National Conference on

CRITICAL AND STRATEGIC MINERALS INDIA 2025

CASMIN 2025

Organized by

Rare Earth Association of India(REAI)

&

Indian Society of Analytical Scientists(ISAS)

Venue

Kochi, Kerala State, India

December 4-5, 2025

National Conference on

Critical and Strategic Minerals India 2025

CASMIN 2025

Theme

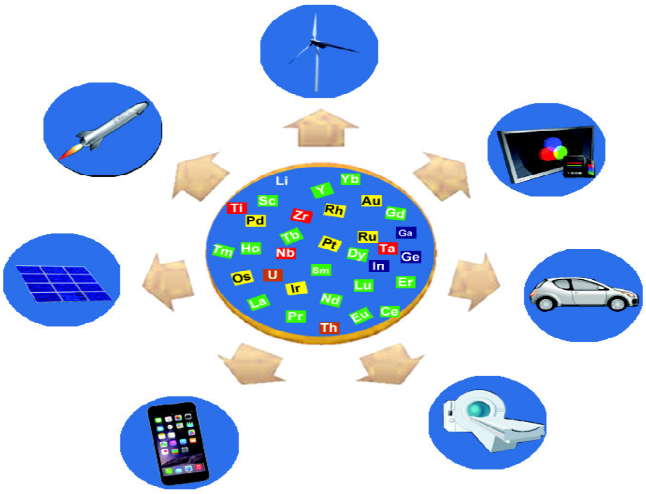
Empowering India’s Green and Technological Future

Organized by

Rare Earth Association of India(REAI)

&

Indian Society of Analytical Scientists(ISAS)



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National Conference on

Critical and Strategic Minerals India 2025

SOUVENIR
&
BOOK OF ABSTRACTS

CASMIN 2025

Jointly Organized by

Rare Earth Association of India(REAI)
&
Indian Society of Analytical Scientists(ISAS)

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Welcome Message

On behalf of the Organizing Committee and myself I am delighted to welcome all the delegates, participants and guests to Kochi for attending the National Conference on Critical and Strategic Minerals 2025(CASMIN 2025) which will take place from December 4-5, 2025 at IMA House, Kochi, Kerala State. It gives me immense pleasure to convey my greetings to all participants and organizers of CASMIN 2025. This prestigious conference , bringing together experts, researchers and industry leaders across India ,provides a valuable platform to discuss advances in critical and strategic minerals, sustainable mining practices, and innovative technologies for resource management.

The Rare Earths Association of India (REAI) has always been committed to promoting research, collaboration, and responsible utilization of these vital resources. With growing emphasis on clean energy, advanced manufacturing ,and digital technologies, the importanceof rare earths and critical minerals has never ben greater. Like REAI Indian Society ofAnalytical Scientists (ISAS) is also committed to promoting research, innovation , collaboration and promoting indigenous technology. CASMIN 2025 will serve as an ideal opportunityto explore pathways for innovation, recycling, and value addition ensuring that India remains at the forefront of this strategic sector.

I extend my heartiest congratulations to the organizing committee for their dedicated efforts in hosting this significant event. It has been a great privilege for me to serve as the chairman of CASMIN 2025 organizing Committee, a stimulating, fulfilling and enjoyable experience. I thank you for your support to CASMIN 2025 and your participation. May CASMIN 2025 inspire new ideas, foster fruitful collaborations, and contribute meaningfully to the sustainable development of our mineral resources.

Dr MLP Reddy, FAPSc
Secretary REAI & Chairman - Organizing Committee,
Rare Earths Association of India

Dr D Singh
President
Rare Earths Association of India

MESSAGE

The Government of India launched the National Critical Mineral Mission in 2025 to establish a robust framework for self-reliance in the critical mineral sector, which is essential for clean energy technologies. REEs are classified as one of the essential critical and strategic materials for the country in India.

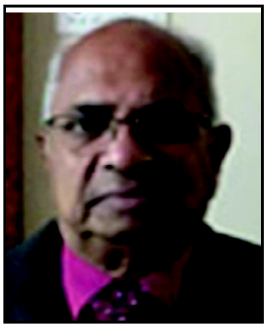
Until 1965, most of the research and development in RE sector involving the elements was metallurgical, not chemical. The major applications for the rare earths included using mixtures of rare-earth oxides for polishing lenses and mirrors, using cerium and lanthanum oxides as promoters in zeolite catalysts for petroleum refining, and using "mischmetal" rare-earth alloys with iron as flints for lighters.

Now on, the internet rules nearly everyone's lives, and handheld devices have greater capabilities than those early bulky devices and gadgets. Much of the technology evolution has come about as researchers discovered that rare earths have abundant magnetic, luminescent, electrochemical, and thermal properties that have made possible smart phones, electric cars, light-emitting diodes, wind turbines, medical imaging, and more. The REAI conference serve as a grand review of the rare-earth chemistry, highlighting how adding a dash of rare-earth metals to materials is like adding a bit of magic fairy dust-the metals help everything perform better.

"The remarkable properties of the rare earths have long engaged the imagination of the scientific community". The scientist and engineers get opportunity to marvel at the metals' importance in applications as varied as automobile starter motors, audio speakers, lasers, and coloured glass.

The conference is expected to reveal new research trends showing that rare-earth chemistry is still very much a scientific frontier of the periodic table, with further technological developments to come. The discussion in the sessions will also highlight the need for better environmental stewardship of rare-earth element resources to ensure their sustainable, socially responsible use in existing and future technologies.

Dr D Singh



Dr Raghaw Saran
President
Indian Society of Analytical Scientists

MESSAGE

It is a matter of great pleasure that Rare Earth Association of India(REAI) and Indian Society of Analytical Scientists(ISA) are collaborating to organize a conference on Critical and Strategic Minerals. These minerals are crucial for renewable energy, energy storage, and advanced technologies, underpinning India's transition to a sustainable future.

Robust Analytical Techniques are essential for exploration, extraction, and processing of these minerals This conference is a crucial step towards empowering India's sustainable development. ISAS is Committed to fostering interdisciplinary research and collaboration to drive innovation to critical mineral exploration, extraction, and utilization.

Let us harness our collective expertise to unlock India's potential in critical and strategic minerals and shape a greener , more sustainable future, achieving net zero goals

Wishing a fruitful conference

Dr Raghaw Saran

PREFACE

It gives us immense pleasure to present the souvenir brought out in connection with the national Conference on Critical and Strategic Mineral India 2025(CASMIN 2025),being organized jointly by the Rare Earth Association of India and Indian Society of Analytical Scientists from December 4-5, 2025 at Kochi, Kerala State.

This publication accompanies a landmark event that brings together scientists, technologists, policy makers, industry leaders and academicians to deliberate on the challenges and opportunities in the field of critical and strategic minerals. These minerals form the backbone of advanced technologies, clean energy systems, and national defence making their sustainable development vital to India's economic and strategic future.

The Souvenir carries messages from distinguished dignitaries, contributions from experts, abstracts of papers, advertisements and acknowledgement to sponsors and patrons whose support has been invaluable in organizing this conference. It also reflect the collective effort of the organizing committee and the scientific community in furthering research, collaboration and policy dialogue in this emerging domain.

We extend our sincere thanks to all delegates, contributors and sponsors for their active participation and encouragement . It is our hope that CASMIN 2025 and this Souvenir will serve as enduring platforms for knowledge sharing and inspiration for continued innovation in the field of critical and strategic minerals.

Dr R Rajeev
Co-Chairman-CASMIN 2025

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Shri M Venugopalan Nair, Former Manager, IREL(India) Limited, Udyogamandal, Kerala State)

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Asit Saha, Geological Survey of India, Kolkata

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RARE EARTH PERMANENT MAGNET- INDIAN DILEMMA

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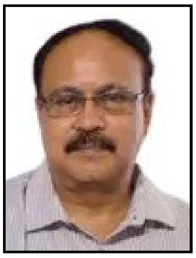
ABSTRACT

Rare Earth Permanent Magnet (REPM) manufacturing sits at the centre of a global commercial dilemma: demand for high-performance magnets is surging across electric mobility, renewable energy, industrial automation, and advanced electronics, yet the economics, supply risks, and strategic dependencies of production remain deeply challenging. While OEMs and Tier-1s urgently seek secure, cost-predictable magnet supply, the commercial viability of domestic manufacturing is constrained by volatile rare-earth prices, China's dominant control of upstream processing, high capital and environmental compliance costs, and the long lead times required to achieve scale, yield stability, and competitiveness.

This presentation unpacks the "make-vs-import" dilemma shaping commercial operations: how companies balance the need for supply chain resilience against the financial realities of building local magnet capability. It explores the tensions between geopolitical pressures, customer expectations for sustainability and traceability, and the operational complexities of mastering critical steps such as oxide preparation, alloying, strip-casting, jet milling, sintering, machining, and coating. Further, emerging pathways are—recycling, substitution research, strategic partnerships, captive JV models, and government-backed incentives—that can help close the commercial gap.

Ultimately, the decision-makers need to equip with a clear understanding of the economic trade-offs, market uncertainties, and strategic choices that will determine whether REPM manufacturing can realistically become a commercially sustainable operation outside entrenched global hubs.

CPT-002

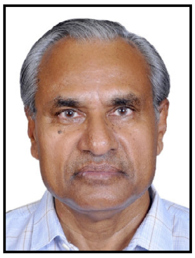


CRITICAL ROLE OF RARE EARTH ELEMENTS AND RARE EARTH MAGNET TECHNOLOGIES FOROUR NATIONAL SECURITY

R Gopalan
Indian National Academy of Engineers Chair Professor & amp;
Former Regional Director, ARCI(DST) IITM Research Park, Chennai

Automotive, aerospace and power sectors are looking for key rare earth materials and manufacturing technology for energy saving high performance applications. Li-ion battery, magnets, fuel cells, solar materials, with rare earth as critical base materials take a vital role for energy saving in many application sectors. The research on these materials demonstrates that a strategic process on industrial scale is required to cater the large scale applications. In this context, it is worth to discuss about the rare earth elements along with high performance rare earth magnets technology for electric vehicle motor applications in combination with the progress inLi-ion battery technology, a great boom to Electric Vehicle / Hybrid electric vehicle zone. The exploration of rare earth materials in recent time, especially after China,s rare earth trade war has attracted a great attention globally from an academic research perspective as well as the technology development for self reliance. Process and chemistry strategy is very important in developing rare earth magnets with a high. The presentation will focus in detail on general aspects of rare earth materials crisis for sustainable energy applications. Specifically, the impact of some of these materials on electric / hybrid vehicles technologies will be discussed apart from the other energy saving applications for National Security.

CIT 001



ASSESSMENT OF INDIA’S CRITICAL AND STRATEGIC MINERAL RESOURCES

Yamuna Singh

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ABSTRACT

The critical and strategic minerals are the bedrock of modern industrial economic development, particularly those transitioning to green energy and advanced technologies, as they ensure strategic autonomy in key technologies. The following 24 commodities, namely, REE (Rare Earth Elements), Lithium, Beryllium, Cadmium, Cobalt, Gallium, Indium, Molybdenum, Nickel, Niobium, PGE (Platinum Group Elements), Rhenium, Selenium, Tantalum, Tellurium, Tin, Titanium, Tungsten, Vanadium, Zirconium, Potash, Phosphate, Glauconite and Graphite are included under critical and strategic minerals (CSMs) in Part D of First Schedule of the MMDR Act. It is clear that CSMs belong to the category of rocks, minerals and elements involving both metallic and non-metallic commodities.

The large resources of REE (as monazite), zirconium (as zircon) and titanium (as ilmenite, leucoxene and rutile) with variable grades are hosted in beach sand deposits along the coastal stretches of Odisha, Andhra Pradesh, Tamil Nadu, Kerala and Maharashtra in association with non-metallic industrial minerals (garnet and sillimanite). In contrast to large deposits of light REE (LREE) along coastal placers, Y and heavy REE (HREE) resources (as xenotime) occur along inland stream placers in central and eastern India. Only these two types of REE deposits are under commercial exploitation in India. Significantly, although substantial LREE deposits are established in carbonatites of Ambadungar (Gujarat) and Kamthai (Rajasthan) with significant amounts of Nb and V in the former and Ga and Ge in the latter, but commercial exploitation has yet to begin. Carbonatites from northeast and southern India and felsic suites of Rajasthan and Andhra Pradesh are also potential for REE, Y, Nb, Ti, Zr and P, besides several other potential natural sources.

The granitic pegmatites of India form potential host for lithium, beryllium, niobium, tantalum and tin minerals in parts of Bihar-Jharkhand, Bastar-Odisha, Karnataka, and some in Rajasthan, Maharashtra, West Bengal and Assam. Likewise, significant tungsten mineralisation also occurs in granites from parts of Rajasthan, Maharashtra and West Bengal, with some occurrences elsewhere. Clay-hosted Li resources are known from Jammu and Kashmir.The layered differentiated mafic-ultramafic complexes with chromite and titaniferous and vanadiferous magnetite of Odisha, Tamil Nadu and Kerala are potential for PGE and Ni deposits. Laterite capping on the ultramafic complexes of Sukinda, Baula-Nausahi and Simplipal hills of Odisha also hold potential for Ni. The sedimentary rocks of Proterozoic and Cambrian ages are potential sources of fertiliser minerals, with potash minerals from Rajasthan. Graphite resources are contained in Eastern Ghats, Kerala khondalites, Chhotanagpur Granite Gneiss Complex terrain and Himalayas. Mo occurrences are restricted. Large resources of REE, Ni, Cu and Co are hosted in Indian Ocean bed/floor mud. In addition to these natural resources, industrial process residues and others also constitute potential secondary resources for the recovery of several critical and strategic minerals. These, among others, include phosphogypsum, phosphoric acid, coal fly ash, sewage sludge ashes, red mud, tin slag, tailings from Pb-Zn-Cu ore, blast furnace slag of steel plants and end-of-life electrical and electronic equipments (Urban mine).

Keywords: Critical minerals, Resources, Placers, Carbonatites, Felsic-Mafic suites, Secondary sources, India.

CIT 002

SUSTAINABILTY ASSESSMENT OF CRITICAL MINERAL MINING AND PROCESSING

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ABSTRACT

The rapid global transition towards clean energy technologies has intensified the demand for critical minerals such as lithium , rare earth elements, etc. While these resources are indispensable for batteries, wind turbines and electric vehicles , their extraction and processing present significant environmental challenges. This paper examines the environmental impacts associated with critical mineral mining and processing across different stages of the supply chain. Key concerns include land degradation, habitat loss, water contamination, green house gas emissions, and the generation of toxic and radioactive waste. Case studies from major producing regions highlight the cumulative ecological footprint and social conflicts arising from unsustainable practices. The paper will also explore emerging technologies and policy frame works aimed at minimizing environmental damage, including improved resource efficiency, circular economy approaches and stringent environmental governance. A comprehensive review of current efforts undrescores the imperative for sustainable mining practices to ensure long term resource availability while preserving ecological balance in India's critical mineral domain.

CIT 03

INDIAN COALFIELDS: A POSSIBLE POTENTIAL SOURCE OF REE AND OTHER CRITICAL MINERALS

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ABSTRACT

India is heavily reliant on coal for its energy security and, simultaneously, imports a majority of the critical minerals (CMs) essential for its economic and national security.

Despite being endowed with rich mineral resources, India's import dependency for minerals is next only to oil. The nation faces a profound strategic vulnerability due to its increasing dependence on imports for essential critical minerals (CMs), a category identified as vital for economic development and national security. This reliance is heightened by limited domestic reserves of many critical elements and a concentration of global processing in few geographical locations, creating supply chain fragility. This paper investigates the often- overlooked potential of the comprehensive Indian coalfields, coal mine wastes, and coal combustion by-products (CCBs) as a viable and sustainable domestic source for a range of strategic elements, particularly Rare Earth Elements (REEs).

While coal is traditionally valued solely for its organic content and energy potential, its complex mineral matrix is known to concentrate various trace elements. In recent years several global studies confirm that coal and coal-associated lithologies contain economically significant concentrations of key CMs and valuable minerals, including Ge, Ga, U, V, Sc, Nb, Au, Ag, Al, and Mg, with REE concentrations in some CCBs (such as fly ash) often matching or exceeding those found in conventional REE ores. The utilization of these resources offers dual benefits: reducing mineral import dependence and transforming vast quantities of coal waste into valuable secondary resources.

To systematically characterize this resource, the Indian government initiated a structured exploration program, led by the Central Mine Planning & Design Institute (CMPDI). This program established standardized procedures (SoP), developed in consultation with the Geological Survey of India, for systematic core sampling and advanced geochemical analysis using techniques like ICPMS and WD-XRF. Under this mandate, 8,832 borehole core samples from 32 boreholes across 29 coal blocks were collected across 14 coalfields in 7 states.

Initial analysis of 4,875 samples yielded highly encouraging results, revealing REE- enriched zones within the non-coal lithologies. Specific promising concentration zones were identified, with total REE concentrations reaching up to 800 ppm in non-coal zones within the Karhichhaper block (Mand - Raigarh coalfield) and 725 ppm in the Mousingha Block (North Karanpura Coalfield). These figures are significantly above the common industry screening threshold of >300ppm (dry ash basis) and approach the high-potential threshold of > 500-600 ppm used for economic extraction by organizations like the U.S. Geological Survey. The data, evaluated based on parameters like concentration coefficient and critical percentage, affirm the potential for economically viable recovery.

In conclusion, the extensive literature review and the encouraging initial exploration data from the CMPDI program strongly suggest that Indian coal, mine wastes, and combustion products may serve as a crucial alternate domestic source of critical minerals, including

REE. Advancing this pathway requires continued resource identification and the design and implementation of specialized, cost-effective separation technologies to recover mixed REEs for downstream purification. This strategic shift is vital for bolstering India's mineral security and achieving self-reliance in the critical raw materials sector for the foreseeable future.

Keywords: Critical Minerals, Coal, REE, Coalfields, Coal mine waste

CIT 004

OPPORTUNITIES AND AUCTIONING OF CRITICAL MINERALS: RELEVANT POLICY FRAMEWORKS

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ABSTRACT

In recent past, world has become increasingly dependent on China for critical and strategic minerals essential for development and national security. Emerging economies like India, this dependence is not just an economic issue but a strategic vulnerability. Geopolitical tensions, trade disruptions and concentrated supply chains have made it clearthat India must secure reliable sources of these minerals to safeguard its future.

Officially, India identified its 30 critical minerals only in mid-2023, lagging behind countries like China, US and Japan that recognized their importance earlier. To overcome this delay, India amended the Mines and Minerals (Development and Regulation) Act in 2023, empowering the Central Government to exclusively e-auction 24 critical and strategic minerals as composite licence and mining lease. This replaced fragmented state- level allocation with a centralized auction regime, greatly enhancing transparency, competition, exploration efforts and private sector participation.

India also introduced new auction rules for 29 critical and deep-seated minerals, including auction-based Exploration Licences (reconnaissance and prospecting). These rules include value-linked royalties and performance securities, which reward successful bidders while ensuring that companies actually develop the resources they acquire. It improves price discovery, avoids discretionary allocations, and promotes faster mineral block development. It is also aligned with national goals such as domestic value addition and technology transfer.

However, if geological knowledge of an area is poor or market risks are high, bidders may stay away. Auctions provide platform for transparent and equal opportunity to all, but lack to automatically solve issues related to mineral processing, refining capacity, or infrastructure.Auctions are just one step in India’s net-zero journey. Further, gradual steps in policy amendments in fields of mineral exploration investments, mineral processing technology,building recycling ecosystem and working closely with global partners are need of hour.Recent tax measures of removing duties on certain critical-mineral waste and scrap areholistic approaches adopted recently by Government.

The launch of the National Critical Minerals Mission (NCMM) added further momentum. It brings together different government agencies under one coordinated framework to speed up domestic exploration, mining, processing and recycling. It also encourages India to acquire overseas mineral assets, reducing exposure to global supply shocks and strengthening long-term security.

Auctions can help drive India’s clean-energy goals and strategic strength, but only with policies that manage geological risks, expand capacity, attract responsible investors, and uphold environmental and social responsibilities which can enable resilient, sustainablecritical-minerals sector.

CIT005

MAPPING AND TAPPING OF LITHIUM FROM NON-TERTIARY RESOURCES IN INDIA

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ABSTRACT

Technologies enabling clean energy transition are the key drivers for growing demand for critical minerals (metals). Though the list of critical minerals is country specific, few of them are common for many nations and one amongst them is lithium (Li). The element Li and its isotopes have multiple applications like battery and energy storage systems, ceramics and glass, lubricants, nuclear, medical, aerospace etc. However, about 80% of the application is in the battery and energy storage systems only mainly due to the attributes it possesses like high-power capacity, safety, longevity, and charging speeds. There are projections that India's EV Li-battery (LiB) demand may skyrocket to nearly 139 gigawatt-hours (GWh) by2035 from 4 GWh in 2023. India's expanding renewable energy sector is also catalysing demand for LiB, with rapid adoption of battery energy storage systems (BESS) to meet India's Net Zero goal by 2070. Besides the recycling of spent LiB (tertiary resource)concerted attempts are also being made in India for exploration and exploitation of hard rock primary resources, brines and even secondary resources for Li. This presentation gives an overview on the present status of non-tertiary resource base of the country and approaches towards exploitation of them including challenges involved.

CIT-006

EVALUATING SECONDARY RARE EARTH ELEMENT (REE) DEPOSITS AS FUTURE EXPLORATION TARGETS

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ABSTRACT

The limitations in exploring the magmatic/primary REE deposits such as carbonatites, alkaline complexes, pegmatites etc. necessitate the search for alternative secondary resources keeping in view of the green energy technological transition. Due to their limited occurrences, expensive extraction processes, complex mineralogical associations along with radioactive elements that cause environmental challenges, primary REE resources are difficult to exploit. Contrarily, secondary REE deposits are comparatively widespread and cause limited environmental issues due to cleaner and relatively cheaper processing techniques. Considering the economic importance of REE and instability in global supply, most of the countries are keen on establishing future sustainable reserves. Though many secondary deposits such as beach and inland stream placers, ion adsorption clays, REE rich regolith etc. are known globally, such occurrences in India are limited which requires prioritized investigation.

REE mobilization and deposition from primary to secondary source is intimately connected to the host rock characteristics, weathering and alteration, hydrothermal and supergene processes, fluid chemistry, Eh-pH conditions etc. In fact, almost all the litho-units irrespective of their age contain REE which are dissolved/mobilized and deposited at suitable sites. Therefore, identification of REE enriched horizons plays a critical role in locating secondary resources. Recent studies on sedimentary phosphorites of Cuddapah basin indicated REE concentrations ranging from 135-1076 ppm which needs further investigations. Early diagenetic remobilization is suggested to have controlled REE enrichment in these phosphorites. A comprehensive analysis of global phosphorite geochemical data further indicates that Cambrian and Ordovician phosphorites are the most prospective for REE exploration, owing to increased riverine phosphate flux, episodic weathering and enhanced phosphorus recycling. Volcano-sedimentary deposits such as pyroclastic rocks in few Precambrian terrains also host Au, Ag, atomic minerals and REE bearing mineral phases including allanite, monazite, thorite etc. Shear zone activity further remobilizes elements through fluid flow, facilitating their transport and deposition at suitable sites. Fe-Mn oxyhydroxides have also been identified to be potential REE scavengers when subjected to supergene processes. The REE concentrations in the Mn ore of Dharwar Craton reaches up to 4199 ppm and their mobilization and sorption are primarily influenced by fluid alkalinity within a specific Eh range (-0.2 to +0.6 V), indicating redox driven REE enrichment. The tropical to sub-tropical climate of Indian sub-continent favours the formation of REE enriched regolith and ion-adsorption clays though weathering of felsic magmatic

rocks, which needs to be focused in identifying secondary REE deposits. Another potential secondary source is the coal fly ash, in which REEs are concentrated during combustion from coal to residual ash. Therefore, the increasing demand for REE and other critical minerals emphasizes the need to broaden the exploration efforts towards secondary deposits to strengthen the Indian REE supply chain.

CIT 07

RARE EARTH SCENARIO IN INDIA

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ABSTRACT

India holds substantial potential in the global rare earth elements (REE) sector, with the world's fifth-largest reserves, mainly in monazite-bearing coastal placer deposits across Andhra Pradesh, Tamil Nadu, Odisha, and Kerala. The sector is led by IREL (India) Limited, which manages most mining and primary processing activities. Despite strong resource availability, India's rare earth industry remains mostly upstream-focused, with limited capabilities in advanced separation, refining, and high-value product manufacturing such as permanent magnets.

Domestic demand for REEs is rising rapidly due to growth in renewable energy, electric vehicles, consumer electronics, and defense applications. Consequently, India still depends heavily on imports of separated REEs and engineered components, particularly those based on neodymium, praseodymium, and dysprosium. To address this gap, the government has initiated reforms to promote exploration, allow private participation, and classify rare earths as critical minerals under strategic programs such as "Make in India" and "Atmanirbhar Bharat."

Recent policy moves—along with collaborations between research institutions, defense organizations, and international partners—aim to strengthen midstream and downstream capabilities, including solvent extraction, magnet manufacturing, and recycling technologies. However, challenges persist: China's dominance in global processing, technological gaps, environmental concerns, and limited investment continue to slow ecosystem development.

India now stands at a strategic inflection point. With abundant resources, rising industrial demand, and supportive policy momentum, the country has the opportunity to evolve from a raw material supplier into a competitive rare earth processing and manufacturing hub, contributing to both national security and global supply chain diversification.

CIT 008

ADVANCING RARE EARTH SUPPLY SECURITY THROUGH EFFICIENT RECYCLING OF NEODYMIUM-IRON-BORON (NDFEB) MAGNETS

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ABSTRACT

Neodymium-Iron-Boron (NdFeB) magnetAs are recognized as the strongest commercially available permanent magnets. Owing to their exceptional magnetic strength, they are widely applied in reducing the overall weight and dimensions of various products. Key areas of application include electric vehicles, renewable energy systems, data storage devices, sensors, switches, motors, generators, and transducers. Market analysis indicates that motors and generators account for the highest consumption of NdFeB magnets (34%). This dominance is largely attributed to their extensive use in electric vehicles and wind turbines. However, with the increasing demand for NdFeB magnets and the limited availability of essential raw materials such as neodymium, praseodymium, and dysprosium, the supply chain faces significant challenges. To ensure sustainable growth, strategies and alternative solutions for raw material procurement are being actively explored.

Discarded NdFeB magnets are now considered a promising secondary source of rare earth elements (REEs). Estimates suggest that nearly 300,000 tons of REEs are stockpiled globally in the form of magnets, with future waste volumes expected to rise substantially from diverse applications. This paper reviews different recycling routes reported in literature for the treatment of spent NdFeB magnets. The approaches broadly include direct recycling, pyrometallurgical, hydrometallurgical, and electrometallurgical methods.

The efficiency of recycling largely depends on the type of NdFeB waste (scrap, sludge, or spent magnets) and the extent of contamination. Direct recycling is primarily applicable to non-oxidized, low-contamination magnets. Pyrometallurgical techniques—such as liquid metal extraction, molten salt extraction, and glass–slag processes—employ high-temperature operations to recover rare earths as alloys or mixed compounds, which then require further refining. A compromise often exists between yield and purity. Hydrometallurgical processes, although effective, are constrained by the high consumption of chemicals, making selective leaching of REEs with minimal acid use, an unresolved challenge. The

merits and drawbacks of these methods have been extensively documented. Despite the progress, no process has yet proven to be robust, environmentally benign, and industrially efficient for the extraction of critical REEs from NdFeB magnets. Thus, there remains considerable scope for developing advanced processes that enable selective recovery and separation of REEs on a large scale. This study also highlights possible future directions for designing sustainable technologies aimed at securing the supply chain of critical raw materials through efficient recycling of waste NdFeB magnets.

CIT 09

CHALLENGES IN PROCESSING OF STRATEGIC MINERALS

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ABSTRACT

Uranium is the primary fuel used in nuclear reactors to ensure its noble and strategic utilisation. The quality requirement of the fuel is extremely stringent to improve its stable sustainability and neutron economy in reactors. Extraction and recovery are depended on grade of resource of uranium and its conformation in earth crust and source material. Additional challenges arise in refining processes based on requirement of purity for final application. In the presentation, the different challenges encounter during extraction of uranium mineral from its ore and its resource (conventional and non-conventional), recovery of it from the mineral by processing it in mill operations and refining to the reactor grade purity have been addressed, elaborated and discussed, and further scope of improvement in nuclear front-end fuel cycle technology is outlined.

CIT 010

ATOMICALLY DISPERSED METAL CATALYSTS: A PROMISING PATHWAY TOWARDS SUSTAINIBILITY

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ABSTRACT

Catalysis lies at the heart of nearly all industrial chemical processes, enabling economically viable production by accelerating reactions with minimal energy input. Among the many classes of catalysts, heterogeneous systems are particularly valued for their robustness, recyclability, and ease of separation. Central to their performance is the use of metals in finely divided forms, which provide the active sites necessary for efficient transformation. In recent years, the advent of single-atom catalysts (SACs) or atomically dispersed metal catalysts (ADMCs) has marked a transformative development in the field. By isolating individual metal atoms on suitable supports, these materials offer unprecedented atom-utilization efficiency and unique catalytic properties distinct from their nanoparticle counterparts. Driven by these advantages, SACs have rapidly gained attention for a broad range of applications, spanning photocatalysis, electrocatalysis, and diverse organic transformations.

The present talk highlights the development of copper-based single-atom or atomically dispersed catalysts (g-C_3N_4/Cu) synthesized through a streamlined one-pot approach, in which precursor mixtures are thermally treated under controlled atmospheres. Advanced spectroscopic analyses including Extended X-ray Absorption Fine Structure (EXAFS) and X-ray Absorption Near-EdgeStructure (XANES) unequivocally confirm the atomic dispersion of Cu, stabilized through C–N coordination within the graphitic carbon nitride matrix. The catalytic prowess of these g-C_3N_4 /Cu single-atom catalysts is demonstrated across a broad array of organic transformations, delivering highyields over diverse substrates and exhibiting exceptional recyclability, with more than 95% activity retained over multiple cycles. This robust performance is attributed to the strong stabilization of isolated Cu centers by the g-C_3N_4 framework, which effectively suppresses aggregation and preserves the integrity of active sites under reaction conditions. In addition, the potential of g-C_3N_4/Cu SACs in photocatalytic CO_2 reduction is explored, an application of critical significance for sustainable carbon management and the development of renewable chemical pathways.

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CIT 011

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CONTRIBUTED PAPERS

CCP-1

CRITICAL METALS & NON-METALS IN SPENT BATTERIES: CHARACTERIZATION & EXTRACTION

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ABSTRACT

With the increasing popularity of electric vehicles (EVs), portable electronics, and renewable energy systems, vast Li-ion batteries (LIBs) are produced and consumed rapidly. Thus, the amount of spent batteries entering the waste stream has increased enormously. Extensive LIB uses create significant environmental and resource management issues. These spent batteries contain many critical metals such as Li, Co, Ni and Mn along with non-metals such as graphite, polymeric binders and fluorine compounds. The black mass obtained after mechanical disassembling and physical separation of electrode materials can be utilized to extract these critical metals and non-metals needed for the production of new batteries. Characterizing black mass is vital in designing an efficient extraction and recovery process. Detailed material characterization enables understanding of the black mass's chemical composition, particle morphology, and phase distribution. This work systematically analyzed black mass samples from various types of spent LIBs to determine the physicochemical characteristics. The phase composition, thermal stability, elemental composition and morphology of the black mass were characterized by X-ray diffraction (XRD), Thermogravimetric analysis (TGA), Inductively coupled plasma (ICP-OES), Scanning electron microscopy (SEM-EDAX) and respectively. Such thorough characterization is instrumental to optimize the extraction processes.

Among the various recycling approaches, thermal treatment, solvent extraction, and direct recovery methods are prominent for extracting metals and non-metals. Thermal treatment, including pyrolysis and calcination, helps decompose organic binders, recover carbon materials, and convert metals to metal oxides that can be easily leached out. The solvent extraction method requires expensive extractants to transfer the metal ions from the leaching solution to the organic phase. This method allows high-purity recovery of metals from the leachates. The direct recovery methods involve froth flotation, which efficiently separates the anode material (graphite) from the black mass.

This study highlights the importance of characterisation of black mass for developing optimized extraction and recovery strategies. Efficient extraction of metals and nonmetals helps achieve economic feasibility and reduce environmental impact.

Keywords: Spent battery, Characterization, Thermal treatment, Solvent extraction, Direct recovery

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CCP-2

SURFACE ENHANCED RAMAN SPECTROSCOPIC QUANTIFICATION OF THIABENDAZOLE BY NANO SILVER COATED SANDPAPER SUBSTRATES

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ABSTRACT

Pesticides play an integral part in food production and storage. However, the failure to follow existing regulations in using them can severely affect human health and the environment. Here, we aim to develop a simple and cost-effective method based on Surface-enhanced Raman spectroscopy (SERS) to detect and quantify the possible existence of thiabendazole (TBZ), a commonly used fungicide. The SERS substrate is prepared by coating spherical silver nanoparticles of ~50 nm size on bare sandpaper. The intrinsic roughness of the sandpaper, along with the surface plasmon resonance of the silver nanoparticles, helps in the enhancement of thiabendazole signals by a factor of 3.6×10^6. The substrate has good uniformity and reproducibility with RSD values of 4.8 % and 3.3 %, respectively, as probed by 4-mercaptophenyl boronic acid (4-mpba) molecule. The high stability of the substrate up to 3 months and the low detection and quantification limits of 0.42 and 2.34 ppb which are lower than the allowed maximum residue limit (MRL), indicate the potency of the proposed substrate. In addition, we have demonstrated the performance of the as prepared substrate in detecting thiabendazole residues present in liquid milk.

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CCP-3

INTEGRATING XRD-XRF-EMP ANALYTICAL STUDIES IN CRITICAL MINERALS EXPLORATION AND RESOURCE EVALUATION

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ABSTRACT

X- ray diffraction (XRD), X-ray Fluorescence (XRF) and Electron-Microprobe (EMP) analytical systems and the mineralogical and geochemical studies that ensue form a well-integrated approach to evaluate the critical Mineral potential during the three main stages of mineral exploration, namely reconnaissance, anomaly detection followed by the different stages of exploration in sequence and finally evaluation and proving the mineral potential within a given region. XRD and EMP provides the specific nature of the critical mineral, its size, shape along with associated gangue minerals all of which form the basis for mineral technology and later extraction of pure oxides or metals. XRF systems, both portable and laboratory-based systems, on the other hand, provide a measure of concentration levels of the desired critical mineral or element, both at the reconnector survey period as well as semi-quantitative-quantitative data on the concentration levels of the critical minerals of interest from surface and bore-hole core samples from a prospect and help in the ore-reserve estimations and thus proving a deposit.

Case studies from carbonatite complexes of India (e.g., Amba Dongar, Gujarat; Sung Valley, Meghalaya; and Samchampi, Assam) and rare-metal pegmatites (Jharkhand and Karnataka) and the Siri River xenotime-monazite beneficiation and resource evaluation of REE, Y, Nb and Ta using these three systems are presented.

CCP-4

A SUSTAINABLE TIME-TEMPERATURE INDICATOR FOR COLD-CHAIN LOGISTICS INTEGRATED WITH A SMARTPHONE APPLICATION

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ABSTRACT

The increased food spoilage, decay or loss of vaccine potency during the cold chain logistics leads to health risks. Maintaining the quality of perishable goods in cold chain logistics is highly challenging. The conventional temperature sensors are highly expensive and are not affordable for remote medical centres, traditional markets, etc. This growing global concern is linked to the economic loss of nations due to food wastage and lack of health security. Therefore, the development of an intelligent, high-performance, low-cost time-temperature indicator (TTI) is crucial for food safety and public health. In this work, a natural pigment- embedded green polymer is used as TTI. It shows high sensitivity towards temperature and is validated with both kinetic and thermodynamic studies. The integration of a novel smartphone application with the TTI indicates the potential of real-time applicability and improves accessibility for consumers. The smartphone application instantaneously displays the freshness level and remaining shelf life of the perishable products. For distributors, retailers, and end users, the TTI system offers a simple, non-destructive monitoring tool. Smartphone technology combined with a natural pigment-based TTI provides an environmentally friendly, economical, and user-friendly intelligent packaging solution.

Keywords: Time-temperature indicator, kinetic modelling, smartphone application, intelligent packaging, food freshness, colorimetric sensor.

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CCP-5

MOLECULAR ANALYSIS OF ATMOSPHERIC AEROSOL PARTICLES – METHOD AND IMPACT

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ABSTRACT

The concentration of transported aerosols over the pristine environment plays a key role in controlling the atmospheric composition. The present study illustrates the impact of long-range transported aerosols on the tropical forest region by characterizing anthropogenic tracers at the molecular level. A campaign mode aerosol collection followed by chromatographic analysis of esterified samples demonstrated that the fingerprints of anthropogenic precursors extend through the air mass, influencing the concentration of ambient aerosols. Molecular fingerprints demonstrate that anthropogenic contamination is significantly altering the composition of ambient aerosols, necessitating a better understanding of the sources and formation pathways of these aerosols. Our research proposes new formation pathways for SOA generation in remote areas by considering the interplay between precursor compounds and the products formed from mixed precursors and oxidants.

The present work introduces an integrated analytical approach for the analysis of both sources and sinks using sophisticated analytical techniques. Gas chromatography coupled with various detectors (GC) employing an analogous derivatization method improves the sensitivity, selectivity, and stability of both source and sink detection and provides insights into the interactions of these gases with fine and ultrafine aerosol particles. The major goal of this work is to develop a technology for removing impactful gaseous and particulate constituents from the ambient air. The derivatization is adopted in such a way to convert reactive, polar, or low-volatility compounds into stable, GC-detectable compounds. Hence, this method increases the analyte volatility, thermal stability, and the response from the detector, helping with the accurate quantification of targeted compounds. Also, this method improved linearity, reduced tailing in the chromatograph, and improved the signal-to-noise ratios compared with the previous one. Currently this technique has been successfully implemented in dicarboxylic acids and associated polar compounds.

Overall, the presented work demonstrates that advanced derivatization methods coupled with gas chromatographic technique significantly improve our understanding about the planetary atmosphere. For the first time we have done this kind of study over a pristine rain forest location and found that the transported precursors are the major air pollutants over this location. The major sources for the precursors were observed to be the marine plastic degradation, especially the degradation products of polyethylene terephthalate (PET), which generates various precursors including phthalate monomers. These released compounds from the oceanic surface, substantially enhance the overall concentration of anthropogenic aerosols over the marine boundary layer. Similarly, p-xylene produced from plastic waste were undergo photochemical oxidation resulting in the formation of terephthalic acid. Using this method, we could trace out the journey of marine plastic waste into harmful carcinogenic aerosol particles over an otherwise pristine atmosphere.

CCP-06

GREEN FABRICATION OF G-Cƒ N„ /AG HETEROJUNCTION PHOTOCATALYSTS WITH SUPERIOR ACTIVITY TOWARD ORGANIC POLLUTANT DEGRADATION

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ABSTRACT

Graphitic carbon nitride (g-C_3N_4), a two-dimensional n-type semiconductor, has attracted a lot of attention as the next-generation photocatalyst in the field of material science because of its high physicochemical stability, suitable band gap structure, low cost, ease of preparation, and earth abundance. However, the g-C_3N_4 material has some unfavourable characteristics that limit its photocatalytic performance, including a high rate of recombination of photogenerated charge carriers, poor quantum efficiency, a smaller surface area, and inefficient light absorption. Numerous methods have been used to surmount each of gC_3N_4's specific drawbacks. Among various modification strategies, element doping is known to be an efficient method to tune the band gap of g-C_3N_4, which considerably broaden the light responsive range and enhance the charge separation. Using the most cost-effective and time-efficient microwave irradiation, we created a photocatalyst made of Ag/C_3N_4 composite that ensures high photocatalytic activity. Structural and morphological studies indicate that the spherical Ag nanoparticles present in the g-C_3N_4 material were well-dispersed on the surfaces without agglomerating. The Ag/C_3N_4 composite's catalytic potential was developed to remove methylene blue, a model organic pollutant that is frequently used as a colorant in the textile industry, when exposed to visible light. The superior photocatalytic activity is mainly ascribed to the increased separation of photogenerated charge carrier and suppressed recombination rate. The present work provides a new insight for the effective synthesis of other multicomponent photocatalytic systems for the water pollutant degradation.

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CCP-07

SYNTHESIS AND CHARACTERIZATION OF ZIF-8 DERIVED ZnO/MoS2 NANOCOMPOSITE FOR PHOTOCATALYTIC REDUCTION OF Cr(VI) UNDER VISIBLE LIGHT

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ABSTRACT

With the economic development and improvement of living standards, human society is facing a series of environmental pollution challenges. Chemical, physical, thermal and biological methods are commonly employed for the removal of pollutants. Among these processes, visible-light photocatalysis is an emerging technology for reducing environmental pollution. Compared to other methods, photocatalysis has received more attention due to its low cost and efficiency, utilising clean and abundant sources of sunlight. Here, a zeolite imidazole framework (ZIF-8) derived ZnO and molybdenum disulfide (MoS2) nanosheets nanocomposite was synthesised using a facile hydrothermal method. The samples were subjected to reduced hexavalent chromium (Cr(VI)) under visible-light irradiation. Among the different compositions, the optimized composite gave the highest photocatalytic activity under visible light. The two-dimensional flower-like morphology of the synthesised MoS2 nanosheet provides more active sites for the adsorption of pollutants. Furthermore, the synergistic effect of ZIF-8-derived ZnO with MoS2 results in higher visible light absorption, thereby enhancing photocatalytic activity.

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CCP-08

SEASONAL DYNAMICS OF PHOSPHORUS CYCLING IN THE COCHIN ESTUARY REVEALED THROUGH FRACTIONATION ANALYSIS

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ABSTRACT

Phosphorus fractionation was used to decipher the seasonal behavior of phosphorus (P) cycling in the Cochin Estuary during 2022 and 2023, covering both monsoon and pre-monsoon seasons. Sub-surface water and surface sediments were collected from 14 stations. Sediment samples were sequentially extracted to quantify five operational P fractions and their percentage contributions to total phosphorus (TP). Phosphate in water column exhibited pronounced seasonality, with elevated concentrations during the pre-monsoon. In sediments, fine-grained deposits consistently hosted higher P fractions, reflecting their larger surface area for phosphate adsorption and retention. Surface sediment TP ranged from 1348.13 to 4278.9 ìg/g in the monsoon and from 737.97 to 2444.9 ìg/g in the pre-monsoon. Inorganic P (IP) levels increased in parallel with salinity, while iron-bound P displayed a distinct seasonal trend, reaching peak values during the pre-monsoon. The sequential order of P fractions follows the trend Iron bound phosphorous [(Fe(OOH)H”P] > Calcium bound phosphorous [CaCO3H”P]> Alkali soluble organic phosphorous [Alk- OP] > Acid soluble organic phosphorous [ASOP] > Residual organic phosphorous [Res-OP]. Residual organic P remained consistently low due to extensive mineralization. Elevated C/P and N/P ratios confirmed P enrichment in sediments. Significant variation in P fractions and bioavailability was linked to industrial, agricultural, and aquaculture discharges, compounded by terrestrial inputs from the 2018 flood. The high proportion of bioavailable P poses a risk of sediment water phosphorus release, potentially altering primary productivity and the trophic status of the estuarine system.

Keywords: Phosphorus fractionation, geochemical parameter, bioavailable fraction, primary productivity

CCT -09

Synthesis and Characterization of Porous Chitosan-Gelatin Blend Membranes

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ABSTRACT

Developing high-performance functional membranes faces real challenges due to the natural limitations of polymers such as chitosan. Chitosan is difficult to form into a film and exhibits low mechanical strength. The mass transport properties are still poor because of its semi-crystalline structure. This study addresses these issues by the smart synthesis of a chitosan/gelatin blend membrane. Gelatin is not only a plasticizer for better flexibility but also introduces bioactive Arg-Gly-Asp sequences. It also helps polymers form a stable network through hydrogen bonds and electrostatic forces. The main innovation of this study is the development of a functional porous structure. We developed a two-stage process using dual porogens to create interconnected pores. Initially, gelatin was utilized as a primary solvent-labile porogen, with FTIR analysis confirming its initial successful incorporation and subsequent partial removal, a process that was vital for successfully disrupting the native CS crystalline structure, as evidenced by X-ray Diffraction (XRD). However, Scanning Electron Microscopy of the initial setup revealed an inefficient microstructure dominated by dead-end pores. These severely limit transport efficiency. To overcome this flaw, a porogen, Polyethylene Glycol(PEG), was added to the chitosan/gelatin mixture. PEG acted as a water-leachable secondary porogen. The best interconnected network was created using a careful removal sequence. PEG was leached out first, followed by the complete leaching of gelatin. Attenuated total reflectance FTIR confirmed this process. Comprehensive characterization of the final membrane revealed significant functional improvements. Thermogravimetric Analysis (TGA) confirmed a marked improvement in the overall thermal stability of the engineered blend, which is a vital characteristic for device integration. Furthermore, the highly interconnected porous network yielded substantial increases in hydrophilicity, most critically, a significant enhancement in ionic conductivity, which was rigorously quantified using electrochemical impedance spectroscopy (Nyquist plots). The successful demonstration of a reproducible, highly controlled porous morphology combined with superior thermal and ionic transport properties positions these CS/GN porous blend membranes as a novel and promising class of functional biopolymer electrolytes, making them exceptionally well-suited for deployment in advanced Solid-State Electrochemical Devices, specifically targeting High-Performance Supercapacitors.

Keywords: *Polyethylene glycol, Porogen, Pores, Hydrogen Bonding, Electrostatic interactions*

CCT- 10

VALIDATION AND ADAPTATION OF REMOTE SENSING-DERIVED OCEAN COLOR ESSENTIAL CLIMATE VARIABLES FOR MONITORING CLIMATE CHANGE IN THE NORTHERN INDIAN OCEAN

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ABSTRACT

Satellite remote sensing has provided major advances in understanding the climate system and its changes, by quantifying processes and Spatio-temporal states of the atmosphere, land and oceans. This work investigates utilization of Essential Climate Variables (ECVs) derived from remote sensing data for the monitoring of climate change across the Northern Indian ocean. The Global Climate Observing System (GCOS) recognizes Ocean Colour (OC) as an Essential Climate Variable (ECV) due to its fundamental capacity to monitor critical biogeochemical properties of the world's oceans. Chlorophyll-a (Chl-a) concentration is a primary parameter in OC observations, representing both the inherent optical properties (IOPs) and apparent optical properties (AOPs) of the water. Phytoplankton are the primary biological component that dictates how light interacts with the water column, they are the microscopic foundation of the marine food web, contributing to half of the planet's primary production and playing a pivotal role in regulating the global carbon cycle through the biological pump. Monitoring their diversity, size, and community composition is thus essential, as these characteristics are major determinants of biogeochemical processes, including nutrient uptake and the export of particulate carbon to the deeper ocean. The imbalance in the global carbon cycle leads to the decline of ocean pH and thus caused ocean acidification. In this research the fieldwork employs both monthly coastal/estuarine sampling off Kochi and Kollam, and dedicated sampling across the Northern Indian Ocean. Satellite instruments collect ocean colour data by measuring the water leaving radiance which is converted into Remote Sensing Reflectance (R_{rs}) which serves as the fundamental input for deriving biogeochemical variables. The satellite data is collected and paired with corresponding in-situ data collected from the Northern Indian Ocean. The OCM 3 (Ocean Colour Monitor on Oceansat 3) satellite sensor serve as a key source of satellite data for the validation and adaptation of ocean colour retrieval algorithms to the unique conditions of the Indian Ocean. This work provides a framework for monitoring climate change impacts in the Indian Ocean.

Keywords: *Satellite, Chlorophyll-a, Ocean acidification, OCM 3, carbon cycle*

CCT-11

SUSTAINABLE FLUORESCENT NANODOTS FROM FISH SCALES FOR METAL ION DETECTION IN AQUATIC ENVIRONMENTS

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ABSTRACT

Heavy metal pollution in aquatic systems poses serious environmental and health risks due to their toxicity, persistence, and bioaccumulation. With the goal of sensitively and selectively detecting ferric ions (Fe^{3}z), the current work investigates a green and economical method for creating fluorescent carbon nanodots (CNDs) from fish scale waste (*Lutjanus campechanus*). Ethanol and water were used as environmentally acceptable solvents in a hydrothermal synthesis. Transmission electron microscopy (TEM), dynamic light scattering (DLS), Fourier-transform infrared (FTIR) spectroscopy, and UV-Vis spectroscopy were used to analyze the resulting CNDs. Surface functional groups such as hydroxyl and carbonyl, a quasi-spherical shape with nanoscale dimensions, and excellent dispersion in aqueous mediums were all validated by characterization. Under UV light, CNDs exhibited a significant blue fluorescence. By integrating them onto paper strips that served as solid-phase sensing substrates, their potential as a fluorescence-based sensor was assessed. Significant fluorescence quenching was seen upon exposure to Fe^{3+} ions as a result of interactions between the ions and the CNDs' surface functional groups. Because of this visual alteration, ferric ions may be detected with the unaided eye, allowing the device to be used in field settings. With potential uses in environmental monitoring, particularly for quick screening of tainted water samples, this study shows that CNDs made from bio-waste can function as environmentally friendly, sensitive, and selective fluorescent probes for metal ion detection. By encouraging eco-innovative approaches to environmental monitoring, marine conservation, and circular resource usage, this work contributes to global sustainability initiatives.

Keywords: *Carbon dots; Marine biomass; Hydrothermal method; Metal ion sensing; Environmental nanotechnology*

CCT-12

SYNTHESIS AND CHARACTERIZATION OF ZINC OXIDE AND CHITOSAN-ZINC OXIDE COMPOSITES, AND THEIR APPLICATION IN THE PHOTOCATALYTIC DEGRADATION OF ORGANIC DYES

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ABSTRACT

This study explores the synthesis, characterization, and photocatalytic performance of zinc oxide (ZnO) and chitosan-zinc oxide (CS-ZnO) composites for degrading organic dyes in water. Synthetic dyes, commonly used in textile and pharmaceutical industries, are environmental hazards due to their persistence and toxicity. Traditional water treatment methods often fail to remove these pollutants effectively, necessitating advanced oxidation processes (AOPs) like photocatalysis. ZnO, a semiconductor capable of generating reactive oxygen species (ROS) under UV or visible light, is promising for breaking down organic contaminants into harmless by-products. However, ZnO's potential toxicity and stability issues under operational conditions have led to the investigation of chitosan as a stabilizing and performance-enhancing agent. This study focuses on synthesizing phase-pure ZnO and uniformly dispersing chitosan within the matrix using a hydrothermal method. Characterization techniques such as X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM) confirm the structural integrity, crystalline properties, and particle distribution of the catalysts .The results show that chitosan was successfully integrated into ZnO without compromising its crystallinity. SEM imaging reveals a uniform distribution of ZnO particles in CS-ZnO composites, essential for maintaining catalytic efficiency. Photocatalytic tests demonstrate that a 10% CS-ZnO composite performs optimally in degrading methylene blue (MB) dye under neutral pH and UV light. This research highlights the effectiveness of chitosan-ZnO composites as advanced photocatalysts for pollutant degradation, contributing to optimizing catalyst composition and operational conditions for sustainable water treatment technologies. These findings provide a pathway to reducing environmental pollution from industrial dye effluents.

Keywords: Photocatalysis, Chitosan-ZnO, Organic Dyes, Methylene Blue

CCP-13

SOLID STATE NMR STUDIES ON COMPOSITE SOLID PROPELLANTS

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ABSTRACT

Composite solid propellants are heterogeneous mixture in which metallic fuel and oxidizer dispersed in polymeric binder matrix. This class of propellants are widely used in defence and space applications due to its ease of processibility and better performance in terms of burning rate, characteristic velocity and low pressure exponent.[1,2] Understanding the structure and dynamics is highly essential to tailor the performance of composites. Solid state NMR parameters such as chemical shift, line-width, line-shape and relaxation times are dependent on the local structure and dynamics of the molecules.[3] The type, amount and extent of exfoliation/dispersion of the fillers influence these parameters significantly. Since these parameters are sensitive to the type of interaction between the filler and matrix or the interactions among the components in a composite, NMR can be used as a tool to study the effectiveness and performance of such composite systems.

In composite solid propellant, HTPB based binder is used as matrix and oxidizer is used as filler. The interaction between the filler and matrix is envisaged by changing the size of the filler and keeping constant burn rate modifier. In this work, oxidizer used is ammonium perchlorate (AP) and burn rate modifier is activated copper chromite (ACR). Four propellant slabs were casted without AP, with Coarse AP, Fine AP and Coarse AP : Fine AP (2:1). Mechanical properties were measured and compared with ^{13}C NMR relaxation parameters. It is found that T_1 (^{13}C) aliphatic is better probe to find the filler matrix interaction in the composite solid propellant formulations and can be correlated with tensile strength.

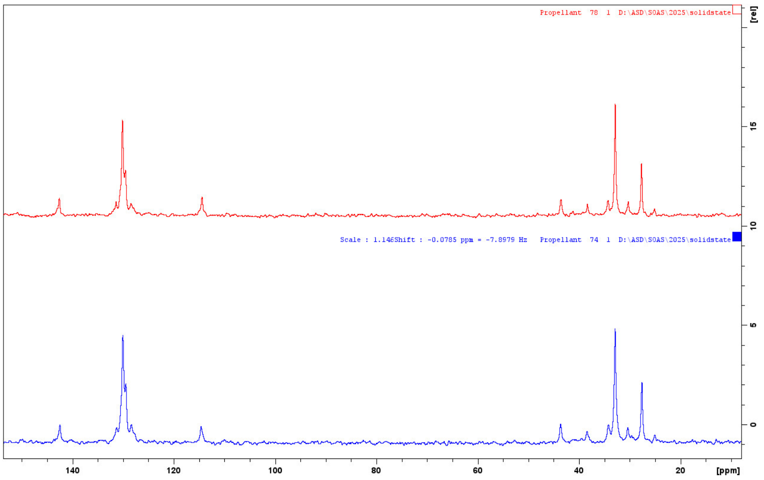

Figure 1. ^{13}C MAS NMR of HTPB-Coarse : Fine AP(2:1)-ACR at 2 kHz spinning.

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CCT-14

IDENTIFICATION OF MOLECULAR MARKERS OF ORGANIC AEROSOLS USING BSTFA DERIVATISATION METHOD

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ABSTRACT

Organics constitute a wide variety of compounds with different volatility, reactivity and elution rate in chromatographs. To a large extent, understanding the processes involving organic compounds in the atmosphere depends on how well these compounds are identified. Molecular level characterisation of specific organic compounds can be used as a tracer for understanding the sources and formation pathways of organic aerosols in the atmosphere. However, identifying the chemical constituents of organic aerosols is challenging task since it constitutes a range of compounds with varying chemical properties. This work presents an optimized method for the characterisation of molecular tracers using BSTFA derivatisation coupled with Gas Chromatography-Mass Spectrometry (GC-MS) for comprehensive molecular speciation of the organic-solvent-extractable fraction of atmospheric aerosols.

Aerosol filter aliquots are extracted with dichloromethane and methanol (2:1) under ultrasonication, filtered using quartz fibre filter, and gently concentrated under nitrogen blow down. Polar functional groups (-OH, -COOH) are subsequently derivatised using N,O-bis(trimethylsilyl)trifluoroacetamide (BSTFA) with pyridine at 70 °C for 1 hour, converting non-volatile multifunctional compounds into trimethylsilyl derivatives suitable to GC-MS analysis. The method employs a 30 m silica capillary column with temperature programming (50–300 °C) and mass spectrometric detection. Tridecane is used as an internal standard for reliable quantification. The protocol successfully quantifies and identifies individual organic species, including source specific tracers like anhydrosugars (levoglucosan, mannosan, galactosan) for biomass burning; primary sugars (glucose, sucrose, xylose) and sugar alcohols (arabitol, mannitol) as markers of fungal spores and plant debris; lignin/resin breakdown products (vanillic, syringic, 4-hydroxybenzoic, dehydroabietic acids); biogenic SOA tracers (2-methyltetrols, pinonic acid, â-caryophyllinic acid); aromatic acids and phthalate esters indicative of plastic combustion and anthropogenic influence. Overall, the BSTFA-GC-MS methodology represents a significant advancement in aerosol chemical characterisation. By enabling high-resolution molecular speciation, it strengthens our ability to investigate organic formation mechanisms and their impacts on air quality and climate.

CCT-15

SYNTHESIS AND CHARACTERIZATION OF CARBON QUANTUM DOTS FOR METAL ION SENSING

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ABSTRACT

Carbon quantum dots (CQDs) have garnered considerable attention due to their unique optical and electronic properties, including luminescence, high biocompatibility, and environmentally friendly nature.[1] Earlier, semiconductor quantum dots were widely used, but their toxicity level guided the researchers towards greener and biocompatible alternatives. The economic development and advanced living standards have triggered a series of challenges, including environmental pollution, such as water contamination due to metal ion poisoning. The identification of these heavy metal ions plays a vital role in removing these pollutants. Countless attempts have been made to synthesize Carbon quantum dots using different methods and sources. Among these processes, hydrothermal synthesis has received the greatest attention as a more viable and environmentally friendly technology for Carbon quantum dot synthesis compared to other methods, due to its benefits like efficiency, controlled synthesis, and low cost.[2] Here, Carbon quantum dots were synthesized using a facile hydrothermal method. The (CQDs) were characterized and analyzed using various characterization techniques. Then the (CQDs) were subjected to detailed metal ion sensing studies using different metal ions. The CQDs demonstrated an exclusive sensing ability towards metal ions under various conditions.

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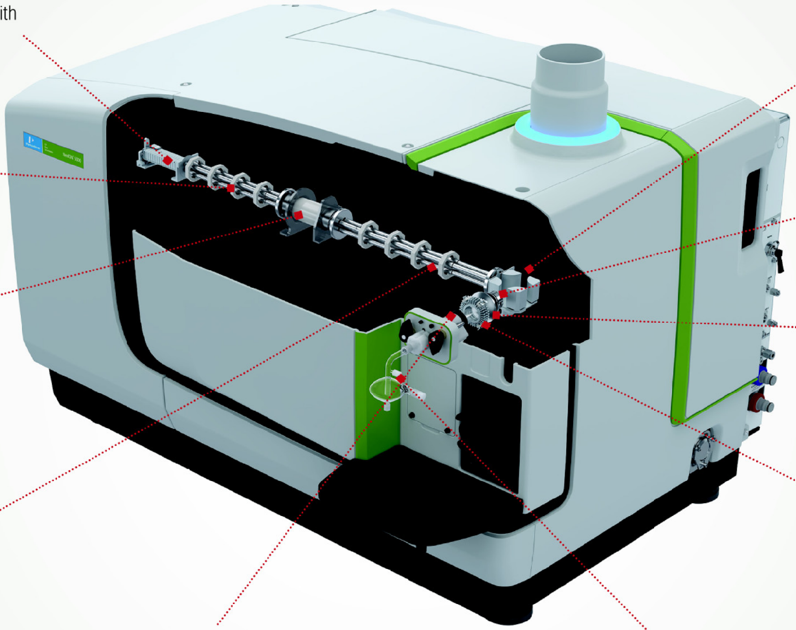

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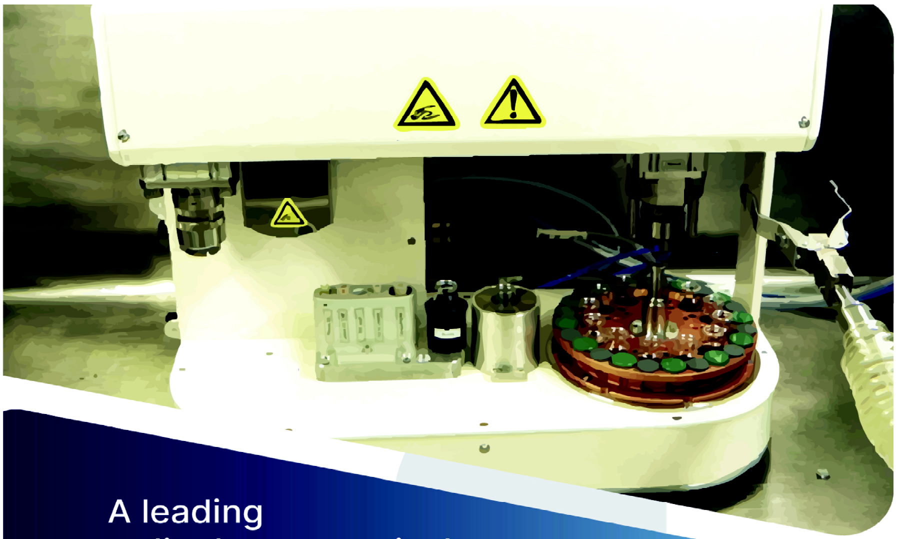

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