable with a standard colorimetric method. In contrast, Ln-TPA exhibited phosphatase-mimetic activity toward phosphor-ester, enabling efficient hydrolysis with good recyclability. Overall, linker engineering provides a versatile strategy for tuning Ln-MOF properties toward complementary sensing and catalytic functions, highlighting their potential for chemical monitoring of aqueous and food matrices and transformation of phosphate-containing compounds relevant to environmental chemistry.

AEP-04 : Voltammetric Analysis of the Synthetic Dye Sunset Yellow at a Poly (asparagine) Modified Chitosan-Capped Silver Nanoparticle/Carbon Nanotube Composite Electrode

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This work introduces a simple and effective voltammetric method for detecting the synthetic dye Sunset Yellow (SY) using a newly developed electrode fabricated from poly(asparagine) modified chitosan-capped silver nanoparticles and carbon nanotube composite paste electrode (P(AS)-Ch@AgNPs/CNTPE). The fabricated sensor's performance was studied using cyclic voltammetry (CV), and linear sweep voltammetry (LSV), which helped understand the redox behaviour of SY and confirm the improved response of the modified electrode. SY gave a clear and well-defined redox signal in phosphate buffer solution (PBS) at pH 6.0, which was selected as the optimal medium for analysis. The surface characterization of both the modified and bare chitosan-capped silver nanoparticles and carbon nanotube composite paste electrode (B-Ch@AgNPs/CNTPE) were studied using SEM, XRD and FTIR techniques to confirm the proper surface coverage and the presence of silver nanoparticles. The scan rate study showed that the electrochemical process was mainly governed by adsorption, indicating strong interaction between SY and the electrode surface. The sensor showed a low detection limit of 0.42 μM and a quantification limit of 1.4 μM , with stable and repeatable results. It was successfully tested in food samples, confirming its usefulness for practical analysis of synthetic dyes.

AEP-05 : Electrodeposition and Synergistic Interfacial Kinetics of Binder-Free NiCN/Ni(OH) Heterojunctions on Conductive Substrates for Overall Water Splitting

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Developing efficient, noble-metal-free bifunctional electrocatalysts is vital for scalable green hydrogen production through alkaline water splitting. In this work, binder-free core-shell heterojunctions comprising a crystalline nickel cyanide (NiCN) core and an amorphous nickel hydroxide [á-Ni(OH),] shell were fabricated on nickel foam (NF) and carbon cloth via a facile, two-step galvanostatic electrodeposition route driven by cathodic nitrate reduction. Structural and spectroscopic analyses (XRD, FTIR, and XPS) confirmed the crystalline-amorphous bilayer architecture and revealed interfacial compressive strain, evidenced by blue-shift in the C≡N stretching band along with active Ni²⁺/Ni³⁺ redox states. The engineered NiCN/Ni(OH)₂/NF heterojunction exhibited remarkable electrocatalytic kinetics in alkaline media. For the oxygen evolution reaction (OER), it delivered an exceptionally low overpotential of 130 mV at 10 mA cm⁻² with a rapid Tafel slope of 25.6 mV dec⁻¹, significantly outperforming commercial IrO₂. For the hydrogen evolution reaction (HER), it achieved an overpotential of 144 mV at 10 mA cm⁻². In an overall alkaline water-splitting electrolyzer (NiCN/Ni(OH)₂ || NiCN/Ni(OH)₂), a cell voltage of only 1.523 V was required to drive 10 mA cm⁻², operating within 23 mV of the benchmark Pt/C || IrO₂ couple. The system demonstrated outstanding electrochemical stability for over 50 hours with negligible voltage loss, while post-catalysis characterization confirmed beneficial in-situ surface reconstruction into catalytic oxyhydroxide (NiOOH) phases. This study demonstrates the power of interfacial strain and phase engineering in transition metal heterostructures for robust, cost-effective water splitting.

AEP-06 : A Study on the Interaction of Light-Absorbing Particles with Ammonia and Water Vapour Using a Computational Method

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Light-absorbing carbonaceous particles, particularly black carbon, are important short-lived climate forcers whose atmospheric transformation and surface reactivity are strongly influenced by interactions with trace gases. Among these, ammonia (NH_3) is particularly relevant because its adsorption on carbonaceous aerosol surfaces can modify surface chemistry, charge distribution, and atmospheric aging. To isolate the molecular factors governing NH_3 adsorption, coronene ($\text{C}_{24}\text{H}_{12}$) was employed as a finite polycyclic aromatic hydrocarbon model of an extended aromatic carbon surface, minimizing complications arising from structural defects and morphological heterogeneity. Density functional theory calculations at the B3LYP/6-31G(df) level were performed to investigate NH_3 adsorption at two representative sites: Middle (A), above the central π -surface, and Side (B), near the peripheral aromatic/C-H region. NH_3 exhibited very similar adsorption energies at the two sites (-5.936 and -5.913 kJ mol^{-1} for Middle and Side, respectively), indicating negligible thermodynamic site preference. However, frontier molecular orbital analysis revealed a substantially different ΔE_{gap} response at the Side site, suggesting that adsorption location can influence the electronic properties of coronene even when binding strengths are nearly identical. The dipole moment was higher for NH_3 at the Middle site, further demonstrating that electronic polarization and adsorption stability are not directly correlated. Comparison with H_2O highlights the adsorbate-dependent nature of surface interactions, with NH_3 displaying weaker site selectivity but pronounced orientation-dependent electronic effects. These findings provide molecular-level insight into NH_3 interactions with aromatic carbonaceous aerosol surfaces and their potential role in atmospheric aging and surface reactivity.

AEP-07 : Development of a Bio-Based Functional Material for Sustainable and Resilient Infrastructure Applications

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The goals of sustainable and resilient infrastructure depend upon materials that are environmentally sustainable and effective in providing structural strength and protection over time. This research is focused on the design and development of a bio-functional material from agricultural waste, which can be used in infrastructure systems to both improve their structural performance and enhance their resistance to environmental degradation. Previous research on the use of agricultural waste materials has focused mainly on either

sustainable sources or resilient performance, leaving a gap between materials that are simultaneously sustainable in both terms. To mitigate this, raw biomass was treated by controlled thermal treatment and particle refinement to obtain a silica-rich, reactive precursor that was tested in two application areas that are relevant to infrastructure: as a partial replacement of cement in concrete and as a protective render coating in paste. The mechanical properties of concrete specimens having different types and amounts of replacement were measured to determine their compressive strength, and the water absorption resistance of the coated substrates was measured, which is an important indicator for assessing durability in environmental exposure. It is seen from the results that the material developed ensures improvement in the mechanical strength at the optimum replacement level, with the coated samples showing a decrease in water ingress, thus making it suitable for use as both structural and protective infrastructure. This work represents a scalable, low-carbon path forward for the development of next generation infrastructure materials, integrating sustainability and resilience in one engineered material.

AEP-08 : Development of Point of Care Device for ALP Detection in Milk Samples

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Alkaline Phosphatase (ALP) is a natural enzyme present in raw milk. The ALP and the vegetative pathogens like such as Mycobacterium bovis, Listeria monocytogenes, Salmonella spp., and Campylobacter jejuni are deactivated using pasteurization. The ALP acts as a gold-standard biomarker for the pasteurization verification. Traditional testing methods require costly instruments like High-Performance Liquid Chromatography (HPLC) and expensive reagents tested by trained personal with several hours of turnaround time. This study presents the design and validation of the low-cost point of care device for ALP measurement. It consists of a single board computer, camera, LED lights and a monitor. The modified paper-based substrates are used to generate concentration-based colour signal which is quantified using the device. The device provides interactive touch screen along with cloud backup for the measurements. The device was tested with the ALP concentration levels in the range of 0–1000 U/mL and it has shown exceptional analytical performance with correlation coefficient values of 0.99. The device has limit of detection limit of 0.1 U/mL with an average sample testing time of

15 seconds. The device was also been tested with ALP-spiked milk samples to check it effectiveness and commercial viability.

AEP-09 : Binder-Free NiFe Phosphate–Oxyhydroxide on Carbonized Wood for Efficient Alkaline Oxygen Evolution Reaction

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A novel binder-free NiFe–PO₄–OH electrocatalyst was deposited on carbonized white pine (PCW), maple (MCW), and cedar (CCW) substrates via a room-temperature successive ionic layer adsorption and reaction (SILAR) method, without post-thermal treatment. The process produced a uniform amorphous mixed phase of NiFe oxyhydroxide and metal phosphate throughout the hierarchical microchannels of the carbonized wood. This integration combines efficient electrolyte transport and accessible active sites with enhanced interfacial charge transfer and coating stability. Among the three substrates, NiFe–PO₄–OH/PCW exhibited the best overall performance, demonstrating that the intrinsic microstructure of carbonized wood strongly influences active-phase loading, adhesion, and electrocatalytic activity. In 1.0 M KOH, NiFe–PO₄–OH/PCW required an overpotential of only 248 mV to achieve 10 mA cm⁻², with a Tafel slope of 73 mV dec⁻¹, outperforming IrO₂, under comparable conditions. The electrode also retained >95% of its initial current density after 70 h of continuous OER operation, compared with 78.5% retention for NiFe–PO₄–OH/MCW after 30 h. In a two-electrode configuration with Pt/C as the cathode, NiFe–PO₄–OH/PCW || Pt/C delivered 10 mA cm⁻² at only 1.64 V. These results establish NiFe–PO₄–OH/PCW as a promising low-cost, binder-free electrode for durable alkaline water electrolysis.

AEP-10 : Biodegradation of PPCP Residues from Coalfield-Region Wastewater Using a Bacterial-Fungal Consortium: Kinetics and Pathway Elucidation

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Pharmaceuticals and personal care products (PPCPs) are increasingly detected in wastewater from industrial and mining-affected

regions, but compounds such as (target PPCP, e.g., fluoxetine/oxybenzone) remain largely unexamined despite their environmental persistence and ecotoxicological relevance. Unlike previous work on synthetic spiked media, this study proposes to evaluate biodegradation in real wastewater from (local STP/coal-industry effluent site, Dhanbad region) which provides a more representative mixture of field-relevant contaminants and matrix effects. Activated sludge will be used to isolate a bacterial-fungal consortium that will be screened for degradation efficiency against the target PPCP and identified as strains by 16S rRNA and ITS gene sequencing. The kinetics of degradation will be established by time-course HPLC/LC-MS/MS monitoring of parent-compound depletion and structural characterisation of transformation intermediates will be used to propose a complete degradation pathway, an aspect rarely resolved in existing consortium-based studies. Bioassays (*Daphnia magna*/seed germination) to evaluate the ecotoxicological effect of the treated effluent will confirm true detoxification and not partial transformation. The study aims to fill a specific gap in the research on consortium-based bioremediation by incorporating an understudied PPCP target, real regional wastewater matrices and pathway-level mechanistic resolution, and to provide scalable insights for decentralised wastewater treatment in industrially impacted regions such as Jharkhand.

AEP-11 : A Novel Voltammetric Method for the Enhanced Detection of the Food Additive Vanillin using an Electrochemical Sensor

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Vanillin (VN) is a primary constituent of Vanilla which is a commonly used flavouring agent in the food and pharmaceutical industry. Electrochemical property of VN and Caffeine (CF) at Poly Alanic acid modified carbon nano tube paste electrode (PAMCNTPE) was examined by cyclic voltammetry (CV) and differential pulse voltammetry (DPV) in 0.2 M phosphate buffer solution (PBS) of an optimum pH of 6.5. Field emission scanning electron microscopy (FE-SEM) was used to compare the surface morphology of PAMCNTPE and a bare carbon nano tube paste electrode (BCNTPE), and electrochemical impedance spectroscopy was used to analyse the kinetics of electron transport (EIS). The increased surface area and interactions between the polymer film and analyte are responsible for PAMCNTPE's superior electrocatalytic activity for the oxidation of VN. The VN sensor showed a low detection limit of 0.17 M by the

DPV method. In spite of prominent interferents as metal ions and organic species, the constructed sensor's selectivity for VN detection was impressive. This facile VN sensor can be effectively used for real sample analysis, due to its simplicity and stability.

AEP-12 : Statistical Analysis of Spatial and Seasonal Variations in Groundwater Quality and Heavy Metal Contamination Using ANOVA: A Study of Firozabad and Agra Districts

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Groundwater is an important source of drinking, domestic, agricultural, and industrial water in the Firozabad and Agra districts of Uttar Pradesh. The present study was undertaken to assess groundwater quality by evaluating physicochemical properties and heavy metal contamination and to determine their spatial, seasonal, and temporal variations. Groundwater samples were collected from 18 sampling sites, comprising nine sites each from Firozabad and Agra districts, during pre-monsoon and post-monsoon seasons for five consecutive years (2021–2025). Physicochemical parameters and heavy metals were determined by using inductively coupled plasma mass spectrometry. Descriptive statistics and analysis of variance (ANOVA) were applied to evaluate significant differences in groundwater quality parameters among sampling sites, seasons, and study years. The ANOVA results were used to determine whether the observed variations in physicochemical characteristics and heavy metal concentrations were statistically significant.

AEP-13 : Electrochemical Determination of Mefenamic Acid Using a WO₃/CTAB/Carbon Composite Electrode

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The electrochemical oxidation of the anti-inflammatory drug mefenamic acid (MFA) was investigated using a carbon paste electrode modified with tungsten trioxide (WO₃) nanostructures and cetyltrimethylammonium bromide (CTAB). Incorporation of WO₃ and CTAB produced a pronounced enhancement in the MFA oxidation current relative to the unmodified carbon paste electrode. The

synthesized WO_3 nanostructures were characterized by scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS) to determine their morphology, crystallographic features, and surface chemical composition. The electrochemical oxidation process was systematically evaluated by examining the effects of temperature, scan rate, accumulation time, pH, and other electrokinetic parameters, including the heterogeneous electron-transfer rate constant and activation energy. Thermodynamic parameters and the number of protons and electrons participating in the oxidation of MFA were also determined. Owing to its increased electroactive surface area, good stability, and high sensitivity, the WO_3 /CTAB-modified carbon paste electrode demonstrated reliable performance for the determination of MFA in pharmaceutical formulations and biological matrices, providing satisfactory recovery results.

AEP-14 : Highly Efficient Zr/SBA-15 Catalysts for the Solvent-free Synthesis of Cyclic Carbonates from CO_2 and Epoxides at Atmospheric Pressure

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The cycloaddition of CO_2 with epoxides to produce cyclic carbonates is an attractive approach for CO_2 utilization and the synthesis of value-added chemicals. In this study, a series of Zr/SBA-15 catalysts with different zirconium loadings was synthesized and characterized using various structural, morphological, surface, and thermal techniques. Their catalytic performance was evaluated for the solvent-free cycloaddition of CO_2 with epoxides under atmospheric-pressure conditions. Among the investigated catalysts, 10Zr/SBA-15 exhibited the highest activity in the presence of TBAB as a cocatalyst, achieving 83.3% styrene oxide conversion with 96% selectivity toward styrene carbonate at 70 °C. The enhanced performance was attributed to well-dispersed Lewis acidic Zr^{4+} sites that activate the epoxide, while Br^- ions from TBAB facilitate nucleophilic ring opening and CO_2 incorporation. Kinetic studies revealed pseudo-first-order behavior, with the apparent rate constant increasing from 0.022 h^{-1} at 40 °C to 0.116 h^{-1} at 70 °C and an apparent activation energy of 40.5 kJ mol^{-1} . The catalyst showed good activity toward different epoxides and retained its performance upon reuse. Spent-catalyst characterization confirmed that its structural properties were largely preserved, highlighting 10Zr/SBA-15 as an efficient and reusable catalyst for cyclic carbonate synthesis under mild conditions.

AEP-15 : Investigation of Lipoprotein-Associated O-Glycans in Coronary Artery Disease

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Coronary artery disease (CAD) is associated with molecular alterations in circulating lipoproteins. Glycosylation represents an important molecular feature that may reflect such disease-associated changes. The present study focuses on the investigation of O-glycans associated with low-density lipoprotein (LDL) and high-density lipoprotein (HDL) in the context of CAD. Lipoprotein fractions isolated from human plasma are being investigated for their associated glycan profiles using mass spectrometry-based analytical approaches. The study aims to characterize lipoprotein-associated O-glycosylation and examine potential differences between LDL and HDL associated glycan profiles in relation to CAD. This preliminary investigation seeks to establish an analytical basis for studying lipoprotein-associated glycosylation and its relevance to CAD biomarker research. The findings may provide further insight into glycosylation-associated molecular alterations in circulating lipoproteins and support future investigations of glycan-based molecular markers for CAD.

INORGANIC CHEMISTRY SECTION

Sectional President's Address

Molecular Fluorescence for Chemical Sensing: A Schiff-Base System for Detecting Zn²⁺ and Nitroaromatics

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Fluorescent sensors offer a convenient way to detect chemical species through changes in light emission. This study explores a Schiff-base ligand and its Zn(II) complexes as a complementary sensing system for two different targets: zinc ions and picric acid. The free ligand shows a fluorescence “turn-on” response to Zn²⁺ in a semi-aqueous medium, with 1:1 binding. Its Zn(II) complexes, in turn, detect picric acid in aqueous medium through fluorescence quenching. Picric acid is an important energetic compound, and its detection in water is relevant to environmental monitoring. Photophysical studies and theoretical calculations were used to examine the sensing responses and the interactions involved. The findings show how metal coordination can tune the optical behaviour of a molecular system, enabling it to respond differently to distinct analytes. This work highlights the potential of coordination chemistry to guide the design of adaptable fluorescent sensors for chemical detection.

IIL-01 : Advanced Nanocomposite Sensors for Monitoring Toxic Heavy Metals in Environmental Samples

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This work presents two complementary nanomaterial-based approaches for detecting toxic heavy metals in environmental water. The first approach uses a ternary polypyrrole/boron carbon nitride/nitrogen-doped carbon quantum dot (PPy/BCN/NCQD) nanocomposite to develop a flexible electrochemical sensor for cadmium ions (Cd^{2+}). NCQDs were synthesized hydrothermally from natural chitosan, while the ternary composite was prepared through in situ oxidative polymerization. Its enhanced sensing performance arises from the synergistic combination of the large surface area and charge-transfer efficiency of BCN, the functional groups and quantum properties of the NCQDs, and the conductive network of PPy. The modified screen-printed carbon electrode detected Cd^{2+} through deposition–stripping analysis, achieving a detection limit of 0.833 nM and a linear range of 1–100 nM. The second approach introduces an eco-friendly colorimetric method for detecting lead (Pb) and mercury (Hg) using biogenic L-cysteine-functionalized gold nanoparticles. Metal-induced nanoparticle aggregation produces visible color changes and shifts the SPR peak from approximately 525 nm to 725 nm for Pb and 700 nm for Hg. The method demonstrated a linear range of 100–500 ppb, with detection limits of 290 ppb for Pb and 140.35 ppb for Hg. Both platforms showed good selectivity and practical applicability, offering sensitive, cost-effective, and sustainable solutions for monitoring heavy metal contamination.

IIL-02 : Organic Cage Encapsulated Silver Nanoparticles for Heterogeneous and Visible Light Triggered Photocatalysis

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Porous materials are always seized wide attention from the material scientists due to their potential application in both industry

and academia. Notably, imine condensation that is known to chemists for more than a century, has recently been well explored to construct self-assembled organic cages of different sizes and shapes. Nevertheless, shape-persistent discrete organic cages have been widely employed as a smart porous material for various applications such as gas adsorption and separation. Apart from their porosity, self-assembled porous organic cages have been further applied as a template for metal nanoparticles (MNPs) synthesis and also as functional material for harmful organic pollutants detection/separation in recent times.

In this present work, a tetragonal organic molecular barrel (OB4R) was synthesized through imine condensation followed by reduction and employed as a confined molecular vessel for the controlled nucleation of ultrafine Ag nanoparticles (≈ 1.44 nm). Its spacious interior, aromatic backbone, and vicinal diamine clefts facilitate nanoparticle formation, while the aromatic walls prevent aggregation. The resulting [Ag^o@OB4R] composite served as an efficient heterogeneous visible-light photocatalyst for Ullmann-type aryl amination, enabling the conversion of haloarenes to imidazole-functionalized products under mild conditions without additives or ligands. The catalyst exhibited broad functional-group tolerance, high yields, and excellent recyclability, offering a sustainable alternative to conventional high-temperature Ullmann coupling. The newly synthesized material [Ag^o@OB4R] leads the way for the incorporation of a variety of other functional groups for the development of novel heterogeneous photocatalysts to carry out other classes of organic transformations.

III-03 : Molecular and Interfacial Engineering of Halide Perovskites for Various Advanced Applications

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Halide perovskites offer exceptional optical properties and tunable structures, making them promising materials for advanced photonic and sensing applications. This lecture will highlight our recent efforts in molecular, dimensional, and interfacial engineering of halide perovskites. The discussion will include cyclodextrin-mediated circularly polarized luminescence in achiral two-dimensional blue perovskites, and halide perovskite–polyoxometalate nanocomposites for ultrasensitive Cu²⁺ detection in nonaqueous media. These studies demonstrate how molecular interactions and interfacial engineering

can be exploited to tune the luminescence and sensing properties of halide perovskites for emerging technological applications.

IIL-04 : Recyclable Heteropoly Acid-Niobium(V) Oxide Hybrid-Catalyzed Synthesis of Coumarin Derivatives in Water

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A hybrid composite of niobium(V) oxide (Nb_2O_5) supported heteropoly acid, referred to as STA@ Nb_2O_5 , has been employed as a recyclable catalyst for the green synthesis of coumarin derivatives in aqueous medium under mild conditions. This catalyst demonstrates a strong tolerance for a diverse range of aryl aldehydes and cinnamaldehyde substrates in the synthesis of chromenes. The catalytic pathway is entirely dependent on the specific nature of the aldehydes used. The mechanistic pathway is completely controlled by the nature of the substituent or functional group on the aldehyde. Also, this methodology offers a straightforward process for catalyst recovery and reuse, achieving high conversion and selectivity across multiple runs with minimal loss of activity.

IIL-05 : Pt(II) Based Anticancer Drug Design and Drug Development: It's Current Status and Future Planning

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Since last few decades cancer is going to be a challenging global threat and the second leading cause of unnatural human death. This sobering reality has encouraged to develop safer and more effective anticancer drugs, to prevent ultimately loss of human life. The serendipitous discovery of anticancer activity of cisplatin, $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ by B. Rosenberg, which was first recognized in 1978 by FDA, USA for the treatment of several types of cancer. However, cisplatin's notable side effects posed significant challenges. To reduce the side effect and toxicity, next generation drugs like carboplatin and oxaliplatin were recognized, but not fully devoid of toxicity. We have designed and synthesized heterocyclic diamine based Pt(II) complex $[\text{Pt}(\text{diamine})\text{Cl}_2]$, C1 and its hydrolysed product $[\text{Pt}(\text{diamine})(\text{OH}_2)_2](\text{NO}_3)_2$, C2. The thiol containing L-cysteine (L-cys) and Glutathione (GSH) chelated Pt(II)

complex [Pt(diamine)(L-cys)]⁺, C3 and [Pt(diamine)(GSH)], C4 were synthesized from complex C2 and were characterized for the same. The binding aptitude of the Pt(II) complexes (C1-C4) with biomacromolecule BSA and DNA were performed to evaluate their binding mode and binding constants. The drug likeness property was evaluated by PASS prediction and molecular docking of the complexes were executed with DNA and BSA. The complexes have better anticancer activity against MCF-7 and MDAMB231 cancer cell lines and less toxic on human normal embryonic kidney cell line HEK293T. The complexes are less toxic on normal cells, whereas more effective on cancer cells compared to recognized anticancer drug cisplatin, carboplatin and oxaliplatin. The cells (MCF-7) undergo necrosis when treated with the complexes (C1 – C4). Their lower level of ROS generation in MCF-7 cell lines are comparable with the recognized anticancer drugs. Their cell death mechanism (Cell cycle arrest) was executed to confirm the drug activity on cancer cell lines.

III-6 : Utilization of In Situ Generated Cyclometallated Complexes as Catalysts in the Construction of Late-Stage Molecules via C–H functionalization

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Over the last two decades, the in situ generation of cyclometallated complexes as catalysts for C–H functionalization reactions, increased the reactivity and improved the selectivities of reactions. Very recently, promising results have been showcased using in situ generated cyclometallated complexes, form a stable C–M bond to delivered the desired product. Furthermore, based on mechanistic studies, the unique catalytic role of some metallacyclic intermediate species has been revealed. With the significant progress in the construction of late-stage molecules, these mechanistic studies have subsequently translated into the rational design of advanced C–H functionalization with various transition metal complexes such as rhodium (Rh), ruthenium (Ru), iridium (Ir), cobalt (Co), etc to deliver an important platform. Using cyclometallated complexes as in situ generated catalyst in the reactions has various benefits such as enhanced control, mild conditions, operational simplicity, and strategic flexibility. In situ monitoring techniques, like real-time spectroscopy, are also key to understanding the formation and role of these transient complexes, which is crucial for optimizing reactions for complex late-stage heterocyclic molecules.

Therefore, the design, and in situ generation of cyclometallated complexes is highly applicable in functional materials, pharmaceutical and agrochemicals industries. Recent breakthroughs in the field of C–H functionalization catalysed by metallacyclic intermediates are thus discussed. In this context, from last few years, we have reported a range of in situ generated cyclometallated complexes for the synthesis of late-stage molecules via C–H bond activation with the help of various directing groups and transition metals. Herein, during my presentation, I will describe a brief summary of our recent works and present progress works on the utilization of in situ generated cyclometallated (organometallic) complexes to synthesize the late-stage biologically relevant heterocyclic drug candidates.

III-07 : Understanding Spin Relaxation Pathways of [CpTi(cot)] Molecular Qubits on Au(111)

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Understanding and controlling spin relaxation in molecular qubits is essential for the development of quantum technologies. The mixed-sandwich complex [CpTi(cot)], (η^8 -cyclooctatetraene)(η^5 -cyclopentadienyl) titanium, is a promising spin qubit, exhibiting a coherence time of 34 ms at 4.5 K in frozen solution, despite a highly protonated framework. This long coherence arises from a favourable balance between intramolecular interactions and weak spin–phonon coupling associated with low-energy ring motions, demonstrating the potential of organometallic sandwich complexes for quantum control.

Here, using DFT and CASSCF/NEVPT2 methods, we examine [CpTi(cot)] on Au(111) surfaces, where the effect of Au(111) towards the spin-relaxation behaviour of [CpTi(cot)] is studied. We have used two molecular orientations, lying and standing, with differing interactions with the Au(111). The theoretical analysis indicates that only the standing molecules undergo partial charge delocalisation toward the surface, while lying molecules remain electronically decoupled. Such orientation-dependent molecule–surface hybridisation directly influences local spin environments and provides a means to modulate spin–phonon relaxation pathways.

These results highlight how molecular orientation, surface interactions, and packing can be used to tailor spin dynamics in hybrid interfaces. The combination of long intrinsic coherence, tunable spin–surface coupling, and accessible molecular orbitals makes [CpTi(cot)] an ideal platform for single-qubit addressing and quantum sensing.

More broadly, this study illustrates strategies for engineering spin relaxation in surface-supported molecular qubits, advancing the design of coherent, controllable spin systems at interfaces.

IO-CYSA-01 : Enhanced Photocatalytic Hydrogen Evolution with Efficient Charge Separation using Heterostructured CoVLDH/CeS₂ Material

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In search of developing cutting-edge photocatalysts for sustainable and clean hydrogen generation via water splitting, we investigated developing a highly effective and stable S-scheme heterojunction photocatalyst as a highly efficient catalyst for water splitting. In this research, visible-light-driven hydrogen (H₂) evolution with the help of cobalt-vanadium layered double hydroxide (CoVLDH), combined with cerium disulfide (CeS₂)-based heterostructured CoVLDH/CeS₂ nanocomposites, was prepared. The material was fully characterized by XRD, FESEM, and TEM measurements, which revealed an exceptional H₂ evolution rate of 16.89 mmol h⁻¹ g⁻¹, nearly twice that of the neat CoVLDH and the optimized CoVLDH/CeS₂ nanocomposite. Reaction time, sacrificial reagents, and photocatalyst dosage were systematically optimized to prove the effectiveness of the material. The strong interfacial coupling between CoVLDH and CeS₂ enabled effective charge separation, directed electron transmission, and suppression of electron–hole recombination via the S-scheme mechanism, thereby enhancing photocatalytic activity. Additionally, the nanocomposite had an outstanding photostability over an extended radiation exposure. The research highlights the potential of transition-metal LDH/sulfide-based heterostructures as viable options for highly efficient solar-to-hydrogen energy conversion.

IO-CYSA-02 : Iron Oxide Magnetic Nanoparticles : A Boon for Pharmaceutical Applications

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A Very fine nanosized metal oxide, namely, iron oxide has been synthesized by precipitation method using ammonia as precipitating agent and characterized by using XRD (X-ray diffraction), TGA/DTA, surface area measurement (FE-SEM), and magnetic measurements

techniques. Magnetic measurements showed that iron oxide has five unpaired electrons and is ferromagnetic in nature, Ms value being 1.7 emu/g. The particle size of the synthesized iron oxide was determined by FE-SEM. Over the years, many different iron oxide nanoparticles have been evaluated for a wide range of biomedical applications. The synthesized magnetic iron oxide nanoparticles have applications in pharmaceutical science, specifically for cell labelling, tissue repair, cancer treatment, immunotherapy, and stem cell therapy. More research in biomedicine should be conducted using different methods.

IO-CYSA-03 : Design and Development of E² Azo-Functionalized Metal (II) Phthalocyanines as Efficient Photo Sensitizers for Dye-Sensitized Solar Cells

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The present research describes about the synthesis and structural investigation of the ecofriendly and economic azo functionalized zinc (II) phthalocyanine derivatives. The resultant compounds were characterized by FT-IR, UV-Visible, ¹H NMR and mass spectral studies. The incorporation of the azo units broadened absorption of the phthalocyanine derivatives in the 300–800 nm region. Electrochemical studies showed that the compounds possess suitable frontier orbital (HOMO-LUMO) energy levels for electron injection into the TiO₂ conduction band and regeneration of the oxidized dye by the redox electrolyte. The photovoltaic properties of the synthesised compounds (4a-4e) were evaluated in dye-sensitized solar cells using TiO₂ photoanodes, under one-sun irradiation. The sensitizers exhibited Jsc values in the range of 3.2-6.0 mA cm⁻², Voc values of 0.53-0.58 V, and power conversion efficiencies (η) of 1.3-2.3%. Among the investigated sensitizers, 4c exhibited the highest photovoltaic performance, with a power conversion efficiency of 2.3% and a maximum incident photon-to-current efficiency (IPCE) of 47%. The incorporation of azo chromophores into the zinc (II) phthalocyanine framework broadens light absorption and influences the electronic and photovoltaic properties of the sensitizers, providing a useful approach for developing phthalocyanine-based sensitizers for DSSC applications.

IO-CYSA-04 : Exploring the Biological Applications of Coumarin-based Derivatives and their Copper Complexes

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The study investigates the interaction of coumarin-based derivatives and their copper (II) complexes with human serum albumin (HSA), emphasizing their significance in transport and biological activity.¹ Utilizing techniques such as fluorescence, UV-visible absorption, circular dichroism (CD), isothermal titration calorimetry (ITC), and molecular docking, the research demonstrates that these compounds reduce HSA's intrinsic fluorescence in a concentration-dependent manner, indicative of a static quenching mechanism and stable ligand-HSA adduct formation, characterized by quenching constants around $10^{12} \text{ M}^{-1}\text{s}^{-1}$. CD analysis showed changes in HSA's secondary structure while ITC offered thermodynamic insights into the binding process, revealing binding energy in the range of 10^{-6} M . Molecular docking identified potential binding sites and crucial non-covalent interactions facilitating ligand-protein recognition. Furthermore, cytotoxicity tests (MTT assay) indicated that copper complexes exhibited superior cytotoxicity towards cancer cell lines compared to the ligands.

IO-CYSA-05 : Efficient Green Synthesis of Carbon Dots as a Corrosion Inhibitor for Mild Steel in an Acidic Environment

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Carbon dots are generally synthesized by a one-step hydrothermal process, which is used as a corrosion inhibitor. These carbon dots inhibited the corrosion process of mild steel (MS) when dissolved in a 15 % HCl solution. They were water-soluble, low-cost, affordable, and environmentally friendly. The compound that contains a lone pair and π -electron, such as S, N, O, P, and B, as well as aromatic heterocyclic rings and other polar functional groups like nitrile (C=N), amine (NH), carbonyl (C=O), and thiol (SH), that are readily available for donation of electrons, act as good corrosion inhibitors for carbon dots on metal surfaces to inhibit the corrosion process. FTIR, UV-Vis, PL, XPS, and HRTEM analysis were used to characterize the

synthesized carbon dots. The inhibitory efficiency of carbon dots was assessed using potentiodynamic polarisation analysis, electrochemical impedance spectroscopy, and weight-loss measurements. By using FESEM, EDX, AFM, and XPS analysis, the surface morphology of the inhibited sample was examined, and the presence of a protective layer on the MS surface was verified.

IO-CYSA-06 : Li-sensitized CdS@ZnO Photoanodes for Enhanced PEC Water Splitting and Green Hydrogen Generation

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Photoelectrochemical (PEC) water splitting is a promising approach to sustainable green hydrogen generation. The Li-doped CdS@ZnO heterostructured photoanodes were fabricated by electrodeposition and SILAR method to enhance visible-light utilisation by charge separation. The Li sensitization effectively modulated the electronic structure and interfacial charge transfer of the CdS@ZnO heterojunction. The 2% Li-CdS@ZnO photoanode delivered the highest photocurrent density of 6.45 mA cm⁻² at 0 V vs. Ag/AgCl, while 3% Li-CdS@ZnO achieved the maximum photoconversion efficiency of 6.73% with a charge-carrier density of 3.85 × 10²⁰ cm⁻³. The enhanced performance is attributed to improved light harvesting, favourable band alignment, and efficient separation of photogenerated charges. These findings highlight Li-sensitised CdS@ZnO as a promising photoanode for efficient PEC water splitting and green hydrogen generation.

IO-CYSA-07 : Optimization of Amorphous Vanadium Doped Nickel Tungstate as an Electrocatalyst for HER in Both Acidic and Alkaline Media

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Electrochemical water splitting offers a sustainable route for hydrogen production, but the development of low-cost, highly active, and durable electrocatalysts that perform efficiently across diverse pH conditions remains challenging. Herein, we report an amorphous vanadium-doped NiWO₄ electrocatalyst, A-V_(4%)-NWO, designed for efficient hydrogen evolution in both acidic and alkaline media. The catalyst was synthesized through a simple and scalable co-precipitation

approach, enabling effective vanadium incorporation and morphological control. Structural characterization revealed non-uniform spherical nanoparticles with a mesoporous architecture, promoting electrolyte accessibility and ion transport. Remarkably, A-V_(4%)-NWO delivered 10 m/cm² at ultralow overpotentials of only 22 mV in 0.5 M H₂SO₄ and 35 mV in 1 M KOH. The corresponding Tafel slopes of 31.4 and 48.2 mV/dec demonstrate favourable HER kinetics. A mean pore size of 41.48 nm further supports the abundance and accessibility of active sites. Notably, the catalyst maintained excellent stability over 100h of continuous operation in both media. These findings highlight V-doping as an effective strategy for engineering NiWO₄ into a robust and versatile dual-pH HER electrocatalyst for sustainable hydrogen generation.

IO-01 : Electrochemically Engineered 3D Bimetallic Nanoflowers for Smartphone enabled Automated Hydrogen Peroxide Sensing in Milk

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Although excessive accumulation of hydrogen peroxide (H₂O₂) can cause oxidative stress and contribute to a number of clinical diseases, H₂O₂ is a key reactive oxygen species involved in cellular control. The inherent chemical and thermal instability of enzymes limits the dependability and long-term performance of conventional enzymatic H₂O₂ sensors. Here, a three-dimensional (3D) bimetallic nanoflower that mimics nonenzymatic peroxidase was created for quick and accurate H₂O₂ detection. With a wide linear range of 0.01–1 nM and a detection limit of 1.46 ± 0.07 pM, the modified sensing platform demonstrated improved charge-transfer characteristics and superior analytical performance. Notably, in the presence of common interferents, the sensor showed strong selectivity towards H₂O₂ and an ultrafast reaction time of 2.10 ± 0.02 s. Additionally, the sensor demonstrated its suitability for real-world matrices with good recoveries of 92.88–99.09% in milk samples. Additionally, the sensor was connected with the user-friendly smartphone app “HPeroxide-Check” to interpret electrochemical signals and offer real-time H₂O₂ concentrations for checking milk adulteration. The platform’s promise for quick, reliable, and portable H₂O₂ monitoring in industrial and point-of-care applications was demonstrated by the one-step fabrication method, which only took ten minutes.

IO-02 : Software Integrated Personalized Biosensing Device for Serum Creatinine Detection Based on Boron doped MXene Nanohybrid

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The rising global burden of chronic kidney disease (CKD), particularly in developing nations, highlights the critical need for accessible diagnostic tools. Monitoring creatinine—a key biomarker for kidney function—is essential for the early diagnosis and management of CKD. To address this, we developed a field-deployable immunosensor for precise creatinine detection in blood serum. The sensor utilizes a nanocomposite of gold nanoparticles, boron-doped MXene, polyaniline, and specific anti-creatinine antibodies. It demonstrates exceptional sensitivity, achieving a broad linear dynamic range of 10 nM to 0.1 M and a low limit of detection of 1.72 (± 0.07) nM. To make the device user-friendly, the sensor is paired with custom “CretCheck” software. This program automates data analysis by directly converting analytical signals into personalized creatinine concentration readings. Highly sensitive and easy to use, this integrated biosensing system offers a practical diagnostic solution that can be readily deployed in primary healthcare facilities for efficient CKD screening.

IO-03 : Novel Bioactive Homo-Binuclear Co(II), Ni(II), Cu(II) and Zn(II) Complexes Based on N₂O₂ type Tetradentate Schiff base Ligand: Synthesis, Characterization, Electrochemical Studies, Dye Adsorption, Fluorescence, Antioxidant and Antimicrobial Activity

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The present study focuses on the synthesis and structural characterization of novel homo-binuclear Co(II), Ni(II), Cu(II), and Zn(II) complexes incorporating an N₂O₂-type tetradentate Schiff base ligand. The ligand was synthesized through the condensation reaction of terephthalaldehyde and 2-amino-4-chloro-6-nitrophenol in a 1:2 molar ratio using methanol as the reaction medium. The synthesized ligand

and its metal complexes were systematically characterized using elemental analysis, molar conductance measurements, UV–Visible spectroscopy, FT-IR spectroscopy, ^1H -NMR, ^{13}C -NMR, mass spectrometry, and powder X-ray diffraction techniques. The thermal behavior and stability of the metal complexes were investigated by thermogravimetric and differential thermal analyses (TGA-DTA). Their electrochemical properties were examined through cyclic voltammetry to understand the redox behavior associated with the metal centers and their coordination environments. In addition, the catalytic potential of the synthesized complexes was evaluated through the adsorption of methylene blue dye. The biological activities of the ligand and metal complexes were also explored. Antibacterial studies were carried out using the agar well-diffusion method against *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*. Antifungal activity was assessed by the growth inhibition method against *Aspergillus niger* and *Fusarium oxysporum*. Furthermore, antioxidant properties were evaluated using the DPPH radical scavenging assay, with several complexes demonstrating considerable activity comparable to that of the standard antioxidant, ascorbic acid. Solid-state fluorescence measurements were also performed to investigate the photophysical properties of the newly synthesized compounds. Overall, the results indicate that these homo-binuclear metal complexes possess promising catalytic, biological, antioxidant, and fluorescence properties, suggesting their potential application as advanced functional materials in catalysis and bioactive systems.

IO-04 : Solid State Kinetics of Cu (II) Complex Derived from Schiff base of 5-Amino-1,2,3,4-Thiatriazole with Ortho-methoxybenzaldehyde.

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The Cu (II) complex was prepared by mixing ligand i.e. 5-amino-1,2,3,4-thiatriazole and Cu (II) in 1:1 molar ratio in minimum quantity of ethanol. Dirty yellow precipitate of complex was obtained after refluxing. The thermogram exhibits almost horizontal extending up to 200° C shows the pyrolytic stability of the complex. The first stage of decomposition was selected to evaluate the order of reaction and activation energy using graphical method of Freeman and Carroll. The values obtained have been corroborated by Doyle's procedure as modified by Zsako. The values of order of reaction and activation energy were found 1 M/sec and 21.714 kcal/mol respectively. The apparent entropy of activation and apparent frequency factor were-

65.88691201 e.u. and $1.38338 \times 10^5 \text{ sec}^{-1}$ respectively. These values are in good agreement with each other, hence may be utilized in the study of solid state reaction mechanism.

IO-05 : Synthesis and Characterization of Complexes of Transition Metals with Schiff Bases Derived from Isatin and Polyamines

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Complexes of Cu(II) and Zn(II) with Schiff bases derived from isatin and ethylenediamine (L^1) or diethylenetriamine (L^2) have been synthesized and characterized by microanalysis, IR, UV-Vis, ^1H NMR, EPR and conductance measurements. Electrical conductance of the divalent metal ions indicated them to non-electrolytes in DMSO. On the basis of magnetic moment and spectral data a pseudooctahedral geometry has been suggested for both complexes. The EPR spectrum of $[\text{Cu}(L^1)\text{Cl}_2]$ complex indicates a considerable exchange interaction in the solid state.

IO-06 : Luminescence and Bioactivity Studies of a Europium(III) Complex Derived from Kynurenic Acid: A Promising Candidate for Biomedical Applications

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A europium(III) complex with 4-hydroxyquinoline-2-carboxylic acid (kynurenic acid, HL) was synthesized via a solution-phase method and characterized using spectroscopic and analytical techniques. The ligand coordinates in its deprotonated form as an O,O2 -bidentate donor through phenolate and carboxylate oxygen atoms, forming a neutral complex of the type $[\text{Eu}(\text{L})_3(\text{H}_2\text{O})_2]$ with an eight-coordinate geometry. FT-IR, UV-Visible, mass spectrometry, and thermogravimetric analyses confirm the structural features and thermal stability of the complex, while molar conductivity measurements indicate its non-electrolytic nature. The electronic spectra exhibit ligand-centered transitions along with weak f-f bands characteristic of Eu(III). The complex demonstrates enhanced catalytic and antimicrobial properties compared to the free ligand, attributed to chelation-induced electronic effects. These findings highlight the potential of quinoline-based lanthanide complexes in functional and bioactive applications.

IO-07 : Green Fabrication of Copper Oxide Nanoparticles Using Plant Extract : An Inorganic Nanomaterial Approach

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The present study focuses on the green fabrication of copper oxide nanoparticles (CuO NPs) using a plant extract as a sustainable and eco-friendly approach for the preparation of inorganic nanomaterials. The phytochemicals present in the plant extract act as natural reducing, complexing and stabilizing agents during the formation of CuO nanoparticles from a copper precursor. The synthesized CuO NPs were systematically characterized to investigate their structural, morphological, elemental and optical properties. UV–Visible spectroscopy was employed to study the characteristic optical absorption of the synthesized nanoparticles, while FTIR spectroscopy was used to identify the functional groups associated with the nanoparticle surface and their possible involvement in the synthesis and stabilization process. X-ray diffraction (XRD) analysis was used to determine the crystalline nature and crystal structure of the CuO nanoparticles. Morphological and particle-size characteristics were investigated using electron microscopy, while energy-dispersive X-ray spectroscopy (EDS) confirmed the elemental composition of the synthesized material. The obtained results demonstrate the successful formation of CuO nanoparticles with characteristic structural and morphological features. The green fabrication route offers an environmentally benign alternative to conventional nanoparticle synthesis methods and minimizes the use of hazardous reducing and stabilizing agents. The synthesized CuO NPs also exhibited promising antimicrobial activity against selected pathogenic microorganisms, indicating their potential for applications in antimicrobial materials and related areas. Overall, the study highlights the significance of plant-mediated synthesis as a sustainable strategy for developing functional copper oxide-based inorganic nanomaterials.

IO-08 : Magnetic and Spectral Study of Some Complexes of N, S-Donor Ligand

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The coordination chemistry of transition metal complexes containing N and S donor ligands has attracted considerable attention

because of their interesting magnetic and spectral properties. The ligands containing N and S donor have gained importance for pursuing research in inorganic chemistry as they have been reported as interesting chromophoric reagent that give intense coloured complexes, show more bathochromic shift, more sensitivity and more selectivity. The present paper reports the synthesis, characterization of the magnetic and spectral properties of N and S containing ligand like 2-acetyl fluorine thiosemicarbazone. This ligand was used for complexation with Fe(II), Co(II) and Ni(II). The FTIR spectra have been compared with that of the free ligand to trace the point of coordination of the ligand to the metal ion. The ligand was found to act as neutral, bidentate coordinating through azomethine nitrogen and thion sulphur forming five membered ring with metal ions. The magnetic moment of Fe(II), Co(II) and Ni(II) were found to correspond to four, three and two unpaired electrons, respectively. The Fe(II) complexes display three bands in their electronic spectra which shows the further splitting of cubic crystal field term ${}^5T_{2g}$ and ${}^5E_g$ of ${}^5D$ term under the influence tetragonally distorted octahedral (D_{4h}) crystal field. The crystal field parameters like $Dq(xy)$, $Dq(z)$, Ds and Dt derived from the electronic spectral band of Fe(II) complexes are consistent with the reported values of distorted octahedral complexes of Fe(II). The electronic spectra of Co(II) and Ni(II) also shows wonderful agreement with tetragonally distorted octahedral symmetry with elongation along the z-axis. It is supported by the less value of $Dq(z)$ than $Dq(xy)$ and also a positive value of Dt .

IO-09 : Nanoscale Morphology Engineering of CoS_2 for Hydrogen Evolution Reaction in Acid Medium

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Controlling the morphology and exposed crystal facets of transition-metal dichalcogenide catalysts offers a promising route to enhance hydrogen evolution reaction (HER) performance, yet the relationship between morphology, crystal facets, and catalytic activity remains incompletely understood. Here, four CoS_2 morphologies—0D nanospheres, 1D nanorods, 2D nanosheets, and 3D nano-octahedra—are synthesized and systematically evaluated for HER activity in acidic media. Electrochemical measurements reveal a clear morphology-dependent activity trend of nano-octahedron > nanosheet > nanorod > nanosphere, highlighting the important role of morphology and exposed crystal facets in determining catalytic performance. Among

the four morphologies, the 3D nano-octahedral CoS₂ exhibits the highest activity, which is associated with its dominant exposure of catalytically active {111} facets. This catalyst requires an overpotential of only 128 mV to reach a current density of 10 mA cm⁻² and delivers a Tafel slope of 76 mV dec⁻¹, indicating active HER kinetics. Moreover, it maintains stable electrochemical performance at 10 mA cm⁻² for 100 h of continuous operation, demonstrating excellent durability. Together, these findings establish a clear relationship between morphology, exposed crystal facets, and HER activity in CoS₂, providing useful design principles for developing morphology- and facet-controlled electrocatalysts for efficient hydrogen production in acidic media.

IO-10 : Selective Cu(II)-Driven Metallogelation of a DIPN, Low Molecular Weight Gelator : Hierarchical Self-Assembly and Application in A³-Coupling Reactions

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The rational design of flexible DIPN, low molecular weight gelator (LMWG), with sites capable of coordination to metal ions along with H-bonding and δ - δ interaction offers a metal-directed hierarchical self-assembly resulting in catalytically functional supramolecular metallogel. Herein, we report a novel LMWG, DIPN that undergoes selective, coordination-driven metallogelation exclusively in the presence of Cu (II) ions under normal pH and room temperature condition within 5-10 minutes. Spectroscopic and morphological analyses (FT-IR, UV-Vis, FE-SEM, and TEM) reveal that metal-ligand coordination directs the hierarchical assembly into nanofibrillar networks, stabilized cooperatively by hydrogen bonding and π - π stacking. Rheological measurements confirm the characteristic viscoelastic solid-like behavior and mechanical robustness of the resulting Cu(II)- metallogel. Taking advantage of the uniform dispersion and accessibility of active catalytic sites within the porous supramolecular matrix, the xerogel of metallogel was employed as a heterogeneous, recyclable catalyst for multicomponent A³-coupling reactions of aldehydes, amines, and terminal alkynes. The catalytic system demonstrated broad substrate scope, affording target propargylamines in excellent yields under mild conditions. This study provides key insights into ion-selective hierarchical self-assembly and highlights the potential of metallogels as catalyst for A³ coupling reactions.

IO-11 : Influence of Transition Metals on the Porous Character of Zeolitic Imidazolate Framework

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Zeolitic imidazolate framework-8 (ZIF-8) are a subclass of metal-organic frameworks, has attracted significant interest owing to its high surface area, tunable pore structure, chemical stability, and potential applications in sensing, adsorption, and catalysis. In the present study, ZIF-8 was synthesized through a solvothermal approach in ethanolic medium using 2-methylimidazole as the organic ligand and three different transition metal, (Co, Ni and Zn) as metal ion. The incorporation and coordination of the transition-metal ions within the framework were investigated using Fourier-transform infrared spectroscopy (FTIR), powder X-ray diffraction (XRD), transmission electron microscopy (TEM), Brunauer–Emmett–Teller (BET) surface-area analysis, and scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM-EDX). The formation of a microporous trimetallic ZIF structure and coordination of the individual metal components with the ligand were confirmed. SEM-EDX analysis further demonstrates the various contributions of the individual metal species inside the synthesized framework, with Co-ZIF showing the highest weight percentage and Zn-ZIF the lowest. The study revealed the successful development of a trimetallic ZIF using solvothermal synthesis and the integration of several transition-metal centres inside a porous imidazolate framework.

IO-12 : Synergistic Integration of Fe-Modified NiAl-LDH anchored on N,S-rGO for enhanced Oxygen Evolution Reaction

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The development of efficient electrocatalysts for alkaline oxygen evolution requires rational regulation of active sites and interfacial charge-transfer processes. In this work, a hybrid electrocatalyst comprising Fe-modified NiAl-layered double hydroxide (NiAl-LDH) and dual-heteroatom-doped reduced graphene oxide (N,S-rGO) was developed through a synergistic integration strategy. The incorporation of Fe into the NiAl-LDH framework provides compositional and electronic modulation of the LDH active sites, while the N,S-rGO framework

offers a conductive platform for facilitating interfacial electron transport. The integration of these components generates a coupled LDH-carbon interface with a favorable architecture for alkaline oxygen evolution. The resulting hybrid exhibits enhanced electrocatalytic activity compared with the corresponding individual components, demonstrating the beneficial role of Fe modification and N,S-rGO coupling. The improved catalytic response is associated with the synergistic interaction between the Fe-modified LDH nanostructure and the heteroatom-doped carbon network, which promotes efficient charge transport and accessibility of catalytically active sites. The hybrid electrode also demonstrates good stability under alkaline operating conditions. This study highlights synergistic interface engineering as a promising approach for developing LDH-based hybrid electrocatalysts for alkaline oxygen evolution.

IO-13 : Sustainable Catalytic CO₂ Fixation Enabled by a Heterogeneous Copper-Based Porous Coordination Polymer

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The catalytic transformation of carbon dioxide (CO₂) into value-added cyclic carbonates provides a long-term solution for reducing greenhouse gas emissions while utilizing abundant C1 feedstock. We present the coordination-driven self-assembly of a copper(II)-based porous coordination polymer (CuL₁) with a multifunctional acylhydrazone ligand (H₂L¹) produced from isonicotinichydrazide and 3-ethoxysalicylaldehyde. Comprehensive structural, spectroscopic, and morphological analyzes showed the creation of a thermally resilient mesoporous framework with a large Brunauer-Emmett-Teller (BET) surface area (1056.77 m²g⁻¹). High-resolution XPS verified that the metal nodes were exclusively in the +2 oxidation state (Cu²⁺, d⁹). CuL₁ in the presence of TBAB displayed exceptional catalytic efficiency for the cycloaddition of CO₂ with different epoxides under mild, solvent-free conditions (60 °C, 1.0 MPa CO₂), reaching conversions of up to >99%, turnover numbers (TON > 990), and turnover frequencies (TOF > 41 h⁻¹). ICP-OES confirmed the catalyst's high recyclability and low copper leaching (<1.2%) throughout multiple cycles. This study emphasizes the collaborative importance of Lewis acidic Cu(II) sites and heteroatom-rich pores in the construction of efficient heterogeneous catalysts for CO₂ valorization.

IO-14 : Dehydrative Imination of Benzil using 2-Amino-4-chloro-5-nitrophenol : Metal Coordination and their Bio-Agricultural Applications

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This paper reports the condensation synthesis and structural fascinations of a novel benzil-derived Schiff base ligand, 6,6'-((1,2-Diphenylethane-1,2-diylidene)bis(azaneylylidene))bis(4-chloro-3-nitrophenol) (SBE). The coordination of ligand with life essential metal ions- Co(II), Ni(II), Cu(II), and Zn(II), have been done. The reflux-assisted condensation of Benzil with 2-Amino-4-chloro-5-nitrophenol, in slight acidic medium, has been done. Structural and electronic features were elucidated by UV-Vis, FT-IR, ¹H-NMR, mass spectrometry, P-XRD, TGA, and supported by DFT studies. Complexation induced distinct spectral shifts and improved thermal stability, confirming metal-ligand coordination through azomethine and phenolic sites. Biological and environmental evaluations revealed diverse activities: fungicidal efficiency of the ligand, strong antioxidant (SBEZn), dye degradation (SBECu), and seed germination promotion (SBECo). These findings highlight the multifunctional potential of benzil-based Schiff bases and their metal complexes, as prospective bioactive candidates.

IO-15 : Electrochemically Nanotuned Surface Comprising 3D Bimetallic Dendrites Fabricated on MWCNT for Detection of 1,4-dioxane in Water

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Toxic industrial pollutants like 1,4-Dioxane are causing major water safety concerns worldwide, with global health authorities pointing out how difficult they are to break down and how harmful they can be to living organisms. To tackle the urgent need for quick and precise testing, we have engineered a novel nanosensor by layering carbon nanotubes and tiny, tree-like gold-copper structures onto a carbon electrode. This clever design lets the device spot trace amounts of the chemical in a mere 1.65 seconds across both tiny and large concentration ranges. When tested on real tap water and river samples

from the Ganga, it consistently flagged up to 99.5% of the pollutant without getting thrown off by other minerals in the water. Because the whole setup and reading process takes under 30 minutes, it serves as a highly efficient, field-ready tool for protecting natural water sources.

IP-CYSA-01: Plasmon-Enhanced Catalytic Activity of Immobilized Enzymes on Ag@CMC Nanocomposites

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This study presents a robust strategy for developing a novel biocatalytic platform through the synthesis of silver nanoparticles stabilized within an oxidized carboxymethyl cellulose (Ag@CMC) matrix. Following controlled CMC oxidation and comprehensive structural characterization, the biocatalytic performance of the Ag@CMC-immobilized enzyme was systematically optimized by evaluating the effects of nanocomposite amount, enzyme concentration, pH, temperature, and incubation hours. Detailed kinetic profiling, evaluating Michaelis-Menten parameters (K_m and V_{max}), revealed enhanced catalytic efficiency and substrate affinity compared to the free enzyme. Crucially, we report a distinctive photo-modulated catalytic enhancement: exposing the system to UV radiation significantly amplified enzyme activity. This phenomenon is driven by the localized surface plasmon resonance (LSPR) of the Ag nanoparticles, which facilitates plasmon-induced photothermal heating and directed electron transfer, thereby accelerating reaction kinetics without compromising bulk enzyme stability. Furthermore, DPPH and MTT assays confirmed the potent antioxidant capacity and excellent cellular biocompatibility of the synthesized nanocomposite. By integrating a tailored biopolymer support architecture with plasmon-enhanced kinetics, these findings establish Ag@CMC as a highly versatile and sustainable platform for advanced, high-performance biocatalysis and biomedical applications.

ORGANIC CHEMISTRY SECTION

Sectional President's Address

Multi-Component Reactions (MCRs): A Sustainable Approach to Identify New Chemical Entities (NCEs)

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Efficient construction of novel molecular scaffolds is pivotal in modern drug discovery, where speed, scalability, and purity govern the transition of small-molecule drugs to clinical applications. This work emphasizes the strategic use of isocyanide-based multicomponent reactions (IMCRs) combined with intelligent post-IMCR functionalizations to achieve atom-economical synthesis of diverse scaffolds. We report the development of one-pot post-IMCR methodologies enabling the synthesis of alkaloid-mimicking tricyclic azaspiroenones, fused quinolines, 2,5-pyrrolidinediones, and functionalized 1,2,3,4-tetrahydroisoquinolines (THIQs). These novel scaffolds have been instrumental in identifying potent drug candidates highlighting the potential of IMCR-based approaches in accelerating drug discovery.

OIL-01 : Mechanochemistry and Palladium Catalysis: Divergent Strategies for the Synthesis of Lignans and (Hetero)Polyarenes

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Mechanochemistry offers an attractive approach to enabling organic transformations under mild, solvent-minimized conditions. In this lecture, we describe our studies of the mechanochemical α -C–C alkylation of itaconates and arylidene succinate derivatives using diverse alkylating agents and readily available inorganic bases. The resulting multifunctional products, particularly bromobenzyl arylidene succinate derivatives, serve as versatile building blocks for subsequent palladium-catalyzed diversification.

A common Pd catalyst–ligand system enables two distinct reaction pathways simply by changing the reaction conditions. Depending on the base and solvent, the substrates undergo either tandem C(sp³)–H cyclopalladation–annulation or 6-endo-trig Heck cyclization, providing divergent access to structurally diverse naphthalene, dihydronaphthalene, and (hetero)polyarene frameworks.² The lecture will highlight the integration of mechanochemical alkylation with palladium catalysis as a strategy for molecular diversification, with particular emphasis on its applications in the synthesis of lignans and (hetero)polyarenes.

OIL-02 : Benzotriazole Ring Cleavage (BtRC) Methodology: Our approach

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Benzotriazole methodology, has now recognised as high popularity since it can easily be introduced into a molecule, activates it towards various transformations, remains sufficiently stable during the reaction course, and finally can easily be removed at the end of reaction sequence. We devised a protocol via free radical intramolecular cyclative cleavage of benzotriazole ring in presence of (TMS)₃SiH/AIBN for an easy access of diverse 2-N, S, and C-substituted benzothiazoles through BtRC. Use of PMHS, a silicon industry waste make this route environmental benign. The short reaction time, wide substrate scope, simple workup, good yield under fairly mild conditions, compatibility under microwave conditions, and moreover readily accessibility of the starting materials are the notable features of this

BtRC protocol. Interestingly, the benzyloxythioacyl benzotriazoles on reaction with silanes or Bu_3SnH undergo free radical β -scission of C-O bond instead of N-N bond to afford deoxy product. Also, acyl benzotriazole under similar free-radical condition afforded respective amides; while AlCl_3 mediated BtRC resulted to respective benzoxazoles. The impact of our established BtRC strategy for an easy access of targeted bioactive molecules will be presented in great detail.

OIL-03 : Formal Vinylic Substitution-enabled Heterocyclic Construction

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Sulfones constitute an important yet under-appreciated class of organic molecules. The unusual propensity of arylsulfonyl groups to de-conjugate adjacent double bonds (in basic medium) allows for the development of novel and highly useful chemical transformations. We have developed a number of intriguing transformations of allyl bromosulfones that led to the formation of substituted pyrroles, dihydropyridines, benzoazepines, benzo-isoquinolines, indolo-azepines from readily available precursors. A novel rearrangement reaction that accomplishes the unprecedented transformation of a tetrahydrocarboline into an azepino indole on exposure to mild acid and a Fischer-indolisation-like benzofuran synthesis⁷ are noteworthy discoveries among these.

OIL-04 : Annulation Chemistry: Expanding the Frontier of Heteroacenes

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The construction of extended π -conjugated heteroaromatic frameworks continues to attract significant interest owing to their potential applications in functional materials, molecular electronics, and beyond. Annulation chemistry offers a powerful and modular approach for the rapid assembly of structurally complex fused-ring architectures. Our research has focused on exploiting diverse annulative transformations for the construction of novel heteroacenes and polycyclic heteroaromatic frameworks, enabling the efficient generation of molecular architectures that are otherwise challenging to access through conventional synthetic approaches.¹

This presentation will highlight our recent contributions towards the synthesis of diverse N-, S-, and O-containing fused heterocyclic systems through transition-metal-catalyzed, Lewis-acid-promoted, and catalyst-controlled annulation strategies. These approaches, involving cascade cyclization and annulative π -extension processes, have provided access to benzothienoindoles, indoloindoles, and other higher fused aromatic frameworks. Collectively, these studies demonstrate the versatility of annulation chemistry as a platform for expanding heteroacene chemical space and establishing new synthetic avenues towards structurally and electronically diverse δ -extended molecular systems.

OIL-05 : Development of Novel Routes for Indole-Containing Drugs (Umifenovir and Alectinib)

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Functionalized indoles are important motif in drug development and have been explored extensively for antiviral, antibacterial, anti-inflammatory, hypotensive and anticancer properties. Amid various indole architectures, sulfenylated indole derivatives such as umifenovir, which is an over-the-counter medicine in Russia and China for influenza with LD₅₀ > 4 g/kg), are particularly relevant in today's scenario due to their established antiviral properties. In this presentation our work towards development of process for Umifenovir will be discussed. Moreover, we will also discuss the potential of functionalized indoles as Anti-DENV agent. In addition, our efforts for the synthesis of Alectinib, which is used as an adjuvant and first line of treatment in ALK-positive non-small cell lung cancer will also be developed. Our strategy employs readily available starting materials (4-(4-Methoxyphenyl)butyric acid or 2-Ethyl anisole) and employs Suzuki-Miyaura cross-coupling and reductive cyclization as key steps. Good yield and no regioisomeric mixture formation are the key highlights of this route.

OIL-06 : Unlocking the Synthetic Potential of Anthranils: A Versatile Platform for Heterocycle Synthesis

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Anthranils, also known as 2,1-benzisoxazoles, have emerged as exceptionally versatile and multitasked bifunctional building blocks in modern organic synthesis. Owing to their unique structural features, with a weak N-O bond and an embedded electrophilic nitrogen, anthranils serve as efficient precursors for nitrogen-centered reactive intermediates. Over the past few years, our group has extensively explored the multifaceted reactivity of anthranils to develop novel and sustainable synthetic methodologies. We have harnessed anthranils as 1,4-dipoles and applied it into various [4+2]-cycloaddition reactions leading to pharmaceutically relevant scaffolds. Our findings significantly expand the synthetic utility of anthranils and open new avenues for the rapid assembly of complex molecular architectures from simple starting materials.

OIL-07 : Multifunctional (E)- β -Iodovinyl Sulfones: Enabling Access to Diverse Heterocycles

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Multicomponent reactions that concomitantly forge carbon–sulfur (C–S) and carbon–halogen (C–X) bonds play a pivotal role in modern organic synthesis. In particular, (E)- β -iodovinyl sulfones represent highly attractive multifunctional building blocks, integrating both vinyl iodide and vinyl sulfone motifs within a single molecular framework, thereby enabling diverse and synthetically valuable transformations. Despite their considerable synthetic potential, β -iodovinyl sulfones have remained relatively underexplored. In recent years, our research group has systematically investigated the synthetic utility of multifunctional (E)- β -iodovinyl sulfones and uncovered several unprecedented reactivity patterns.

In this presentation, we describe novel, efficient, and versatile cycloannulation methodologies involving β -iodovinyl sulfones and diverse coupling partners, providing streamlined access to a range of structurally diverse sulfonyl-derived heterocycle scaffolds, including 3-sulfonylbenzofurans, 3-sulfonylpyrazolo[1,5-a]pyridines, 2,3,4-trisubstituted-4H-benzopyrans, vinyl sulfone-tethered chromenes, benzoheterole-derived vinyl sulfones, 7-sulfonylimidazo[1,2-a]pyridines, and 4-sulfonyl-1,2,3-NH-triazoles. Collectively, these studies highlight the remarkable versatility of (E)- β -iodovinyl sulfones as multifunctional platforms for the efficient construction of diverse heterocyclic architectures.

OIL-08 : Synthetic Explorations Employing Carbon Disulfide: An Easy Access for the Synthesis of Biologically Potent Organosulfur Scaffolds

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Carbon disulfide is a simple yet highly versatile sulfur-containing reagent that plays an important role in modern organic and medicinal chemistry. Owing to its strong electrophilic C=S functionality and its ability to react with a wide range of nucleophiles such as amines, alcohols, and hydrazides, carbon disulfide serves as a valuable precursor for the synthesis of numerous sulfur-rich intermediates and heterocyclic compounds. These reactions enable the formation of important classes of compounds including dithiocarbamates, xanthates, thioureas, and various heterocyclic frameworks. Many of the scaffolds derived from carbon disulfide exhibit significant biological activities, including antimicrobial, antifungal, anticancer, anti-inflammatory, and antitubercular properties. In particular, carbon disulfide-mediated cyclization reactions provide efficient routes for constructing biologically relevant heterocycles such as thiadiazoles, oxadiazoles, and thiazolidinones, which are widely explored in drug discovery and development. The incorporation of sulfur atoms into molecular frameworks often enhances lipophilicity, metabolic stability, and interactions with biological targets, making these derivatives attractive candidates in medicinal chemistry. In present talk, I will be discussing chemistry of some of biologically potent organosulfur scaffolds employing carbon disulfide as a cheap and safe alternative.

OO-CYSA-01 : Regioselective Construction of Pyrido[1,2,3-de]quinoxaline-2,5-diones through Acid-Mediated Post-Ugi Rearrangements

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The synthesis of structurally complex fused heterocycles is important and less explored in medicinal chemistry. Herein, we report a regioselective, metal-free synthesis of pyrido[1,2,3-de]quinoxaline-2,5-diones from 2-aminophenol and alkynoic acid-derived Ugi adducts via an acid-mediated post-Ugi rearrangement. The transformation

proceeds through azaspirotrienone formation followed by condensation, ring expansion, and aromatization. The method showed broad substrate scope and was successfully performed on a 5 g scale (81% yield). Further functionalization demonstrated the synthetic utility of the products. DFT studies provided mechanistic insights into the reaction pathway.

OO-CYSA-02 : Cascade C% H Alkenylation Intramolecular Aminative Cyclization of Benzylsulfonamides for Synthesis of Isoindoline Cores

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Isoindoline-core-bearing compounds are pharmaceutically relevant compounds against a myriad of diseases. Traditionally, the isoindoline core is synthesized from benzylamines by two-step synthesis involving ortho-C-H alkenylation followed by acid or metal-catalyzed cyclization. Herein, we execute a direct synthesis of the isoindoline core by a one-step procedure involving the ortho-C-H alkenylation-oxidative amination mediated cyclization of pyridine-sulfonamide derivatives of benzylamines with acrylates and sulfones via Pd-Ag bimetallic catalysis.

OO-CYSA-03 : Engineered Cubosome Loaded with Dual Drug for Synergistic Co-Delivery of Docetaxel and Curcumin : A Strategy to Combat MDR in Cancer

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The severe systemic toxicity associated with chemotherapeutic agents, along with the emergence of adaptive treatment tolerance (ATT) and multidrug resistance (MDR) during prolonged therapy, continues to limit the efficacy of cancer treatment. In parallel, many promising anticancer candidates fail to achieve their full therapeutic potential due to intrinsic physicochemical limitations, including high hydrophobicity, poor aqueous solubility, limited cellular internalization, rapid systemic clearance, and undesirable serum protein interactions. To address these challenges, we developed cubosome co-loaded with chemotherapeutic drug, docetaxel (Dxl) and secondary metabolite, Curcumin (Cur), to construct a pH-responsive and synergistic therapeutic platform. The resulting dual drug-loaded cubosomes (DC-

DLC) were comprehensively characterized using DLS, HRTEM, FESEM, and SAXS to confirm their size, morphology, and internal cubic structure. Drug encapsulation and loading efficiency were further validated using XRD, FTIR, and HPLC. Leveraging the unique bicontinuous cubic architecture of cubosomes, the DC-DLC facilitate enhanced tumor accumulation via the enhanced permeation and retention (EPR) effect, followed by efficient intracellular delivery and pH-triggered drug release. The co-delivery of Cur and Dxl demonstrated enhanced anticancer efficacy against prostate (PC-3) cancer cells, attributable to their complementary mechanisms of action. Importantly, the DC-DLC exhibited minimal cytotoxicity toward healthy vascular smooth muscle cells, highlighting their favourable safety profile. Collectively, these findings demonstrate that the engineered DC-DLC represent an effective nanotherapeutic platform, offering enhanced anticancer efficacy while minimizing off-target toxicity, thereby providing a promising strategy for targeted cancer therapy.

OO-CYSA-04 : g-C₃N₄/ZnO:Bi/L-Asp Nanocomposite-Catalyzed Synthesis, Antidiabetic Activity and Ab Initio Investigation of Fused Benzimidazo-Pyrimido-Pyrimidine Derivatives

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Herein, the present work elicits the synthesis and catalytic merits of L-Aspartic acid grafted on g-C₃N₄/ZnO:Bi Nanocomposite for tailoring biologically significant new scaffolds of the fused benzimidazo-pyrimido-pyrimidine skeleton. The prepared catalyst and synthesized derivatives were characterized using appropriate spectroscopic and analytical techniques. Ab initio studies were computed at B3LYP/6 311G++(d,p) level of theory to investigate chemical reactivity and HOMO-LUMO energy gap of synthesized heterocycles, whereas in Silico studies were performed to elucidate the binding modes, predicted binding affinities and key ligand–protein interactions within the enzyme active site.

The synthesis of the catalyst and heterocyclic derivatives employs sustainable reaction conditions, minimizing the generation of harmful waste and supporting the principles of green chemistry. Molecular docking studies were carried out to investigate the binding interactions of the synthesized compounds with the selected antidiabetic target. ADMET and Lipinski's rule-of-five analyses were further performed to evaluate their pharmacokinetic properties and drug-likeness. The combined experimental and computational findings provide useful

insights into the potential of these fused heterocyclic derivatives as promising candidates for further antidiabetic evaluation.

OO-CYSA-05 : Tf, O-Mediated Multistate Reactivity to Access N-Acyl and N-Aryl Azacycles, Late-Stage Modification of Bioactive Scaffold

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N-Acyl and N-aryl azacycles represent privileged structural motifs in numerous biologically active compounds and pharmaceutical agents. Herein, we describe an operationally straightforward Tf₂O-mediated synthetic platform for accessing N-acyl and N-aryl azacycles via activation of tetrahydrofuran (THF) and cyclic amines, followed by their interception with nitriles or arylamines and subsequent cyclization–elimination. The protocol facilitates the efficient assembly of five- and six-membered azacyclic frameworks and exhibits appreciable functional-group compatibility. Furthermore, the methodology provides access to monofluorinated derivatives through deconstructive fluorination, enamides, and structurally diversified products arising from late-stage functionalization of bioactive substrates. Sulfanilamide underwent efficient conversion with THF and Tf₂O to furnish the corresponding N-aryl azacycle derivative, highlighting the applicability of this transformation to pharmacologically relevant substrates. Chemoselectivity studies revealed distinctive functional-group reactivity. Treatment of 4-formylbenzonitrile with THF/pyrrolidine preferentially engaged the aldehyde functionality over the nitrile group, affording (Z)-4-(pyrrolidine-1-carbonyl)benzaldehyde oxime as the predominant product. Conversely, methyl 4-cyanobenzoate selectively underwent transformation at the ester functionality while preserving the nitrile moiety, furnishing 4-(pyrrolidine-1-carbonyl)benzonitrile. Collectively, these findings demonstrate the synthetic versatility, chemoselectivity, and functional-group tolerance of this Tf, O-driven methodology under mild conditions, providing a versatile route to complex nitrogen-containing architectures.

OO-CYSA-06 : Development of Carbohydrate-Appended Biologically Relevant Triazene-Cored Hexavalent Glycodendrimers

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Glycodendrimers gained significant attention due to their well-

defined structure, multivalency, and ability to mimic natural glycoconjugates found in biological systems. In previous studies, a rigid, tetravalent sugar-functionalized dendron exhibited notable anti-trypanosomal, anticancer, and antibacterial properties. The multivalent effect of carbohydrates enhances specific interactions with biological receptors, making these systems valuable in biomedical applications. Glucose, galactose and lactose residues contribute to improved biocompatibility and facilitate interactions with the cell surface. Notably, the incorporation of sialic acid plays a crucial role in modulating the biological properties of the glycodendrimer. Sialic acid, a terminal monosaccharide widely present in glycoproteins and glycolipids, is involved in essential biological processes such as cell-cell recognition, immune regulation, and pathogen binding.

Herein, we focused on the development of a novel hexavalent triazene-cored glycodendrimer using a modular ‘CuAAC’ approach by incorporating various carbohydrate units, such as glucose, galactose, lactose, and sialic acid, within a dendritic structural framework. All the developed glycoclusters have been well characterised using standard spectroscopic analysis, including NMR (^1H and ^{13}C), SEC, and MALDI-TOF. The developed triazene-cored hexavalent glycodendrimer demonstrates a promising multifunctional platform with potential applications in targeted drug delivery, biosensing, and therapeutic interventions, highlighting the importance of sialic acid in enhancing biological activity.

OO-01 : Dual Targeted Carbazole Alkaloids as Cancer Epigenetics and Antitubulin Agents

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Cancer is a public health menace causing about 10 million deaths every year, which is one in six human deaths [WHO, Cancer: Keyfacts, 03 July 2026]. Specifically, in cancer drug development, plants have enormously contributed. Nowadays cancer is not only considered as genetic disease but also epigenetic disorders. In fact, epigenetic reasons are more responsible in cancer initiation and progression. Hence, now significant alterations as epigenetic disruption has become a hallmark of cancer. Histone deacetylase (HDAC) enzymes and specifically HDAC6 enzyme is over-expressed in several types of cancer. In the recent past, several HDAC 6 inhibitors have been approved for clinical use. However, due to eleven subtypes of histone deacetylase (HDAC) enzyme with varied functioning, selectivity is an important aspect while designing HDAC6 inhibitors.

Previously, in a study by Prof. Butler group, at University of Illinois, Chicago it was demonstrated that carbazole core is very much suitable ligand for HDAC 6 with high potency and selectivity [Butler et al. 2010]. From data mining, we identified that Curry leaf (*Murraya koenigii*), an Indian Medicinal plant, is rich in carbazole alkaloids. In our study, we found MK-1 as potent antiproliferative carbazole against breast cancer using bioactivity guided isolation approach in curry leaf extract. It also inhibited HDAC6 enzyme activity. Further on logical modification, we achieved a dual targeted potential cancer chemotherapeutics on carbazole core simultaneously tubulin polymerisation inhibition as well as histone deacetylase6 inhibitions. Bioactivity guided isolated natural carbazole, its detailed cancer pharmacology, further logical designing and biological exploration will be discussed in detail.

OO-02 : Exploration of Phytoestrogen-Based Scaffolds for the Development of Selective Estrogen Receptor Modulators (SERMs)

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Estrogen is one of the most important female sex hormones, playing a crucial role in regulating reproductive, skeletal, cardiovascular, and other physiological functions. Declining estrogen levels, particularly during menopause, are associated with several estrogen receptor (ER)-dependent abnormalities. Estrogen receptors (ERs), primarily ER α and ER β , play pivotal roles in regulating diverse physiological processes, including reproductive function and bone homeostasis. Dysregulation of estrogen signaling is associated with several hormone-dependent disorders, particularly those occurring during estrogen deficiency and menopause. Selective estrogen receptor modulators (SERMs) have emerged as important therapeutic agents for their ability to exert tissue-selective estrogenic or antiestrogenic effects. Phytoestrogens, naturally occurring plant-derived compounds that structurally resemble endogenous estrogens, represent a promising source of lead scaffolds for SERM development. Among these, flavonoids, coumarins, stilbenoids, and related phenolic compounds possess structural features that enable them to interact with ERs and modulate estrogen-responsive signaling pathways. The present study aims to explore bioactive phytoestrogenic scaffolds by isolating them, structurally characterizing them, and rationally modifying them to generate novel estrogen receptor-active molecules. The resulting

compounds may serve as valuable lead structures for developing next-generation SERMs with improved potency, selectivity, and therapeutic potential. This approach integrates natural-product chemistry with medicinal chemistry to establish phytoestrogen-derived scaffolds as a valuable platform for the discovery of novel ER-targeted therapeutic agents.

OO-03 : Rate Acceleration and New Pathways in the Morita-Baylis-Hillman Reaction

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Despite having tremendous growth and applications, the Morita-Baylis-Hillman reaction is limited by a slow reaction rate and its susceptibility to steric and electronic parameters. We have uncovered new catalytic systems for rate acceleration and exploration of new avenues for the MBH reaction. A sodium sulphide-catalysed intramolecular MBH reaction was achieved in just 15 minutes. Similarly, an unusual acid catalyzed electrocyclicisation turned out to be a gateway for an inverse aza-MBH reaction.

OO-04 : Electro-Promoted, Site-Selective C-C Bond Constructions via N-Centered Radical Translocation

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Carbon-carbon bond formation is central to building complex molecules, but conventional methods depend on expensive, unsustainable metal catalysts and oxidants that produce waste and environmental concerns. Electro-organic synthesis offers a greener alternative, using electricity to drive reactions without metals or harsh chemicals, improving efficiency, selectivity, and sustainability. We recently developed an electrochemical substrate-controlled method for divergent indole functionalization with electron-deficient π systems via N-Centered Radical Translocation. Under unified conditions, 1,4-naphthoquinones undergo cross radical-radical coupling and radical-anion addition to yield indolyl-naphthoquinones, while α,β -unsaturated enones give β -indolyl-alkanones via cross coupling. We also established an electrochemical, regioselective C(sp²)-H trifluoromethylation of benzo-fused indolizines using TT-CF₃z OTf⁻ (Ritter's reagent) as a CF₃ source under metal- and oxidant-free, ambient conditions. My presentation will detail these approaches.

OO-05 : Novel Synthetic Strategies for the Synthesis of Bioactive Compounds via Sulfoxonium Ylides

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Metal-catalyzed transformations of sulfoxonium ylides have become valuable tools for constructing heterocyclic frameworks such as pyrroles, indoles, furans, pyrimidines, and quinolones. Despite this progress, their potential in metal-free synthesis remains relatively underexplored. In our work, we have shown that sulfoxonium ylides can serve as effective precursors for accessing a wide range of bioactive molecules. These studies have enabled the mild, metal-free synthesis of γ -butyrolactones, α -ketothioamides, α -ketoamides, benzils, quinoxalines, quinazolines, quinazolinones, and related scaffolds. The talk will highlight recent advances in sulfoxonium ylide chemistry with an emphasis on metal- and reagent-free strategies for the synthesis of bioactive molecules and other valuable compounds.

OO-06 : Identification and Optimization of a Cyclohexane-1,3-dione-Based Antitubercular Lead against Mycobacterium Tuberculosis

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The emergence of drug-resistant *Mycobacterium tuberculosis* necessitates the discovery of selective antitubercular agents with novel chemical scaffolds. Whole-cell phenotypic screening of thousands of diverse small molecules against *M. tuberculosis* H37Rv identified cyclohexane-1,3-dione-based hits, which were subsequently optimized to generate a library of 37 compounds across four structural families. Three leads (37, 39, and 41) were identified, with 2-(((2-hydroxyphenyl)amino)methylene)-5,5-dimethylcyclohexane-1,3-dione (PAMCHD; 39) showing the most promising activity (MIC = 2.5 $\mu\text{g mL}^{-1}$). PAMCHD exhibited both tuberculostatic and tuberculocidal effects, with time- and concentration-dependent killing and complete sterilization of *M. tuberculosis* at $\geq 10 \mu\text{g mL}^{-1}$. It showed additive or synergistic interactions with established antitubercular drugs and a favorable mutant-prevention profile (MPC/MIC = 64). PAMCHD was minimally cytotoxic to four human cell lines and showed negligible activity against representative Gram-positive and Gram-negative bacteria and *M. smegmatis*, indicating high selectivity toward *M.*

tuberculosis. Molecular docking revealed favorable binding to KatG ($-9.8 \text{ kcal mol}^{-1}$), substantially stronger than isoniazid ($-6.3 \text{ kcal mol}^{-1}$), with key interactions involving TRP107, HIS270, LEU265, ILE266, and GLY269. Interactions with the InhA binding pocket further supported potential target engagement. In silico ADME profiling indicated favorable drug-like properties, including moderate lipophilicity ($\log P$ 2.13), high gastrointestinal absorption, compliance with Lipinski's rule of five, and no PAINS alerts. In conclusion, PAMCHD represents a selective and promising cyclohexane-1,3-dione-based antitubercular lead for further mechanistic validation and structural optimization.

OO-07 : Green Synthesis of Novel Heterocyclic Compounds as Biologically Potent Molecules

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Heterocyclic compounds are the most often encountered scaffolds in pharmaceutically relevant substances and are essential for the human well being. The remarkable ability of heterocyclic nuclei to serve as reactive pharmacophores has largely contributed to their unique value as traditional key elements of numerous drugs. Certain possible modifications on the heterocyclic moiety may lead to new compounds with better biological profiles. Among the top 50 prescription drugs there are twelve bis-heterocyclic compounds. Therefore methods for the synthesis of such systems are of significant interest. The environmental protection has become a global concern and the synthetic organic chemists are searching the ways of developing and applying more efficiently and environmentally benign strategies for future sustainable growth. One of the thrust areas for achieving this target is use of Green Chemistry Techniques in Organic Synthesis. As a part of our research program towards the green synthesis of pharmaceutically active molecules and above observations prompted us to take up the green synthesis of diverse heterocyclic library.

OO-08 : Synthesis and Characterization of Diphenein (Diphen-ein) Derivatives Containing a Chiral Carbon Centre from the Novel Keto Acid 22 - Benzoyldiphenyl-2-carboxylic Acid

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A series of novel Diphen-ein derivatives, namely Phenyl Phenol

Diphenyl-as-ein, Phenyl Resorcinol Diphenyl-as-ein, and Phenyl Phloroglucinol Diphenyl-as-ein, were synthesized by condensation of the novel keto acid 22 -benzoyldiphenyl-2-carboxylic acid with corresponding phenolic substrates. The Diphenyl-as-ein framework contains a chiral carbon centre, providing an interesting structural feature for investigating its isomeric behaviour. Phenyl Resorcinol Diphenyl-as-ein was found to exist in two isomeric forms, as established through chemical transformation and spectroscopic studies. The structural characteristics of these isomeric forms and their contribution to the observed colour were examined in relation to their electronic structures. The absorption characteristics, particularly the absorption maxima (λ_{max}), revealed a bathochromic shift compared with those of the corresponding analogous phthalein derivatives. These observations suggest that the structural features of the Diphenyl-as-ein system, including the chiral carbon centre and phenolic moiety, influence its spectral and colour properties. The present study provides a novel synthetic route to Diphenyl-as-ein derivatives and contributes to understanding the relationship between molecular structure, isomerism, and colour in this class of organic dyes.

OO-09 : Regioselective Synthesis of Imidazo[1,2-a]quinoxalin-4(5H)-ones via I₂-Promoted Oxidative [3+2] Annulation of Quinoxalin-2(1H)-ones and Oxime Esters

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Fused tricyclic heterocycles incorporating imidazole ring systems are highly prominent in drug discovery, particularly for the treatment of neurological disorders such as pain, depression, and addiction. Imidazo[1,2-a]quinoxalin-4(5H)-ones have distinctive chemical structure that enables efficient interactions with different biological targets, making it useful for developing novel therapeutic medicines. Earlier, our group has reported an efficient method for synthesizing pyrazolo[1,5-a] quinoxalin-4(5H)-ones² and now, we present a novel approach for reversing the order of bond formation, enabling the regioselective synthesis of imidazo[1,2-a]quinoxalin-4(5H)-ones through a molecular iodine-mediated annulation of quinoxalin-2(1H)-ones and oxime acetates in a [3+2] fashion. This method demonstrates excellent regioselectivity and compatibility with both substituted and unsubstituted quinoxalin-2(1H)-ones, as well as with aryl and fused aryl oxime acetates. Furthermore, we extended our work by performing

chlorination followed by amination with piperazine derivatives which leads to synthesize a series of compounds having structural similarity with Navacaprant, which is a phase 3 selective kappa-opioid receptor antagonist and is being developed to treat major depressive disorder.

OO-10 : Electrochemically Enabled Nickel-Catalyzed Intramolecular Amination of Aryl Chlorides with Hydrazones

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Transition-metal-catalysed cross-coupling of aryl halides with various nucleophiles is a powerful strategy for constructing sp² carbon–heteroatom (C–X) bonds that are ubiquitous in natural products and medicinal compounds, playing a pivotal role in the synthesis of pharmaceuticals, agrochemicals, and functional materials. Although Pd-catalyzed cross-coupling reactions are well established, the broader range of readily accessible electrophiles and the sustainable nature of earth-abundant 3d nickel catalysts have attracted considerable attention. Nevertheless, reactions involving the more abundant aryl chlorides under room-temperature or mild conditions remain largely underdeveloped despite their low cost, wide availability, and structural diversity. Towards this goal, we have developed a complementary paired-electrolysis method for electrochemical nickel-catalyzed intramolecular C–N coupling of aryl chlorides, providing an efficient strategy for the synthesis of medicinally important indazole scaffolds. This methodology enables the challenging activation of inert C–Cl bonds together with C=N bond isomerization of hydrazones under constant-current electrolysis in an undivided cell at room temperature. Mechanistic investigations supported by DFT calculations revealed that rapid ligand exchange facilitates a Ni(I)/Ni(III) catalytic cycle as the predominant reaction pathway. Furthermore, the protocol exhibits broad synthetic utility through late-stage functionalization and the formal synthesis of biologically active molecules, including lificiguat (YC-1), YD-3, and axitinib.

OO-11: Green Synthesis of New Heterocyclic Motifs and Evaluation of Their Biological Activity

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The flavonoid compounds are a group of natural products found in

fruits, vegetables, nuts, seeds and flowers as well as in teas and are important constituent of human diet. They have been demonstrated to possess antioxidant, antihypertensive, antiallergic, antinociceptive, antibacterial, antifungal activities. Coumarins fused with other heterocycles are known to have interesting biological properties which, in turn, have encouraged research with regard to procedures for the preparation of families of these compounds. Thus a number of methodologies have been reported for the synthesis of various 3,4-, 6,7- and 7,8-fused furo- and pyranocoumarins. Environmental pressure to reduce waste and reuse materials has driven studies into 'Green' chemistry. Chemical and pharmaceutical industries are always under pressure to develop more environmentally friendly organic reaction methodologies using nonhazardous catalysis. Encouraged by the pharmacological activities of flavanoids we wish to report some new analogs of flavanoids and Macromolecules by simple and convenient microwave irradiation method.

OO-12 : Ultrasound-assisted ring opening of epoxides in HFIP: THF: Synthesis, Characterization, Computational Studies and Molecular Docking of Novel 2 Hydroxy Dithiocarbamates

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Under the influence of ultrasonic irradiation, pyridazinone, triazinone, or phthalimide containing 2 hydroxy dithiocarbamates, a biologically relevant novel organo-sulphur compound, was synthesized. Detailed characterization, computational, and molecular docking studies are being investigated. Molecular interactions were studied using 3D Hirshfeld surfaces and corresponding 2D fingerprint plots. Theoretical (DFT) studies on the molecular structure, HOMO, LUMO, and quantum chemical descriptors were performed at the B3LYP/ 6-311++G(d,p) level of theory. At the same time, the interaction energy was computed using the B3LYP/6-31G (d,p) level of theory. The FMO study revealed that molecules 4a and 4p in the gas phase have 3.545 eV and 3.263 eV HOMO-LUMO energy gaps, respectively, and they are hence kinetically stable. Quantum chemical calculations confirm the electrophilic character of compounds 4a and 4p, as the molecule is stable and highly electrophilic.

OO-13 : Utilization of 4-Thiazolidinone Drug Molecule in the Late-Stage Diversification of C(sp²)-H Functionalization of Phthalazinone

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Thiazolidinone is widely known as a pharmaceutically active scaffold that shows range of biological activities. The moiety can be serves as potent anti-convulsant, antihypertensive, and hypoglycemic agent. The late-stage modification of phthalazinone, a prevalent nitrogen-heterocyclic compound present in various biologically active natural products with thiazolidinone provides great advancement in the synthesis of organic as well as material chemistry. Based on directing group capabilities, recent efforts have been made in the metal-catalyzed C–H functionalization to synthesized complex late-stage drug candidates with thiazolidinone. Herein, we have showed diversification of phthalazinone with 4-thiazolidinone for the construction of drug molecules via C–H functionalization. The directing group assisted metal-catalyzed C–H functionalization of phthalazinone via 4-thiazolidinone proceeded in mild reaction conditions helped in the synthesis of many active phthalazinone derivatives following the atom-economic and facile pathway.

OP-CYSA-01 : Hydrosilylation-Mediated Interpenetrating Polymer Networks of Vinyl- and Hydroxy-Terminated PDMS for Coating Applications

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Interpenetrating polymer networks (IPNs) based on vinyl-terminated polydimethylsiloxane (Vi-PDMS) and hydroxy-terminated polydimethylsiloxane (HO-PDMS) were successfully prepared through catalyst-assisted hydrosilylation and condensation reactions. The resulting hybrid networks exhibited enhanced structural integrity and improved physicochemical properties due to the synergistic contribution of covalently and physically interconnected polymer networks. The synthesized IPNs were systematically characterized using FT-IR, NMR, XRD, FESEM-EDAX, TGA, DSC, and rheological techniques to confirm network formation and evaluate their thermal and mechanical properties. The IPNs demonstrated improved thermal stability,

mechanical strength, adhesion, hardness, and abrasion resistance compared with conventional PDMS. These results highlight the potential of the developed IPNs as high-performance silicone-based materials for advanced coating applications, particularly where thermal stability, durability, and structural integrity are required.

OP-01: Four-Component Selenoazaindolylation-Alkoxylation of Styrenes for the Synthesis of Azaindolyl β -Alkoxyalkyl Selenoethers

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Due to the medicinal importance of selenoether and azaindole cores, the design and execution of efficient routes to new compounds bearing these groups placed in juxtaposition with each other are important. Again, multicomponent reactions provide fast and efficient access to the compounds of interest. Herein, we present a one-step route to azaindolyl β -alkoxyalkyl selenoethers or azaindolyl β -hydroxyalkyl selenoethers via the one-step reaction of azaindoles, styrenes, a selenium source, and an alcohol or water using a Ce-(IV) oxidant.

OP-02 : Glucose-6-Phosphate Dehydrogenase (G6PD): A Comprehensive Review of Its Chemistry, Clinical Significance and Pathophysiological Roles

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Glucose-6-phosphate dehydrogenase (G6PD) is a ubiquitous housekeeping enzyme that serves as the master regulator of cellular redox balance. G6PD is an enzyme that protects red blood cells against oxidative stress and related damage. G6PD deficiency is the most common human enzyme defect. This study synthesizes current knowledge on the enzyme's structure, catalytic mechanism, and genetic basis, while emphasizing its critical role in cellular redox homeostasis. G6PD deficiency predisposes individuals to hemolytic anemia under oxidative stress from drugs, infections, or fava beans (favism) and explore emerging links to metabolic diseases, immune function, and cancer. Understanding G6PD is essential for safe pharmacotherapy, neonatal screening, and public health in endemic regions. The enzyme's structure, particularly its dimeric and tetrameric conformations,

directly influences its catalytic efficacy and stability. The clinical importance of G6PD is underscored by its deficiency, the most common human enzymopathy, affecting an estimated 400-500 million people worldwide. This study concludes that while G6PD deficiency is generally asymptomatic, its evolutionary persistence-driven by protection against severe malaria-necessitates molecular understanding to enable safe prevention strategies, newborn screening, and tailored pharmacotherapy, especially in malaria – endemic regions.

OP-03 : Unlocking Indolizine Reactivity: Oxidative Ring Opening and Cyclopropanone Annulation for the Synthesis of Functionalized Heterocycles

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The development of efficient strategies for constructing structurally complex nitrogen-containing heterocycles is of significant interest in synthetic organic chemistry. In the present study, a three-step synthetic sequence was developed for the synthesis of highly functionalized indolizine derivatives, involving indolizine formation, oxidative ring opening, and subsequent cyclopropanone annulation. Initially, 2-arylindolizines were synthesized through N-alkylation of 2-methylpyridine with phenacyl bromide, followed by base-promoted cyclization. The resulting indolizine framework underwent rapid oxidative ring opening with phenyl iodine diacetate (PIDA) and ammonium carbamate in methanol, affording the corresponding acrylonitrile intermediates. Subsequent annulation with 2,3-diphenylcycloprop-2-en-1-one under heating in dichloromethane afforded highly functionalized indolizine products. The developed protocol provides a concise route for structural diversification of indolizine-based frameworks and highlights the versatility of oxidative ring-opening chemistry in heterocyclic synthesis. The synthesized derivatives were further evaluated for their antibacterial potential against a panel of ESKAPE pathogens, demonstrating the biological relevance of this heterocyclic scaffold. This strategy demonstrates the utility of oxidative indolizine ring opening and cyclopropanone annulation for accessing structurally diverse, highly functionalized nitrogen-containing heterocycles.

OP-04 : Electrochemical Selenocyanation and Thiocyanation of Azaindoles and Deazapurines

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An economical and regioselective electrochemical oxidative C%H selenocyanation or thiocyanation of N rich heteroarenes, such as azaindole and deazapurine, is reported utilizing graphite electrodes. The reaction proceeds without the need for any catalyst or oxidant under a constant electric current in an undivided electrolytic cell. The commercially available reagents KSCN or KSeCN were used for the chalcogenocyanation reactions. A variety of selenocyanated and thiocyanated derivatives were synthesized in yields of 70%–90%, and the reactions also tolerated different electron rich or electron deficient substituents on the heterocyclic core.

OP-05: Sustainable Green Nanotechnology Based Approach to Protect Corrosion

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It is essential to reduce our reliance on petroleum derived resources and move towards sustainable and environment friendly alternatives. The application of green chemistry and green technologies offers significant benefits to both the environment and living organism, primarily due to the inherent biocompatibility and renewable nature of bio-based materials.[1].Green nanotechnology, which combines the principles of green chemistry with nanotechnology, is an emerging field that aims to develop sustainable and eco-friendly strategies for the synthesis, modification, processing, and applications of nonmaterials. Cashew nut shell liquid (CNSL) is a naturally occurring phenolic monomer, commercially available as a natural plant-based resin precursor for coating applications[2]. It is the product of the cashew industry (30–35% in cashew shell) with a reddish-brown color and a soft honeycomb structure which is reported having versatile properties. The main constituents of CNSL are: (i) anacardic acid, (ii) cardanol, (iii) cardol and (iv)2-methyl cardol. Extraction lead by “cold solvent method” is called natural CNSL, whereas “roasting and hot oil” processed (heated at 180–190 °C) CNSL is called technical CNSL. Technical cashew nut shell liquid and formaldehyde was treated with

graphene in different ratio. To prepare polyurethane we added toluene 2,4-diisocyanate (TDI) by drop down method. The structure, morphology and coating properties of the synthesized coating showed excellent properties. The coatings also showed thermal stability up to 250 ± 5 °C.

OP-06 : Regioselective β -Azidoselenoalkylation of Indoles, Azaindoles, and 7-Deazapurines via a Two-Step, One-Pot Protocol

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Herein, we report the synthesis of β -azidoselenoalkylation of indoles, azaindoles, and deazapurines via a one-pot reaction involving two sequential steps% regioselective addition of the selenocyanate to heterocycles such as indole, azaindole, and 7-deazapurine using KSeCN, followed by the incorporation of the azidoalkyl group from styrenes and sodium azide. The two steps are mediated by two different oxidants, which have been optimized. The overall reaction proceeds via addition of the selenocyanate radical to the heterocycle, followed by homolytic cleavage of the SeCN to generate a heteroaryl-seleno radical that adds to the styrene to generate a benzylic radical and is followed by a radical-polar crossover and subsequent nucleophilic addition of the azide ion to form the product.

OP-07 : Green Synthesis of Silver Nanoparticles using Leaves of *Persicaria Capitata* and their Anticarcinogenic Activity against Liver (Hep-2) Cancer

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The next generation of anti-cancer drugs might be made using biological silver nanoparticles (AgNPs). Here, AgNPs were made utilizing *Persicaria capitata* leaves and a natural process. Several spectroscopic methods were used to confirm the produced and described AgNPs. The peak of the AgNPs Surface Plasmon Resonance (SPR) at 424 nm was identified by UV spectroscopic research. Using a transmission electron microscope (TEM), AgNPs were sized and shaped, and it was found that they were 3 nm in size. X-ray Diffraction (XRD) spectrum data supported AgNPs crystallinity. A clear, strong signal at

3.0 keV was visible in the EDX spectra, proving that elemental Ag was present. Silver nanoparticles were created, particle size distribution analysis of synthesized Ag nanoparticles was determined by DLS zetasizer. DLS study showed that the biosynthesized silver nanoparticles have size of 194.43 nm with polydispersity index (PDI) of 24.5%. Using a zeta potentiometer, the stability of silver nanoparticles was evaluated. The produced nanoparticles have a zeta potential of -20.9 mV. Using the analytical method FTIR, the functional groups responsible for the synthesis of nanoparticles and the generated AgNPs were identified. AgNPs anti-cancer efficacy against liver (hep-2) cancer was examined, and its great anti-cancer potential was found. Our results imply that produced AgNPs significantly suppress liver cancer cell (hep-2) formation using the MTT test.

OP-08: Development of Substituted Coumarin Derivatives as Potential Bioactive Compounds

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Coumarins are an important class of oxygen-containing heterocyclic compounds that have attracted considerable attention because of their diverse pharmacological properties and broad applications in medicinal chemistry. The present study focuses on the synthesis of substituted coumarin derivatives and their biological evaluation to explore their potential as biologically active compounds. A series of substituted coumarins were synthesized through appropriate organic synthetic routes using suitably substituted phenolic and carbonyl precursors. The synthesized compounds were purified and characterized using standard analytical and spectroscopic techniques, including melting point determination, FT-IR, ^1H NMR, ^{13}C NMR, and mass spectrometry, wherever applicable. Structural modifications were introduced at different positions of the coumarin nucleus to investigate the influence of substituents on biological activity.

The synthesized derivatives were subjected to preliminary biological screening to evaluate their antimicrobial and/or antioxidant activities using suitable in-vitro methods. The biological results indicated that several substituted coumarin derivatives exhibited appreciable activity compared with the corresponding standard drugs or reference compounds. Differences in activity among the synthesized derivatives suggested that the nature and position of substituents play an important role in determining their biological properties. Electron-donating and electron-withdrawing groups showed varying

effects on the observed activity, indicating a significant structure activity relationship. The findings demonstrate that substituted coumarins constitute a promising scaffold for the development of biologically active molecules. The study provides useful information regarding the synthesis, structural characterization, and biological potential of coumarin derivatives and may serve as a basis for further investigation and optimization of these compounds for pharmaceutical applications.

OP-09: Binding Interaction and Encapsulation Efficiency of Molnupiravir with Bovine Serum Albumin Nanocarriers for Drug Delivery Applications

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COVID-19 crisis highlighted the importance of safe and efficient drug delivery approaches that enhance targeted therapy while minimizing side effects. The present investigation reports spectroscopic interactions between BSA and antiviral drug molnupiravir (MOL). Binding affinity of MOL with BSA was also studied through a spectroscopic quenching mechanism. Molecular docking studies were used to identify the amino acid residues of BSA involved in the interaction with drug. Various batches (F-1 to F-4) of MOL encapsulated BSA nanoparticles were prepared as a biodegradable carrier using desolvation method and further assessed for their improved bioavailability, solubility, and sustained release behavior. Encapsulation efficiency remained nearly constant across formulations F-1 to F-4, suggesting early saturation of drug–protein interaction sites and efficient loading at lower BSA levels. Results from formulation F-2 indicated that drug release patterns were influenced more by the intrinsic physicochemical characteristics of the drug than by nanoparticle characteristics.

OP-10 : Synthesis of Heteroaryl Selenoglycosides from Glycosyl Acetates

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Selenoglycosides are an important class of compounds due to diverse biological activity and potential applications in medicinal chemistry. In particular heteroaryl selenoglycosides have received

significant attention due to incorporation of biological relevant indole and azaindole moieties. Herein we have developed a convenient approach for the stereoselective synthesis of heteroaryl selenoglycosides, from readily available glycosyl acetates. This synthetic method is compatible with different carbohydrate and heteroaryl frameworks including indoles, and azaindoles to provide the corresponding heteroaryl selenoglycosides in good yields.

OP-11 : Nanoelectronic Device Based on a Bimetallic FeNi Metal-Organic Framework for Caffeine Detection in Coffee and Green Tea Samples

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Caffeine is one of the typical enhancer, naturally present in coffee, tea, chocolate, and added to energy beverages, syrup, and specific medicines. As the impact has been found to be greatly reliant on caffeine intake, close tracking is vital for both routine safety and scientific research. In this work, we designed a nanoelectronic sensor using bimetallic metal organic frameworks (MOFs) to detect caffeine rapidly and precisely. The sensor was carefully examined with methods such as EDX, XPS, SEM, FTIR and electrochemical testing to confirm its structure and performance. It responded reliably across broad categories of concentrations i.e., from 1×10^{-5} to 50 nM and resulted in very high sensitivity, with a LOD of about 1.26 ($\pm$ 0.06 nM.) To check selectivity, we tested it against other common compounds that might disrupt, and it efficiently detected caffeine. Real sample trials with coffee and green tea confirmed that the sensor works well outside the lab. A 3D printed cascade design also improved stability and efficiency during fabrication. Altogether, this chip offers a functional and adaptable way to track caffeine in beverages, with urging benefits in pharmaceuticals, food quality control, and wider applications in analysis.

OP-12 : Co-MOF and c-MWCNT Nanocomposite-Based Impedimetric Immunosensor for Sensing of Human Serum Albumin

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Albumin (ALB), the most abundant protein secreted by hepatocytic

cells, plays vital roles in bodily functions; deviations from normal levels can indicate kidney failure and other diseases. A nanohybrid detection system was developed and then functionalized with an anti-ALB antibody to enable the selective electrochemical detection of albumin (ALB), a kidney biomarker. This constituted a Co-MOF-carboxylated multiwalled carbon nanotube (c-MWCNT). Cobalt metal-organic framework (Co-MOF), also known as Zeolite imidazole framework (ZIF-67), is a newly developed subclass of MOFs with high porosity, large surface area, outstanding stability, and flexibility. It has a unique zeolite-like structure, is created by a coordination bond between an organic linker and a redox-active cobalt metal core. However, ZIF-67's application in electrochemical sensing is limited due to its low conductivity. To overcome this, a Co-MOF-carboxylated multiwalled carbon nanotube (c-MWCNT) nanohybrid was developed. The immunosensing device was comprehensively characterized using a variety of physical and electrochemical techniques. Its performance was evaluated using electrochemical impedance spectroscopy (EIS), which has a detection limit of 0.024 mg/mL and linearity over 0.1–60 mg/mL. These remarkable outcomes, which provide an enhanced method for point-of-care ALB detection using MOF-based composites, result from the synergistic interactions between c-MWCNT and Co-MOF.

OP-13 : Chemical Composition and Phytochemicals of Sunflower : Review

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Sunflower (*Helianthus annuus* L.) seed is a chemically diverse food and oilseed matrix containing proteins, triacylglycerols, phenolic acids, flavonoids, tocopherols and phytosterols. This review focuses on the chemical composition, important phytochemicals, extraction and isolation of seeds of sunflower by various researchers. Particular phytochemicals show the presence in the seeds, these are 3-O-, 4-O- and 5-O-caffeoylquinic acids, dicaffeoylquinic acids, caffeic, ferulic and p-coumaric acids, flavonoids such as quercetin, rutin and epicatechin, together with tocopherols, oleic and linoleic acids and β -sitosterol. The review also emphasizes an important distinction between compounds detected by LC-MS and compounds actually isolated and structurally confirmed. Soaking, germination, roasting and dephenolization can modify phenolic composition, lipid stability and protein functionality. Antioxidant and enzyme-inhibitory effects are

mainly supported by in-vitro studies, while wound-related and therapeutic interpretations remain experimental. Overall, sunflower seed is a promising source of natural phytochemicals, but standardized extraction, authentic standards and NMR-supported structural confirmation are needed for stronger compound-level conclusions. In this research work, we have studied the various phytochemicals found in sunflower seeds, as identified at different times. The phytochemicals obtained by the researchers and their teams have been detailed and illustrated.

OP-14 : Copper-Catalyzed Diazo Controlled Annulation of Naphthylamines to Benzo[g]indoles

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We developed a diazo-controlled Cu(II)-catalyzed annulation of naphthylamines, enabling divergent access to benzo[g]indole derivatives with high selectivity. The reaction pathway is governed by the nature of the diazocarbonyl compound, wherein malonate-derived diazo compounds undergo ortho C–H insertion followed by annulation, while phosphonate-derived analogues proceed through N–H insertion and subsequent cyclization. The methodology features broad substrate scope, good to excellent yields, and gram-scale applicability. Mechanistic studies support the divergent reaction pathways. Notably, several synthesized benzo[g]indole derivatives exhibit bright blue-to-green fluorescence with high quantum yields, highlighting the potential of this copper-catalyzed strategy for the synthesis of photophysically active benzo[g]indole scaffolds.

OP-15 : Direct Integration of Phthalazinone and Succinimide Scaffolds via Rh(III)-Catalyzed C–H Functionalization

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C–H bond activation has emerged as a powerful tool for the functionalization of a variety of N-heterocycles. In this methodology, transition-metal catalysts, provides an efficient approach for the direct construction of C–C and carbon heteroatom bonds, thereby reducing the need for pre-functionalization via different nitrogen containing directing groups for the synthesis of heterocyclic drug-like compounds.

Nitrogen-containing heterocycles are of great significance because they are widely present in natural products and play an important role in medicinal chemistry. Among them, phthalazinone frameworks have emerged as an important structural motif found in numerous pharmaceuticals, natural products. These compounds exhibit a wide range of biological activities, including antitumor, anti-inflammatory, antihypertensive, and antimicrobial properties. Herein, Rh(III)-catalyzed C–H functionalization of N-aryl phthalazinones with maleimides provides a site-selective and efficient route to phthalazinone-succinimide derivatives of biological importance.

In this poster, I will present a Direct Integration of Phthalazinone and Succinimide Scaffolds via C–H Functionalization under Rh(III) catalysis, enabling the site-selective synthesis of functionalized phthalazinone derivatives.

OP-16 : Rhenium-Catalyzed Site-Selective Inter- and Intramolecular C(sp²)–H Alkylation of Arenes Enabled by Maleimide as a Key Linker

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An efficient Re(I)-catalyzed regioselective inter- and intramolecular C(sp²)–H alkylation of heteroarenes using activated alkenes has been achieved under base- and ligand-free conditions. The versatile Re(I) catalyst Re₂(CO)₁₀ (2.0 mol%) exhibits excellent atom and step economy, along with high chemo- and site-selectivity, providing expedient access to medicinally relevant maleimides and acrylates with broad functional group tolerance. Furthermore, detailed mechanistic investigations into the catalytic pathway are supported by controlled experiments and density functional theory (DFT) studies.

OP-17 : An Overview on Chemical Pesticides: Recent Trends, Usage, Exposure and Future Perspectives

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Fruits and vegetables have nutritional value, but they can also be source of toxic contaminants such as pesticide residues. The aim of this study was to evaluate the concentration of organochlorine pesticide in seasonal fruits and vegetables purchase from Agra market. The

constant use of pesticides contaminated fruits and vegetables pose a leading threat to public health. Gas chromatography equipped with electron capture detector (GC-ECD) were used to monitor organochlorine pesticides residues including, isomers of HCH, chlordane, aldrin, dieldrin, endosulfan, endosulfan sulphate and endrin ketone in six different seasonal fruits and vegetables (spinach, green peas, cabbage, apple, guava and pomegranate). However, the concentrations of estimated pesticides were less than the (MRLs). But, the regular eating of pesticide infected fruits and vegetables may create serious health problems. The study showed that the need for strict guideline and regular monitoring of banned pesticide residues in fruits and vegetables to protect consumer's health.

OP-18 : Light and Metal-Induced Modulation of H-Aggregation of Derivative of Azobenzene Dye

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Molecular aggregation strongly influences electronic and optical properties and has diverse applications in drug delivery, sensing, catalysis, and optoelectronics. Controlled aggregation through non-covalent interactions provides an effective strategy for tuning the properties of functional molecular materials. Here we present the synthesis of new fluorinated aryl azo derivatives and demonstrate an effective way to convert these derivatives to a stable H-aggregated form through UV light-induced trans-cis-trans photoisomerization. The fluorine substitution significantly influenced the thermal stability of the Z-isomers and their aggregation propensity. This prolonged stability of H-aggregation can be dramatically relieved in the presence of water. This provided us an opportunity to modulate H-aggregation. And it was found that coordination with metal ions, like Cu^{2+} and Ce^{3+} , selectively promoted pronounced H-type aggregation in both E and Z states, accompanied by hypsochromic spectral shifts and significant changes in aggregate size and morphology. These aggregation behaviours and morphological changes were characterized using UV-visible, $^1\text{H}/^{19}\text{F}$ NMR, IR spectroscopy, XRD, and scanning electron microscopy (SEM). Overall, these findings demonstrate that molecular photoisomerization, solvent environment, and metal-ion coordination provide effective stimuli for regulating the self-assembly and aggregation of azo-pyrazole-based molecular systems, highlighting their potential for the development of stimuli-responsive functional materials.

OP-19 : Synthesis and Biological Screening of Novel (E)-5-((3-Methyl-5-phenoxy-1-phenyl-1H-pyrazol-4-yl)methylene)thiazolidine-2,4-dione Derivatives

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In this work, we report the successful synthesis of a novel class of substituted thiazolidin-4-one derivatives using a convenient and efficient approach. The reaction of 5-((3-methyl-5-phenoxy-1-phenyl-1H-pyrazol-4-yl)methylene)thiazolidine-2,4-dione with various substituted phenacyl bromides afforded the final derivatives, namely (Z)-5-((3-methyl-5-phenoxy-1-phenyl-1H-pyrazol-4-yl)methylene)-3-(2-oxo-2-phenylethyl)thiazolidine-2,4-dione, in moderate to excellent yields. The synthetic procedure employed cesium carbonate as a base and dimethylformamide (DMF) as the solvent, which proved to be highly effective for the transformation. A series of ten novel compounds was synthesized, and spectroscopic techniques, including ¹H NMR, IR, and mass spectrometry unambiguously confirmed their structures. The newly synthesized compounds were further evaluated for their antimicrobial potential against selected bacterial and fungal strains. Among the tested derivatives, compounds KYC-2 and KYC-10 exhibited superior activity compared to the other analogues, demonstrating promising potency across both bacterial and fungal strains. Overall, the present study highlights the potential of thiazolidin-4-one derivatives as valuable scaffolds for the development of antimicrobial agents, while also providing an efficient synthetic strategy for generating structurally diverse analogues.

PHYSICAL CHEMISTRY SECTION

Sectional President's Address

From Solution Thermodynamics to Quantum Chemical Drug Design: A Journey in Density Functional Theory, Intermolecular Forces, and Molecular Reactivity

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Over the past four decades, the interface between physical chemistry and computational quantum mechanics has transformed from semi-empirical approximations into an indispensable pillar for explaining molecular phenomena and predicting chemical behavior. This presentation highlights the strategic integration of Density Functional Theory (DFT), semi-empirical quantum methods (PM3, ab initio), and in silico molecular modeling with experimental physical and organic chemistry. Here computational endeavors encompass three core domains: 1. Elucidating Non-Covalent Interactions and Liquid Dynamics: Utilizing DFT calculations, electrostatic potential (ESP) mapping, and frontier molecular orbital (FMO) analyses to reveal the subtle hydrogen-bonding, dispersion, and dipole–dipole interactions governing binary and ternary solvent systems (including terpenes, halobenzenes, cresols, and natural deep eutectic solvents). 2. Rational Drug Discovery and Molecular Docking: Exploring natural bioactives, synthesized heterocyclic frameworks, chalcones, and quinoline scaffolds via quantum chemical reactivity indices, ADMET profiling, and molecular docking against biological targets implicated in oncology, neurodegenerative diseases, and infectious pathogens. 3. Mechanistic Catalysis and Selectivity: Investigating transition-state energetics and Lewis acid–catalyzed reaction mechanisms (such as Diels–Alder additions) to resolve the origin of regio- and stereoselectivity from a fundamental electronic structure perspective. By unifying quantum chemical descriptors with experimental thermodynamic, acoustical, and synthetic benchmarks, illustrates how computational modeling bridges macroscopic observations with sub-angstrom electronic reality, delivering predictive design frameworks for modern chemical and pharmaceutical sciences.

PIL-01: Sustainable Solvents for Pharmaceuticals: Role of Ionic Liquids/ Deep Eutectic Solvents in Pharmaceutical Formulations

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The design of biologic and synthetic drugs in the pharmaceutical industry is facing three key challenges, namely, ensuring bioavailability, solubility, and stability. Ionic liquids (ILs) and deep eutectic solvents (DESs), classified as designer solvents, have emerged as excellent solvents for improving the permeability and stability of biotherapeutic drugs. Moreover, they have shown remarkable solubilizing effects for synthetic drugs, particularly in solubilizing active pharmaceutical ingredients (API) and are known as eco-friendly solvents. Thus, we have reported the development of designer formulations in pharmaceutical industries and examined the underlying strategies for designing the most efficient formulations for both biotherapeutics and synthetic drugs. All over, for the first time, with different experimental approaches, the impact of each biomaterial individually and in combination is explored to study their effect on the stability of antibodies. Thus, better efficient formulations can be designed for the storage/packaging of IgG-based drugs which ultimately will have more applicability in pharmaceuticals.

PIL-02: Ionic Liquids and Deep Eutectic Solvents for Sustainable Separation Processes

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The development of sustainable separation technologies requires a molecular-level understanding of solvent-solute interactions and their influence on macroscopic physicochemical behaviour. Ionic liquids (ILs) and deep eutectic solvents (DESs) offer versatile platforms for designing functional solvents with tunable polarity, hydrogen-bonding ability, and solvation characteristics. This talk presents a physical-chemistry perspective on the molecular design and application of ILs and DESs in sorption and extraction processes. Emphasis is placed on thermophysical properties, solvation thermodynamics, intermolecular interactions, phase behaviour, and structure-property relationships governing solute affinity and separation selectivity. Molecular-level insights obtained using density functional theory (DFT), COSMO-RS, molecular descriptors, and interaction-based approaches will be

correlated with experimental observations. Selected examples involving the removal of organic micropollutants from aqueous systems and the recovery of critical metals such as lithium and cobalt from spent lithium-ion batteries will illustrate how molecular interactions translate into separation performance. The study highlights how integrating experimental thermodynamics, molecular modelling, and solvent design can accelerate the development of next-generation sustainable solvents and advance green separation technologies.

PIL-03: DFT insight into the Effect of Donor Architecture on the Photovoltaic Properties of D- π -A Dye Sensitizers

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The photosensitizer or dye is one of the key components of a dye-sensitized solar cell (DSSC), as it plays a crucial role in determining the efficiency of solar-to-electrical energy conversion. Organic π -conjugated materials have received considerable attention as photosensitizers for DSSCs, owing to the ability to tailor their photovoltaic performance through structural modification of the sensitizer. Therefore, the appropriate selection and structural integration of the donor, π -bridge, and acceptor units are essential for designing efficient sensitizers. Typically, organic photosensitizers possess a D- π -A architecture, where D, π , and A represent the electron donor, π -conjugated bridge, and electron acceptor, respectively. Consequently, the rational selection and structural design of these individual components are critical for optimizing the electronic and photovoltaic characteristics of the dye. In the present study, the effects of systematically varying the donor (δ -conjugation Vs 2D- π -conjugation), and δ -spacer units within the fundamental D- π -A framework of organic dyes have been investigated. The proposed molecular systems were comprehensively analyzed in terms of their geometrical, charge-transfer, photovoltaic, and optoelectronic properties. In addition, the adsorption behavior of the designed dyes on the nanocrystalline titanium dioxide (TiO₂) semiconductor surface was examined. These findings demonstrate that rational modification of the donor architecture and δ -bridge can effectively tune the electronic and photovoltaic properties of D- π -A sensitizers and may provide an effective strategy for improving the overall performance.

PIL-04: Greener Alternatives to Industrial Solvents

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Most of the industrial solvents are hazardous for the environment since they are released as volatile organic compounds in the atmosphere which are carcinogenic, mutagenic and adversely affect human health and aquatic life. Sustainable and greener solvent systems such as IL's, Deep Eutectic Solvents (DESs) are being investigated to envisage their role as alternatives to these hazardous VOC solvents. Thermophysical properties of liquid mixtures play a significant role in determining their applications in multifarious fields like pharmaceuticals, solvent extraction and recovery, heat and mass transfer processes, etc. The thermophysical properties of binary and higher order liquid mixtures of widely used industrial solvents such as dimethyl sulfoxide (DMSO), N-methyl-2-pyrrolidone (NMP), N, N dimethylacetamide (DMAc), etc. gives us an understanding of their physico-chemical nature, structural changes occurring on mixing the constituent components and the molecular interactions occurring in these mixtures. Experimental determination of density (ρ), ultrasonic velocity (u), viscosity (η), refractive index (n_D) have been carried out on the aforementioned systems at varying temperatures. Estimation of excess molar volumes (V_m^E), coefficient of thermal expansion (α_p), adiabatic compressibility (β_s) and their excess counterparts from the experimental data gives us an insight about the deviations of these mixtures from ideal behaviour. Addition of DES to these mixtures and the variation in their thermophysical properties will prove to be a very important step in designing greener and safer alternatives to these toxic solvents.

PO-CYSA-01: Optimizing the Electronic Structure and Charge Transfer Kinetics of Fe_2O_3 via Nitrogen-Incorporated Carbon for Electrochemical Water Splitting

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To promote sustainable and renewable hydrogen production methods via electrolysis, it is difficult but essential to develop effective, stable, readily synthesized, affordable, and non-noble metal (NNM) based catalysts. Considering this, $\text{Fe}_2\text{O}_3@\text{NC}$ (nitrogen-doped carbon)

materials are synthesized and their electrochemical and physical characteristics are investigated. Interestingly, the $\text{Fe}_2\text{O}_3/\text{NC}$ showed the lowest overpotential of 302 mV for OER and 189mV for HER, comparatively low for Fe_2O_3 -based materials ever reported for electrolysis in producing a current density of 10 mA/cm². The created $\text{Fe}_2\text{O}_3/\text{NC}$ electrocatalyst showed good stability, modest Tafel slopes, and effective electrocatalytic activity. $\text{Fe}_2\text{O}_3/\text{NC}$ demonstrated a remarkable turnover frequency (TOF) of 0.175 sec⁻¹, which was consistent with the commercial IrO_2 catalyst's TOF of 0.173 s⁻¹ at 1.60 V. The $\text{Fe}_2\text{O}_3/\text{NC}$ catalyst has the inherent capacity to overcome water's sluggish oxidation rate, leading to exceptional hydrogen and oxygen evolution performances. Using solar cells with a 1.57 V potential to produce H_2 at the cathode and O_2 at the anode, the sustainability of the water-splitting reaction was assessed, demonstrating the promise of the $\text{Fe}_2\text{O}_3/\text{NC}$ catalyst in electrolysis.

PO-CYSA-02: Trace-level Detection and Determination of Thymol at $\text{FeSe}_2/\text{Fe}_2\text{O}_3/\text{CPE}$ in Water and Soil samples

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Thymol, a naturally occurring monoterpenoid phenolic compound derived from thyme and related plants, is often employed in insecticidal formulations. Although these formulations are generally considered less hazardous than many synthetic pesticides, their improper or excessive use can be hazardous to aquatic life, human health and the environment. It has several side effects; hence, it is essential to detect it in low concentrations. The current work reports the synthesis of a $\text{FeSe}_2/\text{Fe}_2\text{O}_3$ nanocomposite-modified electrochemical sensor employed for thymol-sensitive detection. The FeSe_2 and Fe_2O_3 were synthesised via pyrolysis and hydrothermal methods, respectively, followed by ultra-probe sonication to obtain their heterostructure nanocomposite. The synthesised compound was characterized using TEM, EIS, SEM, FTIR, XRD, and Raman. The electrochemical sensor behaviour of the material was evaluated using voltammetric techniques, such as DPV and CV. The fabricated electrode shows a linear response over 5-50 μM , with a low limit of detection (LOD) of 17.6 nM and a limit of quantification (LOQ) of 58.7 nM, and remarkable selectivity over interfering compounds, excellent reproducibility, and stability. The fabricated electrode was employed for the environmental applications; real samples, including soil and water, were analysed,

which yielded good recovery values of 95-100%. The outcomes of these analyses revealed the practical viability of the developed sensor, FeSe₂/Fe₂O₃/CPE, for environmental monitoring.

PO-CYSA-03: Kinetics of Degradation of Caffeine by Hydrogen Peroxide using UiO-66-Ce Catalyst

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In this study, a heterogeneous photocatalytic system based on cerium-modified metal-organic framework UiO-66-Ce was synthesized, characterized and tested for the efficient degradation of caffeine (CAF) in aqueous environments. The material was comprehensively characterized through using the techniques like XRD, FTIR, SEM, and EDS, to evaluate crystalline integrity, coordination environment, and targeted elemental composition. Photocatalytic degradation kinetics, monitored under UV irradiation, conformed to a pseudo-first-order reaction model. The reaction rate exhibited a positive correlation with catalyst dosage up to a threshold, beyond which a plateau was reached due to active-site saturation and light-scattering effects. Optimal degradation parameters were identified at a CAF concentration of 2.74×10^{-4} M and an H₂O₂ concentration of 1.65×10^{-3} M. Conversely, elevated initial CAF concentrations reduced removal efficiency due to active-site blocking. Acidic environments significantly enhanced degradation performance by promoting activation. Furthermore, probing the system with surfactants revealed that SDS promoted the reaction, whereas CTAB, TX-100, PVA, and PEG displayed inhibitory effects, highlighting the importance of surface-mediated mechanisms. Mechanistic insights indicate that the degradation proceeds via redox cycling, which drives the generation of reactive oxygen species (ROS). Reusability evaluations demonstrated that UiO-66-Ce retained 69% of its initial CAF degradation capacity after five consecutive cycles, underscoring its robust structural stability and practical potential for advanced wastewater remediation.

PO-CYSA-04: Kinetic and Mechanistic Investigation of Electrochemical Detection of 2,4,6-TCP using Piowaste-derived Activated Carbon

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Toxic molecules released from industrial and agricultural activities

can contaminate the environment and pose risks to human health. Among them, chlorophenols are persistent and toxic organic pollutants. The 2,4,6-Trichlorophenol (TCP) is an isomer of trichlorophenols, a class of chlorophenols used for various purposes, including the manufacturing of fungicides, herbicides, and insecticides. The kinetic and mechanistic investigation of electrochemical sensing of TCP was studied utilizing a carbon paste electrode (CPE) modified with fish-scale-derived activated carbon (FAC) in a 0.2 M phosphatebuffer saline (PBS)solution. The electrochemical behaviour of 2,4,6-TCP was investigated over the temperature range of 289-323 K. The thermodynamic parameters such as entropy, enthalpy, and free energy changes were evaluated, and the heterogeneous rate constant (k^0) was determined to assess the electron-transfer kinetics at the electrode-solution interface. Probable electrooxidation mechanism was proposed involving 2 electrons and 2 proton transfer. Samples of fruits, vegetables, soil, and water contaminated with TCP pesticide were analyzed using the square wave voltammetry technique in PBSat pH 6.0. The developed sensor demonstrated significantly higher TCP oxidation currents than a standard carbon paste electrode. The developed FAC/CTAB/CPE displayed enhanced electrocatalytic activity, good selectivity in the presence of common interfering species, and satisfactory operational stability. These results demonstrate the potential of fish scale-derived activated carbon as a low-cost and sustainable electrode material for the electrochemical monitoring of 2,4,6-TCP in environmental samples.

PO-CYSA-05: Temperature-Dependent Voltammetric Behaviour and Kinetic insights into Trace Electrochemical Sensing of 2,4-Dicholorophenoxyacetic Acid on Fe-WO₃@C nanocomposites

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Interfacial kinetics and thermodynamic parameters for the electro-oxidation of 2,4-dichlorophenoxyacetic acid (2,4-D) were evaluated with an iron-doped tungsten oxide-intercalated carbon matrix electrode (Fe-WO₃/CPE). The incorporation of nanocomposite in carbon matrix increased the electrochemically active surface area of bare CPE from 0.042 cm² to 0.086 cm² for modified electrode. Voltammetric investigations showed irreversible oxidation followed by a mixed

adsorption–diffusion mechanism ($\log I_{pa}$ vs $\log v$ slope = 0.68). The linear relationship for E_p vs pH plot, with a slope of 55mV/pH, confirmed a proton-coupled equimolar transfer of two electrons and two protons ($2e^-/2H^+$). Kinetic modeling using the Laviron formulation yielded an electron transfer coefficient (α) of 0.58, a heterogeneous rate constant (k^0) of 3.71 s^{-1} , and a surface coverage (Γ) of $8.55 \times 10^{-7}\text{ mol cm}^{-2}$. Thermal investigations in the range of 288–308 K gave an activation energy (E_a) of 30.45 kJ/mol from Arrhenius plots ($\log k^0$ vs $1/T$). Transition-state analysis furnished $\Delta H^\ddagger = 2.93\text{ kJ/mol}$, $\Delta G^\ddagger = 101.95\text{ kJ/mol}$, $\log A = 10.846$, and $\Delta S^\ddagger = 452.63\text{ JK}^{-1}\text{mol}^{-1}$. The low positive $\Delta H^\ddagger$ and negative $\Delta S^\ddagger$ denote a physical adsorption pathway proceeding via an associative, ordered transition state. Also, square wave voltammetry demonstrated a linear range of 0.035–20.5 μM , achieving a limit of detection (LOD) of $6.28 \times 10^{-8}\text{ M}$ and a limit of quantification (LOQ) of $2.08 \times 10^{-7}\text{ M}$.

PO-CYSA-06: Enhanced Enzyme Stability of Stem Bromelain into ZIF-8 through Biomimetic Mineralization-driven in Situ Encapsulation

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This research investigate how the thermoresponsive triblock polymer PEG-PPG-PEG(Pluronic F-108) can have its micellization/phase transition temperature tuned by adding polydopamine(PDA) nanoparticle. The main aim was to see how this additive interact with the hydrophilic PEG block and hydrophobic PPG block of PEG-PPG-PEG and thereby changing its hydrophilic and hydrophobic balance. The polymer normally form micelles when the temperature reaches its critical micelle temperature(CMT). In pure water, the CMT was about 39.3 degree Celsius but after adding the additive polydopamine, the CMT shifted to higher temperature. This means that additive promoted later micelle formation or later hydrophobic collapse of polymer. This happen because of additive stabilizes the hydrated(hydrophilic) state of polymer and delays hydrophobic collapse, resulting in an increase in CMT. Different techniques such as UV–Vis spectroscopy, fluorescence spectroscopy, IR, DLS, zeta potential, and TEM were used to understand the polymer–additive interactions and changes in micelle formation, particle size, surface charge, and morphology. This approach may be useful for designing smart polymeric material for drug delivery, bioimaging, nanotechnology and smart hydrogel etc.

PO-CYSA-07: 5-(Tert-butyl)-2-hydroxy-1, 3-isophthalaldehyde (5-tBHI) : A Single Benzene-Based Emitter useful in Multiple Applications

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5-(tert-butyl)-2-hydroxy-1,3-isophthalaldehyde (5-tBHI) is a photochromic compound. Its emission behaviour is highly sensitive to external factors such as solvent polarity, molecular aggregation, and surfactant interactions. Due to its pronounced responsiveness to hydrophobicity and electrostatic changes, 5-tBHI serves as a promising candidate for environment-sensitive applications.

5-tBHI demonstrates high sensitivity to hydrophobic and electrostatic changes, making it an effective probe for biomolecular sensing. Using a necklace and bead model with human serum albumin (HSA), 5-tBHI successfully monitored protein conformational changes.³ Additionally, 5-tBHI exhibits selective fluorescence-based sensing of Al^{3+} ions through coordination-induced emission shifts.

We have also explored white light emission by co-assembling 5-tBHI with Rhodamine B (RhB) and Al^{3+} , and are currently investigating its integration with HSA to develop tunable, protein-templated white-light-emitting systems. These findings highlight 5-tBHI as a multifunctional platform for applications in sensing, bioimaging, white-light generation, and optoelectronics.

PO-CYSA-08: Investigation of Charge Transport and Energy Storage in PVA-TEOS/Green-Synthesized Ag Nanoparticle Composite Membranes

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The growing demand for flexible and lightweight energy-storage systems has encouraged the development of conductive polymer-based nanocomposite materials. In the present study, PVA-TEOS crosslinked membranes incorporated with green-synthesized silver nanoparticles using *Trigonella foenum-graecum* leaf extract were developed and investigated from a physical chemistry perspective. The influence of Ag nanoparticles on the structural, morphological, electrical, and electrochemical properties of the membranes was systematically studied. FT-IR and WAXD analyses were employed to investigate

molecular interactions and structural changes, while SEM was used to examine surface morphology and nanoparticle distribution. The charge-transport and electrochemical behaviour were evaluated using an electrochemical workstation. The membrane containing 5 mass% Ag nanoparticles exhibited a conductivity of 2.1 S cm^{-1} and a specific capacitance of 275.9 F g^{-1} at 5 mV s^{-1} in $1 \text{ M H}_2\text{SO}_4$. The enhanced conductivity and charge-storage capability demonstrate the potential of the composite membrane for flexible supercapacitor applications.

PO-CYSA-09: Visible-Light Photocatalysis over Fe-Modified WSe₂: Charge-Carrier Dynamics, Hydrogen Evolution, and Dye Degradation

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The electronic structure, band energetics, and charge-carrier dynamics of semiconductor materials govern photocatalytic activity. Herein, we hydrothermally synthesised Fe-modified WSe₂ (Fe-WSe₂) to tune WSe₂'s physicochemical properties for visible-light-driven photocatalysis. Fe incorporation modified the electronic structure and enhanced light absorption and charge-carrier separation. Mott–Schottky analysis confirmed n-type behaviour with a suitably negative flat-band potential, providing favourable energetics for proton reduction. Under simulated solar irradiation, Fe-WSe₂ exhibited a hydrogen evolution rate of $18.45 \text{ mmol h}^{-1}$, compared with 7.42 mmol h^{-1} for pristine WSe₂. The enhanced activity is attributed to improved photogenerated charge separation and interfacial electron transfer. Fe-WSe₂ also achieved 93% degradation of Indigo Carmine within 3 h under visible light, associated with reactive oxygen species formation and prolonged charge-carrier lifetimes. These results demonstrate a clear structure–property relationship and highlight Fe-modified WSe₂ as an efficient noble-metal-free photocatalyst for solar-driven chemical transformations.

PO-CYSA-10: Microwave-assisted Synthesis of Ni-Doped Carbon from Bio-waste as a Cost-Effective Electrocatalyst for Effective and Sustainable Water Electrolysis

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The development of cost-effective and easily synthesizable

electrocatalysts for the oxygen evolution reaction (OER) and hydrogen evolution reaction (HER) is essential for advancing sustainable hydrogen production. In this study, a nickel-doped carbon (Ni@C) electrocatalyst was synthesized from bio-waste using a facile microwave-assisted method. Physicochemical characterization confirmed the successful incorporation of nickel into the carbon matrix, which contributed to the generation of enhanced electrocatalytically active sites. The electrochemical performance of the synthesized Ni@C catalyst was evaluated in 1 M KOH electrolyte, exhibiting overpotentials of 280 mV for OER and 180 mV for HER at a current density of 10 mA cm⁻². Furthermore, full-cell water electrolysis demonstrated excellent electrocatalytic performance, requiring a cell voltage of only 1.65 V to achieve the desired current density. The Ni@C electrocatalyst also exhibited remarkable durability during a prolonged stability test of 100 h. The use of bio-waste as a carbon source, together with the facile microwave-assisted synthesis, provides an environmentally friendly, cost-effective, and scalable approach for hydrogen production through water electrolysis. Integration of such electrolysis systems with renewable energy sources, particularly solar energy, could further contribute to large-scale and sustainable hydrogen generation.

PO-CYSA-11: Enhanced Enzyme Stability of Stem Bromelain into ZIF-8 through Biomimetic Mineralization-Driven in Situ Encapsulation

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The limited stability of proteins under adverse conditions remains a major constraint on their practical and industrial applications. In the present study, stem bromelain, a proteolytic enzyme of significant biotechnological relevance, was stabilized through encapsulation within zeolitic imidazolate framework-8 (ZIF-8) using a biomimetic mineralization approach. The resulting stem bromelain-ZIF-8 composite exhibited a high encapsulation efficiency of $96.4 \pm 1.2\%$. Successful formation of the enzyme-containing composite was supported by X-ray diffraction (XRD), scanning electron microscopy (SEM), and thermogravimetric analysis (TGA). Encapsulation enhanced the thermal stability of stem bromelain by 10 °C compared with the free enzyme. It provided improved resistance against protein-denaturing organic solvents, including dimethyl sulfoxide (DMSO), dimethylformamide (DMF), methanol, and ethanol. The enhanced stability is attributed to the protective confinement provided by the ZIF-8 matrix, which

restricts unfavorable conformational changes of the enzyme. These findings highlight MOF-assisted encapsulation as an effective strategy for preserving protein functionality under harsh conditions and broadening the potential application of stem bromelain as a robust biocatalyst.

PO-01: The Application Process of Nanomaterials Development in Lithium-ion Batteries (LIBs) Cathode Materials of Electrochemicals Performance

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Environmental pollution and energy scarcity are getting worse as science and technology advance, which has a significant influence on people's living conditions. Therefore, in light of the present sustainable development plan, the discovery and implementation of new energy sources are crucial for sustainable development. Lithium-ion batteries (LIBs) have been playing an increasingly significant role in the field of smart grids, electric vehicles, and personal electronic devices due to the fact that solar, wind, hydropower and nuclear energy are new renewable energy sources in this context, but these energy sources are seasonal, regional and discontinuous. There are currently more demanding specifications for lithium-ion batteries (LIBs), including high energy density and high power density, due to the growth of electric vehicles and other energy storage technologies. In order to enhance the electrochemical performance of lithium-ion batteries, this manuscript focuses on the incorporation of nanomaterials into the cathode materials. It is discovered that there is still much opportunity for nanomaterial development in the cathode materials of batteries.

PO-02: Deployable Electro-Immuno-Sensing Device Comprising Bioactive Glass-MWCNT for Alkaline Phosphatase Detection in Human Serum Samples

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One of the most essential dynamic tissues is bone which is

responsible for structural support and organ protection. It is also important site for calcium storage and blood cell formation. Osteoblasts are the cells that live within this system and secrete alkaline phosphatase (ALP). This enzyme is crucial for bone mineralization. As it circulates in the blood, ALP serve as an important clinical biomarker for the diagnosis of bone-related diseases and many other physiological disorders. For advancing the current diagnostic capabilities, this study presents a novel, label-free electrochemical biosensor which is designed specifically for ALP detection. The sensing platform utilizes a unique composite probe which integrates bioactive glass (BG) with multiwalled carbon nanotubes (MWCNT). Operating via electrochemical impedance spectroscopy (EIS), Validation of the successful fabrication of probe was validated using comprehensive physical and electrochemical characterizations. This BG-MWCNT platform demonstrated excellent analytical performance tailored for clinical use. It exhibited a wide linear dynamic range (LDR) of 25 to 600U/L and achieved a highly sensitive limit of detection (LOD) of 2.29 ± 0.35 U/L. Further it displayed exceptional selectivity against common serum interferences ($K_{sel} < 0.06$). This bio-analytical device proves to be a highly reliable, deployable tool for monitoring ALP in complex biological samples.

PO-03: Studies of Ultrasonic of KBr in Dioxan and Water Solvent Mixture at 303.15K

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Various acoustic parameters like isentropic compressibility (β_s) intermolecular free length (L_f), apparent molar volume (ϕ_k), molar sound velocity (R), acoustic impedance (Z) of KBr in 10%, 20%, 30% and dioxan and water solvent mixture at 303.15K have been determined from ultrasonic velocity (V), density (ρ) and relative viscosity (η_r) of the solution. These parameters are related with the molar concentration of the solution and reflects the distortion of the structure of the solvent in dioxan and water mixture when the solute is added to it. The dissolution of electrolyte in various solvents is responsible for structure maker or structure breaker. Viscosity and density data leads an insight to the state of association of the solute and the extent of interaction of the solute with the solvent. The present work mainly deals with the reflects the ion-ion, ion-solvent and solvent-

solvent interaction KBr solution in 10%,20% and 30% in dioxan and water mixture.

PO-04: Phytogetic Copper Oxide Nanoparticles: Structural, Optical, Morphological and Physicochemical Insights

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The present study investigates the phytogetic synthesis of copper oxide nanoparticles (CuO NPs) through an eco-friendly plant-mediated approach and evaluates their structural, optical, morphological and physicochemical characteristics. The synthesized CuO NPs were systematically characterized using UV–Visible spectroscopy, Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), field-emission scanning electron microscopy (FE-SEM), energy-dispersive X-ray spectroscopy (EDS), and high-resolution transmission electron microscopy (HR-TEM). UV–Visible analysis exhibited a characteristic absorption maximum at 375 nm, confirming the formation of CuO nanoparticles and providing evidence of their optical response. FTIR analysis revealed the involvement of various surface-associated functional groups during nanoparticle formation and stabilization. XRD analysis confirmed the crystalline nature of the synthesized CuO, with characteristic diffraction peaks corresponding to copper oxide and an estimated average crystallite size of approximately 97 nm. FE-SEM analysis revealed nanoparticles with an average size ranging from 23.6 to 41.2 nm, while HR-TEM showed predominantly needle-shaped nanoparticles with an average particle size of 38.56 ± 12.23 nm. EDS analysis confirmed copper and oxygen as the principal elements, supporting the formation of CuO nanoparticles. The synthesized nanoparticles further exhibited concentration-dependent antimicrobial activity against selected bacterial and fungal pathogens. In addition, DPPH radical-scavenging studies demonstrated appreciable antioxidant activity, with an IC_{50} value of 136.42 $\mu\text{g/mL}$. The observed structural, optical and morphological characteristics, together with the functional biological properties, demonstrate the potential of phytogetic CuO nanoparticles as versatile functional nanomaterials. The study highlights a sustainable route for developing CuO-based nanomaterials with promising physicochemical and biological applications.

PO-05: Designing of Sulfide-Based MOF@Graphitic Carbon Nitride Composites for Water Splitting and Direct Methanol Fuel Cell Applications

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Developing effective bifunctional electrocatalyst is necessary in alleviation of global energy conversion and storage devices for portable applications via water splitting and direct methanol fuel cell (DMFC) application. In this study bifunctional electrocatalysts were developed using tin and titaniumsulfide-based MOF materials along with graphitic carbon nitride using hydrothermal method. The synthesized material's morphology, structural and oxidation state were confirmed from Field emission-scanning electron microscopy (FESEM), X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS) analysis. Notably, electrocatalyst have shown increased current density and low overpotential of 110 and 160 mV for hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) at 10 and 20 mA/cm² respectively. Composites have also shown good electrocatalytic activity for direct methanol fuel cell application via methanol oxidation reaction (MOR) because of significant reduction in charge transfer resistance, increased surface area and enhanced electrical conductivity owing to synergistic effect observed in the synthesized composites. Stability for long-term operation was also confirmed from chronoamperometry at given overpotential for 24 h duration for HER, OER and MOR respectively. Materials excellent electroactivity and stability makes it highly effective and efficient as an alternative electrocatalyst for hydrogen evolution reaction and methanol oxidation via advanced conversion technologies.

PO-06: Investigation of Heavy Metals in Tap Water and Underground Water using Atomic Absorption Spectrometry (AAS) and Flame Absorption Spectrometry (FAS)

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The present manuscript mainly deals with the quality of drinking water supplied to the general drinking water network of Agra city

(India) tap water and ground water. A total of four different sites were selected for this study. The chemical and biological parameters were carefully determined and compared to the WHO and Indian standard. The chemical analysis was performed mainly to estimate the level of some heavy metals (Zn, Cd, Cu, Pb, Fe) using Atomic Absorption Spectrometry (AAS) followed by biological test using the Most Probable Number (MPN) method for a possible microbial contamination. The obtained results of both chemical and biological analysis revealed that the distributed water is safe to drink except in one site. The analysis also showed that the quality of water remains mostly unchanged in terms of chemical and biological (micro-organisms) aspects. Estimation of heavy metals was below the limits. The percentage of RSD value was less than 2.5% based on triplicate run. Overall, investigation of both chemical and microbial aspects is an effective method of monitoring quality of drinking water. Such investigation is needed to identify possible sources of contamination which could be storage tanks and pipeline to ensure the reach of safe drinking water to the users by Flame Absorption Spectroscopy (FAS).

PO-07: Analysing the Role of Hydrophilic-Lipophilic Balance and Surfactant-to-oil ratio on Physicochemical Properties and Release Kinetics of Essential Oil-Loaded Nanoemulsions

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Nanoemulsions (NEs) are stable two-phase liquid systems with droplet sizes under 100 nm. Their small droplet size makes them effective delivery vehicles for active ingredients like antioxidants, antimicrobials, nutraceuticals, and flavourings. The present study aims to investigate the influence Hydrophilic-Lipophilic Balance (HLB) and surfactant-to-oil ratio (SOR) on different physicochemical parameters like z-average diameter, storage conditions, encapsulation efficiency, release profile and release kinetics of NEs encapsulating lemongrass essential oil (LGEO). Formulation with highest surfactant concentration (SOR3:1) exhibited smallest droplet size of 26.59 ± 0.76 nm (PDI 0.1615). Optimal HLB values enhance the encapsulation efficiency by reducing the interfacial tension, resulting in better oil retention within the emulsions. The best encapsulation efficiency, $91.90 \pm 1.33\%$, was achieved at an HLB of 12 for SOR2:1. The release profiles were evaluated using zero-order, first-order, Higuchi, Hixson-Crowell, and

Korsmeyer-Peppaskinetic models to clarify the diffusion mechanisms across the surfactant barrier. These results highlight the importance of HLB and SOR in enhancing the stability of formulated NE for efficient essential oil delivery and targeted functionality across food, pharmaceutical, and cosmetic sectors.

PO-08: Formulation, Characterization and Biological Evaluation of Bay Leaf Essential Oil- Loaded Eco-Friendly Nanoemulsions

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Essential oils (EOs) are the scented liquids produced by aromatic plants during their secondary metabolism. Cinnamomum tamala essential oil (CTEO) exhibits various biological properties, including antibacterial, antifungal, and antioxidant activity, etc.; however, these EOs are highly volatile, have low bioavailability, and are hydrophobic in nature. In this study, CTEO was encapsulated into nanoemulsions (NEs) to improve their stability and activity. An Oil-in-water NE was prepared using non-ionic surfactants, Tween 20 (HLB 16.7) and Span 20 (HLB 8.6), and a high-energy ultrasonication method. The average hydrodynamic diameter and zeta potential of the synthesized NEs were characterized through a dynamic light scattering (DLS) system. The encapsulation efficiency for the prepared CTEO-NEs was calculated. The formulations showed 30-75 % release of EOs in 12 hours in neutral saline medium. Biological activities of the synthesized CTEO-NEs were also assessed. The antibacterial activity of CTEO and CTEO-NEs was studied in-vitro using agar disc diffusion assay against some common food-borne bacteria. The antioxidant activity of CTEO and CTEO-NE was compared through the 2,2-diphenylpicrylhydrazyl (DPPH) free radical scavenging assay at different concentrations, and their absorbance was measured using UV-Visible spectroscopy. The study concludes a probable application of CTEO and CTNEOs in the food industry as an alternative against bacterial strains.

PO-09: Estimation of Viscosity of Liquid Mixtures using Predictive, Correlative and Machine Learning Models

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Estimation of transport properties of liquid mixtures is essential

due to their widespread applications in diverse industrial processes. The macroscopic behavior of mixtures arises from interactions among their constituent components. Understanding these relationships aids in designing greener and more sustainable solvents to replace conventional toxic ones. However, predicting transport properties such as viscosity remains challenging, as this is highly dependent on temperature, concentration and molecular structure, while their experimental determination is both time-consuming and costly. Therefore, this study employs a range of predictive, correlative, empirical, semi-empirical and AI- ML models to estimate viscosity for various binary liquid mixtures. Predictive models such as Bingham , Kendall–Monroe, Logarithmic model, Dey- Biswas model, etc., correlative models such as, Tamura–Kurata, Wijk, Grunberg Nissan, and Hindalong with machine learning algorithm such as Random Forest, Gradient Boosting, Gaussian Regression etc. have been utilized to predict the viscosity of binary liquid mixtures at varying temperatures and concentrations. The accuracy of these models are evaluated using the Average Absolute Percentage Deviation (AAPD). Furthermore, an analysis will be performed to identify systematic trends responsible for deviations between experimental and calculated values, providing deeper insight into the underlying molecular interactions governing the behavior of these solvent systems.

PO-10: Transition from Inverse to Positive Magneto caloric Effect and Emergence of Giant Exchange Bias Induced by La Doping in Charge Ordered Orthoferrite CaFeO_{3-δ} Nanoparticles

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In this study, we investigate the impact of La doping in CaFeO_{3-δ} (CFO) nanoparticles, focusing on its influence on carrier density, local antiferromagnetic domains, and key magnetic properties—specifically exchange bias and the magnetocaloric effect—along with charge ordering. Our findings reveal that charge ordering is largely suppressed upon La doping due to electron localization, as evidenced by zero-field-cooled (ZFC) and field-cooled (FC) magnetization measurements. Additionally, we observe the emergence of a giant exchange bias in the La-doped CFO system, which we qualitatively attribute to the correlation between antiferromagnetic domain size

and structural domains characterized by defects and grain boundaries affecting domain wall motion. The magnetocaloric effect (MCE) was analyzed through entropy change as a function of temperature, calculated from magnetic isotherms. Notably, La doping induces a transition from inverse to normal MCE, marking a significant shift in the material's magnetothermal response.

PO-11: Flexible $\text{Ti}_2\text{C@PVDF/APBA}$ Nanocomposite Membrane for Real-Time, Non-Invasive Epidermal Glucose Biosensing

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Non-invasive, continuous glucose monitoring from epidermal biofluids represents a promising pathway for pain-free diabetic management. However, developing skin-conformal sensors with simultaneous high conductivity, mechanical resilience, and enzyme-free selectivity remains a key challenge. In this work, we demonstrate a flexible, wearable biosensing platform based on a functionalized titanium carbide MXene/polymer nanocomposite ($\text{Ti}_2\text{C@PVDF/APBA}$). Few-layer Ti_2C MXene nanosheets were synthesized via selective LiF/HCl etching of parent Ti_2AlC MAX phase and subsequently surface-functionalized with 4-aminophenylboronic acid (APBA) as a stable, synthetic receptor for selective cis-diol coordination. To provide high mechanical durability and sweat-permeable porosity, the APBA-grafted Ti_2C was integrated into a polyvinylidene fluoride (PVDF) matrix to fabricate flexible, porous composite membranes via solution casting and electrospinning. Integrated onto flexible interdigitated electrodes, the resulting epidermal patch leverages the reversible cyclic boronate ester complexation between glucose and APBA receptors to modulate the high electronic carrier density of the underlying Ti_2C network. This platform provides real-time, non-invasive electrical transduction of sweat glucose concentrations with high selectivity and mechanical conformability to the human skin, offering an enzyme-free approach for next-generation personalized wearable metabolic healthcare.

PO-12: Polyurethane Acrylate Oligomers Based on Mono Ethylene Glycol Adipate and Methylene Diisocyanate : A Review

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Polyurethane acrylate (PUA) oligomers are versatile functional

materials that combine the desirable mechanical properties of polyurethane with the rapid photocuring ability of acrylate groups. This review focuses on the synthesis, characterization, properties, and applications of PUA oligomers prepared using glycol adipate as the soft segment component and different diisocyanate as hard segment forming agents. Glycol adipate contributes flexibility, chain mobility, chemical resistance, and toughness, whereas the type and structure of the diisocyanate strongly affect the rigidity, molecular architecture, thermal stability, mechanical strength, and curing behaviour of the resulting PUA materials. PUA oligomers are generally synthesized through the formation of an isocyanate terminated polyurethane prepolymer, followed by end group modification with hydroxy functional acrylates. Their chemical structure, molecular weight, thermal properties, mechanical behaviour, and curing characteristics can be evaluated using techniques such as FTIR, NMR, GPC, DSC, TGA, rheological analysis, and mechanical testing. Particular attention is given to the relationship between diisocyanate structure and the final properties of PUA oligomers.

PP-CYSA-01: Cobalt-Doped Tungsten Oxide Nanoparticles for Electrochemical Sensing and Detection of a Penicillin Antibiotic: Amoxicillin

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A sensitive electrochemical sensor based on Co-doped WO₃ - modified carbon paste electrode (Co-WO₃/CPE) was developed for the determination of amoxicillin (AMXL) in pharmaceutical and environmental samples. Co-WO₃ nanostructures were synthesized hydrothermally and characterized by SEM, XRD, TEM, and XPS, confirming a monoclinic WO₃ structure with uniform Co incorporation and an optimum Co content of 1.80 at%. The electrochemical sensing performance was investigated using cyclic voltammetry, electrochemical impedance spectroscopy, and square-wave voltammetry. Under optimized conditions, the Co-WO₃/CPE exhibited two linear detection ranges of 0.01–0.1 μM and 0.1–30.0 μM, with sensitivities of 63.22 and 63.73 μA μM⁻¹ cm⁻², respectively. The sensor achieved a low detection limit of 9.1 nM (S/N = 3) and a quantification limit of 30.6 nM (S/N = 10). In addition, the electrode demonstrated good selectivity and resistance to interfering species. Successful determination of AMXL in spiked water, soil, and Amoxil tablet samples with satisfactory

recoveries demonstrates the potential of Co-WO₃/CPE as a sensitive and practical platform for pharmaceutical and environmental monitoring.

PP-01: Spectral Characterization, Photophysical Properties, and Biological Activity of a Europium(III) Coordination Complex Based on Kynurenic Acid

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A novel europium(III) coordination compound incorporating 4-hydroxyquinoline-2-carboxylic acid (kynurenic acid) was prepared through a facile solution-based synthetic approach and comprehensively investigated using complementary physicochemical techniques. Structural verification was achieved by FT-IR, UV-Visible spectroscopy, mass spectrometry, thermogravimetric analysis, elemental analysis, and molar conductance measurements, collectively confirming the formation of a stable, neutral Eu(III) complex. Spectroscopic evidence supports the deprotonated ligand acting as a bidentate O,O2 -chelating species through the phenolic and carboxylate oxygen atoms, generating an eight-coordinate environment around the europium ion. The characteristic optical response of Eu(III), together with ligand-to-metal interactions, demonstrates efficient electronic communication within the coordination sphere, while thermal analysis reveals appreciable stability over a wide temperature range. In addition to its favorable physicochemical properties, the complex exhibits significantly improved catalytic efficiency and antimicrobial performance relative to the free ligand, reflecting the beneficial influence of metal coordination on molecular reactivity and biological activity. These results underscore the value of europium–kynurenate systems as multifunctional lanthanide materials with promising prospects in physical chemistry and bioinorganic research.

PP-02: Multispectroscopic Characterization and Biological Evaluation of a Newly Synthesized Yb(III) Complex of 4-Hydroxyquinoline-2-carboxylic Acid

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A coordination compound of ytterbium(III) was successfully prepared using 4-hydroxyquinoline-2-carboxylic acid (kynurenic acid) as the chelating ligand and systematically examined through physicochemical and spectroscopic techniques. Elemental composition, FT-IR, UV–

Visible spectroscopy, thermogravimetric analysis (TGA), and mass spectrometry collectively established the formation of a well-defined Yb(III) complex. Spectroscopic evidence indicated that the ligand binds the metal center through the phenolic oxygen and deprotonated carboxylate oxygen atoms, resulting in a stable O,O'-chelated coordination environment. Thermal studies demonstrated the incorporation of coordinated water molecules and confirmed the excellent thermal robustness of the complex. The antimicrobial potential was investigated against representative bacterial and fungal microorganisms, where the metal complex exhibited superior inhibitory performance relative to the uncoordinated ligand. These findings demonstrate that lanthanide coordination effectively modifies the physicochemical properties and enhances the biological response of quinoline-derived ligands, emphasizing the significance of Yb(III) complexes as promising candidates for the development of functional bioinorganic materials.

PP-03: Nanoscale Morphology Engineering of CoS₂ for Hydrogen Evolution Reaction in Acid Medium

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Controlling the morphology and exposed crystal facets of transition-metal dichalcogenide catalysts offers a promising route to enhance hydrogen evolution reaction (HER) performance, yet the relationship between morphology, crystal facets, and catalytic activity remains incompletely understood. Here, four CoS₂ morphologies—0D nanospheres, 1D nanorods, 2D nanosheets, and 3D nano-octahedra—are synthesized and systematically evaluated for HER activity in acidic media. Electrochemical measurements reveal a clear morphology-dependent activity trend of nano-octahedron > nanosheet > nanorod > nanosphere, highlighting the important role of morphology and exposed crystal facets in determining catalytic performance. Among the four morphologies, the 3D nano-octahedral CoS₂ exhibits the highest activity, which is associated with its dominant exposure of catalytically active{111} facets. This catalyst requires an overpotential of only 128 mV to reach a current density of 10 mA cm⁻² and delivers a Tafel slope of 76 mV dec⁻¹, indicating active HER kinetics. Moreover, it maintains stable electrochemical performance at 10 mA cm⁻² for 100 h of continuous operation, demonstrating excellent durability. Together, these findings establish a clear relationship between morphology, exposed crystal facets, and HER activity in CoS₂, providing

useful design principles for developing morphology- and facet-controlled electrocatalysts for efficient hydrogen production in acidic media.

PP-04: Conductometric and Spectral Studies of Chromium Soaps

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Infrared spectral investigations of chromium palmitate and chromium myristate indicate that the corresponding fatty acids possess a dimeric structure arising from intermolecular hydrogen bonding between two carboxylic acid molecules. The spectral features further suggest that the chromium–oxygen bonds in the soaps are predominantly ionic in nature. The premicellar association and micelle formation of chromium soaps in a non-aqueous medium were investigated using conductometric measurements. The limiting molar conductance, degree of ionization, ionization constant, and critical micelle concentration (CMC) were evaluated from the conductivity data. The results indicate that these soaps behave as weak electrolytes in dilute solutions and undergo progressive association leading to micelle formation above the CMC.

PP-05: One-Pot Ultrasonicated Green Synthesis of EC- Synthesized PANI and ZnO Mediate Nanoparticals and its Microbial Activity

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An eco-friendly One-pot ultrasonic-assisted green synthesis was employed to Electro Chemical(EC) synthesize a polyaniline and –ZnO mediated nanocomposite with particle sizes bellow 90 nm. ZnO nanoparticles were synthesized using a low-cost co-precipitation approach, and the polyaniline– ZnO nanocomposite was formed in situ using an ultrasound, single-step oxidative polymerisation process. This approach promoted a uniform dispersion of the metal oxide nanoparticles inside the polyaniline matrix, which improved the physicochemical interactions between the organic and inorganic phases. The structural and morphological properties of the nanocomposite were thoroughly investigated using UV, FTIR, SEM, X-ray diffraction (XRD). Furthermore, the antibacterial activity of the polyaniline–ZnO nanocomposite was tested against E. coli, S. aureus, and S. typhi. The nanocomposite exhibited better antibacterial activity against E. coli

and *S. aureus* but reduced activity against *S. typhi*. The observed antibacterial behavior was due to the synergistic interaction between the polyaniline medium and ZnO, which resulted in improved disruption of bacterial cell membranes. Overall, polyaniline–ZnO nanocomposite synthesized via this green, one pot ultrasonic assisted synthesis technique showed remarkable multifunctional capabilities, making it a prospective way for applications in antimicrobial materials.

PP-06: Synergistic Integration of Fe-Modified NiAl-LDH anchored on N,S-rGO for enhanced Oxygen Evolution Reaction

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The development of efficient electrocatalysts for alkaline oxygen evolution requires rational regulation of active sites and interfacial charge-transfer processes. In this work, a hybrid electrocatalyst comprising Fe-modified NiAl-layered double hydroxide (NiAl-LDH) and dual-heteroatom-doped reduced graphene oxide (N,S-rGO) was developed through a synergistic integration strategy. The incorporation of Fe into the NiAl-LDH framework provides compositional and electronic modulation of the LDH active sites, while the N,S-rGO framework offers a conductive platform for facilitating interfacial electron transport. The integration of these components generates a coupled LDH–carbon interface with a favorable architecture for alkaline oxygen evolution. The resulting hybrid exhibits enhanced electrocatalytic activity compared with the corresponding individual components, demonstrating the beneficial role of Fe modification and N,S-rGO coupling. The improved catalytic response is associated with the synergistic interaction between the Fe-modified LDH nanostructure and the heteroatom-doped carbon network, which promotes efficient charge transport and accessibility of catalytically active sites. The hybrid electrode also demonstrates good stability under alkaline operating conditions. This study highlights synergistic interface engineering as a promising approach for developing LDH-based hybrid electrocatalysts for alkaline oxygen evolution.

Acknowledgements

Distinguished Delegates, Esteemed Colleagues, and Dear Friends,

As the XXXXV Annual National Conference of the Indian Council of Chemists draws to a successful conclusion, I consider it both a privilege and a pleasure to place on record my sincere gratitude to all those whose contributions have enriched this important academic gathering.

I extend my heartfelt appreciation to the delegates, researchers, academicians, and students whose enthusiastic participation, scholarly presentations, and fruitful interactions have contributed significantly to the success of the conference. Their presence has fostered an atmosphere of intellectual exchange and scientific reflection.

I convey my deep gratitude to our sectional presidents, distinguished speakers, invited experts, and session chairpersons for sharing their wisdom, experience, and valuable insights. Their contributions have greatly enhanced the academic stature and scientific quality of the proceedings.

*I wish to acknowledge with special appreciation the invaluable support extended by **Prof. Manoj Rawat, Dr. S. C. Goyal, Prof. Vinod Kumar, Prof. Bhoopendra Singh and Prof. Ajay Taneja** in the preparation and publication of this Abstract Book. Their unwavering commitment, thoughtful guidance, and dedicated efforts have been instrumental in bringing this work to fruition. I remain deeply indebted to them for their steadfast cooperation and continued service to the activities of the Indian Council of Chemists.*

My sincere thanks are also due to the members of the Organizing Committee at Agra, volunteers, and supporting staff whose diligence, efficiency, and tireless efforts ensured the smooth conduct of the conference.

I am particularly grateful to the authorities, faculty members, research scholars, and staff of IIT (ISM), Dhanbad for their generous support, gracious hospitality, and excellent arrangements, which have made this conference a memorable and rewarding experience for all participants.

On behalf of the Indian Council of Chemists, I extend my profound appreciation to everyone who contributed to the success of this conference. May the academic interactions and professional associations strengthened during these deliberations continue to inspire future collaborations and advances in chemical sciences.

With sincere regards,

Prof. Rajesh Dhakarey

Secretary

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