

• NATIONAL CONFERENCE ON •
**ANALYTICAL SCIENCE &
TECHNOLOGY 2026**
(ANASAT 2026)

• THEME •
Analytical Science:
Advances, Challenges and Future Directions

SOUVENIR
• AND •
BOOK OF ABSTRACTS



Organised by



**Indian Society of Analytical
Scientists (ISAS),
Kerala Chapter**

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September
18-19, 2026



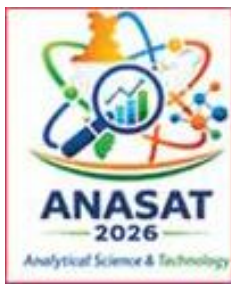
Kochi,
Kerala State,
India



ANALYTICAL SCIENCE AND TECHNOLOGY 2026

ANALYTICAL SCIENCE & TECHNOLOGY 2026

ANASAT 2026



**ANALYTICAL SCIENCE
ADVANCES, CHALLENGES AND FUTURE
DIRECTIONS**

**ORGANISED BY
INDIAN SOCIETY OF ANALYTICAL SCIENTISTS
(ISAS), KERALA CHAPTER**



ANALYTICAL SCIENCE AND TECHNOLOGY 2026

PREFACE

It gives me immense pleasure to present the Souvenir-cum-Abstract Book of ANASAT 2026, the National Conference on Analytical Science & Technology, organized by the Indian Society of Analytical Scientists (ISAS), Kerala Chapter, on 18–19 September 2026 at Kochi, Kerala.

The theme of the conference, “Analytical Science: Advances, Challenges and Future Directions,” reflects the rapidly evolving nature of analytical science and its growing importance in addressing contemporary challenges in science, technology, healthcare, environment and industry. ANASAT 2026 brings together eminent scientists, researchers, academicians, industry professionals and young scholars from across the country to share recent advances, innovative methodologies, emerging technologies and their diverse applications in analytical science.

The conference provides a valuable platform for scientific exchange, interdisciplinary interaction and collaboration, while also offering young researchers and students an opportunity to present their work, interact with experts and gain new perspectives. The plenary lectures, invited talks, oral and poster presentations are expected to stimulate meaningful discussions and open avenues for future research and collaboration.

This Souvenir-cum-Abstract Book brings together the abstracts of the scientific contributions presented at the conference and also serves as a record of the event. We hope that it will remain a useful reference for participants and reflect the spirit of scientific inquiry, interaction and cooperation fostered through ANASAT 2026.

I take this opportunity to express my sincere gratitude to all the distinguished speakers, delegates, authors, reviewers, sponsors and well-wishers whose valuable support has contributed to the organization of this conference. I also place on record my appreciation for the members of the organizing committee and all those who have worked tirelessly behind the scenes to make ANASAT 2026 a reality.

I am confident that ANASAT 2026 will be a memorable and intellectually enriching gathering, strengthening the analytical science community and inspiring new ideas, collaborations and scientific endeavours.

With best wishes for a successful and fruitful conference.

Dr. K.P. Vijayalakshmi
Convenor
ANASAT 2026
Indian Society of Analytical Scientists (ISAS)
Kerala Chapter



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MESSAGE

It is a privilege to send this message to the scientific community gathered at the National Conference on Analytical Science and Technology 2026 (ANASAT 2026) in Kochi, a city that has long been a meeting point of science, industry, and the sea. The Indian Society of Analytical Scientists (ISAS), born at BARC more than four decades ago, has grown into a national forum that unites laboratories, universities, industry, and public institutions around a single conviction: that careful measurement is the foundation of reliable knowledge.

The theme of this conference is both timely and demanding. Analytical science is no longer only the art of identifying what is present and how much. It is becoming the nervous system of modern society. The same discipline that once lived mainly in the chemistry laboratory now speaks to climate and ocean health, food and pharmaceutical safety, materials for energy and space, forensic and clinical diagnosis, nuclear and environmental stewardship, and the quality of everyday life. Advances in spectroscopy, chromatography, sensors, imaging, and hyphenated methods have already transformed what we can see. The next transformation will be decided by how we combine these methods with computation, automation, and artificial intelligence, without surrendering scientific integrity and human ingenuity. Three challenges will define the coming decades of Analytical Sciences:

First, sensitivity with meaning. We will detect ever smaller quantities, in ever more complex matrices, at ever greater speed. The test of excellence will not be the number of digits after the decimal, but whether the result is trustworthy, interpretable, and useful for decision-making. Second, intelligence with responsibility. Machine learning and data science will become ordinary tools of the analytical laboratory. They must remain servants of experiment, not substitutes for it. Calibration, uncertainty, validation, open methods, and ethical data practice will matter as much as algorithms. Third, relevance with sustainability. Green analytical chemistry, portable and in-situ devices, circular-economy materials, and low-cost methods for public health and environmental monitoring must travel from conference halls into the field.

India cannot become Viksit Bharat by 2047 unless analytical capability is strong not only in premier institutes, but also in industry, state laboratories, hospitals, farms, and coastal and industrial regions such as Kerala.

For young researchers, this is an unusually open horizon. The future of analytical science will belong to those who can move across boundaries—chemistry and biology, physics and data science, instrument design and public purpose. I hope ANASAT 2026 will be remembered not only for the papers presented, but also for the collaborations begun, the standards raised, and the questions that young scientists take home with them.

I congratulate the organisers of ISAS and the ANASAT 2026 Organising Committee for creating this national platform, and I wish every participant two days of rigorous discussion

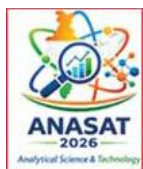
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and lasting scientific friendship. May this conference deliberate not only on what analytical science is today, but also on what it must become.

Prof. V. N. Rajasekharan Pillai
Advisor and Professor of Eminence
Reliance Jio University, Mumbai
2 September 2026



ANALYTICAL SCIENCE AND TECHNOLOGY 2026

Prof. (Dr.) P. RAVEENDRAN
Vice-Chancellor



UNIVERSITY OF CALICUT
(Re-accredited by NAAC with A* Grade)

Message

It gives me immense pleasure to extend my heartiest congratulations and best wishes on the occasion of the National Conference on Analytical Science and Technology 2026 (ANASAT 2026) and the release of its commemorative souvenir.

As Patron, it is deeply gratifying to see ANASAT 2026 emerge as a significant forum bringing together eminent scientists, researchers, academicians, and industry leaders from across the nation. Analytical science remains a cornerstone of scientific research, playing an indispensable role in advancing materials science, promoting environmental sustainability, enabling innovations in healthcare, and addressing challenges related to critical resources.

By bringing together diverse disciplines to deliberate on advances in analytical techniques, measurement science, and emerging technologies, the conference highlights the vital interplay between fundamental research and sustainable innovation. Platforms such as ANASAT 2026 are essential for fostering cross-institutional collaborations, facilitating the exchange of knowledge, and inspiring the next generation of researchers to address complex industrial and societal challenges.

I commend the Organising Committee, Conveners, and members of the Local Organising Team for their dedicated efforts in organising a comprehensive and intellectually stimulating programme


Dr. P. Raveendran
Vice Chancellor



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MESSAGE FROM CHAIRMAN, ORGANIZING COMMITTEE

It is a matter of great privilege and pleasure to welcome all the distinguished delegates, eminent scientists, researchers, and esteemed guests to the National Conference on Analytical Science and Technology 2026 (ANASAT 2026) hosted by the Indian Society of Analytical Scientists, Kerala Chapter in Kochi, Kerala during 18 -19 September, 2026.

Conferences of this scale serve as crucial platforms for bringing together sharp minds to share breakthrough ideas, foster collaborative research, and address pressing contemporary challenges. The theme of this year's conference, "Analytical Science: Advances, Challenges and Future Directions", underscore the critical role of scientific exchange in shaping future developments and interdisciplinary solutions. A key highlight of this event is the publication of this souvenir. Beyond documenting the scientific programme, it stays as a testament to the collective efforts, research contributions, and vision of our academic and professional community. We extend our sincere gratitude to all authors, reviewers, and contributors who have enriched this publication with insights.

I would like to express my deepest appreciation to the members of the national organizing committee, national advisory committee and dedicated local organizing committee members whose tireless work behind the scenes has made the conference possible. We are equally grateful to our sponsors, supporting institutions and industry partners for their steadfast encouragement and financial backing.

I hope this event inspires meaningful discussions, creates lasting professional networks, and offers an enriching scientific experience for all participants.

I wish the event a grand success and hope all our guests have a memorable stay at Kochi

18/09/2026

Prof. (Dr) K. K. Mohammed Yusuff
Chairman



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INDIAN SOCIETY OF ANALYTICAL SCIENTISTS

About Society

The Indian Society of Analytical Scientists (ISAS), was established in 1983 at Bhabha Atomic Research Centre, Mumbai with the aim of dissemination of scientific Information in the field of Analytical Sciences. During the past 40 years this professional body of analytical scientists in India is engaged in assessing and analysing the Impact of analytical sciences on Industry, academia, environment, R&D and community. ISAS has more than 3000 life members and 9 chapters all across India. Over the years, ISAS has organized nearly 40 national and international conferences on various topics of interest to the scientific community, which were very well attended by leading professionals from India and abroad. ISAS has instituted various awards like, Lifetime achievement awards, Awards of Excellence, Aatma Nirbhara awards, etc. to outstanding scientists of our country. In spite of the limitations imposed due to COVID-19 pandemic, ISAS organised more than 75 webinars on weekends. Recently, ISAS launched its own journal, "Journal of ISAS", a quarterly open access peer reviewed journal to publish research papers on analytical science and technology.

ISAS Kerala chapter, the most active and vibrant chapters of ISAS has received 'Best Chapter Awards. In conformity with Its mission to strengthen analytical sciences through an Integrated strategic agenda of research and development (R&D), human capital and Infrastructure, the Kerala Chapter also has been organizing conferences / workshops / seminars, etc. and promoting and popularising analytical science. Latest in the series was national conference IASC-2022 held in March 2022 at Munnar, Kerala on "Analytical Science for Aatmanirbhar Bharat through Technological excellence" which was highly relevant to our nation.

About the Conference

Prime minister Shri Narendra Modi, in his Independence Day speech spoke about the priorities for the next 25 years leading up to the centenary of Independence. Accordingly, the government of India has begun work on a blue print for India@2047- a vision plan for a 'future-ready India' that befits the 100th year of Indian Independence. Analytical science offers a broad spectrum of products and services essential to our daily lives that are safe, sustainable, and environmentally sound. Analytical science has a unique role to play in meeting the sustainable development goals. As one of India's largest and vibrant scientific society, ISAS is in a unique position to make a difference in achieving the goals mentioned above. ISAS members and programs can help to create a community and provide a forum to help solve the chemistry challenges articulated in these goals. Opportunities for new chemical and analytical chemistry research, sustainable chemistry education, green and sustainable chemical manufacturing practices, and a sense of social responsibility are crucial for current and future chemists as we work together to achieve the centenary sustainable development targets listed above. To deliberate on the above, ISAS has now decided to organize "Indian Analytical Science



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Congress 2023 (IASC 2023)" with the theme, "Role of Analytical Sciences in achieving India's Centenary Sustainable Development Goals".

It is with great pleasure and honour we are extending warm invitation to all to participate in the (IASC-2023) to be held at Kochi, Kerala during March 23-25, 2023. The conference will review proposed goals, challenges ahead and evolve a roadmap for achieving them. The advances made by analytical science and technology in diversified and strategic sector will be explored and provide a platform to all the stakeholders to share their research work. The conference will also enable the participants to keep up with the new research areas, cutting edge technologies, Innovative solutions, policies etc. that can contribute to their work. Participants will get opportunity to make connections with experts from industry, government bodies and research Institutes for future collaborations. A national platform will be available to the participants for enabling them to assess the progress to be made for meeting sustainable centenary targets of our nation.



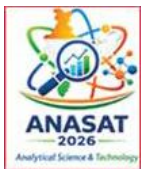
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About Kochi

Kerala, "The God's own Country", is rated one among the top tourist destinations by the World Travel and Tourism Council and also featured in National Geographic Traveler's "50 greatest places of a lifetime". Kochi (formerly named as Cochin) is referred as the Gateway to Kerala. Kochi, known as the "Queen of Arabian Sea" is a vibrant city situated on the south-west coast of Indian peninsula in the breathtaking scenic and prosperous state of Kerala, which is loaded with abundant touristic places to make your day. The Chinese Fishing Nets at Fort Kochi is a must visit attraction. A visit to Jew Town, Mattancherry Palace and Pardesi Synagogue relishes the soothing atmosphere and natural splendour of Kochi. The Hill Palace, the official residence of Maharaja of Kochi showcases Dutch and Kerala styles of architecture. Valanthakad Island, a fragile and virgin stretch of land on the banks of the Vembanad backwaters with its green, seemingly unending stretches of mangroves is fondly called the 'Oxygen Parlour' of the district. St. Francis Church is believed to be one of the oldest churches in India, which was made by the Europeans distinguished for its beautiful architecture and ambience. With all these wonders, Kochi is truly an enigma for travellers.

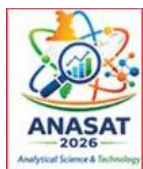
Some top tourist attractions in Kochi

- ❖ Fort Kochi
- ❖ Marine Drive
- ❖ Mattancherry
- ❖ Bolghatty Palace
- ❖ Valanthakad Island
- ❖ Hill Palace Museum
- ❖ Pierce Leslie Bungalow
- ❖ Mangalavanam Bird Sanctuary
- ❖ Museum of Kerala History at Edapally



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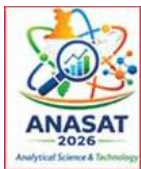
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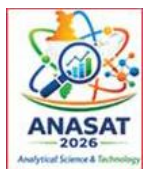
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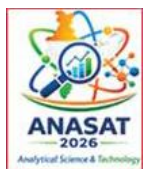
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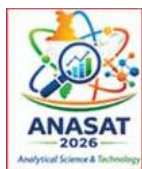
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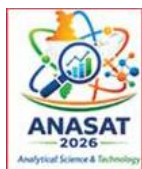
KEYNOTE ADDRESS

ANK1 From Single Molecules to Self-Driving Labs: The Future of Analysis

V. N. Rajasekharan Pillai
Reliance Jio University
Sector 4 & 5, Ulwe, Mumbai - 410 206



Analytical sciences today stand at a transformative juncture, driven by AI integration, miniaturization, and sustainability imperatives. This keynote explores advances in portable and single-entity platforms that resolve chemistry at unprecedented scales. AI and ML now enable spectral deconvolution, automated optimization, and intelligent data interpretation, addressing long-standing challenges like matrix interference. Concurrently, green analytical chemistry principles are operationalized through miniaturized, low-solvent workflows. Key challenges include AI interpretability, reproducibility, and regulatory alignment. The lecture envisions autonomous, self-driving laboratories and i-Metrics as future directions, emphasizing that human expertise remains essential for credible, sustainable innovation.



PLENARY LECTURE

Plenary Lecture - 01

ANP-1 Solving the Analytical Mystery of Palladium Acetate from a User Perspective

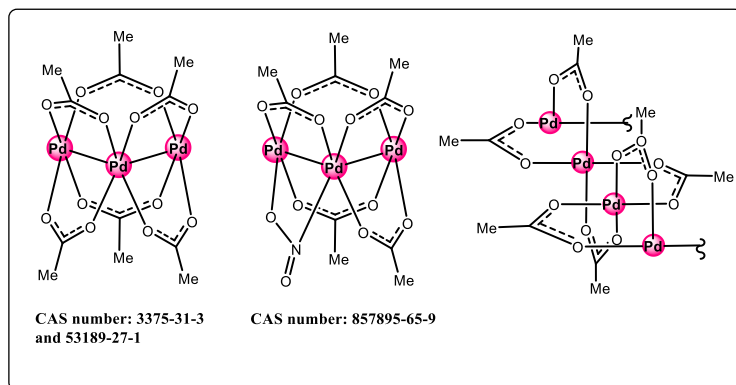
Thomas Colacot

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ABSTRACT

Since the discovery of $\text{Pd}(\text{OAc})_2$ ^[1] by Wilkinson et.al., it has emerged as one of the most widely used commodity chemical in ton quantities worldwide owing to its exceptional efficiency as a precursor for C–C and C–N cross-coupling reactions, as well as for C–H activation, for the development of APIs, electronic materials and agrochemicals. Despite its extensive use in the pharmaceutical industry for the synthesis of diverse classes of generic drugs, many of its users from academia and industry are confused as many of them rely on the metal assays. (Commercially available palladium acetate often contains significant amounts of $[\text{Pd}_3(\text{OAc})_5(\text{NO}_2)]$ and polymeric $[\text{Pd}(\text{OAc})_2]_n$ which can influence its catalytic activities and can compromise reaction reproducibility depending on the chemistry.^[2-4] Interestingly, in certain transformations involving $[\text{Pd}_3(\text{OAc})_5(\text{NO}_2)]$, it exhibits superior reactivity over pure $[\text{Pd}_3(\text{OAc})_6]$, while in certain reactions it gives inferior results.^[4] Despite its promising catalytic potential in cross-coupling reactions, $[\text{Pd}_3(\text{OAc})_5(\text{NO}_2)]$ is not commercially established as a standalone reagent although it is registered with a discrete CAS number (857895-65-9). Therefore, herein we introduce high purity $[\text{Pd}_3(\text{OAc})_5(\text{NO}_2)]$ and $[\text{Pd}_3(\text{OAc})_6]$ aka $\text{Pd}(\text{OAc})_2$ to help the users to have precision in their industrial processes. In addition, we describe the synthesis of these discrete molecules and their in-depth characterization details along with their unique applications.



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Plenary Lecture - 02

ANP-2 Deciphering Catalytic CO₂ Conversion through Operando Spectroscopy and Multimodal Analysis

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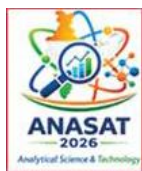
ABSTRACT

The development of sustainable energy and carbon management technologies requires not only the discovery of efficient catalysts but also a fundamental understanding of the chemical transformations occurring at catalytic interfaces. Our research focuses on the analytical investigation of catalytic materials and reaction pathways for CO₂ conversion, green hydrogen production, and electrochemical energy technologies, with particular emphasis on establishing structure–composition–activity relationships. In this presentation, I will discuss the development of intermetallic, chalcogenide, oxide, and organic–inorganic hybrid catalysts for the selective conversion of CO₂ into value-added products, including CO, methanol, methane, dimethyl ether, and C₂–C₁₁ hydrocarbons. Particular emphasis will be placed on the analytical methodologies used to understand catalyst structure, surface chemistry, reaction intermediates, and dynamic changes under operating conditions. A combination of in-situ/operando diffuse reflectance infrared spectroscopy (DRIFTS), X-ray absorption spectroscopy (XAFS), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), vibrational spectroscopy, Photoluminescence, Nuclear Magnetic Resonance (NMR), Transmission/scanning Electron Microscopy (TEM/SEM) and chromatographic product analysis provides complementary information spanning the atomic, molecular, surface, and reaction levels. These analytical approaches enable the identification of key surface intermediates, oxidation states, coordination environments, active sites, and reaction pathways, thereby establishing direct correlations between catalyst structure and product selectivity. I will further highlight how quantitative product analysis and operando characterization can guide the rational design of catalysts for targeted CO₂ conversion and electrochemical

reactions. Examples from industrial flue-gas CO₂ capture and conversion, green hydrogen production, and the utilization of hydrogen, methanol, and ethanol in fuel-cell systems will illustrate the translation of fundamental analytical insights into technologically relevant processes. Overall, the presentation will demonstrate how advanced analytical chemistry can bridge fundamental molecular-level understanding with catalyst development and industrially relevant carbon-recycling technologies, providing a pathway toward sustainable chemical and energy production.

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Plenary Lecture - 03

ANP-3

Spectroscopic Probing of Supramolecular Polymerization: From Structural Precision to Dynamic Function

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ABSTRACT

Supramolecular polymerization provides a powerful route to functional soft materials through the programmed self-assembly of molecular monomers. However, understanding and controlling these processes require analytical methods that can resolve subtle changes in molecular packing, aggregate morphology, polymer length, pathway complexity and exchange dynamics. Spectroscopic tools are therefore central not only to characterizing supramolecular polymers, but also to elucidating the thermodynamic and kinetic principles that govern their formation.

Our laboratory investigates bio-inspired strategies for achieving structural and temporal control in supramolecular polymerization. Using complementary spectroscopic approaches—including absorption, fluorescence, circular dichroism, time-resolved measurements and kinetic analysis—we probe nucleation–elongation mechanisms, pathway selection, living supramolecular polymerization and reaction-coupled assembly. Such measurements allow us to follow the emergence, transformation and adaptation of supramolecular aggregates in real time, while correlating molecular-level events with macroscopic material behaviour.

This presentation will highlight our recent efforts to use spectroscopy as a mechanistic window into dynamic and non-equilibrium supramolecular polymers. Particular emphasis will be placed on reaction-mediated temporal control of self-assembly, dissipative aggregate formation, and strategies for expanding structural diversity through bio-inspired molecular design. These studies illustrate how analytical spectroscopy can guide the rational development of adaptive supramolecular materials.

Plenary Lecture - 04

ANP-4 From CO₂ Capture to High-Energy Polynitrogen Systems: Computational Chemistry as a Predictive Tool for Molecular Design

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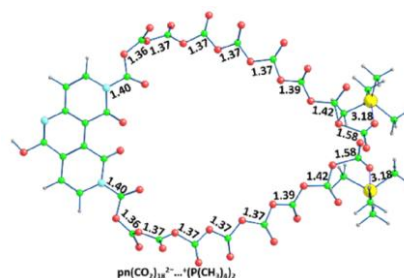


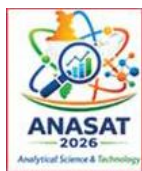
ABSTRACT

The increasing ability of computational chemistry to characterize molecular systems with experimentally relevant accuracy is transforming it from a largely interpretative tool into a predictive platform for chemical discovery. In this plenary talk, I will discuss two contrasting examples from our recent work—CO₂ capture and activation, and the design of high-energy polynitrogen systems—to illustrate how electronic-structure calculations and molecular descriptors can be used to understand, screen and ultimately design functional molecular systems.

The first part will focus on the molecular factors governing CO₂ recognition, binding and activation. Our recent studies examine how charge distribution, electrostatic potential, polarization, noncovalent interactions and metal–ligand coordination control the affinity and selectivity toward CO₂. Particular emphasis will be placed on the use of molecular electrostatic potential, interaction energies, electronic-structure descriptors and bonding analyses to identify the origin of enhanced CO₂ binding. These approaches provide a molecular-level framework for the rational design of improved CO₂-capture materials and molecular receptors.

The second part will address an apparently very different problem—the stability and energetic behaviour of extended polynitrogen chains. Calculations on progressively longer fluorine-terminated nitrogen chains reveal how molecular size, bonding pattern, kinetic stability and stored chemical energy evolve with chain length. Although the total





energy release increases dramatically with increasing nitrogen content, the gravimetric energy density approaches a limiting value, providing insight into the fundamental limits of such high-energy molecular systems. Analysis of bond dissociation, reaction pathways and activation barriers further allows distinction between thermodynamic energy content and kinetic stability.

Together, these studies demonstrate how computational analysis can connect molecular structure, electronic properties, stability and function across chemically very different systems. Such descriptor-rich computational datasets also provide a natural foundation for emerging AI- and machine-learning-assisted molecular screening, where reliable chemical descriptors and physically meaningful training data will be essential. I will briefly discuss how the combination of electronic-structure theory, molecular descriptors and data-driven approaches may contribute to the next generation of predictive chemical science.

Keywords: CO₂ capture; molecular electrostatic potential; noncovalent interactions; polynitrogen compounds; energetic materials; computational chemistry; AI-assisted molecular design

Plenary Lecture - 05

ANP-05 Advanced Polymeric Materials for Aerospace Research

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ABSTRACT

Polymeric materials find immense applications in aerospace field. The versatile nature and tunable backbones render them the material of choice for multitude of applications. In space research, polymeric materials are used as propellant binders, thermal and acoustic insulation, matrix resins for composites used in structural and thermo structural applications, adhesives, sealants, potting compounds, etc. As the aerospace and electronic industries are expanding, several challenging demands arise with respect to various functional requirements involving the electrical, mechanical, thermal and/or structural features. These are met with the development of advanced polymeric materials. The talk involves a brief overview of the materials currently used in different aerospace applications. The emerging trends specialty polymeric systems such as superhydrophobic materials, light weight thermal protection systems, smart polymers and elastic memory composites and self healing polymers and the challenges will be discussed in brief.

Plenary Lecture - 06

ANP-06 Nuclear Imaging techniques: A tool for in vivo analysis of diseases

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ABSTRACT

Analytical chemistry plays a major role in the management of diseases as it helps in providing the exact concentration of several blood parameters that are used for disease diagnosis. Nuclear imaging techniques including SPECT and PET uses radiotracers to detect and quantify diseases including cancer. These molecular imaging techniques quantify biochemical reactions *in vivo*. The talk will illustrate a few techniques using radioactive medicines for disease management.

One of the main impediments in the widespread use of nuclear imaging techniques is the availability of the short-lived radiopharmaceuticals. The efforts taken by the Molecular group to increase the availability of radiopharmaceuticals in the private sector will be highlighted in the presentation. These include setting up two medical cyclotron facilities, an advanced facility for the preparation of iodine-131 based radiopharmaceuticals as well as a GMP certified manufacturing facility for the preparation of cold kits for the preparation of technetium-99m radiopharmaceuticals. The radiopharmaceuticals manufactured by Molecular Group is helping about half a million patients annually.

Plenary Lecture - 07

ANP-07 X-ray Spectroscopy: A Non-Destructive tool for Advanced Characterization of Nuclear Materials

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ABSTRACT

Precise determination of major elemental constituents in nuclear fuels is vital for fuel quality control and performance assessment. Different reactor systems employ diverse fuel matrices, including UO_2 in PHWRs, $(\text{U,Pu})\text{O}_2$ MOX fuels in PFBRs, fluoride-based actinide fuels in MSRs. Conventional analytical techniques such as Biamperometry, isotope dilution mass spectrometry, ICP-OES, and ICP-MS provide accurate actinide quantification but require complete fuel dissolution, which is challenging for refractory thorium- and plutonium-containing fuels. Hence, rapid, non-destructive analytical methodologies with minimal or no dissolution requirements are highly desirable.

X-ray fluorescence (XRF) spectroscopy has emerged as a promising technique for nuclear fuel analysis owing to its minimal sample preparation, non-destructive nature, rapid measurement, and multi-element detection capability. Various XRF-based sample preparation strategies have been developed for direct fuel characterization without dissolution. MOX fuel pellets can be powdered, homogenized with an internal standard such as Y_2O_3 , and pelletized for XRF analysis; however, this involves partial destruction of the sample. Alternatively, micro-sampling approaches using few hundred micrograms of surface material dispersed in dilute surfactant solutions (e.g., 1% Triton-X) and deposited on suitable supports, as well as contact sampling using adhesive tapes, enable analysis with reduced sample requirements and improved radiological safety, while achieving precision better than 5%. These approaches can be extended to plutonium-containing fuels. Although actinide L-series emission lines are commonly used for quantification, M-series lines often suffer from spectral interferences, which can be effectively addressed using advanced spectral deconvolution methods such as artificial neural network (ANN)-based modelling.

Although XRF-based methodologies enable relative actinide determination in complex fuel matrices, accurate estimation of absolute elemental concentrations (wt%) requires effective calibration strategies. Conventional intensity-based calibration is often affected by severe matrix effects and nonlinear behaviour. Normalization of characteristic fluorescence intensities using Rayleigh and Compton scattered radiation, which are sensitive to sample matrix and geometry, provides an effective internal correction approach. This enables linear calibration even for highly absorbing nuclear fuel matrices and has been successfully applied for quantitative determination of uranium and thorium in oxide-based MOX fuels and fluoride-based molten salt reactor fuels. The method achieves recoveries above 95% and precision better than 3% without requiring complete fuel dissolution.

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Plenary Lecture - 08

ANP-08 From Waste To Wealth: Recovery Of Critical Minerals Sc And Ga From Red Mud For Advanced Materials

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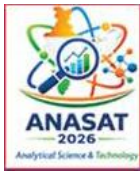
ABSTRACT

The global transition to clean energy, e-mobility, and strategic electronics has triggered an unprecedented demand for critical minerals. Among them, Scandium (Sc) and Gallium (Ga) are classified as most critical due to their irreplaceable role in advanced technologies and extremely vulnerable supply chains. Scandium is essential for high-strength Al-Sc alloys for aerospace and Solid Oxide Fuel Cells, while Gallium is the backbone of GaN and GaAs based semiconductors, LEDs, 5G and defence systems. India is 100% import-dependent for both.

This talk presents a paradigm shift - viewing industrial waste as a secondary resource. India generates ~9-10 million tonnes of Bauxite Residue or Red Mud annually from alumina refineries, with a historical inventory of >150 million tonnes. Red Mud is an environmental liability, but it is enriched with valuable metals: 60-120 ppm Sc and 50-80 ppm Ga, along with Fe, Al, Ti and Rare Earths. Recovering just 50% of Sc from this inventory can meet India's demand for decades.

The presentation will systematically cover: (1) Mineralogical characterization of Indian Red Mud and deportment of Sc and Ga, (2) State-of-the-art recovery routes including acid leaching (H₂SO₄, HCl), selective precipitation, solvent extraction using D2EHPA, TBP and ionic liquids, and ion-exchange resins, and (3) Downstream purification to produce 4N grade Sc₂O₃ and Ga.

Special focus will be on the core challenges that limit commercialization: low concentration and similar chemical behavior leading to poor selectivity, co-dissolution of major impurities like Fe and Si, high acid consumption, and management of secondary waste. The talk will highlight emerging green approaches - sequential leaching, bio-



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leaching and zero-waste utilization of residual Red Mud for construction materials - to improve economic viability.

Finally, the direct linkage of recovered Sc and Ga to Atmanirbhar Bharat and circular economy will be discussed, demonstrating how this "Waste to Wealth" pathway can transform an environmental liability into a strategic asset for advanced materials, ensuring resource security for India's clean energy and semiconductor mission.

Plenary Lecture - 09

ANP-09 From Raman Fingerprints to Intelligent Diagnosis: SERS and Machine Learning for Alzheimer's Disease

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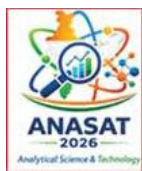


ABSTRACT

Alzheimer's disease (AD) is a complex and progressive neurodegenerative disorder in which pathological changes begin years before the appearance of overt clinical symptoms. The ability to detect these changes early, preferably through a simple blood test, could fundamentally transform the diagnosis and management of the disease. However, the biochemical complexity of blood and the extremely low abundance of disease-associated biomarkers present formidable challenges for conventional diagnostic approaches.

This talk will present our journey towards developing Raman spectroscopy-based intelligent platforms for blood-based detection and classification of Alzheimer's disease. Surface-enhanced Raman spectroscopy (SERS), with its exceptional sensitivity and molecular fingerprinting capability, provides an attractive approach for probing subtle biochemical changes associated with neurodegeneration. We first developed a SERS immunoassay for the multiplex detection of the core Alzheimer's biomarkers A β 40, A β 42, p-tau and t-tau in plasma. By combining the rich spectral information generated by SERS with machine learning, we demonstrated the potential to distinguish Alzheimer's disease, mild cognitive impairment (MCI) and healthy controls, illustrating how artificial intelligence can extract clinically relevant information that may not be apparent from individual Raman peaks alone.

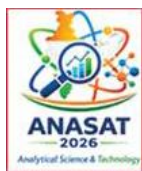
We subsequently extended this concept to neurofilament light chain (NfL), an important indicator of neuroaxonal injury. A dual-mode SERS lateral flow assay based on a gold nanorod–MXene quantum dot nanohybrid provided enhanced Raman amplification and enabled NfL detection in plasma, with a detection limit of 17.38 pg mL⁻¹ in spiked plasma. Importantly, the same Raman fingerprints could be coupled with principal component analysis and an artificial neural network/multilayer perceptron to classify AD, MCI and control samples.



These studies highlight an important paradigm shift: from detecting a biomarker to decoding a disease-associated molecular fingerprint. Rather than relying on a single analyte or a single spectral feature, Raman spectroscopy captures a multidimensional biochemical signature, while machine learning provides the means to recognise complex patterns embedded within that signature. SERS–AI has the potential to translate from proof-of-concept to clinically meaningful diagnostics, including biomarker selection, spectral reproducibility, biological heterogeneity, data augmentation, model robustness and the need for larger and multicentric clinical validation.

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Plenary Lecture - 10

ANP-10 **Future of Refining Beyond Fossil Fuels and the Role of Analytical Science**

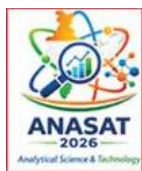
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ABSTRACT

The refinery of the future must respond to changing transport fuel demand, decarbonisation requirements and growing opportunities in chemicals and advanced materials. A phased roadmap is planned for transforming conventional refineries into integrated energy and materials hubs over 2025–2055. It connects feedstock diversification and asset repurposing with clean energy, digital operations and analytical capabilities, placing greater emphasis on value creation from each unit of feedstock and carbon.

The roadmap considers three transition horizons. The near term focuses on renewable and waste-derived feedstocks, cleaner fuels, petrochemical integration and AI-assisted maintenance. The medium term examines circular carbon processing, electrification, low-carbon hydrogen and more autonomous operations. HPCL technology pathways, including HP-Trijet for sustainable aviation fuel and NOVA-HP for enhanced petrochemical production, illustrate opportunities to build on existing refining capabilities. The long-term vision extends to renewable and nuclear energy integration, hydrogen hubs, synthetic fuels, specialty chemicals and advanced carbon materials for batteries and electronics. These pathways require deployment decisions that reflect technology readiness, feedstock availability, infrastructure, lifecycle emissions and commercial viability.

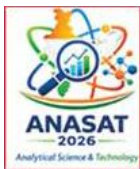


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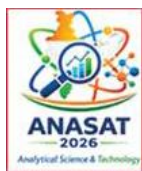
Analytical science provides an essential foundation for this transition. More diverse feeds and demanding product specifications require better characterisation of complex matrices, trace contaminants and catalyst behaviour. High resolution mass spectrometry, multidimensional chromatography, microscopy and operando measurements improve chemical identification and understanding of materials under working conditions. Combining laboratory methods with handheld instruments and inline analysers can support faster screening, process monitoring and specification confirmation. Artificial intelligence can assist signal interpretation, compound identification, experimental planning and anomaly detection. Its application nevertheless requires representative training data, validated methods, calibration, uncertainty assessment and accountable human review.

The proposed framework broadens refinery performance assessment beyond throughput and conventional refining margins to include feedstock flexibility, molecule utilisation, product carbon intensity, circular resource use, predictive reliability and integrated value creation. It identifies a practical relationship between business diversification and measurement capability: new products and processing routes create value only when their quality, performance and environmental attributes can be demonstrated reliably. The resulting vision is a refinery that progressively combines fuels, chemicals, materials and clean energy within an adaptable operating platform, supported by analytical evidence and disciplined technology deployment.

Keywords: Refinery transformation; circular carbon; clean energy; advanced materials; analytical science; artificial intelligence.



INVITED TALKS



Invited Talks - 01

ANI-1 Ligand Isomerism-Assisted Electrochemical Sensing

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ABSTRACT

While the central metal ion in molecular systems has conventionally been regarded as the primary driver of electrochemical activity, emerging evidence highlights the critical role of ligand nature and, notably, ligand isomerism in modulating electrochemical kinetics, mechanisms, and energy storage. In this talk, I will discuss how molecular-scale structural variations in ligands influence interfacial dynamics and reaction pathways, often rivaling or surpassing metal centered effects. These findings challenge conventional design strategies and emphasize the importance of considering ligand architecture as equally vital as the metal ion in molecular electrochemistry. A deeper understanding of this ligand effects will guide the development of highly efficient and tunable molecular platforms, enabling precise control over electrochemical processes and driving transformative breakthroughs in electrochemical sensing.¹⁻⁵

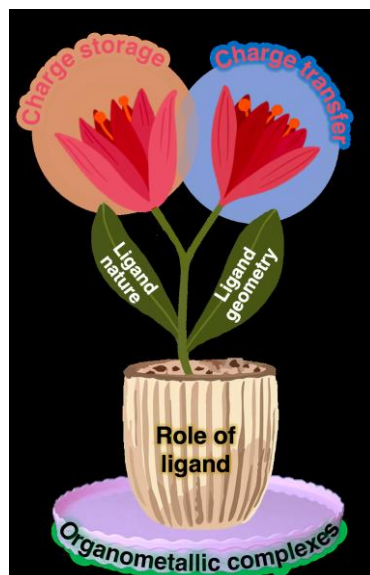


Figure 1. Electrochemical process switching through ligand isomerization.

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Invited Talks - 02

ANI-2 **Bacterial Nanocellulose: A Green Technology Shaping the Future of Sustainable Biomaterials**

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ABSTRACT

Bacterial nanocellulose (BNC) has emerged as a sustainable, high-performance biomaterial with significant potential to address global challenges in healthcare, environmental protection, food technology, and advanced manufacturing. Produced extracellularly by cellulose-synthesizing bacteria, BNC is distinguished from plant-derived cellulose by its exceptional purity, nanoscale fibrillar architecture, high crystallinity, remarkable mechanical strength, superior water-holding capacity, and excellent biocompatibility. As a renewable and biodegradable material, BNC represents an environmentally friendly alternative to petroleum-based polymers and synthetic materials, supporting the transition toward a circular bioeconomy.

Recent advances in microbial fermentation, metabolic engineering, and bioprocess optimization have improved BNC production efficiency while enabling the utilization of low-cost agro-industrial residues and waste streams as sustainable feedstocks. Functionalization of BNC through chemical modification and nanocomposite fabrication has further expanded its applications in wound dressings, tissue engineering, drug delivery systems, biosensors, food packaging, water purification membranes, flexible electronics, and energy storage devices. Despite these advances, challenges such as high production costs, limited large-scale manufacturing, and downstream processing remain barriers to widespread commercialization.

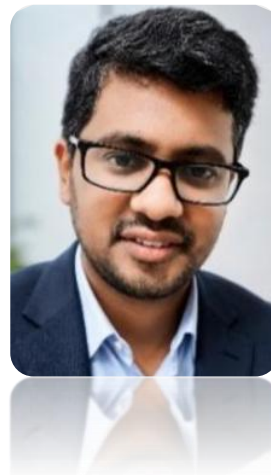
Future research should focus on strain improvement, continuous and scalable bioprocesses, integration with synthetic biology and artificial intelligence for process optimization, and life-cycle assessment to enhance economic and environmental sustainability. With its unique combination of structural, functional, and ecological advantages, bacterial nanocellulose is poised to become a cornerstone of next-generation green technologies, contributing to sustainable industrial development and innovative bio-based solutions across diverse sectors.

Invited Talks - 03

ANI-3 Fabricating Smart Optical Platforms for Selective Detection and Discrimination of Organophosphorus Nerve Agent Simulants

Nilanjan Dey

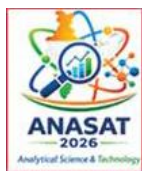
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ABSTRACT

The rapid and selective detection of organophosphorus nerve agents remains a major challenge in chemical defense because of their extreme toxicity, structural similarity, and comparable electrophilic reactivity, which frequently result in poor selectivity and false-positive responses. Herein, we present two complementary reaction-driven oligo(phenylene vinylene) (OPV)-based optical platforms that exploit analyte-specific chemical transformations to achieve highly selective detection and discrimination of nerve agent simulants.

The first platform employs a water-compatible pyridine-terminated OPV that undergoes selective phosphorylation with diethyl chlorophosphate (DCIP), producing simultaneous ratiometric absorption and fluorescence responses together with an unprecedented cyan-to-white fluorescence transition arising from the coexistence of two emissive states. The system operates entirely in aqueous medium and integrates sensing, intrinsic detoxification through hydrolysis, probe regeneration under mild basic conditions, and smartphone-assisted paper-strip analysis, providing a sustainable and field-deployable sensing strategy. In contrast, the second platform utilizes a silyl-protected OPV scaffold for indirect detection of diisopropyl fluorophosphate (DFP), where base-promoted hydrolysis releases fluoride that triggers desilylation and pronounced modulation of intramolecular charge transfer. A previously unexplored counter-ion-regulated aggregation mechanism enables discrimination between organic and inorganic fluoride sources through distinct excited-state behaviors, overcoming the low intrinsic reactivity of P–F-containing nerve agents. These platforms demonstrate how molecular engineering of OPV scaffolds, reaction-driven recognition, controlled self-assembly, aggregation-assisted emission, and excited-state charge-transfer modulation can be integrated to achieve exceptional selectivity toward structurally similar organophosphorus agents. The combination of dual-mode ratiometric sensing, rare white-light emission, analyte



discrimination, portable smartphone-assisted quantification, probe regeneration, and integrated detoxification represents a significant advance over conventional intensity-based optical sensors.

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Invited Talks - 04

ANI-4 **Role of Separation Techniques in the Chemical Characterization of Nuclear Fuels**

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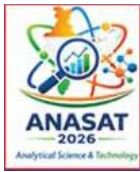


ABSTRACT

Nuclear technology plays an important role in the sustainable development of humanity due to its wide spread applications across energy production, healthcare, agriculture, and industry. Unlike conventional fossil fuels, nuclear power produces energy without emitting greenhouse gases which lead to severe climate changes. Use of nuclear energy can significantly boost industrial decarbonization and support the achievement of net-zero carbon emissions. A large number of radioisotopes produced in the nuclear reactors, have revolutionized medicine, particularly in the fields of diagnostics and cancer treatment. Nuclear technology also contributes to agriculture by extending the shelf life of food, controlling pests, reducing microbial contamination, and thereby enhancing food security. Research in nuclear science also contributes to advancing basic research and innovations in the fields of materials science, engineering, physics and chemistry.

Different activities involved in the production of energy from the nuclear reactors are generally referred as nuclear fuel cycle. It consists of mining, ore refining, conversion, nuclear fuel fabrication, reactor operation, post-irradiation examination, reprocessing, waste management etc. Chemical Quality control (CQC) of the fuels and reactor materials is an important aspect in the nuclear fuel cycle activities. Chemical quality control of the nuclear fuels ensures that the quality of the fabricated fuel conforms to its chemical specifications. Complying with many stringent specifications is critical for smooth and sustained operation of the nuclear reactor to realize the expected performance. In general, chemical quality control of nuclear fuels involves the use of robust and well-established analytical methodologies for providing accurate data on the major, minor and trace constituents.

The candidate materials for the analysis consists of a wide spectrum of nuclear fuel materials and reactor materials. The specifications are worked out for the major, minor and trace constituents that may affect the fuel properties and hence its performance under reactor operating conditions. Control of trace constituents in the fuel is essential to ensure



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the expected performance of the fuel in the reactor. For example, impurities such as fluorine and chlorine are very critical in fuel as they can attack the clad due to their corrosive nature. Elements such as boron, cadmium and certain rare earths elements should also be monitored at trace levels as they can affect the neutron economy due to their relatively large neutron absorption cross-sections.

Different analytical methodologies are employed depending on the nature of the sample, the analyte of interest and the required levels of precision and accuracy. In most analytical methodologies, chemical separation constitutes an essential step, even when sophisticated analytical techniques are employed, as it facilitates the removal of interfering species and enables the accurate and selective determination of the analyte.

The various separation methods employed to overcome the challenges encountered in the analysis of fuel samples will be discussed in the presentation.

Invited Talks - 05

ANI-5 Determination of molecular composition of dicarboxylic acids, oxocarboxylic acids, α -dicarbonyls and fatty acids in atmospheric aerosols using gas chromatograph equipped with flame ionization and mass detector

Prashant Hegde

Space Physics Laboratory, Vikram Sarabhai Space Centre, Thiruvananthapuram

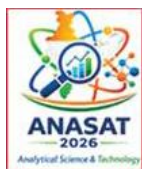
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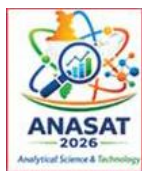
ABSTRACT

Oxalic acid and other low-molecular-weight (LMW) dicarboxylic acids and polar compounds

such as ω -oxocarboxylic acids, ketoacid and α -dicarbonyls (C2 to C12) form a prominent group of water-soluble organic aerosols in the atmosphere. They are likely to be produced in the atmosphere via secondary processes and are crucial for understanding the photochemical transformation of anthropogenic and biogenic volatile organic compounds (VOCs) in the atmosphere. To analyze these water-soluble organic compounds in atmospheric aerosols using the gas chromatograph - flame ionization detector (GC-FID), a portion of the aerosol filter samples was extracted in a pre-combusted glass vial with organic-free ultrapure Milli-Q water (10 mL x 3) in an ultrasonic bath for 10 min. The extracts were collected in a Pear-shaped flask by passing through a Pasteur pipette tightly packed with pre-baked quartz wool to remove the particles and filter debris. The pH of the water extract was adjusted between 8.0-8.5 using 1 M KOH for better recoveries of water-soluble organic compounds. The aerosol extract was then concentrated to near dryness by rotary evaporation attached to a water bath (40°C) and a recirculation chiller (2 to 4°C) under a vacuum. The derivatization of the dried sample was performed by adding 14% BF₃ dissolved in n-butanol (300 μ L) in the Pear-shaped flask tightly sealed with Teflon tape. The derivatization reaction was performed at 100°C for 1 hour to convert the water-soluble organic compounds to their corresponding esters and acetals derivatives. The reaction products were then dissolved in n-hexane (5 mL) and washed with organic-free ultrapure water (3 mL x 3). Acetonitrile (0.3 mL) was added to the derivatives to remove the excess amount of derivatizing reagent from the sample. The hexane layer was then concentrated using a rotary evaporator under vacuum and transferred to a 1.5 mL GC vial. Finally, the sample was completely dried using a nitrogen stream blow concentrator and dissolved in 100 μ L n-hexane.



The derivatives were analysed by using a capillary (0.32 mm i.d x 30 m x 0.25 μ m film thickness) GC (PerkinElmer Clarus® 680) equipped with FID under a splitless mode. The column oven temperature was programmed from 50°C for 2 min to 120°C at 30°C min⁻¹ and then to 300°C at 8°C min⁻¹ and maintained for 10 min. Injection port temperature was kept at 250°C with a Helium as a carrier gas. The GC peak areas of the detected derivatives were calculated using the Total Chrome peak integration software. The identification and quantification of the target compounds were made by comparing GC retention times with those of authentic standards. The identified peaks of water-soluble organic compounds were also confirmed by mass spectral examination using a GC (PerkinElmer Clarus® 690) and mass spectrometer (Perkin Elmer Clarus® SQ8T). Recoveries of target compounds spiked to pre-combusted quartz filter were 85% for oxalic acid (C2) and more than 90% for other related polar compounds. Triplicate analyses of the aerosol samples presented that the analytical errors in the determination of water-soluble organic compounds were less than 10%. We also analysed the field blanks, which showed minor peaks of C2, adipic (C6) and phthalic (Ph) acids. However, they are usually less than 5% of the concentrations found in the actual aerosol samples. The concentrations of water-soluble organic components in aerosol samples were suitably corrected against blanks but not corrected for the recoveries.



Invited Talks - 06

ANI-6 **Phytomedicine: Harnessing Analytical Tools from the Discovery of Herbal Medicines to Single-Molecule APIs**

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ABSTRACT

Plant-derived natural products have long served as a cornerstone of healthcare, providing an exceptionally diverse reservoir of structurally complex and biologically active molecules that continue to inspire modern drug discovery. This presentation, “Phytomedicine: Harnessing Analytical Tools from the Discovery of Herbal Medicines to Single-Molecule APIs,” will highlight the pivotal role of analytical science in translating plant-based medicinal resources into scientifically validated and therapeutically relevant products. Particular emphasis will be placed on the application of analytical tools for the identification, structural characterization, quantification, standardization, and quality assessment of phytochemicals and botanical preparations. The integration of analytical chemistry with phytochemistry, medicinal chemistry, pharmacology, and biotechnology enable the systematic identification of bioactive constituents, elucidation of their mechanisms, and optimization of promising natural-product leads.

The presentation will further discuss the transition from chemically complex herbal medicines to well-characterized phytopharmaceuticals and, ultimately, defined single molecule active pharmaceutical ingredients (APIs). Key challenges related to standardization, reproducibility, regulatory requirements, scalability, and sustainable production will also be addressed. Overall, the talk will demonstrate how analytical science serves as a critical bridge between traditional plant-based knowledge and modern pharmaceutical innovation, facilitating the discovery, validation, and development of next-generation therapeutics from natural resources.



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Invited Talks - 07

ANI-7 Machine Learning Algorithm to predict the Ideal analytical parameters of Electrophoretic deposition technique in development of next-Generation Ceramic Coatings

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ABSTRACT

Electrophoretic deposition (EPD) is a versatile colloidal process that uses an electric field to deposit charged particles onto conductive surfaces. A key challenge is measuring and controlling coating thickness, which is vital for optimal performance, including corrosion resistance and mechanical stability. Relying solely on trial-and-error is time-consuming and resource-intensive for determining ideal analytical parameters to develop. A new method that combines simulation (COMSOL Multiphysics 6.1) with machine learning (ML), compiled from the analytical data reported in literature and previous experimental data (170 points), to predict EPD coating thickness using ML models such as Random Forest (RF), Extreme Gradient Boost (XGBoost) and Support Vector Regression (SVR). Errors were analysed to identify the most accurate model. The simulations and experiments, alongside literature data can be used to predict coating thickness of the deposits and the parameters such as voltage, time, concentration, pH, and zeta potential were optimised and then used to train these models. Experimental coating thickness measurements were confirmed by FE-SEM cross-sectional view. This proposed system was tried with bioceramic coatings on titanium alloys for biomedical applications. ML can effectively reduce time, manpower, and chemical use, enabling faster responses from biomaterial coating implants for next-generation orthopaedics.

Keywords: Machine Learning, Prediction and Electrophoretic deposition

Invited Talks - 08

ANI-8

Lithium occurrence and extraction methodologies: An overview with emphasis on Indian perspective

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ABSTRACT

Lithium is one of the most important critical minerals owing to its indispensable role in rechargeable batteries, electric vehicles, and large-scale energy storage systems. Although its average abundance in the Earth's crust is only about 25 ppm, lithium is widely distributed in igneous, sedimentary, hydrothermal, and brine environments (Taylor and McLennan, 1985; Rudnick and Gao, 2005). Commercial lithium is presently produced mainly from continental brines, hard-rock pegmatites, and sedimentary clay deposits. Continental brines of the Lithium Triangle (Chile, Argentina, and Bolivia) constitute the world's largest low-cost resources, whereas highly fractionated LCT (Li–Cs–Ta) pegmatites containing spodumene, petalite, and lepidolite dominate hard-rock production, particularly in Australia. More recently, clay-hosted deposits such as Jadar (Serbia) and lithium-rich claystones of China and North America have emerged as promising future resources.

Although India has not yet entered commercial lithium production, the country possesses significant geological potential in pegmatites, granitic terrains, mica belts, sedimentary clay deposits, and saline brines. Systematic exploration by the Atomic Minerals Directorate for Exploration and Research (AMD) and the Geological Survey of India (GSI) has considerably enhanced the understanding of India's lithium resources and identified several promising exploration targets (Meshram et al., 2021; Ministry of Mines, 2023). Among the well established Li occurrences in India, the Marlagalla–Allapatna pegmatite belt of Mandya District, Karnataka, is India's best-studied hard-rock lithium province, where AMD delineated India's first inferred hard-rock lithium resource enriched in Li together with Rb, Cs, and Ta. A major milestone was also achieved in 2023, when GSI announced an inferred G3 lithium resource of approximately 5.9 million tonnes in the Salal–Haimana area, Reasi District, Jammu and Kashmir (Ministry of Mines, 2023). The coexistence of pegmatite- and clay-hosted deposits highlights the geological

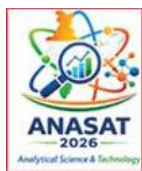
diversity of Indian lithium resources and strengthens the country's prospects for achieving self-reliance in critical minerals.

Because lithium is finely disseminated, conventional physical beneficiation is ineffective and direct chemical extraction is required. The extraction methods for Li depend on the mineralogy, lithium concentration, gangue composition, and impurity levels. Conventional pyrometallurgical–hydrometallurgical routes continue to dominate industrial production of Lithium. However, extensive research is focused on developing low-temperature, energy-efficient, and environmentally sustainable alternatives.

For hard-rock spodumene, the conventional industrial process involves thermal conversion of α -spodumene to the reactive β -spodumene at 1050–1100 °C, followed by sulphuric acid roasting (~250 °C) and water leaching to produce soluble lithium sulphate finally purified as lithium carbonate. Although this process remains the industrial benchmark, its high energy consumption and roasting with highly corrosive acid has prompted the development of alternative technologies. Microwave-assisted calcination achieves lithium recoveries comparable to conventional roasting (~97%) while significantly reducing heating time and energy consumption (Matteo Valpi et al., 2022). Low-temperature fluorination using NaF, KF, or NH_4HF_2 has also emerged as a promising alternative, producing lithium recoveries exceeding 90% without complete β -phase conversion (Alexander et al., 2023). Other approaches such as direct acid or alkaline leaching, mechano-chemical activation, and bioleaching have shown encouraging laboratory-scale results but require further optimization before commercial implementation (Renjith Krishnan et al., 2024). Hence solvent extraction has become increasingly important because of its high lithium recovery, selectivity and cost effectiveness. The TBP– FeCl_3 –MIBK system, together with crown ethers, β -diketones combined with 1,10-phenanthroline, and synergistic organophosphorus extractants, provides high selectivity for lithium over sodium and magnesium, with multistage extraction achieving lithium recoveries exceeding 96% (Linju Qiao et al., 2022; A. Karrecha, 2020). Alternative method of solvent extraction for removal of major matrix elements in Marlagalla–Allapatnaspodumene using phosphoric acid derivatives followed by selective extraction of Li in presence of β -diketone–1,10-orthophenanthroline system and further stripping of Li with dilute HCl is under study. These efforts are directed toward developing low-acid, energy-efficient, and sustainable extraction technologies tailored to India's emerging lithium resources.

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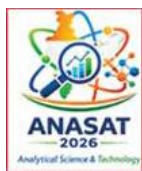
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Invited Talks - 09

ANI-9 Analytical Chemistry for Space Applications: Root Cause Analysis to Material Development

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ABSTRACT

Space-grade materials rarely get a second chance. Once qualified and integrated into a system, there is little room to fix what goes wrong later, which is why analytical chemistry, particularly spectroscopic and microscopic characterization, is central to both failure investigation and material development in space sector. The techniques are not new, but the constraints under which they are applied often are: limited sample, no repeat test, and a result that has to hold up under scrutiny. Root cause investigations of polymeric, ceramic and composite materials typically begin with non-destructive analysis. Vibrational spectroscopy including Raman microscopy can reveal chemical changes, contamination or degradation pathways that would otherwise stay invisible. Electron microscopy with elemental analysis (SEM-EDS) takes this further, tying a physical defect such as a crack, a delamination, a particle back to its composition. Thermal and chromatographic methods fill in the rest, identifying process deviations, ageing effects or trace contaminants that spectroscopy alone might miss. Generic case studies will illustrate how these techniques can be combined to resolve failures where the evidence is partial, indirect or limited to a few milligrams of material. The same tools carry into material development, where the question shifts from “what went wrong” to “what will hold up.” Structural and compositional data are correlated with mechanical behaviour, thermal stability and long-term durability, with the aim of discovering weaknesses before they become failures rather than explaining them afterward. Where the field is headed matters as much as where it stands. Non-destructive and micro-sampling methods are becoming increasingly important, given how little material is often available to work with. The talk will examine this balance between analytical capability, sample limitations and the reproducibility required for high-reliability applications

Invited Talks - 10

ANI-10 Ceramic Sorbents for High and Intermediate Temperature CO₂ Capture

U. S. Hareesh

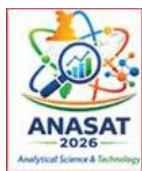
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ABSTRACT

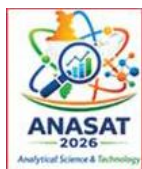
Decarbonisation in heavy industries like steel and cement has become a top priority in light of government initiatives to achieve net-zero targets. The steel industry alone contributes nearly 9–10% of all global CO₂ emissions and are actively exploring carbon capture solutions. Advanced functional materials possessing high absorption capacity, fast reaction speeds (appreciable kinetics), and long-term recyclability are essential to achieve the carbon capture targets. While lithium silicate has been widely studied for high-temperature CO₂ absorption, its real-world application has been limited by poor capacity and slow reaction speeds at intermediate temperatures. To solve this, we are actively developing lithium zincate ceramics, which achieve an absorption capacity close to 10 mmol/g at temperatures above 500°C.

This talk covers the synthesis, characterisation, and application of lithium zincate, as well as its composite blends with low-melting-point (eutectic) mixtures designed to capture CO₂ in the 250–400°C range. This technology is uniquely suited for trapping emissions from steel industry stove waste gases, where concentrated streams of 20–25% CO₂ are currently released straight into the atmosphere.



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CONTRIBUTORY PAPERS

Contributory Paper - 01

ANC 01 Dual Drug-Loaded Polymer Hybrid Nanocomposite For The Enhanced Transdermal Delivery in Breast Cancer Therapy

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ABSTRACT

Mesoporous silica (MSN) nanoparticles are emerging as promising drug carriers to deliver drugs to the site of action without loss. In this study, a redox and pH-responsive dual drug-loaded MSN-polymer hybrid nanomaterial device was synthesized for the transdermal delivery of doxorubicin (DOX) and curcumin (CUR) to treat breast cancer. MSN with a pore size of 5.7 nm was synthesized and aminated for further modifications, and hydrophobic CUR was loaded into the pores. DOX-loaded disulfide crosslinked nanomaterial was synthesized with gelatine (Gel) and polyethylene glycol (PEG) for the redox-responsive delivery of drugs to the cancer cells. The DOX-loaded Gel-S-S-PEG was coated on the surface of CUR-loaded aminated MSN through imine linkage. The synthesized dual drug-loaded MSN-polymer hybrid nanomaterial was physicochemically characterized. The material was observed with a drug loading efficiency of $46.72 \pm 2.41\%$ for CUR and $58.11 \pm 2.03\%$ for DOX, along with an encapsulation efficiency of $93.44 \pm 2.92\%$ for CUR and $96.83 \pm 1.87\%$ for DOX. The pH and redox-responsive release profiles of DOX and CUR were determined. The hemocompatibility, biocompatibility, in vitro cell viability, and antibacterial and cell co-localization studies were analyzed. The ex vivo permeation was investigated using a Franz diffusion cell without an external skin permeation enhancer. The in vivo pharmacokinetics, biodistribution, and histopathology assays, in comparison with oral and transdermal routes of administration in Wistar rats, confirmed the potential activity of the synthesized dual drug-loaded mesoporous silica-polymer hybrid nanomaterial as a device for transdermal breast cancer therapy.

Contributory Paper - 02

ANC 02 Cobalt-Doped Layered La_2NiO_4 Ruddlesden-Popper Phase Layered Perovskite Oxides For The Hydrogenation Of Furfural

P.J. Arsha^a, V P. Krishnendhu^a, A. Sakthivel^{a*}

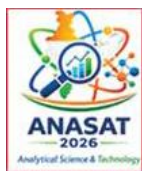
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ABSTRACT

Catalytically converting biomass-derived platform molecules into value-added chemicals is an important strategy for developing sustainable alternatives to fossil-based resources.¹ Furfural, obtained from the hemicellulose (C_5) fraction of lignocellulosic biomass, is a versatile platform molecule that can be transformed into a range of value-added chemicals and fuel precursors through selective hydrogenation.^{1,2} In this context, the development of sustainable, multifunctional catalysts for controlled hydrogenation of furfural is a subject of research interest. Ruddlesden–Popper (RP) layered perovskite oxides offer unique structural features and tunable redox properties, making them attractive precursors for sustainable catalysts.

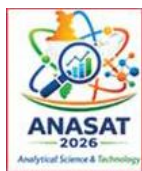
Herein, a series of Co-doped La_2NiO_4 RP layered perovskites were synthesised by solution combustion using sucrose as the fuel. The calcination of the combusted precursors at 750 °C yielded well-crystalline RP phases. Powder X-ray diffraction analysis confirmed the formation of the tetragonal La_2NiO_4 structure. The perovskite precursors were subsequently reduced under a hydrogen atmosphere to generate metallic Ni–Co species through the reduction-induced structural transformation of the RP phase. The resulting reduced materials were investigated as catalysts for furfural hydrogenation. The formation of Ni–Co bimetallic species (as evidenced by XPS) from the layered perovskite precursor provides an effective strategy for tuning the hydrogenation activity and product selectivity. This work highlights the potential of Co-doped La_2NiO_4 RP perovskites as versatile catalyst precursors for the sustainable valorisation of biomass-derived furfural.

Acknowledgement: Authors indebted to the DST-SERB (CRG/2023/001107) for financial assistance.



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Contributory Paper – 03

ANC 03	Assessment of ageing of carbon epoxy prepreg by Differential Scanning Calorimetry (DSC) Method
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ABSTRACT

Reactive matrix systems like Epoxies (single part system) undergo polymerization when exposed above its prescribed storage temperature. Owing to its reactivity under temperature, each polymer material has specified Shelf life and Out life. Carbon epoxy prepreps are qualified based on mechanical test data obtained before and after shelf life. Extensive specimen preparation activities are involved for mechanical tests.

This study attempts to introduce a chemical test which can give an overall assessment of ageing. Polymerization is primarily influenced by temperature, duration of exposure above storage temperature, and contamination; specifically, the presence of proton donors or other reactive species. As these factors trigger the reaction of epoxy groups, its condition can be determined by analyzing cure-characteristics. On evaluating various test methodologies, Differential Scanning Calorimetry (DSC) was selected in this chemical characterization. The enthalpy of cure (ΔH_{cure}) is a primary parameter measured via DSC to assess the extent of cure, hence ageing.

Two primary studies were conducted. The first study selected prepreg samples, maintained under cold storage conditions (-18°C), while the second one involved an accelerated aging study with samples stored at ambient temperature ($21-24^{\circ}\text{C}$). To validate the DSC data of accelerated aged samples, mechanical properties were evaluated on specimen made from prepreps aged at the same condition and duration. The DSC data was finally correlated with the mechanical properties.

In Phase-1 of the study, the enthalpy of cure for the prepreg was evaluated across multiple batches. Phase-2 focused on assessing the reduction in enthalpy values resulting from ageing. This study was conducted on two selected batches. Finally, Phase-3 investigated the correlation between micro-level enthalpy of cure and macro-level mechanical properties of the two batches.

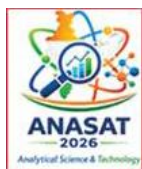
This study presents an '*efficient method*' for assessing the health of carbon/epoxy prepreps, significantly saving resources and man-hours. Furthermore, it elucidates micro level changes within prepreg and adhesive resin systems, providing a reliable basis for the evaluation of materials beyond its date of Expiry

Contributory Paper - 04

ANC 04	Unravelling Legacy Pesticide Footprints In Lakshadweep: Distribution, Source Diagnostics And Ecological Risk Of Ddt And Hch Residues In Kavaratti And Andrott Islands Of Lakshadweep, Indian Ocean
	<i>Dhinesh R^{1*}, Kirthiga SS¹, Anu Gopinath¹, Paromita Chakraborty², Mahendra R S³, Prakash Chandra Mohanty³, Sudheer Joseph³, T. M. Balakrishnan Nair³, Harikumar R³, Abdul Raheem C N⁴</i> <i>¹Department of Aquatic Environment Management, Faculty of Fisheries Science, Kerala University of Fisheries and Ocean Studies, Kochi, Kerala, India.</i> <i>²SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu, India.</i> <i>³Indian National Centre for Ocean Information Services, Hyderabad, India.</i> <i>⁴Department of Environment and Forest, Kavaratti, Lakshadweep, India.</i>

ABSTRACT

Remote tropical islands are often perceived as pristine environments; however, their limited land area, restricted freshwater resources and intense human dependence on coastal ecosystems can make them particularly vulnerable to persistent contaminants. Organochlorine pesticides (OCPs), especially DDT and HCH, represent an important legacy contaminant group because of their persistence, environmental mobility and potential for bioaccumulation. This study investigates the occurrence, distribution, source characteristics and ecological risk of pesticidal persistent organic pollutants in the aquatic ecosystems of Kavaratti and Andrott, two of the larger and more densely inhabited islands of the Lakshadweep archipelago. A multi-compound assessment was undertaken to characterize the contamination profiles of DDT and HCH groups, with the complete suite of targeted DDT isomers/metabolites being detected, providing a detailed chemical fingerprint of DDT transformation within the island environment. The relative abundance of parent DDT and its degradation products, together with the distribution of α -, β -, γ - and δ -HCH isomers, was evaluated to distinguish between potential recent inputs and historically weathered residues. Diagnostic ratios of DDT metabolites and HCH isomers, supported by spatial distribution patterns, were used to trace contaminant sources and transformation pathways. The predominance of degradation products and characteristic isomeric signatures provides evidence for the persistence of aged residues and the contribution of legacy contamination rather than a simple concentration-based interpretation. Ecological risk was subsequently evaluated by comparing measured



concentrations with sediment quality guideline thresholds and by applying risk-based metrics to identify individual compounds and locations contributing disproportionately to ecological concern. The comparative assessment of Kavaratti and Andrott provides a spatial perspective on the persistence and ecological significance of legacy pesticides within inhabited coral-island environments. By integrating chemical fingerprints, source diagnostics and ecological risk assessment, this study moves beyond contaminant detection to establish a forensic framework for identifying the legacy pesticide burden of Lakshadweep's aquatic ecosystems. The findings highlight the importance of sustained monitoring of persistent pesticide residues in vulnerable island environments where historical contamination can remain environmentally relevant long after restrictions on their use.

Keywords: DDT; HCH; Organochlorine pesticides; Legacy contamination; Source diagnostics; Ecological risk; Aquatic ecosystems; Lakshadweep.

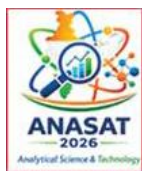
Contributory Paper - 05

ANC 05	Strain-Responsive Optical Behavior of Cellulose Nanocrystal–Carbon quantum dot nematic liquid Crystal Films
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ABSTRACT

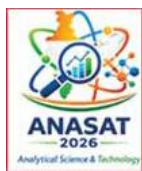
Sustainable solid-state circularly polarized luminescent biomaterials are emerging as promising platforms for next-generation polarized display technologies and advanced anti-counterfeiting systems, offering opportunities for multilevel optical information encryption. Cellulose nanocrystals (CNCs) are renewable and biocompatible nanomaterials, and their self-assembly into left-handed chiral nematic structures yields photonic properties, including iridescent structural colouration. Despite extensive research on CNC-based polymer composites, the structural organization and optical behaviour of CNCs in polymer matrices incorporating luminescent molecules remain insufficiently explored. Herein, CNCs were isolated from microcrystalline cellulose through acid hydrolysis. The CNCs exhibited rod-like morphology with an average diameter of ~2-3 nm and length of ~300 nm, along with a zeta potential of -42 mV, indicating high colloidal stability. Luminescent carbon quantum dots (CQDs) were synthesized via hydrothermal route, exhibiting blue fluorescence centred at ~480nm, yielding a quantum efficiency of 7.1%. The precursors for the CQD synthesis were selected to yield an N-doped CQD, as confirmed by XPS analysis

Hybrid CNC–CQD systems were prepared at various compositions and analysed using microscopic, spectroscopic, and photo-physical techniques. Dried CNC–CQD films showed emission at 505 (cyan) nm. The bio-composite, prepared by physical blending of CNC and CQD, exhibited circular dichroism and circularly polarised emission. The mechanical robustness of the film has been improved by integrating a polymer matrix without compromising the bio composite film's chiroptical properties. An optimized CNC–CQD formulation was incorporated into a poly (vinyl alcohol) (PVA) matrix to produce optically transparent composite films. The resulting CNC–CQD/PVA films exhibited strong green fluorescence with a maximum emission at approximately 515 nm. The as-prepared films exhibit good flexibility, excellent fluorescence, positive CD (circular dichroism), and CPL. The change in the optical and chiroptical properties of the as-prepared films in response to mechanical deformation is also evaluated, and a plausible mechanism is proposed.



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Contributory Paper - 06

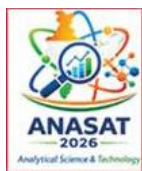
ANC 06	Plastic Fingerprints in the Changing Arctic: Tracing Microplastic Pathways and Ecological Risk from Rivers To Fjords
	<u>Kirthiga SS^{1*}</u>, Dhinesh R¹, Anu Gopinath¹, Shaju SS², Paromita Chakraborty³
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ABSTRACT

The rapidly changing Arctic is increasingly exposed to emerging contaminants transported across interconnected freshwater and marine environments. Microplastics (MPs), owing to their persistence, mobility, diverse physicochemical characteristics and polymer-specific hazards, are emerging as important indicators of anthropogenic pressure and contaminant connectivity in fragile polar ecosystems. This study investigates microplastic pathways, matrix-specific signatures and potential ecological risk across a river-to-fjord spatial gradient extending from near-origin environments towards Kongsfjorden and Krossfjorden, Svalbard. Microplastics were systematically characterized in water and sediment based on abundance, size, morphology, colour and polymer composition, enabling assessment of suspended and deposited plastic assemblages along the freshwater-to-fjord transition. Distinct differences between environmental compartments revealed a clear matrix-specific plastic signature. Fibres dominated the water assemblage, highlighting their potential for prolonged suspension and transport, whereas fibres and fragments were predominant in sediment, indicating differential settling, deposition and environmental retention. Transparent particles constituted the dominant colour category in both water and sediment, pertaining to the possibility of photodegradation or weathering. Spatial variations in particle characteristics and polymer composition were further interpreted in relation to potential riverine, local, marine and atmospheric transport pathways, recognizing that microplastic distribution may reflect multiple interacting sources and processes rather than a single pathway. The

environmental significance of the observed contamination was evaluated using a multidimensional risk framework incorporating the Pollution Load Index (PLI) and Contamination Factor (CF) to characterize contamination intensity, the Polymer Hazard Index (PHI) to account for polymer-specific hazard, and the Microplastic Diversity Integrated Index (MDII) to quantify the compositional complexity of microplastic assemblages. The integration of abundance, polymer hazard and diversity provides a more comprehensive assessment than particle abundance alone and enables differentiation between contamination hotspots and locations exhibiting greater compositional or hazard-related concern. The resulting spatial patterns reveal distinct plastic fingerprints along the Arctic River–fjord continuum, demonstrating that microplastic contamination is a dynamic and multidimensional phenomenon governed by particle characteristics, environmental compartment and multiple transport pathways. Considering potential long-range atmospheric transport alongside riverine, local and marine pathways provides a broader perspective on contaminant connectivity in the Arctic. Overall, the study establishes an integrated framework linking microplastic occurrence, particle signatures, transport pathways and ecological risk, supporting risk-informed environmental surveillance and sustainable management of vulnerable Arctic freshwater and fjord ecosystems under accelerating environmental change.

Keywords: Arctic microplastics; river–fjord continuum; Kongsfjorden; Krossfjorden; long-range atmospheric transport;

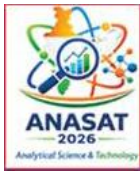


Contributory Paper - 07

ANC 07	Performance Evaluation of OCM-3-Derived CDOM In the Coastal Waters of Tamil Nadu Using In Situ and Radiometric Observations
	<i>Nagarajan Manimozhi¹, Murugan Vennila¹, Ranjit Kumar Sarangi², Anu Gopinath¹</i> <i>¹Kerala University of Fisheries and Ocean Studies (KUFOS), Kochi, Kerala,</i> <i>²AESG/EPESA, Space Applications Centre (ISRO), Ahmedabad, India</i> <i>* E-mail: manimozhinallur@gmail.com</i>

ABSTRACT

Colored dissolved organic matter (CDOM), the light-absorbing fraction of dissolved organic matter, plays an important role in aquatic optical properties, biogeochemical processes, and carbon cycling. Traditional field-based measurements of CDOM are resource-intensive and spatially limited, whereas satellite remote sensing provides an efficient approach for large-scale monitoring of CDOM variability. The Indian Oceansat-3 Ocean Colour Monitor (OCM-3), equipped with 13 visible and near-infrared (VNIR) spectral bands at a spatial resolution of 360 m, provides an opportunity for monitoring optically active constituents in coastal waters. Despite the increasing availability of satellite-derived CDOM data, their accuracy may vary among sensors and across different coastal environments, highlighting the need for validation and inter-sensor assessment. This study evaluates the performance of OCM-3-derived CDOM retrievals using independent in situ and radiometric observations from the coastal waters of Tamil Nadu. A total of 53 surface water samples were collected onboard the NIOT research vessel CRV *Sagar Tara* during 17–24 July 2026 along the Nagapattinam to Chennai coastal transect using a Niskin sampler. The collected water was transferred into pre-rinsed amber borosilicate bottles, filtered immediately through 0.2 μm membrane filters, and analysed for CDOM absorption at 440 nm ($a_{\text{CDOM}(440)}$). Hyperspectral remote sensing reflectance (R_{rs}) measurements were acquired using a SatlanticTM hyperspectral radiometer. The radiometric data were recorded using SatViewTM and further processed using Prosoft 7.7.19 to derive R_{rs} for CDOM retrieval and validation. Corresponding OCM-3 Remote Sensing Reflectance data were downloaded from the Bhoonidhi portal and processed using SeaDAS software for satellite-derived CDOM retrieval. The radiometer- and OCM-3-derived R_{rs} data were subsequently used in the Mannino et al. (2014) empirical algorithm to retrieve CDOM absorption, which was compared with the corresponding in situ measurements. The observed $a_{\text{CDOM}(440)}$ values were within the range of 0.01–0.10 m^{-1} . The comparison between in situ and radiometer-derived CDOM showed good correspondence, with an R^2 of 0.78, demonstrating the applicability of the retrieval



approach to field radiometric observations. Similarly, comparison between in situ measurements and OCM-3-derived CDOM showed good agreement, with an R^2 of 0.71, indicating reasonable satellite retrieval performance. Further evaluation of OCM-3 performance through comparison with in situ observations and other satellite sensors, including MODIS-Aqua, Sentinel-3B and VIIRS, demonstrated good correlation and low RMSE, indicating its potential for effective CDOM monitoring. The study highlights the potential of OCM-3 for monitoring CDOM variability in the coastal waters of Tamil Nadu. Future work should focus on region-specific CDOM algorithms for OCM-3 using AI and machine learning approaches, supported by long-term time series observations to assess seasonal, interannual, and cyclone related CDOM variability.

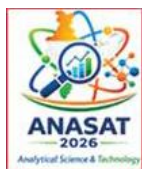
Keywords: CDOM, OCM-3, Remote Sensing Reflectance, hyperspectral radiometer, Tamil Nadu coastal waters

Contributory Paper - 08

ANC 08	Evaluation Of Ocm-3 Chlorophyll-A Retrieval Along The Tamil Nadu Coast: A Comparative Assessment With Modis-Aqua And Sentinel-3b <u>Murugan Vennila</u>¹, Nagarajan Manimozhi ¹, Ranjith Kumar Sarangi², Anu Gopinath¹ ¹Kerala University of Fisheries and Ocean Studies, Kochi, Kerala - 682506, India ²Space Applications Centre - ISRO, Ahmedabad, Gujarat – 380015, India
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ABSTRACT

Chlorophyll-a (Chl-a) is an important indicator of phytoplankton biomass and primary productivity and is widely used to assess the ecological condition of coastal waters. Satellite ocean-colour observations provide an effective means of monitoring the spatial variability of Chl-a over large coastal regions. Since the launch of the Coastal Zone Color Scanner (CZCS) in 1978, satellite sensors such as SeaWiFS, MODIS, MERIS, and Sentinel-3 have significantly improved global ocean-colour monitoring. The Indian Space Research Organisation (ISRO) launched Oceansat-3/EOS-6 (November 26, 2022) to provide crucial ocean-surface observations for climate studies and marine resource monitoring. In the present study, the performance of the Ocean Colour Monitor-3 (OCM-3) sensor in retrieving surface Chl-a concentrations was evaluated along the Tamil Nadu coast using in situ observations. A total of 53 in-situ observations were collected during the research cruise CRV Sagar Tara conducted between Nagapattinam and Chennai coastal transects from 17 to 24 July 2026. Chl-a concentrations estimated from OCM-3 were compared with corresponding products from MODIS-Aqua and Sentinel-3A OLCI and validated against the in-situ observations. Among the three sensors, OCM-3 demonstrated good agreement with the in-situ measurements, with a coefficient of determination ($R^2 > 0.5$) and relatively low RMSE and bias, followed by MODIS-Aqua and Sentinel-3A OLCI. For Chl-a concentrations below 1 mg m^{-3} , OCM-3 showed a good correlation with in-situ observations, with a slight overestimation and underestimation, when the Chl-a is exceeding 1 mg m^{-3} . The observed differences in sensor performance indicate the influence of regional coastal water characteristics on satellite-derived Chl-a retrievals and highlight the need for region-specific algorithm evaluation and refinement. The complex optical properties of the Tamil Nadu coastal waters, including the presence of coloured dissolved organic matter (CDOM) and non-algal particles (NAP), may influence the spectral response and consequently affect Chl-a retrieval accuracy. Overall, the results demonstrate that OCM-3 performs comparably well with standard ocean-



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colour sensors and has good potential for monitoring Chl-a variability along the Tamil Nadu coast.

Keywords: *Chlorophyll-a (Chl-a), Ocean colour monitor-3(OCM-3), MODIS-Aqua, Sentinel-3A, tamil Nadu coast*

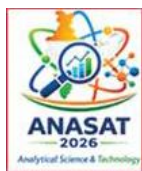
Contributory Paper - 09

ANC 09	Catalytic Application of Nickel On β -Mo ₂ C for Biomass-Derived Veratraldehyde Hydrogenation
	<i>Vrinda T V</i>, Amritha Krishna R, Sakthivel A* <i>Inorganic Materials & Heterogeneous Catalysis Laboratory, Department of Chemistry, School of Physical Sciences, Central University of Kerala, Kasaragod – 671325, India.</i> E-mail: sakthivelcuk@cukerala.ac.in/ vrinda.2301107011@cukerala.ac.in

ABSTRACT

The depletion of fossil fuel resources and growing environmental concerns associated with their use necessitate the development of sustainable and innovative catalytic strategies for biomass valorisation. Lignocellulosic biomass (LCB), a renewable and abundant carbon resource, is an alternative resource for the production of biofuels and value-added chemicals, offering advantage of biodegradability over fossil-fuel-derived products.¹ The oxygen-rich biomass-components can be converted into platform molecules and further transformed into valuable chemicals and high-energy-density fuels. In this context, transition-metal oxides, zeolites, perovskite-type materials, and layered double hydroxides (LDHs) have attracted significant attention due to their tunable structural, redox, acid–base, and surface properties.¹ Among these materials, LDHs are versatile heterogeneous catalyst platforms, offering compositional flexibility in the layers and interlayers while maintaining a well-defined layered structure.² The present study explores the development of non-noble-metal catalysts based on transition-metal carbides derived from hydrotalcite as cost-effective materials for biomass-transformation.

Ni/ β -Mo₂C composite was synthesized by incorporating molybdenum blue into a nickel–aluminium hydrotalcite precursor, followed by temperature-programmed reduction. The physicochemical properties of the catalyst were investigated using complementary analytical techniques, including FTIR, XRD, TGA, BET, and TPR, to elucidate its bonding, structural, thermal, textural, and reduction characteristics. The incorporation of carbon into the transition-metal frame work imparts noble-metal-like electronic properties, while the interaction between Ni and β -Mo₂C can provide synergistic catalytic functionality.³ The catalytic performance was evaluated using veratraldehyde, a lignin-derived aromatic aldehyde, as a model biomass-derived substrate. The catalyst showed complete conversion with the formation of veratryl alcohol and 4-methylveratrole, as major products. Overall, this study highlights the relationships between catalyst properties and its performance, demonstrating the potential of hydrotalcite-derived Ni–



Mo₂C catalysts for the selective transformation of biomass-derived molecules into value-added chemicals.

Acknowledgement: Authors indebted to the DST-SERB(CRG/2023/001107) for financial assistance.

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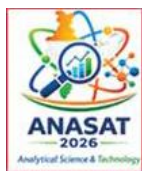
Contributory Paper - 10

ANC 10	Molybdenum carbide supported on zeolite-β: An Efficient catalyst for selective conversion of Furfuryl alcohol to Ethyl Levulinate
	<i>K.V.Athira, M. Megha, K.K. Shabana, N.P. Nimisha, B.N. Soumya and A.Sakthivel</i>[□] <i>Inorganic Materials & Heterogeneous Catalysis Laboratory, Department of Chemistry, School of Physical Sciences, Central University of Kerala, Kasaragod -671316, Kerala, India.</i> <i>*Email: sakthiveldu@gmail.com, athirakv771@gmail.com;</i> <i>ORCID information: https://orcid.org/0000-0003-2330-5192</i>

ABSTRACT

Heterogeneous catalysis offers a sustainable route for converting biomass into value-added chemicals and fuel additives; however, its application is limited by reproducibility in synthesis, noble-metal cost, and selectivity. In particular, converting petroleum from crude oil and biomass into fuel involves noble-metal-containing zeolite-based catalysts, in which recovering noble metals is challenging. In this regard, researchers in recent years have focused on developing transition-metal carbide-based catalytic materials, which have emerged as promising alternatives to noble metals. For example, molybdenum carbide (Mo_2C) is particularly attractive owing to its high catalytic potential and electronic properties. It will be interesting to incorporate Mo_2C into the zeolite matrix, particularly strong acidic zeolite- β . In this study, zeolite- β was synthesized via a dry-gel method and post-synthetically modified with a molybdenum-blue precursor, followed by temperature-programmed reduction (TPR) to obtain Mo_2C on zeolite- β . The synthesized materials were comprehensively characterized to elucidate their structural, textural, and morphological properties. Powder X-ray diffraction confirmed the formation of the Mo_2C phase in the zeolite- β catalyst (ZB- MoC). The presence of Mo_2C in the channels of the zeolite framework was further supported by the observed low surface area of $268 \text{ m}^2 \text{ g}^{-1}$. FE-SEM and HR-TEM analyses further revealed the uniform dispersion of the carbide phase over zeolite- β . ZB- MoC exhibited excellent catalytic performance for the conversion of biomass-derived furfuryl alcohol to ethyl levulinate (EL), achieving near-complete conversion with 97.5 % selectivity toward EL at ambient conditions. The enhanced catalytic performance was associated with the increased total acidity following Mo_2C incorporation, as evidenced by NH_3 -TPD analysis. Overall, this study demonstrates that Mo_2C -supported zeolite- β is an effective catalyst for selectively upgrading biomass-derived furfuryl alcohol toward sustainable ethyl levulinate production.

Acknowledgement: Authors indebted to the DST-SERB (CRG/2023/001107) for financial assistance.



References:

- 1) Athira, K. V., Sakthivel, A. et al., *Chem. Commun.*, **2026**, 62, 12443-12467 and reference therein.
- 2) Nimisha, N.P., Sakthivel, A. et al., *Chem Cat Chem.*, **2026**, 6277931 inpress.

Contributory Paper - 11

ANC 11	Evaluating the Precursor Effect on the Catalytic Activity of Derived Polymeric Carbon Nitriles for the Thermal Decomposition of Ammonium Perchlorate
	Gladiya Mani and Suresh Mathew School of Chemical Sciences, Mahatma Gandhi University, Kottayam E-mail Address: gladiyamani23k@gmail.com

ABSTRACT

The call for sustainability necessitates the development of inexpensive, earth-abundant and environmentally benign catalysts for composite solid propellants. Polymeric carbon nitride (gCN)-based catalysts have recently been widely used in studies of the thermal decomposition of ammonium perchlorate (AP). Herein, we have prepared gCNs from different precursors: urea (UCN), melamine (MCN), and dicyandiamide (DCN), respectively. Surface studies revealed that UCN has the highest surface area and pore volume among MCN and DCN, which facilitates the rapid adsorption of reaction intermediates (perchloric acid and ammonia) onto the gCN surface, thereby accelerating AP decomposition. Similarly, the thick planar sheets observed for MCN and DCN differ from the wrinkled, highly porous, and fluffy nanosheets of UCN, suggesting that the heteroatom (oxygen) and the molecular arrangement of the precursors play influential roles in defining the condensation pathway of gCNs and their resulting morphology. Furthermore, the abundance of edge-NH_x groups with high basicity suggests better catalytic potential for UCN. Thermal analyses revealed similar catalytic performances observed for all gCNs, with UCN exhibiting a slightly better performance in terms of the combined single-stage decomposition pattern, the highest rate of decomposition, and relatively higher volume of released decomposition products. This study highlights the superior catalytic performance of urea-derived gCN in the decomposition of ammonium perchlorate.

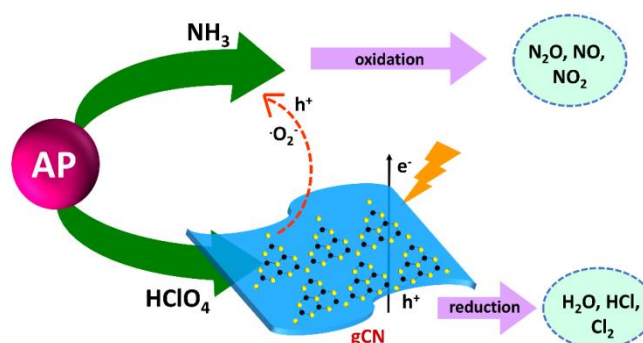
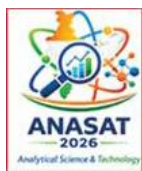
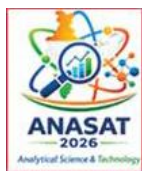


Fig.1: A plausible mechanism of the catalytic effect of polymeric carbon nitride towards ammonium perchlorate decomposition



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Contributory Paper - 12

ANC 12	Engineering A Multifunctional Nanocomposite Hydrogel Film Reinforced With Bacterial Cellulose–Glycerol For Sustained Antibiotic Delivery And Diabetic Wound Healing
	Lekshmi G.S.,¹ Rajeev M. R.,¹ Anirudhan Thayyath Sreenivasan^{1, *} <i>¹Department of Chemistry, Research Centre, School of Physical and Mathematical Sciences, University of Kerala, Kariavattom, Trivandrum, 695581, India</i> Email: lekshmigsankarklm@gmail.com

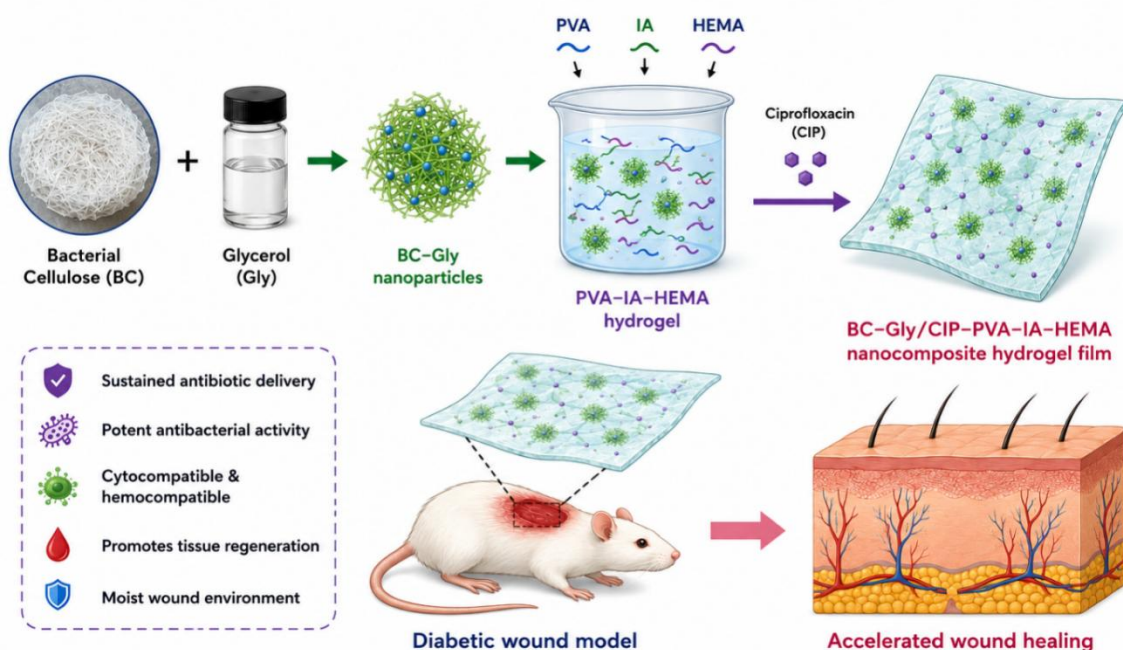
ABSTRACT

Diabetic wounds are characterized by delayed healing, persistent bacterial infections, prolonged inflammation, and impaired tissue regeneration, highlighting the need for advanced wound dressings that provide localized antimicrobial therapy while supporting tissue repair¹. In this study, a multifunctional bacterial cellulose–glycerol reinforced ciprofloxacin-loaded poly(vinyl alcohol)–itaconic acid–2-hydroxyethyl methacrylate (BC-Gly/CIP-PVA-IA-HEMA) nanocomposite hydrogel film was developed for diabetic wound management. The hydrogel film was fabricated by incorporating ciprofloxacin (CIP) into a PVA-IA-HEMA hydrogel matrix reinforced with bacterial cellulose–glycerol nanoparticles to improve its structural stability, drug-delivery characteristics, and biological performance.

The physicochemical, structural, and morphological characteristics of the developed nanocomposite hydrogel film were investigated using Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), dynamic light scattering (DLS), scanning electron microscopy (SEM), and high-resolution transmission electron microscopy (HRTEM). The fabricated film exhibited good structural integrity, flexibility, and sustained CIP release, enabling prolonged localized antibacterial activity. The nanocomposite demonstrated potent antibacterial efficacy against the tested bacterial strains. In vitro investigations further revealed excellent cytocompatibility and hemocompatibility, indicating its suitability for biomedical applications.

The therapeutic efficacy of the nanocomposite hydrogel film was subsequently evaluated using a diabetic Sprague–Dawley rat wound model. The BC-Gly/CIP-PVA-IA-HEMA-treated wounds exhibited significantly accelerated wound closure compared with the control and other treatment groups. Histopathological examination further demonstrated enhanced re-epithelialization, increased collagen deposition, improved angiogenesis, and the development of thicker and more organized epidermal tissue. Overall, the synergistic

combination of bacterial cellulose–glycerol nanoparticles and sustained localized CIP delivery provided the developed hydrogel film with enhanced physicochemical, antibacterial, and wound-healing properties. The findings demonstrate that the BC-Gly/CIP-PVA-IA-HEMA nanocomposite hydrogel film represents a promising multifunctional wound dressing for effective management of diabetic wounds.



Schematic representation of the fabrication and therapeutic application of the BC-Gly/CIP-PVA-IA-HEMA nanocomposite hydrogel film for diabetic wound healing.

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ANC 13	ATOMISTIC INVESTIGATION OF THE CATALYTIC ACTIVITY OF ACTIVATED COPPER CHROMITE IN COMPOSITE SOLID PROPELLANTS
	Ashitha S. , Renjith S, Sreelekshmi K R, Vijayalakshmi K P, Lakshmi V M <i>Molecular Modeling Section, Modeling and Mechanical Testing Division, Analytical Project Engineering and Molecular Modeling Group, Propellant Polymers, Chemicals and Materials Entity, Vikram Sarabhai Space Center, Trivandrum, Corresponding author email: renjith_sp@vssc.gov.in</i>

ABSTRACT

Ammonium perchlorate (AP) is the most widely employed oxidizer in composite solid propellants [1]. The enhancement of performance of AP as an oxidizer is primarily achieved through the incorporation of catalysts. Among the numerous catalysts investigated, transition metal oxides such as Fe_2O_3 , CuO , MnO_2 , and CuCr_2O_4 have demonstrated remarkable catalytic activity owing to their multiple oxidation states, facile oxygen exchange capability, and favourable electron-transfer characteristics [2]. Activated copper chromite (ACR), a commercially employed combustion catalyst has attracted particular interest [3] because it consists of multiple catalytically active phases, CuO , CuCr_2O_4 (copper chromite), and BaCrO_4 (barium chromate), whose synergistic interactions collectively contribute to enhanced catalytic performance during AP decomposition.

Although numerous experimental studies have established the catalytic effectiveness of ACR, the atomistic understanding of the catalytic mechanism, and identification of the most active surface binding sites within the individual catalyst components remain largely unexplored [4]. Such mechanistic insight is essential for establishing structure–activity relationships and for the rational design of next-generation catalysts [5]. The primary objective of this study is to identify the most energetically favourable adsorption site and determine the catalytically dominant metal center responsible for promoting AP decomposition using Density Functional Theory (DFT) calculations. The decomposition mechanism was investigated based on the oxygen-transfer pathway, wherein oxygen released from perchloric acid (HClO_4), generated during AP decomposition, is abstracted by the hydroxyl-terminated polybutadiene (HTPB) in the presence of the catalyst (ACR). To elucidate the complete reaction mechanism the optimized bulk crystal structures of CuO , CuCr_2O_4 , and BaCrO_4 , together with the adsorbate species such as HClO_4 , NH_3 and electron rich C_4H_6 is represented as HTPB, were initially optimized to obtain energetically stable equilibrium configurations as the initial structure. Subsequently, the intermediate and product configuration created. The transition-state structures were determined using the Climbing Image Nudged Elastic Band (CI-NEB) method.

The corresponding activation energy barriers, Gibbs free-energy changes, and reaction rate constants were subsequently evaluated through DFT calculations, enabling a quantitative comparison of the catalytic affinity associated with the available metal–oxygen active sites within the framework of Transition State Theory and thus find the most active metal site. Comparative analysis of the adsorption energies revealed the binding affinity in the order $\text{CuCr}_2\text{O}_4:\text{Cr}-\text{O} > \text{CuO}:\text{Cu}-\text{O} > \text{BaCrO}_4:\text{Cr}-\text{O} > \text{CuCr}_2\text{O}_4:\text{Cu}-\text{O} > \text{BaCrO}_4:\text{Ba}-\text{O}$, indicating substantial differences in catalytic interactions among the available active sites. Furthermore, the calculated kinetic and thermodynamic parameters consistently identified the Cr–O active site of CuCr_2O_4 as the most catalytically favorable site for facilitating oxygen transfer and promoting the decomposition of AP.

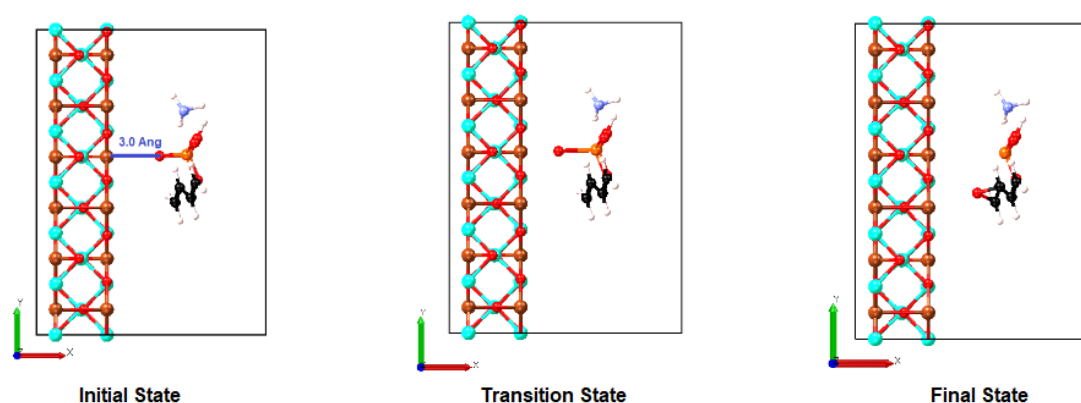
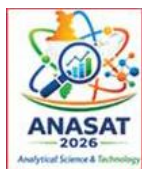


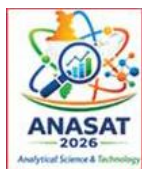
Fig. 1 Selected Configurations used for Climbing Image Nudged Elastic Band (CI-NEB) calculation for identifying the transition state of the reaction kinetics.

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Contributory Paper - 14

ANC 14	A Computational SMD Screening Approach For Rational Solvent Selection In Extraction
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ABSTRACT

The selection of an appropriate solvent is a critical step in extraction of bioactive, pharmaceutical and industrially relevant compounds. A predictive computational strategy can reduce solvent consumption, experimental effort and environmental burden by screening solute–solvent interactions before laboratory validation. A computational framework for rational solvent selection, based on Density Functional Theory (DFT) and the SMD (Solvation Model based on Density) approach, is developed and evaluated. Caffeine was employed as a representative model compound to evaluate the applicability of the framework. The molecular structure was optimized at the M06-2X/6-311++G(d,p) level, and solvent effects were evaluated using the SCRF formalism with SMD. Twenty solvents covering a broad range of dielectric environments were screened using solvent descriptors including dielectric constant, refractive index, hydrogen-bond acidity and basicity, surface tension, aromaticity and electronegative halogenicity. The calculated solvation and non-electrostatic contributions showed pronounced variation among the solvent systems, demonstrating the sensitivity of solute–solvent interactions to solvent properties. As a benchmark, the calculated solvation energy of caffeine in water ($-13.06 \text{ kcal mol}^{-1}$) showed close agreement with the experimentally reported value ($-12.64 \pm 0.74 \text{ kcal mol}^{-1}$), supporting the applicability of the computational approach for solvent screening. Among the organic solvents screened, acetone ($-9.82 \text{ kcal mol}^{-1}$), N,N-dimethylformamide ($-9.62 \text{ kcal mol}^{-1}$), acetonitrile ($-9.30 \text{ kcal mol}^{-1}$), dichloromethane ($-9.15 \text{ kcal mol}^{-1}$) and ethyl ethanoate ($-8.43 \text{ kcal mol}^{-1}$) exhibited comparatively favourable calculated solvation energies. Although caffeine is used here as a demonstration system, the framework is intended to be transferable to the rational selection of solvents for diverse extraction applications and supports the development of more efficient and sustainable analytical extraction strategies.

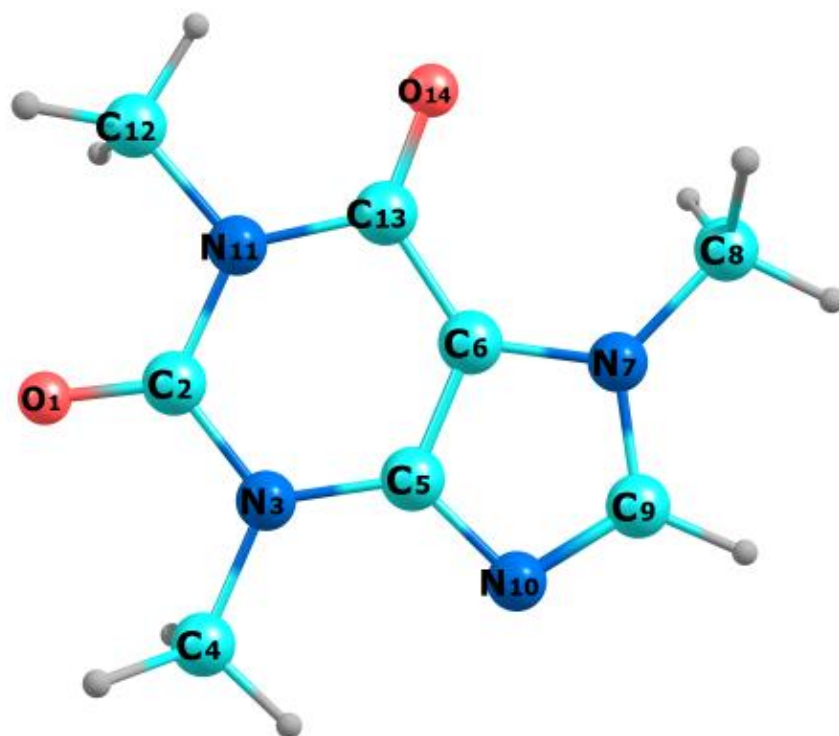


Figure 1. Optimised structure of Caffeine (C₈H₁₀N₄O₂)

Keywords: DFT, SMD, Solvation energy, Extraction, Computational chemistry

Contributory Paper - 15

ANC 15	CuO@B-g-C₃N₄ nanocatalyst for Sustainable C–H Selenation: Integrating Nanomaterial Characterization with Catalytic and Mechanistic Insights
	<i>Maruboina Hemanth Kumar and Siddappa A. Patil*</i> <i>Centre for Nano and Material Sciences, Jain University, Jain Global Campus, Bangalore 562112, India.</i> <i>E-mail: maruboina.hk@jainuniversity.ac.in and p.siddappa@jainuniversity.ac.in</i>

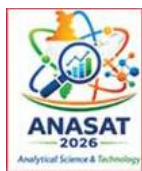
ABSTRACT

The development of efficient and recyclable heterogeneous nanocatalysts, together with reliable analytical approaches for understanding their structure and catalytic behaviour, is important for advancing sustainable chemical transformations. In this study, a CuO@B-g-C₃N₄ nanocatalyst was developed for the site-selective C–H arylselenation of benzothiazoles using elemental selenium (Se⁰) and aryl iodides. Boron-doped graphitic carbon nitride (B-g-C₃N₄) was employed as a functional support for CuO nanoparticles, providing nitrogen-rich coordination sites and modified electronic environments that facilitate metal anchoring and dispersion.

The synthesized nanocatalyst was systematically investigated using **PXRD, FT-IR, BET/BJH, TGA, XPS, FE-SEM, HR-TEM, HAADF-STEM, elemental mapping, and ICP-OES**. These analyses confirmed the formation and structural characteristics of the CuO@B-g-C₃N₄ nanocomposite, with Cu loading determined to be 8.29 wt%. The catalyst exhibited excellent catalytic performance in the direct construction of C–Se bonds. It enabled selective C2–H arylselenation of benzothiazoles, affording a broad range of organo-selenium products with good to excellent yields and functional-group tolerance. The optimized benzothiazole reaction provided 97% yield of the model product.

Importantly, the heterogeneous catalyst could be readily recovered and reused, while hot-filtration and leaching studies supported its heterogeneous catalytic nature and stability. The methodology was further demonstrated on a gram scale, giving an isolated yield of 89% for the representative benzothiazole product. Mechanistic investigations involving control experiments and characterization of a proposed Cu–Se intermediate provided insight into selenium activation and C–Se bond formation.

The analytical dimension of the study was further strengthened by comprehensive ⁷⁷Se NMR characterization of the synthesized organo-selenium compounds, **variable-temperature ⁷⁷Se NMR** studies, and **single-crystal X-ray diffraction** analysis of a

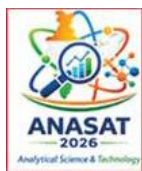


representative product. Overall, this work demonstrates the integration of advanced analytical characterization, nanomaterial engineering, heterogeneous catalysis, and mechanistic analysis to establish a recyclable platform for sustainable C–Se bond formation using elemental selenium.

Keywords: CuO@B-g-C₃N₄; Nanocatalysis; C–H Selenation; Elemental Selenium; Analytical Characterization

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Contributory Paper - 16

ANC 16 **Estimation Of Heavy Metal Contamination And Assessment Of Drinking Water Quality Of Ground Water In A Coastal Segment Of Alappuzha, Kerala, India**

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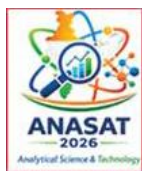
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ABSTRACT

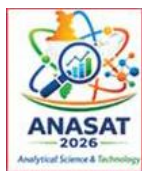
Humans have a birth right to clean air and safe drinking water. Ground water, the biggest dispersed freshwater reserve in the world, is essential to maintaining ecosystems and facilitating human adaptation to climate change and variability. Natural and anthropogenic sources contaminate ground water. This study was undertaken to evaluate the water quality and heavy metal contamination of groundwater in a coastal segment of Alappuzha district in Kerala, India. A total of twenty-two ground water samples were collected from selected stations in a coastal region of Alappuzha district during monsoon and postmonsoon season. The analytical methods were carried out as per standard methods of APHA. All the samples were analyzed for physicochemical parameters such as pH, Redox potential, Conductivity, Total dissolved solids (TDS), Dissolved Oxygen (DO), Turbidity, Total Alkalinity, Total Hardness etc. And evaluated the concentration of selected toxic heavy metals such as As, Cr, Pb, and Zn using standard procedures. The observed concentration of these metals was compared with National and International standards of drinking water. The concentration of Lead (Pb) in groundwater is found abundantly compared to other metals, which causes severe contamination in ground water as these were the drinking water sources for people inhabited in the study area. The concentration of Pb above the permissible limit in drinking water can build up in body tissues which can lead to immune system dysfunction, neurological disorders, delayed development, cardiovascular problems, hearing loss, and cognitive decline. The overall water quality of drinking water evaluated using Water Quality Index (WQI) had found poor. The study attempts to untangle the deterioration of ground water quality and heavy metal contamination found in the coastal region as these were the fresh water and drinking water sources to the denizens.

Keywords: Heavy metal, Alappuzha, Water Quality, Coastal segment



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Contributory Paper - 17

ANC 17 **Study on the Correlation of Specific Gravity & Volatile Matter in Activated Copper Chromite**

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ABSTRACT

Activated copper chromite (ACR) is an important burn-rate catalyst used in composite solid propellant systems. Quality control checks for all propellant raw materials are carried before its acceptance for processing in solid rocket motors. Specific gravity is one of the major quality control parameters ensured for the acceptance of materials. A systematic study was conducted on different batches of ACR to evaluate the correlation of specific gravity, density and volatile matter. Since specific gravity measurements can be influenced by various experimental conditions a detailed study was undertaken to identify the factors affecting specific gravity measurements. This study examines the relationship among specific gravity, density and volatile matter of copper chromite and also evaluates the influence of measurement-related parameters like immersion liquid, entrapped air and temperature.

Specific gravity was initially determined using liquid-displacement method with specific gravity bottles. The influence of different immersion media, namely toluene, silicone oil, ISROsene and ACR- saturated ISROsene, was investigated. The effect of entrapped air was evaluated by comparing vacuum degassing and repeated tapping, while the influence of temperature was examined by conducting experiments in three different temperatures; 23, 25 and 27 °C. To determine whether the difference in specific gravity was associated with the measurement procedure or represented an actual material-related variation, density was independently determined using a helium gas pycnometer also. The results obtained from the two experimental approaches were compared for different production batches.

The study demonstrated that the liquid-displacement measurement was sensitive to the choice of immersion liquid. Lower specific gravity values were generally obtained when ISROsene was used, while measurements obtained using toluene and silicone oil were comparatively consistent. The use of ACR in saturated ISROsene resulted in values more comparable with those obtained using the other suitable immersion media. The study also showed that removal of entrapped air was important for obtaining reproducible

measurements. Results with degassing were more consistent than results with tapping under the conditions investigated. Temperature was found to have a measurable effect on the specific gravity value. These findings confirmed that appropriate control of the measurement conditions is necessary for reliable batch-to-batch comparison.

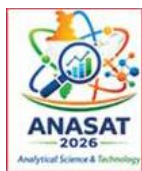
The relationship between density and volatile matter was subsequently investigated using data from 16 copper chromite batches. The analysis showed a strong inverse relationship between density and volatile matter. The higher-density batch generally exhibited lower volatile matter values. This observation was further examined through a controlled drying experiment using selected copper chromite batch. Density was measured in the as-received condition, after drying at 120 °C for 4 hrs, and after drying to constant weight. Drying resulted in a higher value in density for the entire investigated batch. The average increase in density was approximately **3 -5%**

The agreement between the batch-wise correlation analysis and the controlled drying experiment provides experimental evidence for the association between volatile matter content and the measured density of copper chromite. The study demonstrates the usefulness of combining routine quality-control data, independent density measurements and controlled drying experiments to investigate correlation in physical properties of propellant raw materials. The findings also provide a scientific basis for considering volatile matter as an important parameter when interpreting specific gravity and density during the quality assessment of copper chromite.

Hence, this paper details the experiments carried out to find the correlation in specific gravity, density and volatile matter for selected batches of ACR using instrument (Gas Pycnometer) and manual method (specific gravity bottles). Even though this study explains the association of volatile matter content with the obtained specific gravity/density values, further study is desirable to understand the chemical, physical and morphological properties of different batches of ACR.

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3. Indian Standard: IS 2720 PART III Determination of Specific Gravity
4. ASTM B923 – 23; Standard Test Method for Metal Powder Skeletal Density by Helium or Nitrogen Pycnometry



Contributory Paper - 18

ANC 18 Quality Assurance in Radiation Metrology at Kudankulam – A Case Study

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ABSTRACT

Introduction

Quality assurance in a laboratory is a systematic and comprehensive approach to ensure the accuracy, reliability and consistency of test results and data generated in a scientific or analytical environment is in compliance with the requirements of a laboratory management system (ISO, 17025). It encompasses a set of processes, standards and practices designed to minimize errors and discrepancies in the work conducted by laboratory personnel. The primary goal of quality assurance is to maintain and improve the quality and integrity of laboratory testing, which is crucial in the field of environmental analysis and forms an integral part of environmental surveillance program. Regardless of the target analyte or sample type, quality assurance and quality control are very important for analytical data validation. The quality assurance program of our lab (Environmental Survey Lab, Kudankulam) for alpha, beta and gamma measurements has been assessed by the annually organized proficiency tests of International Atomic Energy Agency (IAEA). Environmental Survey Laboratory, Kudankulam regularly participates in the IAEA proficiency tests every year using instruments and standard techniques which demonstrate competence in radionuclide identification, estimation and validation of adopted analytical method. This paper presents the results of our participation in inter-comparison exercises organized by IAEA during the period 2018-25.

Material and methods

The concentration of radionuclides present in various types of samples like water, soil, sediments, surface samples etc were determined by employing appropriate detectors and radiometric techniques. Alpha activity is determined using ZnS (Ag) scintillation counter and alpha spectrometry system. Beta activity is determined using low background beta plastic scintillation counter. Tritium activity is measured using Liquid Scintillation Counter (LSC). Gamma emitters are determined using a high resolution High Purity

Germanium Gamma Spectrometry (HPGe) system. Energy and efficiency calibration of these systems is carried out using standard radioactive sources like ^{137}Cs , ^{60}Co , ^{152}Eu & ^{133}Ba for γ , ^{90}Sr , ^{40}K & ^3H for β and ^{239}Pu & ^{241}Am for α in suitable geometries. Using efficiency and recovery factors, the activities are calculated for all the radionuclides in the sample matrix.

Results and Discussion:

Table 1: Analysis profile during 2018-25

Method of analysis	No of analysis	Evaluation of Results
Direct counting	92	72(A),9(W),11(NA)
RCA	24	10 (A),10(W),4(NA)

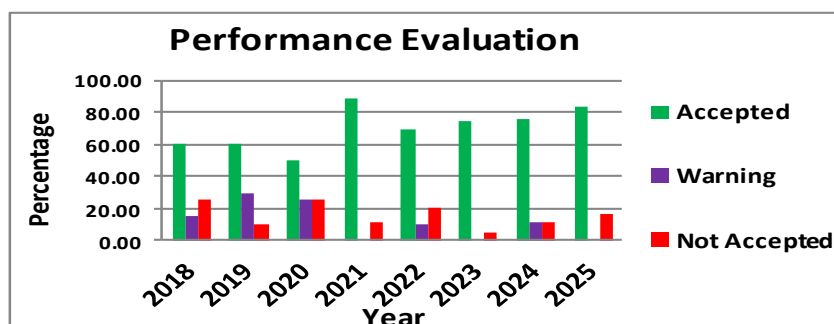


Fig 1: Performance profile during 2018-25

The quality assurance programme is assessed by the proficiency tests of IAEA. **Table 1** shows the number of analysis carried out by different methods during 2018-25. As per standard evaluation methodology adopted by IAEA, it is observed that out of 116 tests, 82 were in acceptable (A) range, 19 were accepted with warning (W) and 15 were not in acceptable (NA) range, thus registering an impressive 90 % pass category. **Figure 1** shows the performance evaluation for different samples analyzed in the IAEA proficiency tests. For the unaccepted tests, non-conformance analysis is carried out to help correct the methods.

ANC 19 Synthesis Of Tryptanthrin Appended Thiadiazole Hybrids For The Dual Metal Sensing Of Ag⁺ And Cu²⁺ Ions

Devika Krishnan and Ani Deepthi

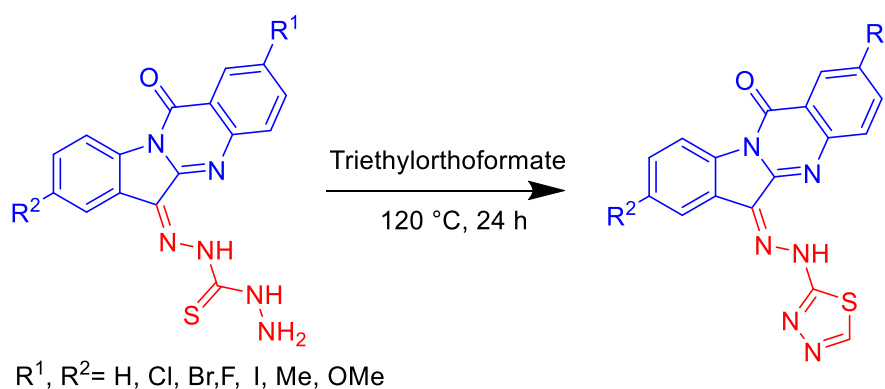
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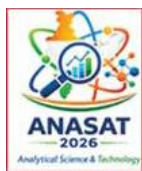
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ABSTRACT

Tryptanthrin (indolo[2,1-*b*]quinazoline-6,12-dione) originally isolated from medicinal plants such as *Strobilanthes cusia*, *Polygonum tinctorium* etc has a wide range of biological as well as photophysical applications.¹ Recent investigations by our research group have reported a tryptanthrin malononitrile adduct^{2(a)} and a tryptanthrin derived hydrazide hydrazone^{2(b)} as fluorescent chemosensors for aniline and picric acid detection respectively. In addition, Vesela *et al.*, synthesized tryptanthrin hydrazone based thiosemicarbazone which was efficient in the detection of Cu²⁺ ions in solution.³ Also, thiadiazole is another important heterocycle which has an inherent fluorescent core, making them useful framework for chemo sensors.⁴

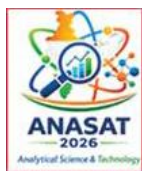
With the above background, we have now synthesized heterocycles of tryptanthrin containing thiadiazole core by the cyclization of corresponding thiosemicarbazide derivatives and all the synthesized compounds were characterized using FTIR, ¹H NMR, ¹³C NMR and CHN analysis. Among the synthesized compounds, methoxy substituted derivative was found to be an excellent chemosensor for the dual metal sensing of Ag⁺ and Cu²⁺ ions. The synthesis, characterization and photophysical investigation of dual metal sensing of Ag⁺ and Cu²⁺ ions by tryptanthrin appended thiadiazole sensor will be presented.





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Contributory Paper - 20

ANC 20 Integrated Methodology to unravel the atmospheric chemistry and molecular composition of Organic Aerosols

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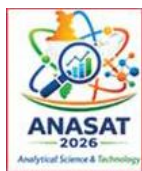
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ABSTRACT

Understanding the molecular composition of atmospheric organic aerosols (OA) is essential for improving predictions of climate forcing and air-quality impacts. In this work, water-soluble dicarboxylic acids (DCAs; C₂–C₉), oxocarboxylic acids, and α -dicarbonyl compounds were quantified in aerosol samples collected from the Western Ghats, Kerala, India. Aerosol samples were collected in a campaign mode for one year during three distinct seasons representing Indo-Gangetic Plain–Bay of Bengal (IGP–BoB), Arabian Sea (AS), and mixed marine–continental air masses.

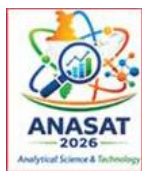
This work demonstrates the comprehensive analytical approach for both sources and sinks in a real atmospheric condition. Gas chromatography (GC) equipped with various detectors, including a flame ionization detector (FID) and mass spectrometer (MS), were used for the analysis. Since the samples can't be directly injected, water extraction followed by ester derivatization (using BF₃/n-butanol) was adopted. This derivatization improves the selectivity, and stability of the samples injected into the inlet of the GC column. This esterification helps to convert a reactive, polar, or low-volatility compound into a stable, GC-detectable form. This further improves the volatility of the analyte, thermal stability, and the response from the detector. Using this analytical approach, dominant dicarboxylic compounds, including oxalic, succinic, phthalic, terephthalic, and azelaic acids, together with important oxidation products, were further confirmed by computational modeling using density functional theory (DFT). Distinct molecular fingerprints were observed for each air mass regime, demonstrating strong influences of long-range transported anthropogenic emissions together with locally produced biogenic precursors. Diagnostic ratios (C₃/C₄ and Ph/C₉) successfully distinguished photochemical aging and relative anthropogenic/biogenic contributions. The study further proposes a new conceptual formation pathway for terephthalic acid involving mixed anthropogenic and marine-derived precursors, including p-xylene. This method is well suited to understanding how molecular-level measurements combined with computational modeling can unravel the complex SOA formation pathways in remote environments.

References:



ANALYTICAL SCIENCE AND TECHNOLOGY 2026

Ramya, C.B., Aswini, A.R., Hegde, P., Boreddy, S.K. and Babu, S.S., 2023. Water-soluble organic aerosols over South Asia—Seasonal changes and source characteristics. *Science of The Total Environment*, 900, p.165644.



Contributory Paper - 21

ANC 21 Application of House–Meinwald Rearrangement on Spiro-epoxy Indanones: Design and Synthesis of 3-Substituted Lawsones

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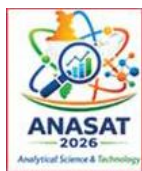
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ABSTRACT

Naphthoquinones are structurally diverse aromatic quinones that play a vital role as scaffolds in various natural products. Their quinone functionality is highly reactive and participates in redox processes, drawing significant interest in both chemical and pharmaceutical fields. In addition to their biological significance, naphthoquinones are important intermediates in the synthesis of heterocycles and are utilized in diverse industrial applications such as cosmetics, dyes, and agrochemicals. Among this group, 3-aryllawsones stand out due to their structural variety and strong biological activity, making them promising candidates for drug discovery.

Despite the benefits associated with 3-aryllawsones, efficient synthetic methods are limited. Initial techniques primarily utilized activated lawsone derivatives like phenyl iodonium ylides, which demanded high reaction temperatures. Other approaches included hydroxylating 2-arylnaphthoquinones and conducting tandem organocatalytic reactions involving lawsone derivatives. More innovative methods, such as the ring-expansion of indantrione with diazomethanes generated in situ, have recently emerged. Nevertheless, many existing methods depend on expensive or toxic transition-metal catalysts and pre-functionalized substrates, involving costly arylating reagents, typically demand high temperatures, and require extended reaction times. Furthermore, these methods often present challenges related to limited functional-group tolerance and a narrow substrate scope. Thus, achieving a mild, transition-metal-free synthesis of 3-aryllawsones remains a crucial objective in the field.

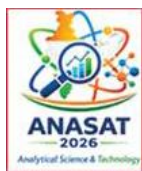
Herein we report an efficient and conceptually distinctive approach for accessing 3-aryllawsones through a one-pot sequence featuring HMR as the pivotal step. The reaction proceeds under mild, operationally straightforward, and open-atmosphere conditions, relying on inexpensive and readily accessible starting materials, which are the key advantages of the protocol. This methodology accommodates a broad range of



arylidene- and heteroarylidene-2,3-dihydroindenone substrates capable of forming o/p-quinone methide intermediates, thereby enabling the construction of diverse naphthoquinone frameworks. The TBHP/base-mediated cascade integrates epoxidation, quinone-methide generation, chemoselective 1,2-aryl migration-driven ring expansion, and oxidation into a seamless transformation. Collectively, these findings highlight a versatile and general strategy for the synthesis of 3-aryllawsones and underscore the concealed potential of HMR-driven ring-expansion chemistry in naphthoquinone synthesis.

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Contributory Paper - 22

ANC 22 Persistent blue light-emitting garnet phosphors for anti-counterfeiting applications

¹Aiswarya Lakshmi, ^{1,2*}Subrata Das

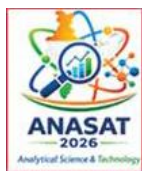
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ABSTRACT

A series of persistent blue light emitting $\text{Sr}_3\text{Y}_2\text{Ge}_3\text{O}_{12}:\text{xBi}^{3+}$ phosphors were synthesised using a high-temperature solid-state synthesis. The persistence of blue emission was improved via tuning of crystal structure through suitable cationic substitutions. Introduction of cations with high valence potentially increased the concentration of energy storage traps such as oxygen or cation vacancies to enhance the intensity and duration of the persistent luminescence. Photoluminescence excitation spectra of the phosphors revealed a broad excitation band extending from 300 to 450 nm, with maximum intensity centred at 378 nm due to Bi^{3+} ions' electronic transitions ($^1\text{S}_0 \rightarrow ^3\text{P}_1(^1\text{P}_1)$). Under 378 nm excitation, the samples exhibited a broad, asymmetric blue emission band peaked at 465 nm and that extend from 400 to 600 nm because of Bi^{3+} ions' $^3\text{P}_1 \rightarrow ^1\text{S}_0$ transitions. After cationic substitutions, the persistence duration of the blue emission increased up to 1 minute. The present research was conducted to assess the potential of these Bi^{3+} activated phosphors for persistent luminescence-based anti-counterfeiting applications.



Contributory Paper - 23

ANC 23 Integrated *In-silico* and Experimental Screening of Bioactive compounds for Liposomal Candidates Against Drug-Resistant Bacterial Pathogens

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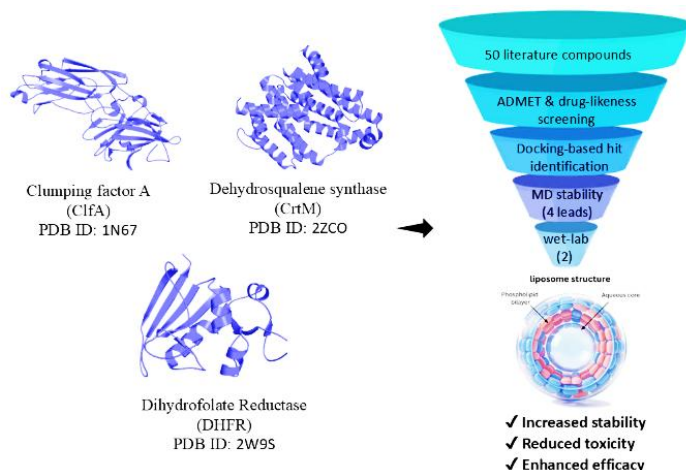
ABSTRACT

Keywords: Antimicrobial resistance; Molecular docking; Molecular dynamics; Nanocarrier;

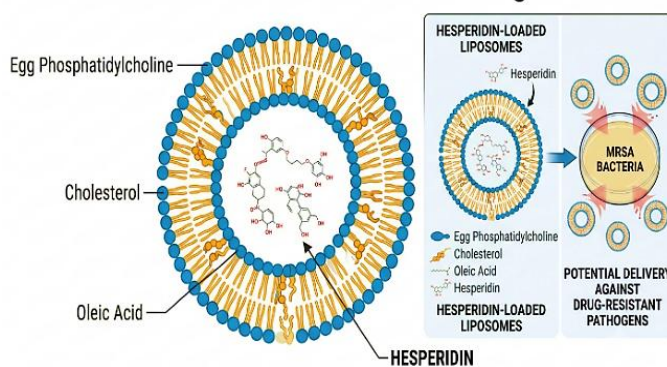
Antimicrobial resistance (AMR) poses a critical challenge in the treatment of infections caused by priority drug-resistant pathogens, necessitating the development of alternative antimicrobial candidates and effective delivery strategies. In this study, an integrated computational and experimental approach was employed to identify a phytochemical antimicrobial candidate and develop a liposomal nanocarrier platform for its potential delivery against drug-resistant bacterial pathogens. A library of approximately 50 FDA-approved drugs and bioactive phytochemicals was subjected to ADMET profiling and molecular docking against selected therapeutic targets of *Staphylococcus aureus*.

Based on comparative computational screening, the selected protein-ligand complexes were evaluated using 100 ns molecular dynamics simulations through RMSD, RMSF, radius of gyration, Dynamic cross-correlation and free-energy landscape analyses. Hesperidin exhibited favourable predicted binding toward *S. aureus* dihydrofolate reductase, with docking scores of -10.7 kcal, respectively, and demonstrated stable dynamic behaviour during simulation. Experimental antibacterial evaluation confirmed measurable activity of hesperidin against MRSA, with a zone of inhibition of 20 ± 1 mm and MIC of $128 \mu\text{g/mL}$, while the established antibacterial drug ciprofloxacin, used as a reference control, exhibited 25 ± 2 mm and $0.96 \mu\text{g/mL}$. To advance the selected phytochemical toward a nanomedicine-based delivery strategy, hesperidin-loaded liposomes comprising egg phosphatidylcholine, cholesterol and oleic acid were developed using thin-film hydration method. The integrated findings demonstrate a

computationally guided approach for prioritizing phytochemical antimicrobial candidates and establishing their translation into liposomal nanocarriers, providing a foundation for further optimization of hesperidin- based nanomedicine strategies against drug- resistant bacterial infections.



HESPERIDIN-BASED NANO-THERAPY against AMR



Reference:

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Contributory Paper - 24

ANC 24 Metal-Free Synthesis of α , β -Dehydroamino Acids Through p-TSA Catalyzed Ring Opening of Arylidene Oxazolones

Anjana Gangadharan, Jagadeesh Krishnan* and Rony Rajan Paul*

Department of Chemistry

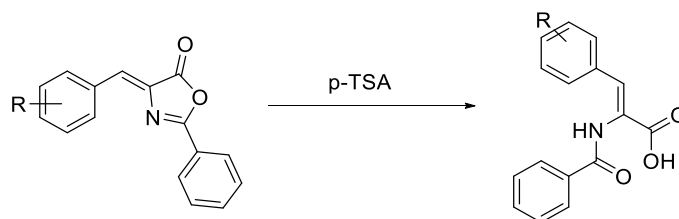
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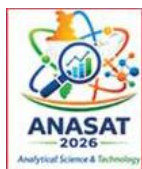
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ABSTRACT

Arylidene oxazolones are important synthetic intermediates for the preparation of various biologically relevant compounds. Ring opening reactions of azlactones give direct access to a wide range of α , β -dehydroamino acid derivatives. Despite of these developments, there remains an interest in developing more practical methods that have operational simplicity, broad substrate scope and mild reaction conditions. In this context, a simple and efficient method for the synthesis of α , β -dehydroamino acid has been developed using a Brønsted acid catalyst. The reaction was carried out under mild conditions using p-toluene sulfonic acid (p-TSA) as the catalyst. A broad range of arylidene oxazolones are transformed into corresponding α , β -dehydroamino acids with excellent yields up to 95%. The significant advantage of this method is that column chromatography is not required for the purification of the products. A plausible mechanism was proposed for the transformation of arylidene oxazolones. The developed methodology provides a practical and sustainable approach for the synthesis of biologically relevant dehydroamino acid derivatives.



Keywords: Erlenmeyer Azlactone, Arylidene oxazolone, Ring opening reaction, p-TSA catalyzed reactions, dehydroamino acids.



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Contributory Paper - 25

ANC 25 A TERTIARY AMINE MEDIATED [2+2] ANNULATION OF ALLENOATES WITH 1,2-DIONES AND α -KETOAMIDES

Ganga V S, Aswathy Ajayan, Jagadeesh Krishnan* and Rony Rajan Paul*

Department of Chemistry

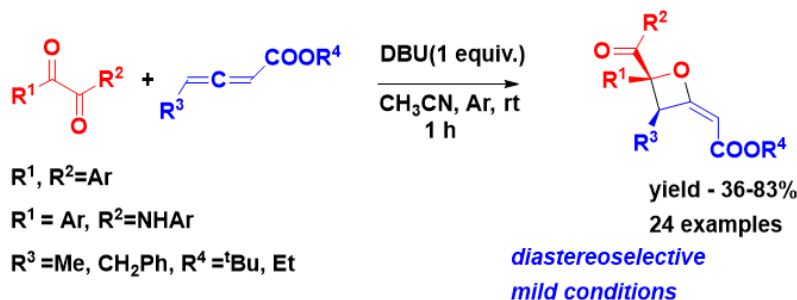
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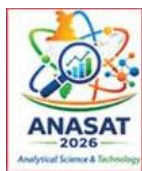
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ABSTRACT

A simple and efficient tertiary amine mediated [2+2] annulation reaction between 3-alkyl allenates and acyclic diaryl 1,2-diones or α -ketoamides has been developed for the synthesis of highly substituted alkylene-oxetanes. The reaction is carried out under mild conditions using DBU as the base in acetonitrile and gives the desired oxetane products in moderate to good yields with high diastereoselectivity. A wide range of substituted 1,2-diones and α -ketoamides were found to be compatible with the reaction, and most products were obtained as single E-isomers. A plausible mechanism involving the formation of a zwitterionic intermediate followed by nucleophilic addition and cyclization is proposed. The synthetic usefulness of the oxetanes was further demonstrated by their conversion into 5-methylene-1H-pyrrol-2(5H)-one derivatives using $\text{BF}_3 \cdot \text{OEt}_2$, showing the potential of this method for preparing biologically important heterocyclic compounds.



Keywords: Zwitterions, Tertiary Amine mediated reaction, Allenates, Diaryl 1,2-diones/ α -Ketoamides, Oxetanes



References:

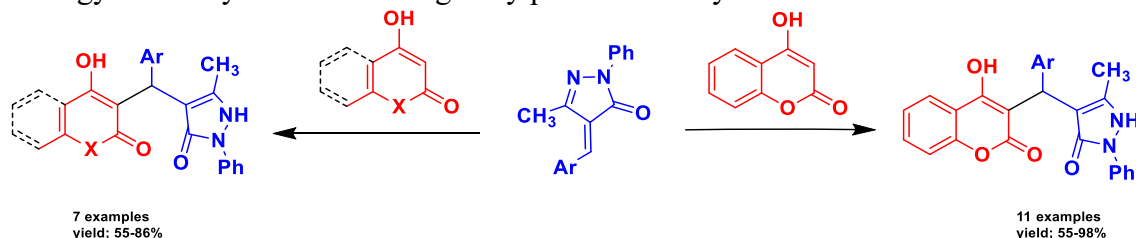
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Contributory Paper - 26

ANC 26	Novel Metal Free Lewis Acid Catalyzed Synthesis Of Biologically Potent Hydroxy Coumarin Fused Pyrazolones <i>Geethu G, Jagadeesh Krishnan* and Rony Rajan</i> <i>Paul*geethuphdchem25@cmscollege.ac.in</i> <i>Department of Chemistry, CMS College Kottayam (Autonomous)-686001, India</i>
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ABSTRACT

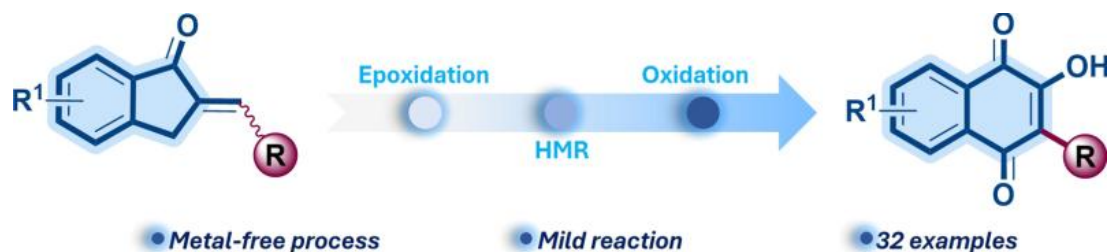
Pyrazolones are an important class of heterocyclic compounds known for their structural versatility and biological relevance. Among them, α -arylidene pyrazolones have gained considerable attention as key intermediates in cascade, annulation, and multicomponent reactions. In this work, a novel metal-free p-toluene sulfonic acid (PTSA) catalyzed protocol was employed for the synthesis of fused α -arylidene pyrazolones. Here, α -arylidene pyrazolones were reacted with 4-hydroxy coumarin in anhydrous dichloromethane at room temperature yielded coumarin fused α -arylidene pyrazolones. The reaction was also extended with 4-hydroxy-6-methyl-2-pyrone and 4-hydroxy-1-methylquinolin-2-one. This methodology effectively afforded coumarin, pyrone or quinolinone fused pyrazolones derivatives in excellent yields for a wide range of substituted substrates. Mechanistically the reaction proceeds via a Michael addition–rearrangement pathway. The structures of all synthesized compounds were confirmed by spectroscopic techniques. This method has a broad substrate scope, making it a valuable strategy for the synthesis of biologically potent heterocycles fused frameworks.



Keywords: arylidene pyrazolone, 4-hydroxy coumarin, 4-hydroxy-6-methyl-2-pyrone, 4-hydroxy-1-methyl-1-quinoline-2-one, p-TSA

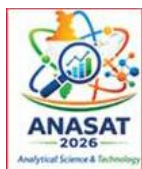
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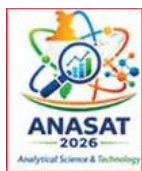


Contributory Paper - 27

ANC 27	Dynamic Imine-Linked Functional Aerogel Derived From Post-Consumer Pet Bottles For Oil–Water Separation
	Abhirami S P^{1,2} Sushanta Kumar Sahoo^{*1,2} <i>¹Advanced Functional Materials Division, CSIR-National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram, 695019, India</i> <i>²Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, 201002, India</i> <i>*Corresponding Author: sushantasahoo.niist@csir.res.in</i>

ABSTRACT

Water pollution arising from oil spillage and the industrial disposal of organic solvents has become a significant environmental concern, posing challenges to aquatic ecosystems. Meanwhile waste management of post consumed PET bottles through unique recycling strategies is a crucial step for sustainability and circular economy. In present study, the vitrimerization process is adopted for making waste PET bottles into functional aerogels by incorporating dynamic imine crosslinkers, which possess high potential to physically crosslink with PET oligomers. It imparts the structural and surface characteristics as required for efficient oil–water separation. The dynamic imine crosslinkers were synthesised via aldimine condensation between an aldehyde and a diamine, to prepare vitrimer aerogel. The prepared aerogels have densities in the range of 0.164–0.205 g cm⁻³, with porosity values between 83–86 %. The samples displayed reasonable mechanical properties with compressive modulus values ranging from 1.2–1.5 MPa and good thermal stability. Furthermore, the aerogel materials displayed good solvent absorption capacity (2000–5000 mg/g) and excellent oil water separation performance over multiple cycles. Recovery of PET from the fabricated aerogel is readily achievable by treating the aerogel in an excess amine solution and can be recycled to prepare PET sheets by hot pressing. Thus, this circular approach paved a way to develop vitrimeric functional aerogel from PET waste for mitigating oil-contamination in water bodies.

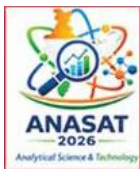


Contributory Paper - 28

ANC 28	Regional NO₂ Pollution Trajectories And Population Health Risk In India: An Observational Data-Driven Assessment
	<i>S Ramkesav^{a,b} S V Ajay^a Thomas M Kanthappally^{a,b} K P Prathish^{a,b*}</i> <i>^a Environmental Technology Division, CSIR, National Institute for Interdisciplinary Science & Technology, Industrial Estate P.O, Thiruvananthapuram, Kerala 695019, India</i> <i>^b Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India</i> <i>*Corresponding Author: K. P. Prathish(prathishkp@niist.res.in)</i> <i>Presenting author –Ramkesav S(ramkesavs654@gmail.com)</i>

ABSTRACT

Nitrogen dioxide (NO₂) is a proxy for combustion-related emissions and is associated with adverse respiratory and cardiovascular health effects. However, national assessments of NO₂ in India have often been limited by fragmented observations, uneven monitoring coverage, and a lack of systematic integration between evolving pollution patterns and quantitative health-outcome estimates. This study developed an observation-based analytical framework to examine the long-term evolution, spatial heterogeneity, and health implications of ambient NO₂ pollution across India. A 25-year dataset covering 2000–2025 was assembled by combining measurements extracted from peer-reviewed studies with recent observations from India’s continuous ambient air-quality monitoring network. The harmonized dataset was analysed using spatial-regime comparisons, trajectory-based K-means clustering, and the health impact assessment was done by the Environmental Benefits Mapping and Analysis Program. The study also compared ground-based observations with a national satellite-informed land-use regression product to evaluate differences in exposure characterization and regulatory classification. The results showed an increase in NO₂ concentrations between 2000 and 2020, followed by a marked decline during 2021–2025. However, this decline was not spatially uniform. The trajectory analysis identified five distinct urban pollution patterns, including persistent high-exposure regions, highly volatile industrial corridors, gradual urbanization zones, early-peak and stabilization zones, and relatively low-pollution baselines. Ambient NO₂ concentrations decreased by approximately 46% during the COVID-19 lockdown period, while short-term emission-intensive events produced significant increases in concentrations, confirming the strong responsiveness of NO₂ levels to changes in anthropogenic activity. The health impact assessment estimated that in 2023, while



compliance with the Indian NO₂ standard could avoid 8,219 premature deaths, adherence to the stricter WHO guideline could have prevented 233,983 deaths—implying that approximately 97% of the modelled mortality burden lies in regions classified as compliant under current national regulations. The findings demonstrate that national average trends and statutory compliance can conceal persistent regional and population-level risks. A differentiated management approach is therefore needed, combining stringent source controls in industrial and high-exposure regions with preventive measures in rapidly urbanizing areas.

Keywords: Ambient NO₂, Air-quality monitoring, Pollution trajectories, Health-impact assessment, Premature mortality

Contributory Paper - 29

ANC 29	Fluorine-Doped Cesium Tungsten Bronze ($\text{Cs}_{0.33}\text{WO}_{3-x}\text{F}_x$) Integrated Thermally Responsive Copolymeric Smart Hydrogel Films For Smart Windows
	Roshni S^a, Subrata Das^{a,b*}, Sushanta K. Sahoo^{a,b*} <i>a. Advanced Functional Materials Division, CSIR-National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram 695019, India</i> <i>b. Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India</i> <i>Corresponding Author- *E-mail: sushantasahoo.niist@csir.res.in</i>

ABSTRACT

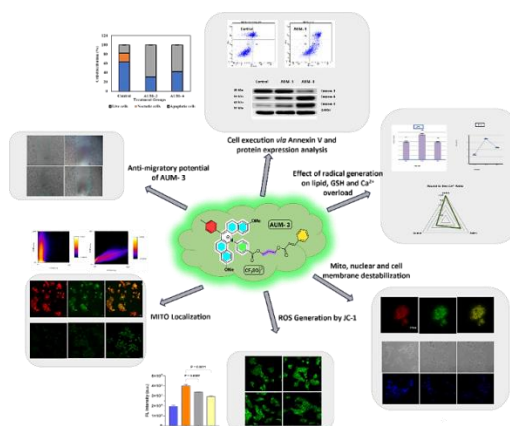
The rise in global temperature and increasing heat events worldwide demands the need for developing advanced thermo-responsive materials with NIR shielding. The present research reports preparation of thermo-responsive hydrogel film for thermochromic light regulation and solar NIR shielding. Poly(N-isopropylacrylamide-co-acrylamide) (PNAM) copolymeric hydrogels integrated with castor oil sourced acrylated epoxide methyl ricinoleate (AEMR) monomer are prepared through free radical polymerization with a tunable lower critical solution temperature (LCST) in the range 35-40 °C. Dark blue colored fluorine (F⁻) doped cesium tungsten bronze, $\text{Cs}_{0.33}\text{WO}_{3-x}\text{F}_x$ (FCWO) nanoparticles were synthesized via a facile hydrothermal route and incorporated to the hydrogel matrix. The hydrogel film with 0.3 wt% of $\text{Cs}_{0.33}\text{WO}_{3-x}\text{F}_x$ (FCWO) nanoparticles was identified as the optimized sample with visible light transmittance (T_{lum}) of ~70.03 %, a remarkable solar modulation (ΔT_{sol}) of ~67.99 %, and high NIR shielding of ~89 %. Moreover, the optimized composite hydrogel film (PNAM-FCWO - 0.3) decreased the internal temperature of the model house by ~10.8 °C compared to the standard glass window-based identical model house. With its excellent flexibility, water stability and heat absorption capacity, the PNAM-FCWO composite films showed significant potential for NIR shielding and energy saving materials for smart window.

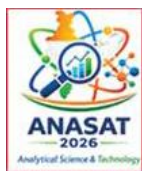
Contributory Paper - 30

ANC 30	Delocalized Pyridinium Cations for Mitochondria-Targeted Imaging and Apoptosis-Based Cancer Theranostics
	Siddalingeshwar Vijaykumar D,^a Sasidhar B. Somappa,^{a*} and Ayyappan PillaiAjayaghosh,^{b*} ^a<i>Chemical Sciences and Technology Division, CSIR-National Institute for Interdisciplinary Science and Technology (), Thiruvananthapuram - 695 019, Kerala, India.</i> ^b<i>SRM Institute of Science and Technology (Main Campus), Kattankulathur, Chengalpattu District, Tamil Nadu – 603203.</i> Email: sasidharbs.niist@csir.res.insiddudmn94@gmail.com

ABSTRACT

Cancer remains a major global health challenge, with hepatocellular carcinoma exhibiting considerable resistance to conventional therapeutic strategies. Programmed cell death (PCD), particularly apoptosis, represents an important mechanism for selectively eliminating cancer cells. In this context, we designed and synthesized **AUM-3**, a delocalized cationic molecule incorporating cinnamic acid, as a potential theranostic agent capable of simultaneously inducing and monitoring cancer cell death. AUM-3 exhibited tunable photoluminescence in response to changes in solvent polarity, viscosity, and physiological pH, with pronounced responses observed at 10 μ M, suggesting its potential for monitoring cellular microenvironmental changes. The intrinsic green fluorescence of AUM-3 enabled its time-dependent localization within the mitochondrial membrane of cancer cells.





Mechanistically, the delocalized cationic framework facilitated membrane permeability and destabilization, as evidenced by JC-1 analysis, accompanied by increased reactive species generation, lipid peroxidation, and glutathione depletion. AUM-3 also induced marked morphological alterations, inhibited cell migration, and promoted apoptosis, as demonstrated by wound-healing and Annexin V/PI assays. Elevated intracellular Ca^{2+} levels further supported cellular stress and death. Western blot analysis revealed activation of caspases 8 and 9, followed by caspase 3 activation, indicating engagement of both extrinsic and intrinsic apoptotic pathways. Overall, AUM-3 induces cancer cell death at 10 μM through a dual-action mechanism while providing an intrinsic fluorescent readout of cellular changes.

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Contributory Paper - 31

ANC 31 INVESTIGATION ON THE EFFECT OF REACTIVE PLASTICIZER AND CURING AID ON VISCO ELASTIC BEHAVIOR OF SOLID PROPELLANT BINDER

Ambili K^a, Athul Raj R^b, Divya Haridas^a, Bhatt Tushar Shriram^a

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ABSTRACT

Reactive plasticizers play significant role in modifying the mechanical and ballistic properties of hydroxyl-terminated polybutadiene (HTPB)/ toluene diisocyanate (TDI) based propellant systems, by participating in the curing reaction and becoming an integral part of the polymer network. Reactive plasticizers contain functional groups that chemically bond with the binder matrix, thereby influencing crosslink density and network structure. Their incorporation reduces viscosity during processing, improving slurry castability and filler dispersion, simultaneously enhancing flexibility and elongation of the cured propellant. However, excessive incorporation may reduce tensile strength and modulus due to decreased crosslink density.

This study is conducted with varying concentrations of Castor oil, a naturally derived triglyceride, as plasticizer in HTPB based propellant. The hydroxyl functional groups in castor oil react with diisocyanates, forming urethane linkages and become integral part of the polymer network. Compared to conventional plasticizers such as dioctyl adipate, castor oil exhibits significantly lower migration and volatilization due to its chemical bonding within the network, thereby improving long-term aging stability and mechanical integrity. Additionally, castor oil contributes to low glass transition temperature, facilitating better low-temperature performance, while maintaining adequate tensile strength. Its renewable origin, biodegradability, and non-toxicity further provide environmental and safety advantages.

The variation in mechanical properties with castor oil content (2.5–20 phr) influences the wettability of fillers and the ballistic performance of the propellant. The tensile strength increases from 0.405 to 0.472 MPa, elongation shows a maximum at 10 phr (981.4%) and modulus increases from 0.075 to 0.088 MPa, indicating a progressive modification in network structure. Increased elongation and moderate modulus at 10 phr indicate enhanced chain mobility and surface adaptability, allowing the binder to effectively spread over and adhere to fillers. This results in improved wetting efficiency, reduced void

formation, and better particle–binder contact. At lower phr (2.5), limited flexibility restricts complete wetting, whereas at higher phr (20), increased modulus and reduced elongation limit chain rearrangement, reducing optimal wetting behavior. Improved mechanicals support ballistic performance by maintaining binder integrity under combustion-induced stress, enabling higher solid loading and consistent burn rates. Improved wettability at optimal phr enhances the homogeneous distribution of oxidizer particles, which contributes to more uniform combustion and efficient heat transfer, thereby supporting stable ballistic performance.

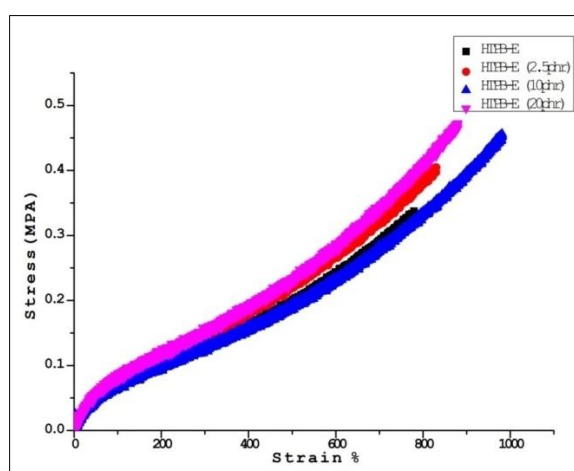


Fig. 1. Stress strain curve of Castor oil based

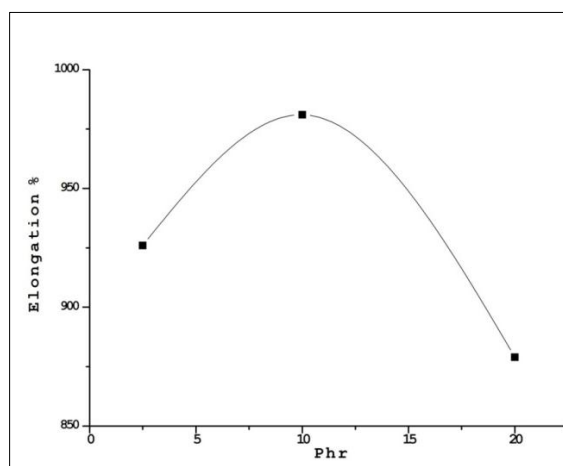
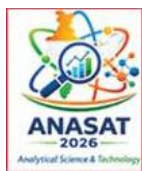


Fig. 2 Effect of castor oil content on HTPB/TDI polyurethane system Elongation



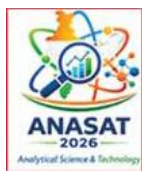
The higher elongation observed at 10 phr enhances the strain tolerance of the propellant grain, minimizing crack formation under thermal and mechanical stresses. At 20 phr, although tensile strength and modulus are higher, the reduction in elongation can decrease the material's ability to accommodate strain, potentially increasing the risk of microcrack formation under extreme conditions.

10 phr system provides the most balanced combination of tensile strength, elongation, and modulus, resulting in enhanced wettability, improved grain integrity, and stable ballistic performance.

A comprehensive evaluation of the structure–property relationships in HTPB–TDI based polyurethane networks through systematic variation of the NCO/OH ratio and assessment of reactive plasticizer effects was also done. A higher NCO/OH ratio (0.85) resulted in a substantial increase in tensile strength and modulus, attributed to enhanced urethane linkage formation, elevated crosslink density, and increased hard segment content, which collectively promote stronger intermolecular interactions and effective stress transfer. In contrast, the reduction in elongation at break reflects restricted segmental mobility and increased network rigidity, highlighting the classical trade-off between stiffness and extensibility in crosslinked elastomeric systems.

Quantitative evaluation of crosslink density using equilibrium swelling and mechanical approaches revealed consistent trends, confirming the robustness of the adopted methodologies and reinforcing the direct correlation between network density and mechanical response. The viscosity studies indicated that the incorporation of castor oil reduces the resin viscosity and help to maintain a good flow. Crosslink density increases with castor oil content, it also increase sol gel content to a certain level.

Furthermore, sol–gel analysis substantiated the progressive evolution of a three-dimensional network structure with increasing curing ratio, as evidenced by higher gel fractions and reduced sol content, indicative of improved network integrity and reduced extractable species.



Contributory Paper - 32

ANC 32 Characterization Of Ommochrome And Melanin-Free Ink Incorporated Fish Gelatin/Chitosan Bioactive Films Using Response Surface Methodology

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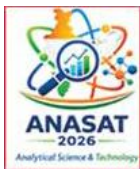
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ABSTRACT

This study developed bioactive composite films from fish gelatin/chitosan (FG30:CH70) blends by incorporating two squid-processing by-products, namely squid skin (ommochrome) pigment extract (SSPE, 0–0.5% w/v) and squid melanin-free ink extract (SMFI, 0–10 mL), and their formulation was subsequently optimised using D-optimal response surface methodology (RSM). The individual, quadratic, and interactive effects of both pigments were evaluated for tensile strength (TS), elongation at fracture (EAF), water vapor transmission rate (WVTR), and ABTS radical-scavenging activity (ABTS-RSA). Over eight experimental runs, values ranged from 2.08–9.73 MPa for TS, 55.46–75.05% for EAF, 67.57–162.90 g/m²/day for WVTR, and 362.72–386.89 μ mol TE/g for ABTS-RSA. The quadratic models fitted TS, EAF, and WVTR reasonably well ($R^2 = 0.92$ – 0.97), although the model for ABTS-RSA was comparatively weak ($R^2 = 0.54$), owing to the narrow range of this response. Numerical optimisation based on desirability functions identified 0.239% w/v SSPE and 4.569 mL SMFI as the optimal formulation, which upon experimental verification agreed closely with predicted values for EAF, WVTR, and ABTS-RSA (errors below 6%), though a larger deviation was noted for TS (18.28%). FTIR analysis suggested that pigment incorporation was primarily mediated by hydrogen bonding, while XRD and TGA revealed a modest reduction in crystallinity and thermal stability. SEM further showed increased surface roughness and heterogeneity in the pigmented film, and the water contact angle increased from 65.08° to 78.49°, reflecting improved surface hydrophobicity. These findings confirm the feasibility of valorising squid skin and ink by-products as functional pigments for developing sustainable, antioxidant-active gelatin/chitosan packaging films.



Keywords: Squid skin (ommochrome)pigment extract (SSPE); squid melanin-free ink (SMFI); fish gelatin/chitosan film; response surface methodology; active packaging; antioxidant film

Contributory Paper - 33

ANC 33 Influence of Oxalic Acid-Mediated Synthesis on the Physio-Chemical Properties of ZnO Nanoparticles

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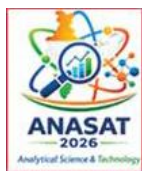
ABSTRACT

Zinc oxide nanoparticles were synthesized using a wet chemical co-precipitation method using oxalic acid as a catalyst at different weight percentage of 1:0.5, 1:1, 1:1.5, and 1:2 (ZnO₁, ZnO₂, ZnO₃ and ZnO₄) at room temperature. The resulting white powder was collected after being dried at 100°C for 12 hours followed by calcination process at 700°C for 4 hours. The resulted powder was characterized by XRD, FT-IR, TGA and SEM analysis and the catalytic activity on the thermal decomposition of ammonium perchlorate was evaluated. Infrared (IR) spectroscopy profiles recorded in Transmittance mode demonstrate uniform, highly overlapping structural tracks across all batches. The sharp, intensive band at the low-frequency boundary confirms successful ZnO crystallization within a hexagonal wurtzite lattice. The presence of a broad hydroxyl (-OH) band near 3450 cm⁻¹ and a weak water bending (H-O-H) vibration at 1630 cm⁻¹ reveals high surface energy and post-synthesis environmental moisture adsorption. Meanwhile, the complete absence of bands around 1000 cm⁻¹ indicates that organic precursors were thoroughly decomposed without leaving behind impurities. Correspondingly, X-ray diffractograms across 10° to 90° confirm chemical purity and structural maturity, showing a prominent triplet between 31.7° and 36.2° as a key hexagonal fingerprint. Growth is dominant along the (101) plane.

The Brunauer-Emmett Teller (BET) specific surface area varies from 3.6247 m²/g up to 9.8322 m²/g. Adjusting the oxalic acid concentration during preparation alters these values: increasing the concentration from 50% to 150% raises the surface area from 4 to 10 m²/g, whereas concentrations above 150% reduce it back to 6 m²/g. Nitrogen adsorption isotherms exhibit a standard IUPAC Type II classification, indicating unrestricted monolayer-multilayer adsorption on non-porous or microporous surfaces. The statistical monolayer completes at a relative pressure (p/p₀) of roughly 0.05. Adsorbed nitrogen volume follows the descending sequence of ZnO₃ > ZnO₄ > ZnO₂ > ZnO¹. Field Emission Scanning Electron Microscopy (FESEM) shows a

Homogeneous matrix of multifaceted, non-agglomerated polygonal grains with diameters bounded between 40 nm and 160 nm. ZnO_3 yields the highest surface area and forms a uniform, highly porous 3D net work with small particle diameters clustering between 40 nm and 90 nm, while ZnO_4 indicates minor localized sintering.

Blending 3 wt% of these nanocatalysts with ammonium perchlorate (AP) alters its typical two stage thermal decomposition into a single-stage process. This reduces the high-temperature decomposition (HTD) threshold by 40–60 °C. ZnO_3 provides the most exceptional catalytic reduction due to its high particle dispersion. Uncatalyzed low-temperature decomposition (LTD) of AP releases NH_3 and HClO_4 , but accumulates excess NH_3 on the surface, which suppresses the proton transfer and halts reaction progress. When ZnO is added, HClO_4 adsorbs and decomposes on the catalyst's exposed facets. Electron transfers generate highly active oxygen ions (O^-) that exothermically oxidize the blocking surface NH_3 into N_2O , reducing ammonia coverage and accelerating total decomposition.



Contributory Paper - 34

ANC 34 2D Nanomaterials Based Photocatalytic Membranes for Sustainable Water Treatment

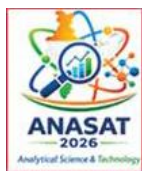
Sreelakshmi Dileep, Suja Haridas*

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ABSTRACT

Water pollution arises from industrial discharge, agricultural runoff, dyes, pharmaceuticals, and other emerging contaminants emerged as a serious global concern, threatening both ecological balance and human health. Conventional treatment methods, though widely practised, are inadequate for the treatment of complex and persistent pollutants. Membrane- based separation technology has emerged as a superior alternative, due to its operational simplicity, separation efficiency, low energy consumption and scalability. However, membrane fouling caused by the continuous accumulation of pollutants, is a critical concern, which leads to low flux and poor sustainability. This has necessitated the development of photocatalytic membranes (PMs), which integrates the advantages of membrane filtration along with photocatalytic degradation, by the generation of reactive oxygen species (ROS), imparting self-cleaning and antifouling functionalities to the membrane. Among various photocatalytic materials explored, 2D nanomaterials have proven to be effective due to their large surface area, tunable surface chemistry and efficient charge carrier separation. This work focuses on graphitic carbon nitrides (g-C₃N₄) based photocatalytic membranes. g-C₃N₄ is a visible light responsive, metal-free polymeric semiconductor photocatalyst with excellent chemical stability and low toxicity. However, pristine g-C₃N₄ has limited surface area and rapid electron- hole recombination. This work mainly focuses on modification of pristine g-C₃N₄ with MOF to produce composites that can enhance visible light harvesting, charge separation and surface properties. The composites are fabricated onto membranes and utilised for the treatment of diverse classes of pollutants, to demonstrate the potential of the membranes as multifunctional, sustainable platforms for wastewater treatment.



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Contributory Paper - 35

ANC 35 Quality Characterization Of Freeze Dried Brown Shrimp (*Metapenaeusdobsonii*)

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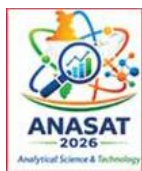
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ABSTRACT

Freeze drying is an advanced dehydration technology capable of extending the shelf life of seafood while minimizing quality deterioration and producing lightweight, nutritionally dense products. This study evaluated the effects of freeze drying duration on the physicochemical, biochemical, nutritional, microbiological, textural, colour, rehydration, and sensory properties of brown shrimp (*Metapenaeusdobsonii*). Peeled and deveined shrimp were frozen at -20°C and freeze-dried for 5, 10, and 16 h at 0.001 mbar using a laboratory freeze dryer with a condenser temperature of -81.9°C . Increasing drying duration significantly ($p < 0.05$) reduced moisture from 82.65% in fresh shrimp to 70.37%, 32.68%, and 0.47% after 5, 10, and 16 h, respectively. Similarly, protein increased from 14.76% to 19.96%, 44.04%, and 71.85%, while fat increased from 0.39% to 1.10%, 3.66%, and 5.79%; ash reached 3.26% after 16 h. Product yield decreased from 41.48% at 5 h to 14.32% at 16 h. Rehydration was temperature and time dependent, with room temperature providing greater water uptake and 80°C enabling faster reconstitution. Prolonged drying increased TMA-N ($1.40\text{--}3.45\text{ mg N }100\text{ g}^{-1}$), TVB-N ($8.40\text{--}22.40\text{ mg N }100\text{ g}^{-1}$), TBA ($0.22\text{--}1.13\text{ mg MDA kg}^{-1}$), and free fatty acids ($21.21\text{--}29.02\%$), indicating slightly biochemical changes. Aerobic plate count decreased from 5.94 to 5.53 log CFU g^{-1} . After 16 h, L^* increased from 51.70 to 83.83, while browning index decreased from 24.63 to 14.27. Although hardness, chewiness, and gumminess declined, rehydration partially restored texture. All freeze dried shrimp remained sensorially acceptable. This study indicated that greatest degree of rehydration and nutrient concentration while maintaining the favourable sensory quality and acceptable microbial quality of the final products. The study highlights the potential of optimized freeze drying as a value-addition strategy for developing stable, lightweight, nutritionally concentrated shrimp products with promising rehydration and consumer acceptability.

Keywords: Shrimp; Freeze Drying; Rehydration, Seafood Preservation; Shelf life Extension; Nutritional Quality

Contributory Paper - 36



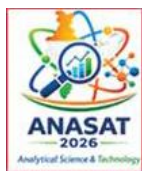
ANC - 36 NANO IRON OXIDE BASED FERROFLUID: TAILORING THE PROPERTIES VIA DIFFERENT SYNTHESIS APPROACHES

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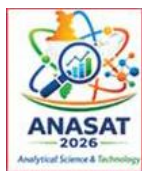
ABSTRACT

Iron oxide nanoparticles (IONP) have attracted significant attention owing to their unique magnetic, structural, and surface properties, which make them promising materials for ferrofluid, biomedical, environmental, and engineering applications. In the present work, two sets of iron oxide nanoparticles were synthesized via co-precipitation and sol-gel methods, with the objective of investigating the influence of the synthesis route on their structural and morphological characteristics. The synthesized nanoparticles were characterized using X-ray diffraction (XRD), Raman spectroscopy and scanning electron microscopy (SEM). XRD analysis was used to determine the crystalline phase and structural parameters, while Raman spectroscopy provided information on the vibrational characteristics of the iron oxide phases. SEM analysis was employed to examine the morphology and particle-size characteristics of the synthesized nanoparticles. The average crystallite size of the IONP were calculated to be 11nm (coprecipitation) and 24nm (sol-gel) using the Scherrer equation. The prepared iron oxide nanoparticles were subsequently dispersed in a tetramethylammonium hydroxide based medium to develop magnetic fluids (ferrofluids). The resulting ferrofluids offer the advantages of nanoscale magnetic particles suspended in a liquid medium and the fluidity can be controlled using an external magnetic field. A comparative evaluation of nanoparticles obtained by the two synthesis routes provides insight into the relationship between synthesis conditions, structural properties, morphology, and ferrofluid characteristics. The study highlights the importance of nanoparticle synthesis methodology in tailoring the properties of iron oxide-based ferrofluids and provides a basis for their application in advanced magnetic-fluid technologies.

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Contributory Paper - 37

ANC - 37 Development of low density biomass derived C/SiO₂ composite foam for thermal insulation

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ABSTRACT

Carbon foams are emerging lightweight macro porous carbon materials with attractive properties such as excellent fire resistance, tunable electrical and thermal conductivities and capability to absorb sound and electromagnetic waves. Hence, they find various applications in the field of thermal management, EMI shielding, energy storage and sound damping [1]. Recently, researches are focused on biomass derived materials for sustainable development [2,3]. In the present work, natural cotton, rice husk and sucrose were used for the preparation of thermally insulating carbon composite foams. Carbon composite foams were evaluated for X-ray diffraction, Raman spectrum, density, compressive strength and oxidation resistance. TG analysis of rice husk in an air atmosphere shows multiple-stage decomposition and leaves a residue of 13%. The residue analysed for FTIR spectrum and it confirmed that presence of silica in the rice husk. Amorphous nature of the carbon composite foam was confirmed by XRD and Raman analysis. They exhibited low density in the range of 0.32 to 0.36 g/cm³. They exhibited reasonably good mechanical strength of 0.8- 1.0 MPa. The SEM analysis (fig.1a) showed that the carbonized cotton fibres form a network structure and these carbonized cotton fibres are properly connected by sucrose derived carbon. The rice husk-derived C/SiO₂ particles are also sandwiched between the networks of carbonized cotton fibres. The prepared carbon composite foams are thermally stable up to 500 °C in air atmosphere Fig. 1b.

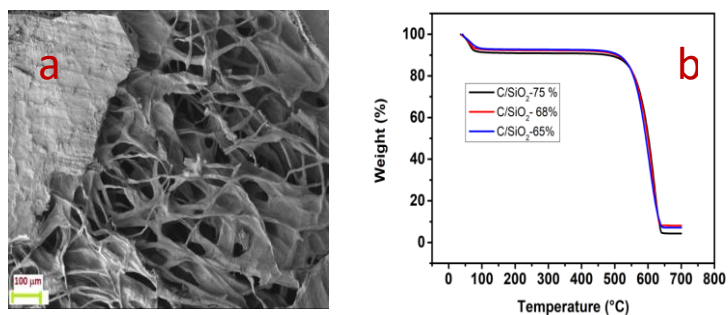
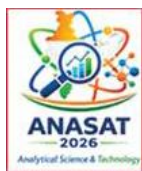


Fig.1 (a) SEM image (b) TGA curve of C/SiO₂ composite foam

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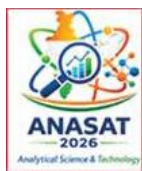
Contributory Paper - 38

ANC - 38 Nutritional Quality Of Ready To Eat Shrimp Curry In Retortable Pouch: Influence Of Blanching And Shallow Frying

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ABSTRACT

The present study was conducted to develop a shelf-stable shrimp curry and to evaluate the influence of pre-processing methods and retort treatment on its nutritional quality characteristics. Blanching and shallow frying were evaluated for the preparation of shrimp curry. The blanched and shallow fried shrimp and their respective curry preparations were evaluated before and after retort processing for proximate composition, pH, lipid oxidation, freshness indicators, amino acid profile, fatty acid profile and cholesterol. In fresh shrimp samples, moisture, protein, fat and ash contents ranged were 77.95, 18.07, 1.90 and 1.14% respectively, for blanched shrimp and 74.09, 19.88, 1.87 and 1.12% respectively, for shallow fried shrimp, which changed to 69.71, 16.30, 3.86, 1.77% respectively, and 69.13, 16.95, 4.09, 1.76% respectively, upon retorting. The pH decreased from 7.09 to 6.13 in blanched shrimp and from 7.06 to 6.06 in shallow-fried shrimp. TBARS values decreased from 0.211 to 0.113 in blanched shrimp and from 0.152 to 0.117 in shallow-fried shrimp. FFA value also decreased following retort processing, from 9.05 to 3.34 in blanched shrimp and from 3.50 to 2.82 in shallow-fried shrimp. For curry samples, moisture, protein, fat and ash contents ranged from 74.29–75.61%, 7.71–9.08%, 5.31–6.15% and 1.84–1.92%, respectively. The effect of retort processing was comparatively less pronounced in the shrimp curry. In blanched shrimp curry (BC), moisture increased slightly from 74.29 to 75.61%, while protein decreased from 9.08 to 7.71%. In shallow fried shrimp curry (SC), moisture remained nearly unchanged, while protein increased from 8.51 to 8.99%. The pH of BC decreased from 6.21 to 5.85, whereas in SC remained almost unchanged (6.02–6.01). TBARS, TVB-N and FFA decreased upon retort processing in BC and the decrease are not prominent in the shallow fried curry. High-Performance Liquid Chromatography and Gas Chromatography-Mass Spectrometry were used for analysis of amino acid and fatty acid profile. Both essential and non-essential amino acids were detected, with glutamic acid and aspartic acid were among the predominant amino acids. The total amino acid content ranged from 5.85 to 21.38 g/100 g sample across the analyzed treatments. Among the essential amino acids, leucine, lysine, valine, phenylalanine, isoleucine, threonine, methionine and histidine were detected, with leucine and lysine contributing substantially to the essential amino acid fraction. Fatty acid profile demonstrated the presence of saturated, monounsaturated and polyunsaturated fatty acids. Palmitic acid, oleic acid, linoleic acid, α -linolenic acid,



arachidonic acid and docosahexaenoic acid (DHA), were detected among the major fatty acids, indicating retention of nutritionally relevant polyunsaturated fatty acids following processing. Overall, retort processing induced more noticeable changes in proximate composition and physicochemical characteristics of shrimp samples than in the corresponding curry preparations. Among the retort-processed curry products, BC exhibited comparatively lower TBARS, TVB-N and FFA values than SC, indicating favorable quality characteristics following retort processing. The findings demonstrate the potential of retort processing for the development of convenient and shelf-stable shrimp curry products while maintaining their nutritional and quality attributes

Contributory Paper - 39

ANC – 39 Quality Characterization Of Spirulina-Enriched Cookies: Composition, Fatty Acid Profile And Mineral Elemental Analysis

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ABSTRACT

The introduction of nutrient-rich seaweed ingredients into commonly consumed foods offers a potential avenue for the development of value-added functional food products. The current study focused on the analytical characterization of spirulina-enriched cookies in comparison with the other variants. The cookie formulated with local ingredients incorporating known quantity of spirulina. Other variants of cookies incorporating cashew, chocolate and masala based preparations were also subjected to comparative nutritional and elemental characterization analysis. Proximate composition analysis of the spirulina containing sugarfree besan cookies revealed moisture, ash, fat, carbohydrate, protein and fibre contents of 4.81, 2.36, 30.07, 10.78, 10.60 and 47.56, respectively, while cholesterol was estimated to be 1.22%. The analysis revealed a high amount of dietary fibre associated with a significant presence of protein in the developed product. In turn, the major fatty acid found in the sample was palmitic acid (C16:0) that constituted 32.41% of total, followed by cis-oleic acid (C18:1 cis-9, 27.14%) and stearic acid (C18:0, 15.47%). Thus, the determined lipid content can be considered as mainly saturated (64.52%), monounsaturated (29.94%) and polyunsaturated (5.37%) according to the determined area percentages. Further, an elemental analysis revealed a significant content of potassium (3679 ppm), phosphorus (2031 ppm), magnesium (1126 ppm), calcium (658.2 ppm), sodium (679.5 ppm), sulphur (823.5 ppm), iron (103.7 ppm) and zinc (30.14 ppm) in the spirulina-containing cookie. In turn, the comparative analysis of the other cookie variants has revealed the differences in their proximate and mineral contents, which prove the impact of the used formulation ingredients on the final content in the produced cookies. The current findings proved the possibility of using analytical characterization in order to determine the nutritional and elemental compositions of the seaweed/spirulina-enriched bakery products. Therefore, it can be concluded that the use of spirulina in the production of the cookie products may help in the creation of nutritionally improved products, and the analytical science plays an essential role in the characterization of such innovations.

Contributory Paper - 40

ANC – 40 Nutritional Benefit–Risk Assessment of Bio- calcium Enriched 3D-Printed Fish Products derived from Fishery Wastes: A Circular Economy Approach

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ABSTRACT

The valorization of fishery processing wastes to develop functional food ingredients offers a sustainable strategy for nutrient recovery and circularity in food matrices. The present study evaluated the nutritional quality and benefit–risk profile of 3D-printed fish products enriched with bio calcium extracted from clam shells and fish bones. Bio calcium thus derived was incorporated into fish-based printable formulations, fabricated by extrusion-based three-dimensional (3D) food printing and subjected to post printing in the study. The developed clam-shell and fish-bone based products were characterized for proximate composition, physicochemical and biochemical quality, mineral and amino acid profiles, protein quality indices, and benefit–risk with respect to essential amino acids heavy-metals. The clam-shell based 3D printed product exhibited higher protein (29.66 %) and fat (20.94%) in comparison to the fish-bone based product (protein-25.64 % and fat-18.49%, respectively). Mineral analysis demonstrated revealed higher calcium (3886.9 ppm) in the clam-shell product when compared to the fish-bone product. Essential amino acids constituted approximately 41% of total amino acids in both products. The clam-shell product was observed to have higher values for essential amino acid index (40.11), nutritional index (11.89) and biological value (32.02) than the fish-bone product. The limiting amino acid group in both the products was methionine + cystine. Benefit–risk ratio based on the hazard quotient for essential fatty acids (HQEAA) in relation to Lead, Cadmium, Mercury, Tin and Arsenic showed values below one for both products, with the highest value being 0.09. This indicated a healthful balance between essential amino acid benefits and potential risks associated with metal exposure. The findings demonstrate the potential of conversion of calcium-rich fishery discards into functional ingredients for developing nutrient rich 3D-printed fish products, integrating nutrient enhancement, food innovation and waste valorization within the circular economy framework.

Keywords: 3D food printing; bio calcium; fishery waste; benefit–risk assessment; protein quality; circular economy

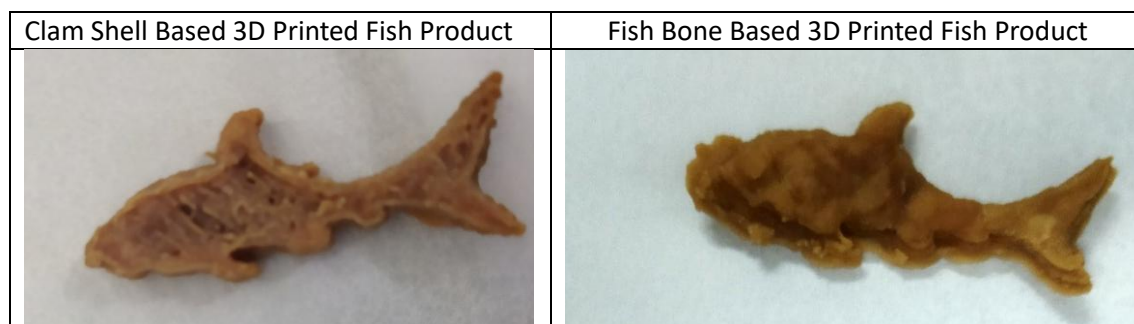
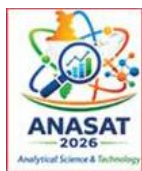


Figure 1. 3D-Printed Fish Products Enriched with Bio-calcium Derived from Fishery Discards



Contributory Paper - 41

ANC – 41 Investigative Study On The Cure Kinetics Of Htpb-Tdi System By Using Digital Refractometer

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ABSTRACT

Hydroxyl-Terminated Polybutadiene (HTPB) is a widely used polymeric binder whose performance strongly depends on the curing process and crosslink density¹. In this study, the cure kinetics of HTPB cured with Toluene Diisocyanate (TDI) at different stoichiometric ratios and temperature was investigated using refractive index (RI) measurements. Refractive index, a significant physical parameter, was employed as an economical and convenient method for monitoring the curing process in place of sophisticated analytical methods². The change in refractive index with curing time was used to determine the degree of cure (α) at different temperatures. Kinetic analysis was performed using a first-order reaction model, and the rate constants were obtained from plots of $\ln(1-\alpha)$ versus time. The activation energy of curing was determined using the Arrhenius equation³. The results confirmed the influence of curing agent concentration and reaction temperature in cross linking behaviour. Mechanical characterization of the cured samples further demonstrated the relationship between stoichiometry and material properties in accordance with the kinetic analysis⁴. The calculated kinetic parameters were compared to the literature values reported by various analytical techniques like FTIR, DSC, viscometry etc. ⁵⁻⁸

In general, the study demonstrates that refractive index measurement is a rapid and simple reliable method for monitoring the curing reaction of the HTPB–TDI system. The results provide valuable insights into the effect of temperature and stoichiometry on reaction behaviour and final polymer properties, which are essential for optimizing polyurethane formulations for practical applications. Even though the comparison with literature values shows well explainable differences among various methods, the observed trend obtained by refractometry is in excellent agreement with the trend in published studies. Hence refractive index measurements are best suited as a practical preliminary tool for cure monitoring and optimisation in HTPB-TDI system

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Contributory Paper - 42

ANC - 42 An Innovative Environmentally Weighted Net Present Value Assessment of Fire-Affected Dumpsites Towards Sustainable Reclamation

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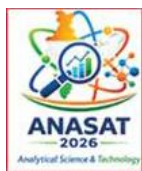
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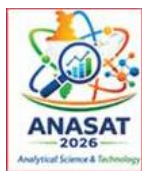
ABSTRACT

The study assesses the effects of a fire breakout occurrence at the Brahmapuram dumpsite in southern India on resource and energy recovery by estimating the damages caused by environmental pollution in the landfills. The study focuses on formulating an equation better suited to estimating the economic viability associated with the reclamation of legacy dumpsites. Damage costs are correlated to dumpsite environmental impacts, such as recurrent fires, leachate generation and other pollutant emissions, which are not included in conventional economic evaluation, and there are no scientifically established valuation frameworks for quantification of impacts and decision making applications. Environmentally Weighted Net Present Value (NPV_E), a novel decision-support tool created by incorporating environmental expenses (E) into the conventional Net Present Value (NPV) framework, fills this gap. The Environmental Damage Cost (EDC) at the legacy landfill site was calculated (15.9 to 933.8 USD/tonne of waste) and a reclamation strategy was formulated using site-specific post-fire breakout data and unit damage cost of pollutants adjusted for Indian scenario. Compared to the traditional NPV of -9.1 million USD, the reclamation plan obtained NPV_E of +8.5 million USD with the new formula supporting the necessity for immediate intervention. A sensitivity analysis to analyse the versatility of the formula was conducted. It altered the EDC by $\pm 20\%$ and the discount rate by $\pm 2\%$ from their baseline values, as well as a stress test of -10% on profits and +10% on project expenses, was also done to confirm the robustness of the NPV_E strategy. Across India there is approximately 2452 dumpsites, prompt reclamation can save 22.6 million tons of recyclables and 239.1 million tons of RDF (≈ 6.1 billion USD).



Reclamation can prevent an estimated 29 million tons CO₂-eq of landfill gas emissions, with an estimated EDC of 4.36 billion USD.

Keywords: Dumpsite reclamation; Environmental damage cost; Decision-support framework; Net Present Value (NPV); Sustainable waste management



Contributory Paper - 43

ANC - 43 pH-Responsive Intelligent Packaging Films Based On Jamun Anthocyanins And Pineapple Leaf-Derived Carbon Quantum Dots For Seafood Freshness Monitoring

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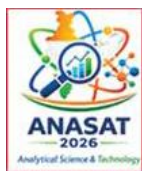
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ABSTRACT

The development of sustainable packaging materials capable of both protecting food and communicating its quality is important for reducing food spoilage and waste. In this study, pineapple leaf waste was utilised as a carbon precursor for the preparation of carbon quantum dots (P-CQDs), which were combined with anthocyanin-rich jamun (*Syzygiumcumini*) pulp extract and polyvinyl alcohol (PVA) to fabricate colour-responsive composite films. The P-CQDs were synthesised through a one-step hydrothermal process and incorporated into the PVA-jamun anthocyanin matrix at different concentrations. The resulting materials were examined for their structural, optical, mechanical, barrier, antioxidant, antimicrobial and pH-responsive properties.

The synthesised P-CQDs exhibited a nanoscale morphology, with an average particle size of approximately 8.06 nm, and showed blue fluorescence under ultraviolet illumination. Incorporation of the carbon dots improved the functional performance of the composite films. The film containing the highest P-CQD concentration exhibited a tensile strength of 34.78 MPa, compared with 13.74 MPa for the control film, while its oxygen permeability and water vapour transmission rate decreased to 0.60 cm³ m⁻¹ 24 h⁻¹ atm⁻¹ and 84.92 g m⁻² h⁻¹, respectively. The composite films also demonstrated strong ultraviolet shielding, with UV transmittance below 7%, together with antioxidant activity of 88.7% in the DPPH assay.

The anthocyanin-containing films displayed distinct colour transitions under acidic, neutral and alkaline conditions. Exposure to volatile amines, particularly ammonia and triethylamine, produced visible colour changes, demonstrating their potential for spoilage-related gas detection. In a practical evaluation, the films were placed inside containers holding fresh shrimp without direct contact with the food. During storage at room temperature, progressive colour changes corresponded with increases in shrimp pH



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and TVB-N values. The highest P-CQD formulation exhibited a colour difference (ΔE) of 18.02 after two days of shrimp storage, indicating enhanced visual sensitivity. Overall, the developed biomass-derived composite films combine protective and sensing functions in a single platform and show promise as sustainable indicators for non-invasive seafood freshness monitoring.

Contributory Paper - 44

ANC - 44 Proton assisted electrochemical synthesis of covalent triazine framework- a localised deposition strategy on conductive surfaces for the photoelectrochemical sensing of Thiabendazole.

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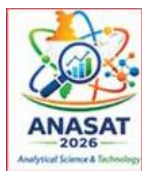
ABSTRACT

Thiabendazole (TBZ) is a widely used benzimidazole-based fungicide employed for the protection of agricultural crops and post-harvest products. Its excessive use and persistence can result in its occurrence in environmental and food matrices, highlighting the need for rapid, sensitive, and reliable detection methods.^{1,2} Photoelectrochemical (PEC) sensing has emerged as an attractive sensing strategy because it combines the advantages of photochemical excitation and electrochemical signal transduction, offering enhanced sensitivity with relatively simple instrumentation. Among the various functional materials explored for PEC applications, covalent triazine frameworks (CTFs) are particularly promising owing to their π -conjugated structure, high chemical stability, porous architecture, and tunable electronic properties. These characteristics make CTFs suitable for facilitating charge generation and transport during PEC sensing.³ However, conventional CTF synthesis generally relies on solvothermal or other batch processes, where the synthesized material needs to be isolated, purified, dispersed, and subsequently deposited onto a conductive electrode. Such multiple processing steps can affect electrode-material contact, film uniformity, and charge-transfer efficiency, while also making electrode fabrication more complicated. Thus CTF_{TFPOT-TAPB} was synthesized directly on an ITO substrate through a proton-assisted electrochemical process using diphenylhydrazine (DPH) as an electrogenerated acid source.⁴ Upon electrochemical oxidation, DPH facilitates proton generation, creating an acidic environment that promotes the condensation of the aldehyde-functionalized TFPOT and TAPB monomers, resulting in the formation of imine (C=N) linkages. This approach enables direct CTF growth on the ITO surface, eliminating the need for separate synthesis, isolation, dispersion, and electrode coating steps. The electrochemically deposited CTF exhibits pronounced photoactivity under irradiation with light of wavelength below 450 nm. Upon illumination, the CTF generates photoinduced charge carriers, resulting in an enhanced photocurrent response. Interestingly, the introduction of thiabendazole (TBZ) leads to a further increase in photocurrent, attributed to the interaction of TBZ with the photoactive

CTF and enhanced charge separation. This concentration-dependent photocurrent enhancement enables the sensitive photoelectrochemical detection of TBZ.

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Contributory Paper - 45

ANC 45 Bio-Nucleating Agent Mediated Crystallization and Functional Property Enhancement in PLA/PBAT Blend Films for Food Packaging Applications

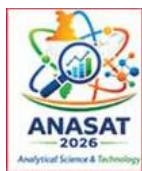
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ABSTRACT

The development of advanced compostable polymer blends with enhanced functional properties has drawn a lot of attention due to the rising demand for sustainable and environmentally friendly food packaging products. Among various strategies, blending polylactic acid (PLA) with poly(butylene adipate-co-terephthalate) (PBAT) has emerged as one of the most successful ways to overcome the inherent limitations of the individual polymers. In this study, particular emphasis is given to orotic acid (OA), a naturally derived bio-based nucleating agent, for its potential to significantly enhance the crystallization behavior and overall performance of PLA/PBAT blend films. Compatibilized PLA/PBAT blend films containing various concentrations of OA (0.3, 0.5, and 1 wt%) were fabricated using an industrially relevant blown film extrusion process. The incorporation of OA acted as an efficient nucleation promoter, accelerating crystal formation and improving the structural organization of the polymer matrix. FTIR, XRD, DSC, and TGA analyses confirmed that OA effectively enhanced the crystallinity and thermal stability of the PLA/PBAT blend films. The OA-modified films also exhibited remarkable functional improvements, including nearly 65% reduction in water vapor transmission rate, indicating superior moisture barrier performance. Among the investigated formulations, the PLA/PBAT blend film containing 0.5 wt% OA exhibited the best overall balance of crystallization behavior, mechanical strength, thermal stability, and barrier performance. Migration studies carried out for the optimized formulation further confirmed the suitability and safety of OA-incorporated films for food packaging applications. The findings demonstrate the strong potential of OA for producing high-quality, compostable, and active food packaging materials.



Contributory Paper - 46

ANC- 46 A Low-Cost Portable Spectrophotometric Device for Creatinine Quantification

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Chronic kidney disease (CKD) is a major global health challenge due to reduced glomerular filtration rate (eGFR) and increased urinary protein excretion. Biomarkers are measurable biological substances used to assess kidney function and monitor the progression of renal disease. Common renal biomarkers include creatinine, urea, uric acid, albumin, and proteins.

Among these, creatinine is the most widely used biomarker because it is produced at a relatively constant rate under normal physiological conditions and is primarily eliminated through glomerular filtration [1,2] . The Jaffe method is widely used due to its cost-effectiveness, simplicity, and adaptability for routine laboratory use. To facilitate point-of-care CKD diagnosis, we developed a low-cost device integrating a blue LED light source, a light- dependent resistor (LDR) detector, and a microcontroller unit, operating on the principles of the Jaffe assay by measuring optical density at 463 nm [3,4] . The ESP32 microcontroller's built- in Wi-Fi module enabled seamless data transfer to a computer or mobile phone for further analysis. The system exhibits an excellent linear relationship between the absorbance and creatinine concentration ($R^2 = 0.999$; slope = 0.06745), matching to the conventional spectrophotometric device. Validation experiments utilizing samples in water, artificial urine, and artificial serum demonstrated low limits of detection (~ 0.029 mg/dL) and quantification (~ 0.098 mg/dL). The device showed strong predictive performance, with RMSE values of 0.206 mg/dL for water samples and ~ 0.3 mg/dL for artificial urine and artificial serum samples. High correlation coefficients ($R^2 > 0.99$) across matrices confirm the system's good accuracy, precision, and reliability.

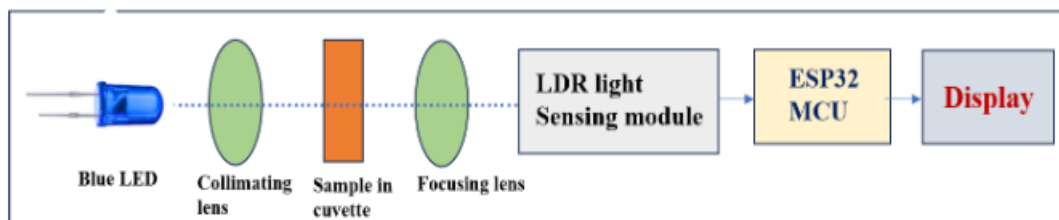
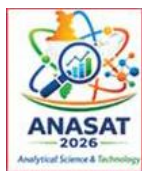


Figure 1: The pictorial representation of the overall optical configuration of the developed device

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Contributory Paper - 47

ANC 47 **Innovative Spectrophotometric Assay Integrated Colorimetric Quantification of ‘Vitamin C’ and Fabrication of Low - Cost Smart Device for in - Situ Applications**

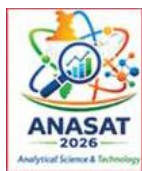
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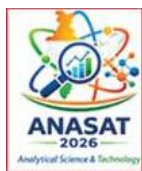
ABSTRACT

Oxidative stress, resulting from an imbalance between the production of reactive oxygen species (ROS) and antioxidant defense in our body, can cause extensive cellular damage. Vitamin C, a key water-soluble antioxidant abundant in fruits, plays a vital role in neutralizing ROS. Accurate quantification of Vitamin C in food matrices is therefore essential to prevent both deficiency and toxicity. Conventional determination methods provide reliable results but often require expensive instrumentation, trained personnel, and laboratory infrastructure. In this study, we developed a spectrophotometric assay for the rapid quantification of vitamin C in fruit juices, and translated the developed assay to a smartphone-integrated colorimetric platform (SICP). The assay exploits the specific redox reaction between ascorbic acid and DCPIP dye, wherein the dye is reduced to its leuco-form, producing a measurable color change. The SICP employs an LED light source with images captured by a smartphone camera for subsequent colorimetric analysis. Results demonstrated a linear relationship between analyte concentration and the lightness values, confirming the quantitative capability of the platform. The results obtained were compared with the established techniques. The proposed assay, based on UV–Vis spectroscopic measurements, showcased accuracy and reproducibility. The smartphone integrated analytical device developed from the proposed assay is portable, cost-effective, and user-friendly, offering an alternative to conventional assays for on-site monitoring of vitamin C in food matrices.



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Contributory Paper - 48

ANC 48 Chemically Activated Carbon Aerogels for Efficient Methylene Blue Removal: Kinetic, Isotherm, and Characterization Studies

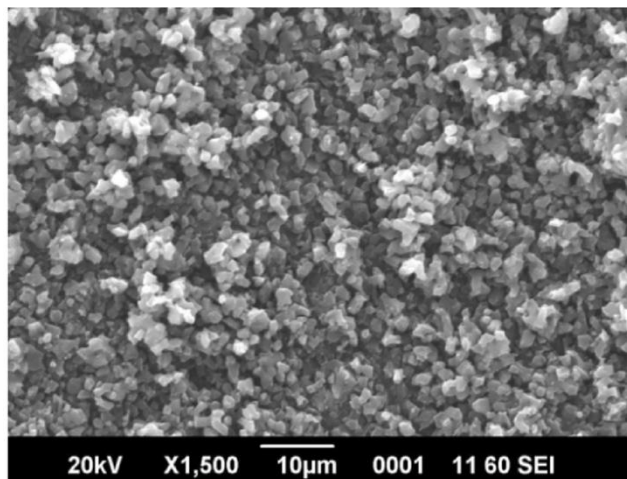
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ABSTRACT

This study investigates the adsorption performance of chemically activated carbon aerogels (CA) for the removal of Methylene Blue (MB), a cationic dye widely used in textile industries, from contaminated aqueous solutions[1]. Carbon aerogel samples were synthesized via sol-gel polymerization of resorcinol and formaldehyde using Na_2CO_3 as catalyst (CA500), followed by chemical activation with KOH and ZnCl_2 [2]. The prepared adsorbents were comprehensively characterized using FTIR, XRD, XPS, and BET surface area analysis to elucidate their structural and chemical properties.

Adsorption isotherm of Methylene Blue on Carbon aerogels are determined and analyzed using John-Sivanandan Achari isotherm, Langmuir and Freundlich isotherm models for different concentrations (25-500mg/l) and at 30°C for equilibrium time of 8hrs. The equilibrium data were analyzed using John-Sivanandan Achari isotherm, Langmuir and Freundlich isotherm models. The maximum monolayer adsorption capacity ($J\text{-SA}$) was determined to be 370.70 mg/g for the KOH activated CA500. Kinetic studies performed at 250 mg/L MB concentration revealed that adsorption data followed the pseudo-second-order kinetic model for all activated carbon aerogel samples, indicating chemisorption as the rate-controlling mechanism.

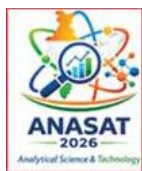
SEM imaging confirmed the highly porous structure with interconnected bead-like morphologies characteristic of carbon aerogels. Among the three samples tested, the KOH and ZnCl_2 activated CA demonstrated superior adsorption capacity compared to the Na_2CO_3 -catalyzed CA500. The experimental results confirm that chemically activated carbon aerogels are highly effective adsorbents for MB removal from wastewater, with the activated material showing enhanced performance suitable for industrial wastewater treatment applications.



SEM image of carbon aerogel [3]

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Contributory Paper - 49

ANC 49 Insight in to the Thermal, Morphological and Particle Characteristics of Ammonium Perchlorate Produced by Surfactant Mediated Recrystallization

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ABSTRACT

Ammonium Perchlorate (AP) is the oxidiser used in all solid rocket propellant motors used for space exploration due to its high available oxygen content and thermal decomposition without any solid residue. On industrial scale, Ammonium Perchlorate is manufactured by double decomposition reaction of Sodium Perchlorate with Ammonium chloride salt. During the reaction, AP will be produced as crystals and sodium salt will be the by-product, which remains as solution. The AP crystals produced are separated by cooling crystallization utilizing the difference in the temperature coefficient of solubility of AP and sodium chloride in water¹. The crystallization being the critical step in the manufacturing of AP, the modifications made in crystallization parameters will change the particle properties. A surface active agent generally changes the morphology and purity of crystals during recrystallization by adsorbing onto specific crystal faces and interfaces². Moreover Surfactant molecules provide electrostatic repulsion at the solid-liquid interface, which effectively prevents crystal aggregation and caking during storage³. In this study Uncoated AP with purity of greater than 99% produced by Double Decomposition reaction between Sodium Perchlorate and Ammonium chloride in aqueous medium, is used as raw material for the process. The surfactant is a hydrocarbon based which contains organic amines and acids. The cooling crystallization was carried out in double jacketed 1L capacity glass reactor in a temperature 83-85 °C to 30-32 °C (cooling rate of 0.25 ± 0.05 °C per minute), with an agitator RPM maintained at 620 ± 5 revolutions per minute (rpm). The product was filtered and vacuum dried and characterized. The DSC TGA analysis revealed a lower decomposition temperature of 248°C, and phase transition temperature at 243°C. The particle size of the product was analysed by sieve shaker and average particle size obtained was $<100 \mu\text{m}$. The product was also characterized for its surface characteristics by SEM analysis.

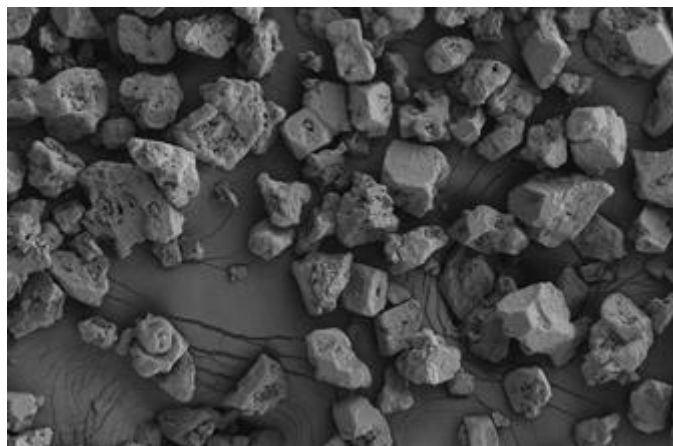
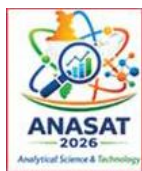


Fig 1. SEM image

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Contributory Paper - 50

ANC 50 In Silico Screenig of Phyto Compounds as Potential Anti-Alzheimers Lead Molecules

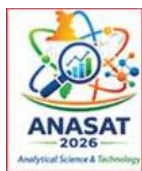
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ABSTRACT

Alzheimer's Disease (AD), affecting a large population worldwide is characterized by the loss of memory and cognitive and learning ability in the old population. Recently there is a surge of interest to combat this disease with regard to its socio-economic impacts. The enzyme Acetylcholinesterase Enzyme (AChE) is the most versatile chemotherapeutic target for drug development. The current investigation focused on the AChE receptor 6O4W, with the co-crystallized ligand (R)-donepezil and docking studies were carried out with the selected phyto molecules using AutoDock Vina (version 1.2.7) and the binding energy values obtained are -8.964, -9.297, -8.539, -8.268 for Kcal/ mol for Confoline, Galantamine, Convolidine and Withasomnine respectively. An interesting comparison of the docking has been carried out with the drugs Donepezil which had binding energy values -12.37 Kcal/mol. The results of the study point to the fact that all of the selected inhibitors are of comparable interaction stability with that of the Standard drug. Chemical properties of all the above molecules were evaluated by Swiss Adme and found that all are BBB permeant. All the molecules obey Lipinski rules. Molecular dynamic simulation analysis of Confoline GROMACS (version 2025.4) simulation engine and the protein structure remained stable throughout the simulation. The ligand maintained consistent binding within the active site without major conformational disruptions were observed. these significant results underscore the futuristic aspect of these molecules as lead for the management of Alzheimer's disease.

Key words: Alzheimer's Disease, AChE inhibitor, Curcumin, Donepezil



Contributory Paper - 51

ANC 51 Development of Mil-101(Cr)/Mwcnt Composite-Based Chemiresistive Sensor for Room-Temperature H₂s Detection

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ABSTRACT

Hydrogen sulfide (H₂S) is a toxic and hazardous gas, whose sensitive and reliable detection is important for environmental monitoring and industrial safety. Metal-organic frameworks (MOFs) have attracted considerable attention as sensing materials owing to their high surface area, tunable porosity, and abundance of active sites [1]. However, their intrinsically low electrical conductivity can limit their application in chemiresistive sensors. In this study, pristine MIL-101(Cr) and MIL-101(Cr)/MWCNT composite were investigated for room-temperature H₂S detection. Chemiresistive sensing devices were fabricated by drop-casting these materials on gold interdigitated electrodes and evaluated towards H₂S, along with ethanol, propanol, acetone, and ammonia as potential interfering analytes. Incorporating MWCNT into MIL-101(Cr) substantially improved sensing performance, with the composite exhibiting approximately three times higher response towards H₂S than pristine MIL-101(Cr). The MIL-101(Cr)/MWCNT sensor also demonstrated good selectivity towards H₂S, concentration-dependent response, excellent repeatability over 50 consecutive sensing cycles, and stable sensing performance over a 30-day evaluation period. The enhanced response is attributed to the improved electrical conductivity and synergistic interaction between the MOF and conductive carbon nanotube network. These results highlight the potential of MIL-101(Cr)/MWCNT composites as room-temperature chemiresistive sensing platforms for the detection and monitoring of H₂S.

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Contributory Paper - 52

ANC 52 Fate of Environmentally Relevant Concentrations of Sulfonamide Mixtures in Tropical Aquatic Mesocosms: Influence of Microbial, Photolytic, and Sediment Processes

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ABSTRACT

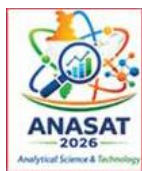
Sulfonamide (SA) antibiotics are increasingly detected in aquatic environments as mixtures at low concentrations, with their persistence controlled by biological and abiotic processes. Their behaviour as mixtures under environmentally relevant conditions remains poorly understood. This study investigated the dissipation of 11 SAs—sulfamethoxazole (SMX), sulfaquinoxaline (SQX), sulfadimethoxine (SDM), sulfamethoxypyridazine (SMP), sulfamerazine (SMR), sulfathiazole (STZ), sulfadoxin (SDX), sulfadiazine (SDZ), sulfapyridine (SPY), sulfaethoxypyridazine (SEP), and sulfachloropyridazine (SCP)—under controlled mesocosm conditions. Sterile and non-sterile water and water–sediment systems, with and without illumination, were used to evaluate hydrolysis, biodegradation, photodegradation, and sediment-associated processes. Degradation kinetics were assessed using simple first-order (SFO) and dual first-order in parallel (DFOP) models in Computer Assisted Kinetic Evaluation (CAKE) software. In sterile water, hydrolysis was the main process, with half-lives of 28.13 ± 2.23 – 219.33 ± 1.25 days. Non-sterile systems showed shorter half-lives of 24.57 ± 0.33 – 123.0 ± 9.80 days, indicating the contribution of biodegradation, while illuminated conditions further reduced half-lives to 5.58 ± 0.11 – 41.53 ± 1.68 days through the combined effects of hydrolysis, biodegradation, and photodegradation. In water–sediment systems, adsorption transferred most SAs from water to sediment, whereas SMX and SDZ showed greater association with the water phase. Under waterlogged sediment conditions, sediment-associated SAs showed half-lives of 6.57 ± 0.01 – 42.37 ± 0.34 days, demonstrating that loss from the water phase does not necessarily indicate complete removal and highlighting the importance of assessing degradation within sediment. Across all treatments, half-lives ranged from 5.56 ± 0.10 to 219.33 ± 1.25 days. SDX was the most persistent compound in sterile water, whereas SEP showed the shortest half-life in the illuminated water–sediment system. Overall,

SA fate was influenced by hydrolysis, biodegradation, photodegradation, and sediment interactions, emphasising the need to evaluate both water and waterlogged sediment when assessing antibiotic persistence.

Table 1- Benefit-Risk ratio of 3D Printed Fish Products

Benefit/Risk ratio	Clam Shell incorporated Baked Product	Fish Bone Incorporated Baked Product
HQEAA vs Pb	0	0
HQEAA vs Cd	0.003	0.015
HQEAA vs Hg	0	0
HQEAA vs Sn	0.0006	0.00007
HQEAA vs As	0.08	0.09

HQEAA- Benefit/Risk ratio with respect to Essential Amino Acids



Contributory Paper - 53

ANC 53 Indigenously Fabricated Low-Cost UV Exposure Chamber for Photolithography Application

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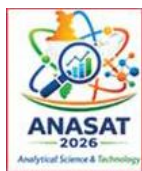
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ABSTRACT

Photolithography is an important microfabrication technique widely employed for the fabrication of microelectronic devices, sensors, MEMS, and other patterned structures. However, commercial photolithography systems involve sophisticated and expensive equipment, limiting their accessibility in academic and research laboratories. In this work, a compact and low-cost ultraviolet (UV) exposure chamber was designed and fabricated as an in-house facility for laboratory-scale photolithography. The chamber was constructed using an aluminium enclosure with approximate dimensions of 60 cm × 35 cm × 25 cm, providing mechanical stability, light isolation, and effective heat dissipation. A 125 W UV lamp operating at 365 nm was incorporated as the exposure source. The system was equipped with a manual shutter mechanism for controlled exposure, a substrate holder with mask-alignment provision, and a forced-air cooling arrangement using blower fans and a bottom air vent to minimise heat accumulation during operation. Opaque enclosure doors were incorporated to provide a light-tight environment and minimise UV leakage, while rubber supports improved mechanical stability. The developed system integrates the essential requirements of controlled UV exposure, including exposure regulation, thermal management, mask-substrate positioning, ventilation, and operator safety. The fabricated chamber provides a simple and cost-effective alternative for establishing basic photolithography capability within the laboratory and can serve as a useful platform for academic training, preliminary microfabrication studies, and the development of patterned sensor and microdevice structures. The applicability of the developed system was demonstrated through the successful fabrication of an interdigitated electrode with 40 µm finger width and 20 µm inter-finger spacing, highlighting its potential for low-cost fabrication of sensing platforms.



Contributory Paper - 54

ANC 54 Amine-Functionalized Graphene Oxide Incorporated With Zinc Oxide Nanoparticles as an Adsorptive Material

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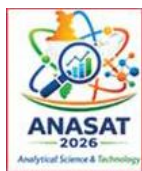
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ABSTRACT

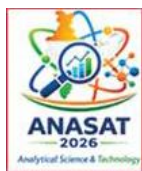
An amine-functionalized Graphene Oxide incorporated with zinc oxide nanoparticles (NGO/ZnO) was synthesized and studied for the removal of Pb^{2+} ions from water. The composite was fabricated through the hydrothermal method at 160°C for 5 h. The physicochemical properties and morphologies of the product were determined using XRD, FTIR, and SEM analysis. This Zinc oxide is uniformly dispersed over the surface of the GO. The XRD and FTIR data confirm the presence of amine and zinc oxide on the surface of the graphene oxide sheet. The efficiency of the NGO/ZnO composite towards removing Pb^{2+} in a solid-liquid batch reactor system is tested for 10-2000mg/L. This is compared with amine-functionalized graphene oxide (NGO) and amine-functionalized (NZnO). Isotherm data analysis by the John-Sivanandan Achari (J-SA) model found that the uptake occurs in three phases with three kinks for the composite NGO/ZnO. The material exhibits monolayer capacity, q_m (Pb^{2+}) of 796.8 mg/g for NGO/ZnO, with capillary condensation (486.43mg/g, $n_3=0.277$), mesoporous filling (162.54mg/g, $n_2=0.42$), and fractional micropore filling (147.91mg/g, $n_1=0.21$) during J-SA analysis. Kinetic study of the materials shows that the composite follows the pseudo-second-order kinetics model, suggesting a chemisorption nature. The results show that the synthesized nanocomposite has great potential for Pb^{2+} ion removal.

Keywords: Graphene Oxide, Zinc Oxide nanoflower, Amine functionalized, Wastewater treatment, Adsorption, John-Sivanandan Achari (J-SA) isotherm model.



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Contributory Paper - 55

ANC 55 Response of Carbonate Chemistry to Ocean Alkalinity Enhancement in the Indian Sector of the Southern Ocean

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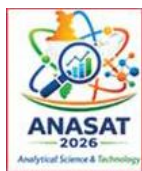
ABSTRACT

Ocean Alkalinity Enhancement (OAE) is a prominent Marine Carbon Dioxide Removal (mCDR) strategy designed to accelerate the ocean's natural weathering process, enhance Total Alkalinity (TA), and drive atmospheric CO₂ drawdown. The Southern Ocean plays a pivotal role in global ocean-atmosphere carbon exchange, making it a critical region for evaluating OAE efficacy and environmental impacts. This study presents experimental findings from 20 L microcosm experiments conducted in two distinct Southern Ocean hydrographic regimes (Station 1 and Station 2). The setup evaluated the performance of two alkaline minerals-Periclase (MgO) and Hydrated Lime (CO(OH)₂) against untreated control conditions.

High-precision analytical techniques were employed to track perturbation kinetics and carbonate system shifts. Total Alkalinity was measured via open-cell potentiometric titration, and the broader marine carbonate parameters, including Dissolved Inorganic Carbon (DIC), partial pressure of carbon dioxide ($p\text{CO}_2$), and saturation states ($\Omega_{\text{Aragonite}}$, Ω_{Calcite}) were calculated using CO2SYS software. Elemental and isotopic dynamics of particulate organic carbon (POC), particulate nitrogen (PN), $\delta^{13}\text{C}_{\text{POC}}$, and $\delta^{15}\text{N}_{\text{PN}}$ were quantified using Elemental Analyzer–Isotope Ratio Mass Spectrometry (EA-IRMS) calibrated against international standards.

Results demonstrate that both mineral treatments induced rapid, significant increases in TA and a corresponding drawdown of $p\text{CO}_2$, accompanied by elevated calcite and aragonite saturation levels. Hydrated Lime exhibited faster dissolution kinetics and immediate TA elevation compared to Periclase. EA-IRMS isotopic profiling revealed distinct shifts in $\delta^{13}\text{C}_{\text{POC}}$ and

$\delta^{15}\text{N}_{\text{PN}}$, illustrating the sensitivity of biological carbon uptake and nutrient utilization to mineral-induced alkalinity changes. These findings highlight the analytical precision required to monitor mCDR interventions and provide baseline constraints on mineral dissolution dynamics and biogeochemical feedbacks in polar ocean waters.



Contributory Paper - 56

ANC 56 Biomass-Derived Silica Nanoparticles as Potential Anticancer Agents: in Vitro Evaluation of Cytotoxicity, Apoptosis, Cell-Cycle and Migration

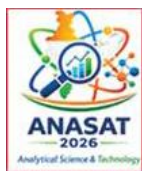
Haritha L P^a, Dr P M Sabura Begum^a, Dr Jomon Sebastian^b

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ABSTRACT

The valorisation of agro-biomass into functional nanomaterials offers a sustainable approach for developing novel biomedical agents while reducing agricultural waste. In the present study, silica nanoparticles were synthesized from biomass waste and investigated for their potential anticancer activity. The synthesized silica nanoparticles were characterized for their physicochemical properties and evaluated against HeLa cervical cancer cells through a series of complementary in vitro assays. Cytotoxicity was assessed to determine the concentration-dependent inhibitory effect of the nanoparticles on cell viability. The induction of apoptosis was further investigated using acridine orange/propidium iodide (AO/PI) dual-fluorescence staining, while flow cytometric (FACS) analysis was employed to evaluate alterations in cell-cycle distribution following nanoparticle treatment. In addition, a cell migration assay was performed to assess the ability of the nanoparticles to inhibit cancer cell migration. The results demonstrated that the biomass-derived silica nanoparticles exhibited significant cytotoxic activity against HeLa cells, with an IC₅₀ of approximately 50 µg/mL. AO/PI staining revealed an increased population of apoptotic cells following treatment, indicating the involvement of apoptosis-associated cellular changes. FACS analysis showed alterations in cell-cycle distribution in treated cells, suggesting interference with normal cell-cycle progression. The migration assay further demonstrated reduced migratory ability of nanoparticle-treated HeLa cells. Collectively, these findings indicate that biomass-derived silica nanoparticles exert multifaceted anticancer effects involving cytotoxicity, apoptosis-associated changes, cell-cycle modulation, and inhibition of cell migration. The study highlights the potential of agro-biomass-derived silica nanoparticles as sustainable nanomaterials for further investigation in cancer therapeutics.



Contributory Paper - 57

ANC 57 Fruit Peel-Derived Alkali Lignin-Reinforced Pva Films with Improved UV Protection and Mechanical Performance

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ABSTRACT

The growing demand for sustainable and biodegradable materials has led to the valorisation of agricultural and food processing residue into high-value functional materials. In this study alkali lignin (AL) was isolated from fruit peel residue through an alkaline extraction method and incorporated into a poly(vinyl alcohol) (PVA) matrix to fabricate PVA-alkali lignin (PVA-AL) composite films. Lemon peel residue was subjected to alkaline pretreatment using sodium hydroxide in an autoclave followed by acid precipitation using hydrochloric acid, followed by filtration, washing, and drying to recover AL. The isolated lignin was then dispersed with PVA solution and processed through solution mixing, casting, and drying to obtain a composite film. The AL was characterised using various spectroscopic techniques. AL shows an apparent weight-average molecular weight of 6708 g mol^{-1} with a spherical morphology and size of 111 nm. It also shows good absorption in the ultraviolet region. The structural, optical, and mechanical properties of the PVA-AL films were also studied to elucidate the influence of lignin incorporation, and it was observed that upon addition of lignin, the PVA film shows enhanced UV-blocking properties owing to the aromatic and chromophore structures of lignin while also influencing their mechanical properties. The resulting PVA-AL composite films demonstrate the potential of fruit peel residue as a renewable source of lignin for the development of functional and sustainable biopolymer materials.

Contributory Paper - 58

ANC 58 Waste to Energy: Co-Digestion of Coffee Husk for Enhanced Biogas Yield Aligned With SDG 7

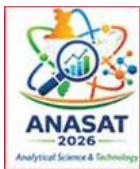
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ABSTRACT

Coffee is one of the most consumed beverages worldwide, with global production exceeding 10 million tonnes annually. The processing of coffee generates enormous quantities of solid waste including coffee husk, coffee pulp, spent coffee grounds etc which are often disposed in open dumps, burned or discharged into water bodies leading to severe environmental pollution due to their high organic load. These wastes represent a significant renewable energy resource due to their high volatile solids (85-90%) content. Anaerobic digestion (AD) is a promising sustainable technology for valorising coffee waste into biogas. However, AD of coffee waste as a mono-substrate faces significant technical challenges due to its high cellulose, hemicellulose and lignin content. Hence to overcome these challenges, the present study explores the use of coffee waste with food waste and cow-dung for biogas generation. Coffee Husk (CH) was chosen as the substrate. The study was conducted using batch tests at room temperatures (37°C) for a retention period of 30-days. Cow-Dung (CD) was used as the inoculum for the study. Water displacement method was used to measure the biogas produced. Different inoculum to substrate ratios (ISR) of 1:1, 2:1, 3:1 and 4:1 was done to determine the optimum ISR for coffee husk. The proportion which produced the maximum biogas for a retention period of 30-days was chosen as the optimum proportion. The effect of pretreatment was also studied using water washing by soaking the substrate in distilled water for 24h to remove caffeine and tannins. Alkaline pretreatment using 2% NaOH for 24h was done to reduce the lignin content of CH. Results from batch studies showed an ISR of 3:1 provided the maximum biogas for CH. Mono-digestion of raw CH yielded less cumulative biogas with a lag phase of 9 days indicating inhibition. Water washing improved the yield by reducing the caffeine content from 1.3% to 0.9%. Alkaline pretreated samples showed the maximum biogas production compared to other samples with a cumulative yield of 455 ml. The increase in alkali pretreated samples was due to reduction in lignin content from 25% to 15%. The observed pH of the sample was 6.9. Based on the results obtained from mono-digestion the study explored the effects of food



waste (FW) with CH at various proportion. Different proportions of CH:FW:CD of 1:1:2, 1:2:1, 1:3:1, 1:3:2 was used to arrive at the optimum proportion. The proportion 1:3:2 of CH:FW:CD gave the maximum biogas production with a lesser retention time. The biogas produced from co-digested samples showed an 80% increase compared to raw coffee husk. The study concludes that the limitations of coffee husk anaerobic digestion due to lignin and caffeine inhibition can be effectively mitigated by pretreatment aided with co-digestion. AD of CH not only solves the disposal problems of coffee manufacturing units but also contributes to circular economy and climate change mitigation attaining SDG 7.

Contributory Paper - 59

ANC 59 Development of Chitosan-Pva-Based Composite films Incorporated with Nanosilica-Loaded Therapeutic Agent for Wound-Healing Applications.

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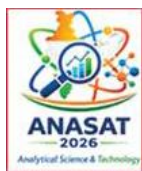
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ABSTRACT

The worldwide health care system is facing increasing difficulty in wound healing, particularly for chronic and infected wounds that call for more sophisticated treatment approaches. Because of their biocompatibility, biodegradability, and capacity to promote tissue regeneration, biopolymer-based materials have drawn a lot of interest in the field of wound healing. In this work, a biocompatible Chitosan–PVA composite film was developed by incorporating a nanosilica loaded with a therapeutic agent using a green approach. Nanosilica was isolated from a novel and sustainable source and served as a stable carrier for the incorporation of the leaf extract. The resulting therapeutic agent-loaded nanoparticles were uniformly dispersed within the chitosan–PVA matrix to fabricate a flexible and transparent wound dressing film. Structural and morphological analyses confirmed the successful integration of the therapeutic agent-loaded nanosilica into the polymeric network. The composite film exhibited enhanced mechanical strength, swelling capacity, and water vapour permeability, along with notable antibacterial activity against pathogenic bacteria. Cytocompatibility studies indicated that the film is non-toxic and promotes cell viability, demonstrating its potential as an effective material for wound healing. This study presents a sustainable and low-cost strategy for designing multifunctional nanocomposite dressings using renewable biomass-derived nanosilica.

Keywords: Nanosilica, Chitosan, PVA



Contributory Paper - 60

ANC 60 **Structure-Based Screening and Experimental Validation of A Perimidine Library as Potential EGFR-Targeting Anticancer Agents**

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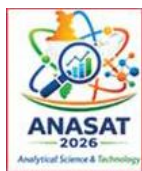
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ABSTRACT

Breast cancer remains a major global health challenge, with dysregulated Epidermal Growth Factor Receptor (EGFR) signalling contributing to tumor progression, aggressive behaviour and therapeutic resistance. In the present study, a virtual library of 201 structurally diverse perimidine derivatives was designed and systematically investigated as potential EGFR-targeting anticancer candidates using a structure-guided approach. Molecular docking studies were performed against four EGFR crystal structures (PDB IDs: 4HJO, 1M17, 4I23 and 5UGB), enabling the identification of Compounds 101 and 201 as promising candidates based on their predicted binding affinities and favourable molecular interactions. Molecular dynamics simulations were subsequently employed to evaluate the conformational stability and persistence of protein–ligand interactions. Cross-target rank correlation analysis further indicated consistent binding behaviour for selected derivatives, particularly Compound 201. In silico ADME and toxicity assessment using SwissADME and ADMETlab 3.0 suggested favourable drug-like and pharmacokinetic characteristics, although certain parameters may require further optimization. The selected compounds were subsequently synthesized, structurally characterized and theoretically validated through density functional theory calculations. Their anticancer potential was further investigated using an in vitro MTT assay against MCF-7 breast cancer cells and a triple-negative breast cancer cell line, revealing differential cytotoxic responses. Overall, the integrated computational and experimental findings highlight perimidine derivatives, particularly Compounds 101 and 201, as promising lead structures for further investigation in EGFR-targeted anticancer drug development.

Keywords: Perimidine derivatives; EGFR targeting; Molecular docking; Molecular dynamics; Breast cancer



Contributory Paper - 61

ANC 61 Imine Linked Porous Organic Polymer as an Efficient Fluorescence Sensor For Mercury Ions

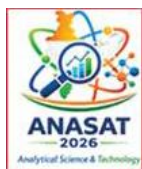
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ABSTRACT

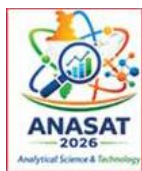
Mercury ions (Hg^{2+}) are among the most concerning toxic pollutants due to their persistence, bioaccumulation, and potential to adversely affect human health and ecosystem. The development of sensitive and selective methods for the detection of Hg^{2+} has considerable importance¹. Among advanced analytical methods, fluorescence-based sensing has attracted considerable attention due to its rapid response, operational simplicity, high selectivity, and excellent sensitivity towards target analytes^{2,3}. The ability to monitor changes in fluorescence intensity or emission behaviour upon interaction with specific metal ions makes these systems highly promising for the selective and sensitive detection of toxic ions such as Hg^{2+} . In this context, fluorescence-based detection offers a rapid and effective approach for monitoring mercury ions in environmental and analytical samples.

In this work, an imine-linked porous organic polymer (POP) was successfully synthesised via a Schiff-base condensation reaction, resulting in a highly porous and chemically stable polymeric framework. The synthesised polymer was subjected to comprehensive structural and photophysical characterisation to investigate its morphological features, thermal stability, and optical properties. The polymer exhibited distinct fluorescence emission, which was significantly quenched upon the gradual addition of mercury ions (Hg^{2+}), resulting in a prominent fluorescence “turn-off” response. The fluorescence sensing mechanism was systematically investigated to understand the interaction between Hg^{2+} ions and the polymer and consequent changes in its photophysical behaviour. The sensing studies demonstrated a highly selective response towards Hg^{2+} in the presence of various competing metal ions, indicating a strong affinity of the polymeric framework towards mercury ions. Furthermore, the material exhibited high sensitivity toward Hg^{2+} , highlighting its potential for the detection of low concentrations of mercury ions. The combination of porosity, structural stability, favourable photophysical properties, fluorescence “turn-off” behaviour, and the investigated sensing mechanism establishes the developed imine-linked POP as a promising material for selective and sensitive fluorescence-based detection of Hg^{2+} ions and environmental monitoring applications.



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Contributory Paper - 62

ANC 62 Elucidating Functional Groups in Organic aerosols: A ^1H NMR Study

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ABSTRACT

The chemical composition of organic aerosol (OA) is of scientific interest due to its importance in climate, environmental chemistry, and human health impacts.¹ Sources of primary (ie, directly emitted in the atmosphere) OA include natural terrestrial plant epicuticular waxes and resin residues, windblown or mechanically re-suspended soil dust, traffic exhausts, oil residues, and biomass burning.² Secondary OA (SOA, i.e., formed in the atmosphere) are generated from the condensation of low vapor pressure mono- and poly-functional organic compounds formed from the photo-oxidation of biogenic and anthropogenic volatile organic compounds.²

Functional groups present in organic aerosols exhibit a high degree of diversity, with several species demonstrating potential toxicity & environmental harm. Fine sized aerosols are collected on the pre-combusted (450°C for 6 h) quartz fiber filters using high volume air sampler (model HV 1000R, SIBATA Scientific Technology Ltd., Japan; flow rate: 566 LPM) equipped with a particle selector (Anderson sampler, AH-600). The characterization of functional groups in water soluble organic aerosols (WSOA) and methanol soluble organic aerosols (MSOA), commonly known as hydrophilic and hydrophobic organic aerosols respectively, was carried out using ^1H NMR spectroscopy.

The findings gave us insight about composition (%) of five main functional groups namely saturated aliphatic regions (H-C), unsaturated aliphatic region or secondary or tertiary amines (HC-NR₂) may be present in region with chemical shift values from 2.2-2.9ppm.

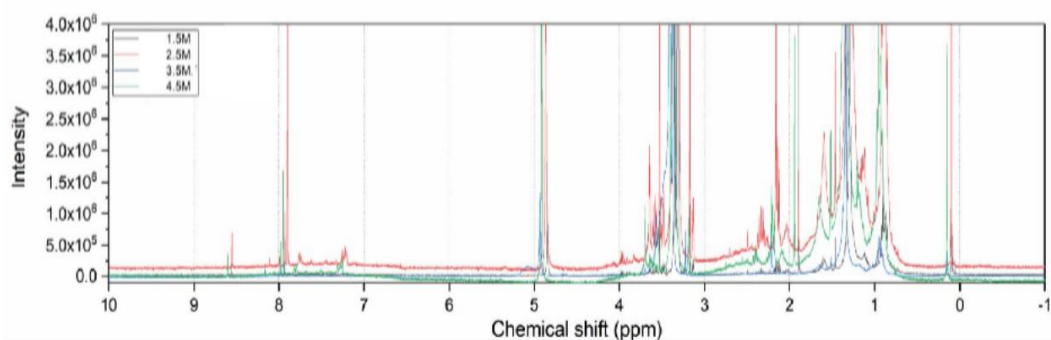
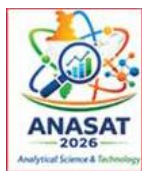


Figure 1. ^1H NMR Spectra for 1.5, 2.5, 3.5 and 4.5 labeled MSOA samples collected during north-eastern air masses arrived over the sampling site (Cochin). 3-4.5ppm characterized as oxygenated saturated aliphatic groups (H-C-O). Regions from 5- 6.5ppm characterized as acetalic protons (O-CH-O). One such example is shown in Figure 1. It allows the reconciliation of ambient organic aerosol sources including the degree of atmospheric aging and based on the wind direction, gives the pollution in the particular region.

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Contributory Paper - 63

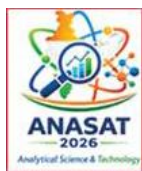
ANC 63 RESIDUAL CHLORINE DETECTION USING PAPER MICROFLUIDICS

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Water is an essential resource for human survival, and maintaining its quality is crucial for ensuring public health and environmental sustainability. One of the key aspects of drinking water safety is effective disinfection, commonly achieved using chlorine. While chlorine eliminates harmful microorganisms, a certain amount remains in the water as residual chlorine, which continues to protect against contamination during storage and distribution. However, both insufficient and excessive chlorine levels can pose risks, making continuous monitoring of residual chlorine essential. Monitoring residual chlorine in drinking water is essential to ensure effective disinfection and public health safety. Conventional detection methods such as spectrophotometry, titration, and electrochemical analysis, although accurate, require sophisticated equipment, trained personnel, and laboratory facilities, thereby limiting their applicability for rapid, on-site testing. Conventional methods for residual chlorine detection, although accurate, often require sophisticated laboratory equipment, trained personnel, and are not suitable for rapid on-site analysis. This project presents the development of a simple, cost-effective, and portable method for detecting residual chlorine using a paper-based microfluidic analytical device (μ PAD). The device was fabricated using Whatman filter paper, where hydrophobic barriers were created through laser printing followed by heat treatment to form microfluidic channels. The detection of chlorine was carried out using the DPD (N, N-diethyl-p-phenylenediamine) colorimetric method, which produces a pink colour proportional to the chlorine concentration. The intensity of the colour change enables visual estimation of residual chlorine levels. The water samples used in this study were collected from a distribution system of Aruvikkara, with sampling points located at Vattiyoorkavu, Kowdiar, and Vizhinjam to analyse the variation of residual chlorine along the supply network. The results showed a gradual decrease in residual chlorine with increasing distance from the treatment plant, confirming chlorine decay during distribution. Additionally, the effect of storage time on chlorine concentration was



studied, revealing a reduction in chlorine levels over time. The developed μ PAD demonstrated reliable performance, rapid response, and ease of use without requiring complex instrumentation. The study highlights the potential of paper-based microfluidic devices as an efficient tool for real-time, on-site water quality monitoring, particularly in resource-limited areas. In conclusion, this study highlights the effectiveness of paper-based microfluidic technology as a reliable and efficient tool for real-time monitoring of residual chlorine in water. The proposed method has significant potential to improve water quality assessment practices and contribute to safer drinking water management systems.

Contributory Paper - 64

ANC 64 PHOTOELECTROCHEMICAL SENSING OF L-PHENYLALANINE USING DONOR-ACCEPTOR-BASED POROUS ORGANIC POLYMER

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Cochin University of Science and Technology

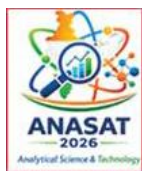
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ABSTRACT

L-Phenylalanine (L-Phe) is an essential aromatic amino acid, which undergoes metabolic transformation into other aromatic amino acids such as tyrosine (Tyr) through the action of the enzyme Phenyl hydroxylase. Any metabolic abnormalities in L-Phe transformation can lead to conditions like phenylketonuria, behavioural disorders, imbalance in calcium homeostasis, and impairment in the central nervous system. The development of sensors for detecting L-Phe could significantly impact health management for both human and veterinary needs. Determining the concentration of L-Phe in various biological fluids is important for analysing the health status of individuals.¹ Development of adaptable point-of-care devices could enable early detection and effective treatment planning.²

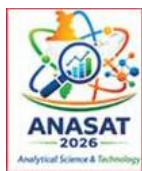
In this work a photoelectrochemical sensor (PEC) was developed with acrylonitrile-linked porous organic polymer for the sensing of L-Phe. PEC sensors are an emerging class of detection technology which couples the photoexcitation of the material with the electrochemical signal generation. PEC offers several advantages including low background noise, rapid response, operational simplicity, and the potential for self-powered operation. These sensors utilise light as the excitation source and employ the photocurrent generated by photoactive materials as the detection signal, effectively decoupling excitation from signal readout to minimise background interference, thereby enabling lower detection limits and improved signal clarity.³

Here, acrylonitrile-linked porous organic polymer (BTDC-CPT) was synthesised through Knoevenagel condensation between [2,2'-Bithiophene]-5,5'-dicarboxaldehyde (BTDC) and 2,2'-(5'-(4-(Cyanomethyl)phenyl)-[1,1':3',1''-terphenyl]-4,4''-diyl)-Di acetonitrile (CPT). Under visible light illumination, this material showed good photoconductivity. A significant enhancement in the photocurrent response was observed for the BTDC-CPT polymer with the addition of L-Phe, indicating potential of the material for L-Phe sensing. The specificity of the synthesised material toward L-Phe was evaluated against various amino acids, as well as organic molecules. The developed PEC sensor exhibited a good linear response over the concentration range of



1.996–23.436 μM with a limit of detection (LOD) of 3.483 μM .⁴

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Contributory Paper - 64

ANC 65 **Phytochemical Profiling of *Clitoria ternatea* Seeds: Isolation Strategies and Therapeutic Potential**

Kamalakaran PV¹, Anirudh M¹, Prabu D², C. Murugan³, M.B. Amanulla⁴, Sridhar T.M.^{1,*}

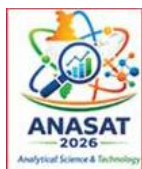
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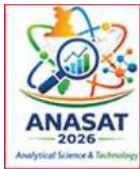
Abstract

Contemporary biomedical research has increasingly focused on the identification of novel plant-derived bioactive compounds and therapeutic agents. The therapeutic potential of medicinal plants is largely attributed to their diverse phytochemical constituents, particularly secondary metabolites, which exhibit a wide range of pharmacological activities. Traditional medicinal plants have gained increasing attention as alternative therapeutic agents due to their rich bioactive phytochemicals, biocompatibility, and minimal side effects. Among these, *Clitoria ternatea* (CT) is a promising medicinal plant rich in diverse bioactive secondary metabolites. In particular, CT seeds are rich in flavonoids, alkaloids, terpenoids, phenolic compounds, and other biologically active metabolites. A systematic investigation of these phytochemical constituents and evaluation of their antimicrobial, antioxidant, and enzyme-inhibitory activities was performed using the cell diffusion method, with the aim of identifying promising bioactive compounds for the management of infectious and chronic diseases. Further, isolation of individual bioactive metabolites may validate their development as plant-derived drug molecules for biomedical applications. The identified bioactive constituents may serve as potential candidates for further pharmacological evaluation and biomaterial development. This research emphasizes the potential of phytochemical-based approaches for creating next-generation biomaterials relevant to regenerative medicine and wound care.

Keywords: Traditional medicinal plants, secondary metabolites, seed extract, enzyme-inhibitory activities, regenerative medicine.



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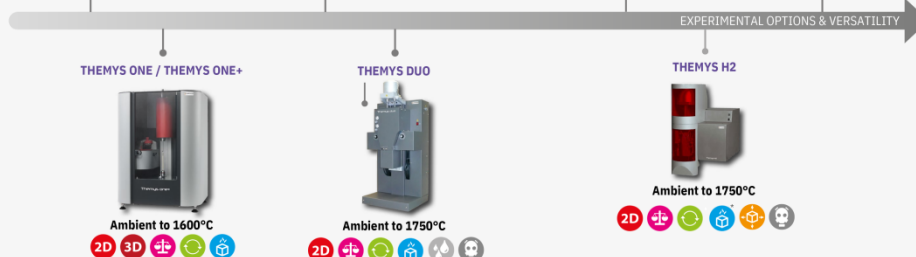
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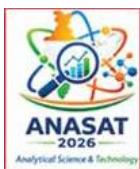


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For over two decades, C-Therm's innovative sensor technology has been pioneering the way for many of the world's most prominent manufacturers, research facilities, and academic institutions to test and measure thermal properties of materials. The technology behind Trident represents a paradigm shift in thermal conductivity measurement and earned the inventor behind the technology the Manning Innovation Principle Award and an R&D 100 Award. These coveted awards are given to the top global innovators, and place C-Therm in the distinguished company of such other winners as the developers of the ATM, Polaroid™ and anti-lock brakes. Since its launch, C-Therm's unique technology has evolved to new levels of accuracy, speed and flexibility. Today, it is being used around the globe for R&D, quality control, and on-line production monitoring in a wide range of industries.

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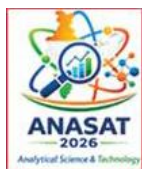


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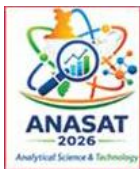


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