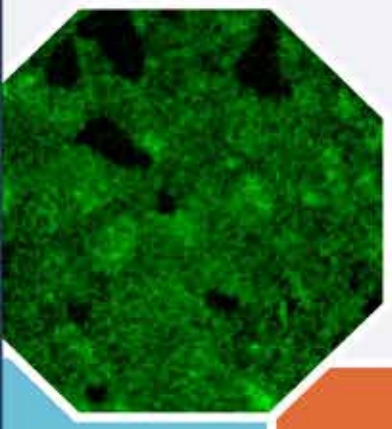
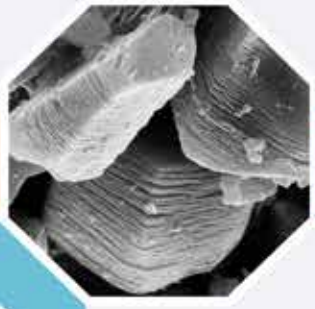
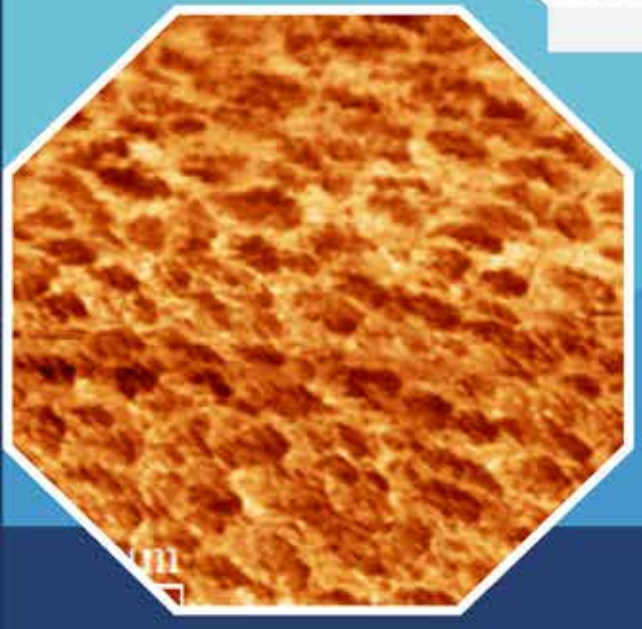


ANNUAL REPORT



2022-23



Diamond Jubilee 1964-2023

सीएसआईआर – खनिज एवं पदार्थ प्रौद्योगिकी संस्थान

CSIR-INSTITUTE OF MINERALS AND MATERIALS TECHNOLOGY
Council of Scientific & Industrial Research
(Under DSIR, Ministry of Science and Technology, Govt. of India)
Bhubaneswar - 751013, Odisha, INDIA

वार्षिक प्रतिवेदन

ANNUAL REPORT

2022-23

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Quality Policy

CSIR – Institute of Minerals and Materials Technology, Bhubaneswar is committed to adopt Quality Management Principles in pursuing world-class basic and applied research leading to the development of energy-efficient, environment-friendly and competitive technologies for effective utilization of mineral and other natural resources.

The institute shall systematically and continually improve its quality management policy to achieve success in a complex, demanding and ever changing system in addressing the needs and expectations of its stakeholders, while fulfilling the industrial, societal, statutory and regulatory norms.

Dr. G. Narahari Sastry
Director

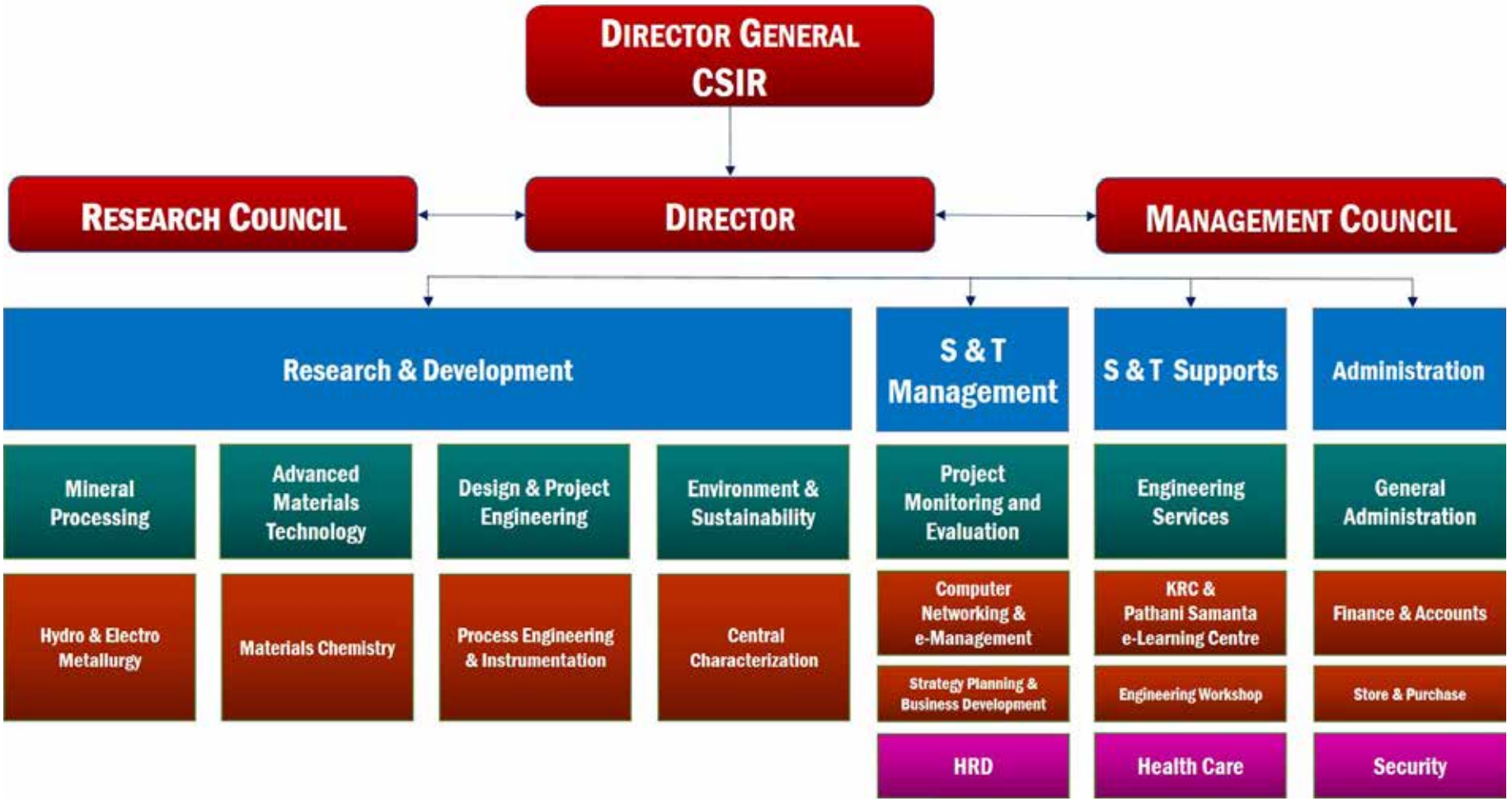
गुणवत्ता नीति

सी एस आइ आर – खनिज एवं पदार्थ प्रौधोगिकी संस्थान, भुवनेश्वर खनिजों एवं अन्य प्राकृतिक संसाधनों के प्रभावकारी उपयोग हेतु ऊर्जा–दक्ष, पर्या–हितौषी व प्रतिस्पर्धात्मक प्रौधोगिकियों के विकास में विश्व स्तर के मौलिक एवं अनुप्रयुक्त अनुसंधान के लिए गुणवत्ता प्रबंधन नीतियों को अंगीकार करने के लिए संकल्पबद्ध है।

अपने हितधारकों की अपेक्षाओं और आवश्यकताओं की पूर्ति के लिए जटिल, माँगपूर्ण एवं सदैव परिवर्तनशील प्रणाली में सफलता प्राप्त करने के लिए औधोगिक, सामाजिक, वैधानिक एवं नियामक मानदंडों की पूर्ति करते हुए यह संस्थान अपनी गुणवत्ता प्रबंधन नीति में व्यवस्थित ढंग से निरंतर सुधार करता रहेगा।

डॉ. जी. नरहरी सास्त्री
नदिशक

CSIR-INSTITUTE OF MINERALS AND MATERIALS TECHNOLOGY
BHUBANEWAR



BUDGET AT A GLANCE

(in Lakhs)

Budget Head	2019-20	2020-21	2021-22	2022-23
Recurring				
Pay & Allowances	2769.319	3281.031	3322.304	3720.523
Contingency	317.670	210.700	301.765	313.000
Maintenance (Office & Staff quarters)	538.475	346.197	563.678	582.000
Chemical & Consumables	280.250	179.800	198.721	212.000
HRD				
Total Recurring	3950.714	4017.728	4386.468	4827.523
Capital				
Works and Services	250.000	270.349	91.989	47.800
Equipment	341.000	743.200	592.453	907.800
Library	144.485	163.170	184.059	75.000
P702-SQ- Capital	100.000	58.291	62.885	77.200
Other Capital	10.000	26.00	56.417	31.500
Total Capital	845.485	1261.010	987.803	1139.300
CSIR Network Projects	2209.308	480.079	875.678	860.687
GRAND TOTAL	7005.507	5758.817	5374.271	6827.510
EXTERNAL CASH FLOW*	#3963.000	#2931.494	#1933.043	2198.744

* Post Tax
#excluding GST

From Director's Desk

CSIR-Institute of Minerals and Materials Technology (IMMT) is celebrating its Diamond Jubilee year during 2023-24. It is my honour and pleasure to present the annual report of the institute for the year 2022-23 on it's 60th Foundation Day. The report I am presenting is primarily the work carried out during my predecessor's tenure. At the outset, I would like to record our deep appreciation of the leadership and contribution of Prof. S. Basu, who led this institute as Director for more than five years and relieved in January, 2023. I also take this opportunity to thank all the previous directors and staff for their contributions toward growth of this institute.

CSIR-IMMT has constantly been striving for new contemporary goals and objectives in nation-building since its existence in 1964. The recent R & D activities primarily related to sustainable mineral processing and extractive metallurgy, design and manufacturing of new functional materials, provide engineering design and tackle environmental issues related to the above fields. All the R & D activities of this institute continued to adhere to its mandate to carry out industrial research. With India's growth projected to touch double digits soon, the metal requirement is increasing. It is a great opportunity for Odisha and adjoining states to exploit mineral deposits to give final marketable raw metal to finish products using IMMT's expertise. Let me present the lab performance for the year 2022-23 in detail.

The institute completed the financial year 2022-23 with sound performance figures. The total plan and non-plan budget from CSIR were Rs 68.27 crores. Our external cash flow was Rs. 21.98 crore (excluding GST). The lab's R&D activities are primarily funded by NALCO, Vedanta, Tata Steel, AM/NS India, BRPL, JSL, BALCO, Lloyds Metals and Energy Ltd, OMCL, HINDALCO, Godawari Power & Ispat Ltd, SMIOL, Ministry of Mines, Ministry of Steel, Ministry of Science & Technology, IREL (India) Limited, etc.

The total number of external projects (GAP, SSP, CNP) executed is 129, whereas CSIR projects (Network, Young Scientists, Mission Mode, MLPs) executed is 32. The institute also provided seed grants in 25 OLPs to young Scientists to encourage them to pursue R&D work. Researchers have published 165 papers in SCI journals, with an average Impact Factor of 5.005. The institute has filed ten patents, and eight patents have been granted. Three technologies have been transfered and sixteen MoUs have been signed. Institute conducted twelve skill development and training programs during this period. All these are possible because of the tremendous work done by the Scientists and Staff members of the institute.

There are several awards won by the Scientists and Staff members, and prominent ones are: Dr DS Rao, awarded Odisha Bigyan Academy's Samanta Chandra Sekhar Award in Engineering and Technology; Dr Kali Sanjay received the IEI Eminent Engineering Personality Award; Dr Mamata Mohapatra received Prof. Manju Mishra Award for the best female researcher; Dr Trupti Das received The Governor's Award for High Impact Research 2022 from the State of Colorado and the Healthy Community Award; Dr Priyanka

Rajput, Sh. Santosh Deb Barma and Mrs Pallishree Prusti received the IEI Young Engineers award in their respective field; Dr A.K. Chaubey Received Dr Tamotia Medal -2022; Dr Chinmaya Kumar Sarangi received the NESA Eminent Scientist award; Dr Barsha Dash received a Commendation Award from HPCL; Dr Y.S Chaudhary and Dr Bikash Kumar Jena received the IIM Bhubaneswar Chapter Award-2022 from the Indian Institute of Metals; Dr Santosh Kumar Behera received IETE - Hari Ramji Toshniwal Award; Mrs Pallishree Prusti, received Young Innovator's Award under R&D category from the Indian Institute of Mineral Engineers (IIME) Bhubaneswar Chapter.

Some institute scientists got professional recognition, such as Dr Nabin Kumar Dhal, elected to the Executive Council of the Indian Association for Angiosperm Taxonomy; Dr.(Ms.) Mamata Mohapatra was selected as State President of Odisha Water Resources Council; Dr Manas Kumar Dalai and Dr Sisir Mantry were awarded CSIR Raman Research Fellowship 2022-2023; Dr Bikash Kumar Jena was selected as the Fellow of the Royal Society of Chemistry; Mr Abdul Rauf Sheik received the prestigious Chevening CRISP fellowship from the University of Oxford. During 2022-23; many Research Scholars were also recognized for their scholarly activities in National conferences or competitions. They are Ms. Shradha Suman, Ms. Manasi Jena, Sh Sukanta Kumar Mahanta, Sh Priyabrata Nayak, Ms Monami Mukherjee and Ms Soumya Prakash Dutta.

During the last year, many events were organized such as National Technology Day, World Environment Day, National e-workshop on IPR, i-Connect, Engineer's Day, MCNEM-III, National Science Day, etc. Other organized events were the 59th IMMT Foundation Day, 131st Dr BR Ambedkar Jayanti, International Day of Yoga, CSIR Foundation Day, 7th Ayurveda Day, Vigilance Awareness Week, International Day of Women & Girls, etc. Under the JIGYASA program, different activities were conducted, such as S&T-based Project Model Competition, Student visits and Sir SS Bhatnagar Birth Anniversary Memorial Lecture. The institute also organized the 51st SSBMT Zonal football tournament from Aug 31 to Sept 03 2022, to encourage sports among staff.

On the R&D front, the departments have taken up several new activities: the Mineral Processing Department has made significant engagement in the mineral sector with intense industry engagement and commercial outreach. IMMT has tied up with one of the biggest steel manufacturers (SAIL) for R&D intervention in the sustainable utilization of its iron ore resources in Bolani Iron Ore mines. Iron Ore-related studies have been taken up for industries like BSBK Pvt Ltd., 4Mann Industries and Brahmani River Pellet Ltd. Similar works for other Ores (Bauxite, chromite and BHJ Ore) or tailings are undertaken for GSI Nagpur, Ministry of Mines, Vedanta Ltd, etc. The department has initiated a study to upgrade the SiO2 % of silica sand to 99.9% for its use in Solar Wafer applications sponsored by GSI, Gandhinagar.

In Hydro & Electro-Metallurgy department, the technology development on the extraction of four metals such as Cu, Ni, Co and Mn, from polymetallic nodules was taken up with the active support of the Ministry of Earth Sciences, Govt. of India. IMMT has also taken up projects from NALCO to develop technology for the holistic utilization of red mud for extraction of metallic values and residue utilization. Studies like the recovery of Electrolytic Manganese Dioxide (EMD) from manganese ore, recovery of Co from scrap and impure hydroxide, development of materials for energy and stealth applications, process development for producing fused magnesia from Kimberlite and recovery of REEs from Bauxite residue, etc. were other highlights.

In the Advanced Materials and Technology department, the studies on the development of biodegradable magnesium alloy for orthopaedic applications, the production of Fe-Cr-Ni-Mn stainless alloy from mine waste by a thermal plasma process, the development of oxide-dispersed tungsten heavy alloy, L10 FeNi:

a promising material for next generation permanent magnets, and S&T intervention for revitalizing metal handicraft are key highlights.

The Material chemistry department has taken up studies on the new conducting materials for Flexible Optoelectronic Devices, Flexible piezocomposite materials for self-powered electronics, Luminescent Gold Nanocluster Assembly for Biomedical Applications, Tungsten-based polyoxometalate complexes for photocatalytic degradation of toxic chemical dyes, etc.

Environment and Sustainability department has led several projects in the area of environmental monitoring (air, water and soil), chromite mine reclamation of Odisha Mine Corporation (OMC), JSL etc. and waste management (fly ash, phosphogypsum, agro-waste etc.). Also, with support from Paradeep Phosphate Limited, a continuous rotary pyrolysis unit has been established at the Centre for Waste Utilisation in the department.

The Design & Project Engineering department has taken an R&D project to study erosion and corrosion wear in the presence of chemical/bio-additives to forecast the life cycle of the industrial pipeline. The department is involved in socioeconomic project implementation of TERAFIL water filtration systems in iron contaminated areas of Jharkhand & Odisha. The institute is involved in S&T intervention for socioeconomic development in Nabarangpur District, under RKVY, Odisha.

The Process Engineering and Instrumentation department worked on the modelling and optimization of gaseous reduction of iron ore in fluidized bed reactor, thermal analysis of rotary kiln, AI-based process control for pelletization plant, pellet-bed thermal mapper.

The Central Characterization department studied the petrographic, mineralogical and bulk density of iron and manganese ores from the exploration blocks of OMC Ltd., Odisha; characterization and process flowsheet development for the recovery of Iron values from low-grade ore. New sample preparation units for HR-TEM, such as ion-beam mealing, dimple grinding etc., have been added to the Central Characterization department. The utilization of sophisticated equipment facilities has reached a record high of Rs. 2.53 crores, including external earnings and savings in internal use by scientists and research scholars.

Computer Networking & e-Management (CNeM) division facilitates the S&T activities of the institute by providing IT services and application development. Last year CNeM division extended a helping hand by developing websites and systems for events like EPCIA, FIMTA 2022, New IPR-2022, etc. During 2022-23 different sections of the workshop have fabricated, designed and assembled more than 200 items for the scientists and technologists of the institute.

There are perspective changes taking place in the country and CSIR with greater emphasis on delivering outcomes. In this Diamond Jubilee year, I sincerely thank the researchers and staff of IMMT, whose sincere and tireless efforts help the nation's progress. And I hope we all should continue to work sincerely to make India proud through Research and Development.

Jai Hind.

Dr. G. Narahari Sastry

Director

निदेशक डेस्क से

सीएसआईआर-खनिज एवं पदार्थ प्रौद्योगिकी संस्थान (आईएमएमटी) हीरक जयंती मना रहा है। 60वें स्थापना दिवस पर 2022-23 की वार्षिक रिपोर्ट प्रस्तुत करना मेरे लिए सम्मान और खुशी की बात है। मैं जो रिपोर्ट प्रस्तुत कर रहा हूं वह मुख्य रूप से मेरे पूर्ववर्ती नेतृत्व के दौरान किए गए कार्य हैं। सबसे पहले, मैं प्रोफेसर एस. बसु के नेतृत्व और योगदान की सराहना करना चाहूंगा, जिन्होंने पिछले पांच साल से अधिक समय तक निदेशक के रूप में इस संस्थान का नेतृत्व किया। प्रोफेसर एस. बसु अपने मूल संस्थान आईआईटी दिल्ली में फिर से शामिल होने के लिए 31.01.2023 (ए.एन.) को आईएमएमटी से कार्यमुक्त हुये । मैं संस्थान के सभी पिछले निदेशकों और कर्मचारियों को 60 वर्षों की प्रगति में योगदान के लिए धन्यवाद देता हूं।

सीएसआईआर-आईएमएमटी 1964 से अपने अस्तित्व के बाद राष्ट्र निर्माण में नए समकालीन लक्ष्यों और उद्देश्यों के लिए लगातार प्रयास कर रहा है। हाल की अनुसंधान एवं विकास गतिविधियां मुख्य रूप से टिकाऊ खनिज प्रसंस्करण और निष्कर्षण धातु विज्ञान, नई कार्यात्मक सामग्रियों के डिजाइन और निर्माण, इंजीनियरिंग डिजाइन और उपरोक्त क्षेत्रों से संबंधित पर्यावरणीय मुद्दों से निपटना से संबंधित हैं | संस्थान की सभी अनुसंधान एवं विकास गतिविधियां अपने औद्योगिक अनुसंधान अधिदेश का पालन करती रहीं। भारत की विकास दर जल्द ही दोहरे अंक तक पहुंचने का अनुमान है, जिससे धातु की आवश्यकता बढ़ जाएगी। यह ओडिशा और आसपास के राज्यों के लिए आईएमएमटी की विशेषज्ञता का उपयोग करके उत्पादों को तैयार करने का एक बड़ा अवसर है। आइए वर्ष 2022-23 मैं प्रयोगशाला के बारे में विस्तार से चर्चा करते हैं ।

संस्थान ने वित्तीय वर्ष 2022-23 की अवधि में कुछ अच्छे आंकड़ों के साथ प्रदर्शन पूरा किया। सीएसआईआर का कुल योजना और गैर-योजना बजट 60.45 करोड़ रुपये था। 2022-23 की अवधि के दौरान हमारा बाहरी नकदी प्रवाह रु. 19.33 करोड़ (जीएसटी को छोड़कर) था। लैब की अनुसंधान एवं विकास गतिविधियों को मुख्य रूप से नाल्को, वेदांता, टाटा स्टील, एएम/एनएस इंडिया, बीआरपीएल, जेएसएल, बाल्को, लॉयड्स मेटल्स एंड एनर्जी लिमिटेड, ओएमसीएल, हिंडाल्को, गोदावरी पावर एंड इस्पात लिमिटेड, एसएमआईओएल, खान मंत्रालय, इस्पात मंत्रालय, विज्ञान और प्रौद्योगिकी मंत्रालय, आईआरईएल (इंडिया) लिमिटेड, आदि द्वारा वित्त पोषित किया जाता है।

निष्पादित बाहरी परियोजनाओं (जीएपी, एसएसपी, सीएनपी) की कुल संख्या 129 है, जबकि निष्पादित सीएसआईआर परियोजनाएं (नेटवर्क, युवा वैज्ञानिक, मिशन मोड, एमएलपी) 32 है। संस्थान ने युवा वैज्ञानिकों को प्रोत्साहित करने के लिए 25 ओएलपी में बीज अनुदान भी दिया। शोधकर्ताओं ने एससीआई पत्रिकाओं में 165 पेपर प्रकाशित किए हैं, जिनका औसत प्रभाव कारक 5.005 है। शोधकर्ताओं ने दस पेटेंट दायर किए, और आठ पेटेंट प्रदान किए गए। 2022-23 में तीन प्रौद्योगिकी हस्तांतरण और सोलह समझौता ज्ञापनों पर हस्ताक्षर किए गए। संस्थान ने इस अवधि के दौरान बारह कौशल विकास और प्रशिक्षण कार्यक्रम आयोजित किए। यह सब विभाग के वैज्ञानिकों और स्टाफ सदस्यों द्वारा किए गए अद्त प्रयास के कारण संभव हुआ है।

वैज्ञानिकों और स्टाफ सदस्यों द्वारा जीते गए कई पुरस्कार हैं, और उनमें से प्रमुख हैं: डॉ. डी एस राव, जिन्हें ओडिशा बिग्यान अकादमी के सामंत चंद्र शेखर इंजीनियरिंग और प्रौद्योगिकी पुरस्कार; डॉ काली संजय को आई ई आई प्रख्यात इंजीनियरिंग व्यक्तित्व पुरस्कार; डॉ. ममता महापात्रा को सर्वश्रेष्ठ महिला शोधकर्ता के लिए प्रोफेसर मंजू मिश्रा पुरस्कार;

डॉ. तृप्ति दास को कोलोराडो राज्य से उच्च प्रभाव अनुसंधान 2022 के लिए गवर्नर पुरस्कार और स्वस्थ समुदाय पुरस्कार; डॉ प्रियंका राजपूत, श्री. संतोष देब बर्मा और श्रीमती पल्लीश्री प्रुस्टी को अपने-अपने क्षेत्र में IEI यंग इंजीनियर्स पुरस्कार; डॉ. ए.के. चौबे को "डॉ. तमोटिया मेडल-2022; डॉ. चिन्मय कुमार सारंगी को एनईएसए प्रख्यात वैज्ञानिक पुरस्कार; डॉ. वर्षा दाश को एचपीसीएल से प्रशस्ति पुरस्कार; डॉ. वाई.एस. चौधरी और डॉ. विकास कुमार जेना को भारतीय धातु संस्थान से आईआईएम भुवनेश्वर चैप्टर अवार्ड-2022; डॉ संतोष कुमार बेहरा को आईईटीई - हरि रामजी तोशनीवाल पुरस्कार; श्रीमती पल्लीश्री प्रुस्टी को इंडियन इंस्टीट्यूट ऑफ मिनरल इंजीनियर्स (आईआईएमई) भुवनेश्वर चैप्टर से आर एंड डी (R&D) श्रेणी के तहत यंग इनोवेटर पुरस्कार मिला।

संस्थान के कुछ वैज्ञानिकों को पेशेवर मान्यता मिली, जैसे डॉ. नबीन कुमार ढल, इंडियन एसोसिएशन फॉर एंजियोस्पर्म टैक्सोनॉमी की कार्यकारी परिषद के लिए चुने गए; डॉ. (सुश्री) ममता महापात्र को ओडिशा जल संसाधन परिषद के राज्य अध्यक्ष के रूप में चुना गया; डॉ. मानस कुमार दलाई और डॉ. शिशिरमंत्री को सीएसआईआर रमन रिसर्च फेलोशिप 2022-2023 से सम्मानित किया गया; डॉ बिकाश कुमार जेना को रॉयल सोसाइटी ऑफ केमिस्ट्री के फेलो के रूप में चुना गया; श्री अब्दुल रऊफ शेख को ऑक्सफोर्ड विश्वविद्यालय से प्रतिष्ठित शेवनिंग सीआरआईएसपी फ़ेलोशिप प्राप्त हुई। 2022-23 के दौरान; कई छात्रों या अनुसंधान विद्वानों को राष्ट्रीय सम्मेलनों या प्रतियोगिताओं में उनकी विद्वतापूर्ण गतिविधियों के लिए भी मान्यता दी गई थी। वे हैं सुश्री श्रद्धा सुमन, सुश्री मानसी जेना, श्री सुकांत कुमार महंत, श्री प्रियब्रत नायक, सुश्री मोनामी मुखर्जी और सुश्री सौम्या प्रकाश दत्ता।

पिछले वर्ष के दौरान अनेक कार्यक्रम आयोजित किये गये। कुछ एस एंड टी (S&T) कार्यक्रम राष्ट्रीय प्रौद्योगिकी दिवस, विश्व पर्यावरण दिवस, आईपीआर पर राष्ट्रीय ई-कार्यशाला, आई-कनेक्ट, इंजीनियर दिवस, एमसीएनईएम-III, राष्ट्रीय विज्ञान दिवस आदि थे। अन्य आयोजित कार्यक्रम थे 59वां आईएमएमटी स्थापना दिवस, 131वां डॉ. बीआर अंबेडकर जयंती, अंतर्राष्ट्रीय योग दिवस, सीएसआईआर स्थापना दिवस, 7वां आयुर्वेद दिवस, सतर्कता जागरूकता सप्ताह, अंतर्राष्ट्रीय महिला दिवस, आदि। जिज्ञासा कार्यक्रम के तहत, विभिन्न गतिविधियाँ आयोजित की गईं, जैसे एस एंड टी-आधारित परियोजना मॉडल प्रतियोगिता, छात्र दौरे और सर एसएस भटनागर जयंती स्मृति व्याख्यान। संस्थान ने कर्मचारियों के बीच खेल को प्रोत्साहित करने के लिए 31 अगस्त से 3 सितंबर 2022 तक 51वें एसएसबीएमटी जोनल फुटबॉल टूर्नामेंट का भी आयोजन किया।

अनुसंधान एवं विकास के क्षेत्र में, विभागों ने अपनी निरंतर महत्वपूर्ण गतिविधियों के साथ कई नई गतिविधियाँ शुरू की हैं: खनिज प्रसंस्करण विभाग ने गहन उद्योग भागीदारी और वाणिज्यिक आउटरीच के साथ खनिज क्षेत्र में महत्वपूर्ण भागीदारी की है। IMMT ने बोलानी लौह अयस्क खदानों में लौह अयस्क संसाधनों के सतत उपयोग में अनुसंधान एवं विकास के लिए सबसे बड़े इस्पात निर्माताओं (SAIL) में से एक के साथ समझौता किया है। बीएसबीके प्राइवेट लिमिटेड, फ़ार मैन इंडस्ट्रीज और ब्राह्मणी रिवर पेलेट लिमिटेड जैसे उद्योगों के लिए खनिज प्रसंस्करण विभाग में लौह अयस्क से संबंधित अध्ययन किए गए हैं। जीएसआई नागपुर के लिए अन्य अयस्कों (बॉक्साइट, क्रोमाइट और बीएचजे अयस्क) या टेलिंग्स के लिए समान कार्य किए गए हैं। खान मंत्रालय, वेदांता लिमिटेड आदि विभाग ने जीएसआई, गांधीनगर द्वारा प्रायोजित सौर वेफर अनुप्रयोगों में उपयोग के लिए सिलिका रेत के SiO2 % को 99.9% तक अपग्रेड करने के लिए एक अध्ययन शुरू किया है।

पॉलीमेटैलिक नोड्यूल्स से चार धातुओं, Cu, Ni, Co और Mn के निष्कर्षण पर प्रौद्योगिकी विकास में पृथ्वी विज्ञान मंत्रालय, भारत सरकार ने एचईएम विभाग का सक्रिय सहयोग किया। सीएसआईआर-आईएमएमटी ने धात्विक मूल्यों के निष्कर्षण और अवशेषों के उपयोग के लिए रेड- मड के समग्र उपयोग के लिए प्रौद्योगिकी विकसित करने के लिए नाल्को से परियोजनाएं भी ली हैं। मैंगनीज अयस्क से इलेक्ट्रोलाइटिक मैंगनीज डाइऑक्साइड (EMD) की रिकवरी, स्क्रैप और अशुद्ध हाइड्रॉक्साइड से Co की रिकवरी, ऊर्जा और स्टील्थ अनुप्रयोगों के लिए सामग्री का विकास, किम्बरलाइट से फ्यूज्ड मैग्नेशिया के उत्पादन के लिए प्रक्रिया विकास और बॉक्साइट अवशेषों से आरईई की रिकवरी आदि जैसे अध्ययन अन्य मुख्य आकर्षण है ।

उन्नत सामग्रियों के क्षेत्र में, आर्थोपेडिक अनुप्रयोगों के लिए बायोडिग्रेडेबल मैग्नीशियम मिश्र धातु के विकास पर अध्ययन,

थर्मल प्लाज्मा प्रक्रिया द्वारा खदान अपशिष्ट से Fe-Cr-Ni-Mn स्टेनलेस मिश्र धातु का उत्पादन, ऑक्साइड-छितरी हुई टंगस्टन भारी मिश्र धातु का विकास , L10 FeNi: अगली पीढ़ी के स्थायी चुंबकों के लिए एक आशाजनक सामग्री, और धातु हस्तशिल्प को पुनर्जीवित करने के लिए S&T हस्तक्षेप प्रमुख आकर्षण हैं।

सामग्री रसायन विज्ञान विभाग ने लचीले ऑप्टोइलेक्ट्रॉनिक उपकरणों के लिए नई संचालन सामग्री, स्व-संचालित इलेक्ट्रॉनिक्स के लिए लचीली पीज़ोकंपोजिट सामग्री, बायोमेडिकल अनुप्रयोगों के लिए ल्यूमिनसेंट गोल्ड नैनोक्लस्टर असेंबली, जहरीले रासायनिक रंगों के फोटोकैटलिटिक क्षरण के लिए टंगस्टन-आधारित पॉलीऑक्सोमेटलेट कॉम्प्लेक्स आदि पर अध्ययन शुरू किया है।

वर्ष 2022- 2023 में, पर्यावरण एवं सम्पोषण विभाग ने पर्यावरण निगरानी (वायु, जल और मिट्टी), ओडिशा माइन कॉरपोरेशन (ओएमसी), जेएसएल आदि के क्रोमाइट खदान सुधार और अपशिष्ट प्रबंधन (फ्लाई ऐश) के क्षेत्र में कई परियोजनाओं का नेतृत्व किया है। पारादीप फॉस्फेट लिमिटेड के समर्थन से अपशिष्ट उपयोग केंद्र, पर्यावरण और स्थिरता विभाग में में एक सतत रोटरी पायरोलिसिस इकाई स्थापित की गई है जहां फॉस्फोजिप्सम, कृषि-अपशिष्ट आदि मूल्यवान उत्पादों में परिवर्तित किया जा रहा है ।

डिज़ाइन और प्रोजेक्ट इंजीनियरिंग विभाग ने औद्योगिक पाइपलाइन के जीवन चक्र का पूर्वानुमान लगाने के लिए रासायनिक/जैव-योजकों की उपस्थिति में क्षरण और संक्षारण अध्ययन करने के लिए एक अनुसंधान एवं विकास परियोजना शुरू की है। हमारा संस्थान कृषि विभाग, ओडिशा सरकार द्वारा प्रायोजित "मिशन नबरंगपुर" परियोजना द्वारा सामाजिक आर्थिक विकास के लिए एस एंड टी हस्तक्षेप जैसी सामाजिक आर्थिक परियोजनाओं में भी शामिल है। झारखंड और ओडिशा के लौह प्रदूषित क्षेत्रों में टेराफिल जल निस्पंदन प्रणाली का कार्यान्वयन भी किया गया है। प्रोसेस इंजीनियरिंग और इंस्ट्रुमेंटेशन विभाग ने द्रवीकृत बेड रिएक्टर में लौह अयस्क की गैसीय कमी की मॉडलिंग और अनुकूलन, रोटरी भट्ठी का थर्मल विश्लेषण, पेलेटाइजेशन प्लांट के लिए एआई-आधारित प्रक्रिया नियंत्रण, पेलेट-बेड थर्मल मैपर आदि पर काम किया।

केंद्रीय अभिलक्षणन विभाग ने ओएमसी लिमिटेड, ओडिशा के अन्वेषण ब्लॉकों से लौह और मैंगनीज अयस्कों के पेट्रोग्राफिक, खनिज और थोक घनत्व का अध्ययन किया, निम्न-श्रेणी के अयस्क से लौह मूल्यों की पुनर्प्राप्ति के लिए अभिलक्षणन और प्रक्रिया फ़्लोशीट विकास आदि का अध्ययन किया। नया नमूना तैयार करना एचआर-टीईएम के लिए इकाइयां, जैसे आयन-बीम मीलिंग, डिंपल ग्राइंडिंग आदि को केंद्रीय विशेषता विभाग में जोड़ा गया है। परिष्कृत उपकरण सुविधाओं का उपयोग 2.53 करोड़ रुपये के रिकॉर्ड उच्च स्तर पर पहुंच गया है।, जिसमें बाहरी कमाई और वैज्ञानिकों और अन्य विद्वानों द्वारा आंतरिक उपयोग में बचत शामिल है। कंप्यूटर नेटवर्किंग और ई-प्रबंधन (सीएनईएम) विभाग आईटी सेवाएं और एप्लिकेशन विकास प्रदान करके संस्थान की एस एंड टी गतिविधियों को सुविधाजनक बनाता है। पिछले वर्ष सीएनईएम डिवीजन ने ईपीसीआईए, एफआईएमटीए 2022, न्यू आईपीआर-2022 आदि आयोजनों के लिए वेबसाइट और सिस्टम विकसित करने मे मदद किया। 2022-23 के दौरान कार्यशाला के विभिन्न वर्गों ने वैज्ञानिकों और संस्थान के प्रौद्योगिकियों के लिए 200 से अधिक वस्तुओं का निर्माण, डिजाइन और संयोजन किया है।

देश और सीएसआईआर में परिप्रेक्ष्य परिवर्तन हो रहे हैं, और परिणाम देने पर अधिक जोर दिया जा रहा है। इस हीरक जयंती वर्ष में, मैं आईएमएमटी के शोधकर्ताओं और कर्मचारियों को धन्यवाद देता हूं, जिनके ईमानदार और अथक प्रयास देश की प्रगति में मदद करते हैं। और मुझे आशा है कि हम सभी को अनुसंधान और विकास के माध्यम से भारत को गौरवान्वित करने के लिए ईमानदारी से काम करना जारी रखना चाहिए।

ड़. जी. नरहरी सास्त्री
निदेशक

CONTENTS

Performance Indicators 2022-23

Budget Grants from CSIR (Rs. Lakh)		6827
External Cash Flow(excluding GST)		2198
Projects Undertaken (Externally Funded, CSIR Network, In-house)		206
Patents	Granted in India	08
	Granted in Abroad	-
	Filed in India	05
	Filed in Abroad	05
Paper Published in Journals	Total/SCI	175/165
Book Chapters		04
Papers Published in Proceedings		10
Foreign Visits		04
Awards/Honours/Fellowships		16
HRD Programmes		12
MoU Signed (Academic/Consultancy)		16
Technologies/ Released		65
Staff Strength	S&T	174
	Administrative	34
	Total	208

MINERAL PROCESSING

FOCUS

To maximize the recovery of mineral values from lean and low-grade resources as well as waste generated from mineral-based industries by developing eco-friendly processes through basic and applied research for accelerating industrial growth in the areas of bulk, strategic and precious minerals.

CORE AREA EXPERTISE

- Process development from bench scale to pilot scale study for beneficiation of low and lean grade ores and minerals through physical beneficiation and reduction roasting/reduction pro cesses to enrich the mineral values
- Agglomeration of fine concentrate generated through the beneficiation process
- DRI and smelting of oxide ores (ironore, chromite ore, manganese ore, and ilmenite ore)
- Simulation and optimization of the process of the existing mineral-based industries
- Equipment development for mineral-based industries
- Preparation of TEFR for mineral beneficiation process
- HRD in the area of Mineral Processing

Development of process for reduction roasting of low and lean grade iron ores using fluidized bed roaster (in pilot scale) to maximize the recovery of iron values

To meet the anticipated increase in demand for iron and steel, it is imperative to utilise low-grade ore for manufacturing these materials. By using reduction roasting followed by magnetic separation, this low/lean quality iron ore may be upgraded. In order to reduce-roast low and lean grade iron ore fines and slimes in a pilot-scale fluidized bed roaster, a suitable technique must be developed. To carry out the reduction roasting of low/lean grade iron ore fines, the existing batch type fluidized bed reactor with 1.5m height was modified to a 4m high continuous type FBR with PID controlled electrically heating system. The present capacity of this modified FBR is 100 kg/hr. The modified FBR is shown in Figure 1 below. The present study is utilizing the high ash non-coking coal as a reductant for the reduction reaction. The results obtained from this study are promising. To support the reduction roasting process under inert atmosphere, a pilot scale nitrogen generator setup was installed. The pilot scale nitrogen generator is shown in Figure 2. The nitrogen gas is used as carrier gas for the fluidization of all low and lean grade iron ore fines.

Figure 1: Modified Continuous Fluidized Bed Reactor (100 kg/hr)

Figure 2: Pilot scale Nitrogen generator

Furthermore, to carry out the lab-scale fluidized bed reduction roasting study, an existing lab-scale electrically heated fluidized bed furnace (1 kg scale) has been modified for reduction / magnetizing roasting with a provision for introduction of N2 and CO gas to achieve the reduction atmosphere as shown in the Figure 1. The Modified setup

is shown below in Figure 3. The setup consists of a tubular furnace(inconel) of 40 mm dia. with 150 mm fluidized heating zone, which is heated electrically. Provisons are there for regulated supply of air/ N2/ CO to achieve the fluidizing condition. This PID controlled fluidized bed system can be heated upto 1100 °C with required ramp rate. This lab-scale facility is helpful in carrying out the fluidization roasting study for various low/ lean grade ores with maximum capacity of 1 kg.

Figure 3: Modified Lab-scale fluidized bed setup with the provision for gas supply

An innovative and viable process for recovery of iron values from red mud and processing of non-iron material for developing value added products - complete utilization of red mud

Red mud is produced in the process of alumina extraction from bauxite. In this context, development of its effective handling, storage, usage and management therefore stands as a burning issue for the global community as a whole. Usually, the production of 1 tonne of alumina generates 1-1.5 tonnes of red mud depending upon the mineralogical composition of the bauxite and extraction efficiencies. The treatment and utilisation of high volume red mud waste has been a major challenge for the alumina industry. A typical chemical analysis would reveal that red mud contains silica, aluminum, iron, calcium, titanium, as well as an array of minor constituents, namely: Na, K, Cr, V, Ni, Ba, Cu, Mn, Pb, Zn etc. The iron phase minerals are almost 40-60% in the red mud. If 70-80% of iron values can be recovered, a good amount of waste generation can be minimised. The major challenge is to aim for bulk utilization of red mud in a reliable manner.

Reduction roasting study has been carried out using as received red mud sample after the air drying is done. The as received sample was containing high moisture which is not suitable for the handling and preparation of pellets. Hence, the as received sample has been air dried under sun for five days. The dried red mud is in agglomerated form and larger in size. These agglomerated red mud are size reduced (below 100 micron) before being used for reduction roasting study. The size reduced red mud has been subjected to pelletization study to understand the micropellet formation. Then the reduction roasting study has been carried out either by taking the raw red mud feed as it is or by taking micropellet made from these red mud. Reduction roasting study has been carried out taking non-coking coal as the reductant. Laboratory muffle furnace has been used for the reduction roasting study. Magnetic fraction of LIMS study is the final product in the form of magnetite. The results indicate it is possible to recover the iron values from the red mud with Fe content more than 61% in the concentrate with a yield of 30 to 32% depending on the feed characterises and operating conditions from a feed Fe content of around 35%.

Pellet making using different grades of Tata Steel iron ores for gas based DRI

Indian iron ore inherently contains higher alumina, compared to other iron ores found in rest of the world. One of the thrust area is to utilize this kind of low grade in steel value chain efficiently and effectively through pelletizing and DRI making. Detail study including sample preparation, characterization, pellet feed material preparation and pelletization were carried out for three iron ore fines supplied from the sponsor industry. The detail metallurgical, physical, chemical and mineralogical characteristics of the pellets were studied and compared thoroughly for their suitability in gas based DRI (Figure).

Figure: Pelletisation of Tata iron ore for gas based DRI process

Studies on improvement of lime content of the alkali bypass dust

Scientists of MPD, CSIR-IMMT have developed a novel process for the reduction of alkali metal oxides, chlorides and sulphates from cement bypass dust (CBD) to reutilize the processed back to the cement manufacturing process (Figure). This project was sponsored by Sewagram Cement Works, M/s. UltraTech Cement Limited (UTCL), Gujarat. A joint patent between CSIR (though CSIR-IMMT) and UTCL is presently under process.

Figure: Demonstration of process to the officials of UTCL at CSIR-IMMT Bhubaneswar

Beneficiation of silica sand of Gujarat for solar wafer applications

This study aims to upgrade the SiO2 % of silica sand to 99.9% for its use in Solar Wafer applications. The study includes mineralogy and a detailed beneficiation study for the upgradation of SiO2 content from 96-97 % to 99.9 %. The target of 99.9 % SiO2 content in the silica sand of Gujarat by the combination of physical, physicochemical and chemical processes was achieved successfully. Based on this work, a flowsheet has been developed and submitted to GSI, Gandhinagar, Gujarat.

Figure: Discussions between CSIR-IMMT Bhubaneswar and GSI, Gandhinagar officials at State Unit: Gujarat, Daman, Diu and Dadra & Nagar Haveli, Gandhinagar

Beneficiation of iron ore fines samples from dalli mines of Bhilai steel plant

The Government of India targets 300 MTPA steel production in 2030 from the current output of about 138 MTPA, and therefore, the nation needs high-quality iron ores of around 450 MTPA in the form of calibrated ores/ sinter or pellet. However, the country is not endowed with high-grade requisite iron ore resources to meet this demand. It is therefore imperative to achieve the best use of available low-grade iron ore resources and iron ore fines through scientific methods of beneficiation techniques. In this context, M/s. BSBK Pvt. Ltd., Bhilai, requested CSIR-IMMT, Bhubaneswar, to carry out the pilot-scale studies for beneficiation of iron ore fines samples from Dalli Mines of Bhilai Steel Plant with the existing facilities and expertise available at CSIR-IMMT, Bhubaneswar. The characterization studies of the as-received iron ore reveal that the sample contains 61.53% Fe, 8.73% SiO2, 2.35% Al2O3 and 0.87% LOI. It is inferred from the classification studies that the fraction less than 1 mm is relatively inferior in grade, with an iron content of 55.44%. The -1 mm fraction of the sample has been beneficiated through desliming hydrocyclone followed by magnetic separation. A flowsheet is developed to beneficiate the as-received iron ore sample along with material and water balance. It suggests that a concentrate having 65.28% Fe, 4.10% SiO2, 2.01% Al2O3 and 0.51% LOI with a yield of 86.25% can be obtained.

Flowsheet development for processing of beach sand minerals from tailings of Srikakulam district, Andhra Pradesh

India is endowed with large reserves of heavy minerals occurring mainly along the coastal stretches of the country. Heavy mineral sands comprise many valuable minerals such as ilmenite, rutile, leucoxene, zircon, sillimanite, garnet and monazite. These minerals have a wide range of applications, including pigment industries, refractories, nuclear reactors, abrasives, and filtration industries. Hence, it is essential to utilize the 25 km length and 700 m average width stretch of beach sand minerals in the Srikakulam district, Andhra Pradesh, to separate the heavy minerals. Besides, processing and extraction of strategic minerals from plant tailings will improve India's domestic production. In this regard, different flowsheets were developed for the processing of the as-received beach sand samples of Srikakulam District, Andhra Pradesh. About two tons each of magnetic and non-magnetic samples were sampled and collected from the tailings of Srikakulam District, Andhra Pradesh. The grade of the ilmenite product derived from the magnetic sample was found to be 96.39%. Similarly, the rutile product derived from the magnetic sample had a grade of 93.46%. The coarse garnet had a grade of 94.30%, whereas the medium garnet had a grade of 93.10%. Besides, the sillimanite product derived from the magnetic and non-magnetic had a grade of 97.11% and 94.15%, respectively. The zircon product obtained from the magnetic sample had a grade of 93.40%.

Figure: Photographs of the sampling process of the beach sand samples at Srikakulam

Pelletization of a low-grade Indian chromite overburden

High-quality pellets have been developed from a low-grade Indian chromite overburden containing high silica. The thermodynamic, hot stage microscopic and thermogravimetric analyses of the overburden and pellet mixes predict the temperature of formation of low melting slag phases at various basicity. A temperature in the range of 1200-1300 °C and basicity between 0.10 and 0.15 have been found ideal for the initiation of the slag phases, whereas higher conditions lead to softening of the pellets. The effect of basicity, binder content, induration temperature and time on the physical and metallurgical properties of the indurated pellets has been investigated. A binder content of 1 wt.%, basicity of 0.15, induration temperature of 1250 °C and a time of 20 min are optimum to provide the desired properties to the pellets. X-ray diffraction and Scanning Electron Microscopy coupled with Energy Dispersion Spectroscopy analysis reveal that under the optimum conditions, hematite recrystallization and slag formation impart the needed strength (133.8 kg/pellet), porosity (27.8%), tumbler index (99.2%), RI (76.2%) and RDI (1.2%). Conversely, increasing the basicity and the induration temperature results in melting of the slag phases, and therefore, impair the consolidation of the pellets.

Insight of reduction roasting of a low-grade goethitic Indian iron ore in a rotary kiln

A detailed investigation of the reduction roasting-magnetic separation of a low-grade goethitic Indian iron ore, unresponsive to physical separation methods, in a bench-scale rotary kiln has been conducted. The effect of various parameters such as roasting temperature, roasting time, kiln rotational speed and dosage of reductant on the yield and grade of the magnetic product has been evaluated. Further, detailed characterization studies of the feed and the upgraded products have been undertaken to understand better the phase transformations that occurred during the reduction roasting process. The experiments were conducted under the following conditions: roasting temperature (650 – 850 °C), roasting time (10 – 60 min), kiln rotational speed (3 – 9 rpm) and reductant dosage (15 – 30%). The low-grade iron ore could be upgraded from 56% Fe to 65.3% Fe with a yield of 82.6% at a roasting temperature of 750 °C, a roasting time of 45 min, a kiln rotational speed of 5 rpm, and a reductant dosage of 20%. The process was further upscaled under the optimum parameters derived from the lab scale study, which corroborated with the small-scale results. While the lab scale reduction roasting experiments aided by the optical microscopic and scanning electron microscopic studies helped understand the reduction sequence, the scale-up studies indicated that the process offers sufficient scope for commercial exploitation.

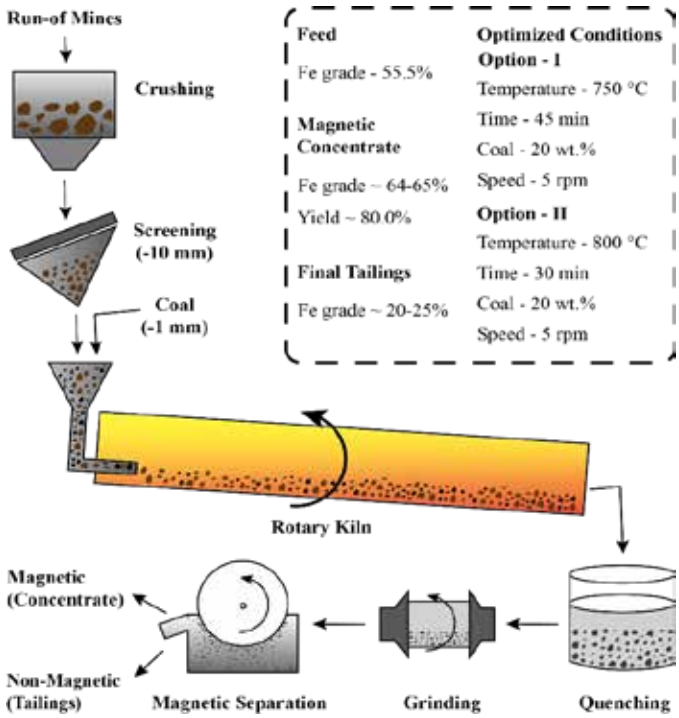


Figure: Flowsheet for reduction roasting of goethitic iron ore in rotary kiln

Characterization study of low-grade iron ore and tailings

M/s 4Mann Industries Pvt. Ltd. Jabalpur has sponsored the project to study "Characterization Study of Low-Grade Iron Ore and Tailings". The physical, chemical, microstructural and mineralogical characterizations of six different low-grade iron ores and one tailing sample have been done. This study provides the primary data about the mineralogy of the samples, phases present, associated impurities, particle size and iron distribution. A feasibility study has been done to analyse the response of iron ore fines when subjected to the magnetic separation process. Ultrafine particles of tailing samples have been analysed by Cyclosizer operation.

Study the effect of process parameters on physical and metallurgical characteristics of iron ore pellets

M/s. Brahmani River Pellet Ltd., Jaipur, Odisha has sponsored the project to analyse the effect of process paramters on indurated iron ore pellet quality. Detailed physical, chemical and metallurgical characterization studies of the iron oxide pellet were done through various equipment and facilities. Metallurgical characterization includes ISO-4695, 4696-2, 4696-1, 4698, 4700 and 7215. The effect of Process parameters like firing pattern and blend composition was analysed with reference to suitable properties for iron making.

Figure: Multi-standard Test Equipment for Metallurgical testing of iron ore pellet

Continuous extraction of magnetite reduced from low-grade iron ores in the fluidized bed reactors for higher productivity

- Detailed review done on the gaseous reduction of iron ores to magnetite and published in Reviews in Chemical Engineering journal.
- Gas-Solid Fluidized Bed Reactor setup is established for experimental investigations.
- Modelling and simulation based optimization was done for the controlled reduction to magnetite.
- Optimal conditions obtained for the gaseous reduction in fluidized bed reactor.

Pre-feasibility studies to concentrate the minor metals and REE from Pb-Zn ore tailings of HZL

- This study aims to concentrate the minor metals and REE from Pb-Zn ore tailings of HZL.
- The total REE content in the bulk Pb-Zn tailing was upgraded from 195 ppm to 448.5 ppm.
- The concentration of REE and also other minor metals have been enriched successfully by the combination of advanced ultrafine grinding followed by advanced gravity techniques. Based on this work, appropriate flowsheets were developed and presented.

Characterization and beneficiation of low-grade bauxite ores from Gujrat

- This study aims the detail characterization and beneficiation study of low-grade bauxite ore from Gujarat.
- The desired alumina grade by the combination of gravity, magnetic, and flotation processes was achieved successfully. Based on this work, appropriate process flowsheets were developed.

Recovery of galena, sphalerite and valuable minor metals from lead/zinc tailings by integrated energy efficient ultrafine comminution and classification and novel ultrasonic treated shear floc-flotation and its impact on downstream paste fill

- This is an ongoing project, aims to increase the grade of galena and sphalerite liberation from the locked Particles using by adopting ultrafine grinding using stirred mill for subsequent easy of separation of different downstream separation processes.
- The existing Netzsch stirred mill was made ready to work.
- Ball mill and stirred mill comparative studies were performed the energy efficient fine grinding of Pb-Zn-Cu ore and tailings supplied by HZL.
- The grinding studies were also performed in the stirred mills developed at CSIR-IMMT. Highly encouraging results have been obtained which shall be communicated soon.

Value addition of bauxite mining waste rocks for refractory applications

- Established the process for removal detrimental elements associated with the PLK/PKK mining waste.
- Improved quality of PLK/PKK bricks prepared are much cheaper than the standard Alumina refractory bricks available in the market.
- Concluded that the utilization of bauxite mining waste for value addition is possible and may be adopted by the refractory industries.

Innovative approach to recover chromite value from low grade chromite ore, fines & slime by dry and wet beneficiation technique

- This is an ongoing project mainly to establish the proof of concept for recovery of chromite values using dry beneficiation techniques from the low-grade chromite ore, slimes & tailings.
- The detailed characterization and preliminary beneficiation studies were completed.
- Established the air classifier optimal conditions for enrichment of chromite vales.
- Further dry beneficiation studies are under progress to establish the proof of concept.

Process flowsheet development for the beneficiation of chromite ores

M/s. Vedanta Ltd (FACOR) has sponsored the investigations on two low-grade chromite ores (Ostapal and Kalarengitta samples). The Ostapal sample contains 25.3% Cr_2O_3, 22.4% FeO, and 24.0% SiO_2 contents. Whereas the Kalarengitta sample bears 22.9 % Cr_2O_3, 27.8% FeO, and 18.7% SiO_2 contents. The Kalarengitta sample shows higher FeO content than the Ostapal sample. The beneficiation studies were carried out on various unit operations such as scrubbing, classification, hydrocyclone, grinding, spiral concentration, shaking table, floatex density separation, and dewatering (thickening and filtration) to recover the chromite values from the low-grade ores. The studies on Ostapal ore have shown that a concentrate of 50.42% Cr_2O_3 and 40.6% yield can be produced by the suggested flowsheet. The same flowsheet has been used to beneficiate the Karalengitta ore that generates a concentrate of 51.42% Cr_2O_3 and a yield of 33.5%. A processing flowsheet is developed in the project is producing greater than 50% Cr_2O_3 content

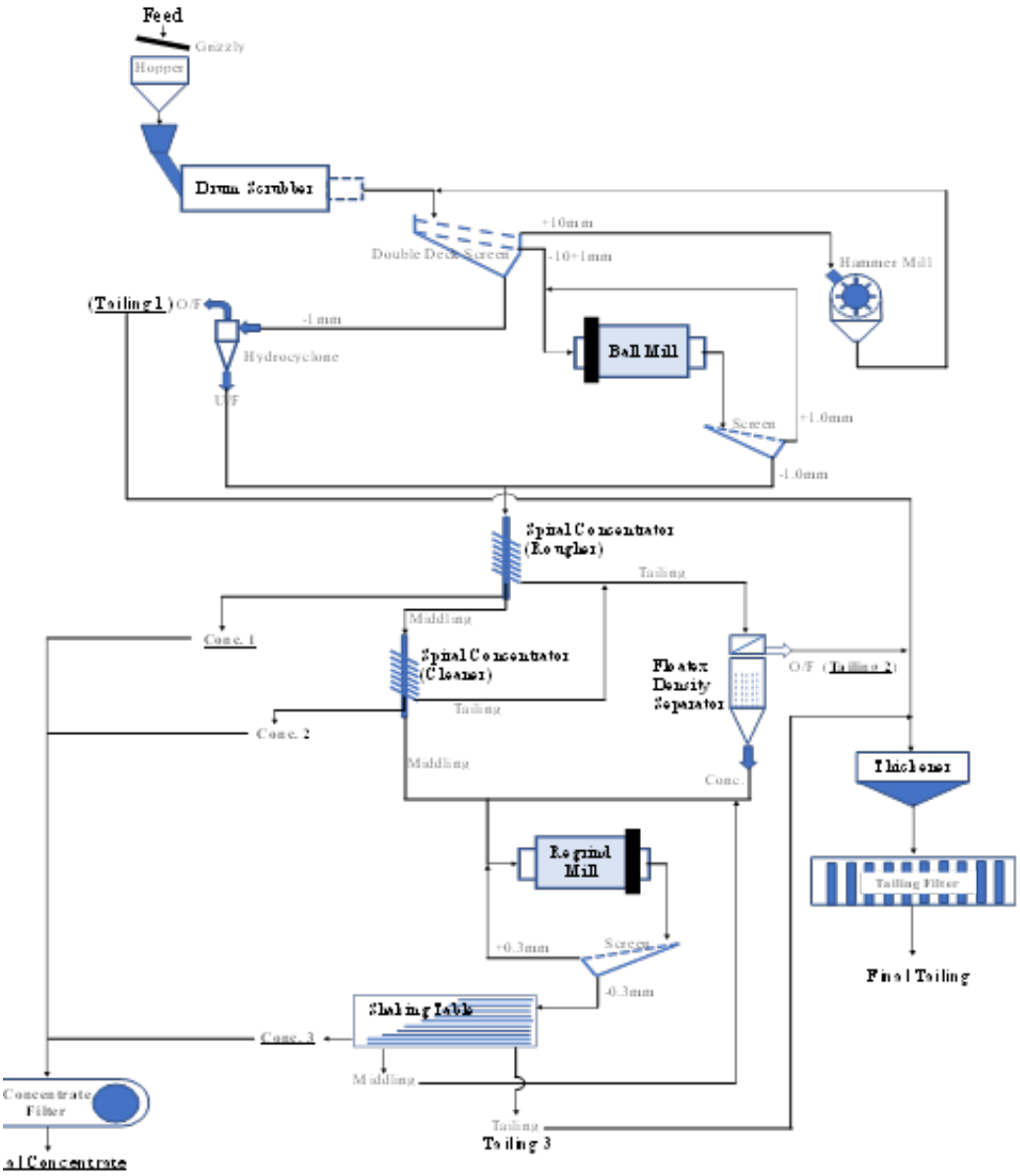


Figure: Process flowsheet for beneficiation of chromite ore

Process Flowsheet Development for the Recovery of Iron Values from the Lean-grade BHJ Ore

The objectives of the project were to conduct beneficiation studies and thereby develop a process flowsheet for the recovery of iron values from the low-grade BHJ ore. M/s. Thriveni Earthmovers Pvt. Ltd., (TEMPL), Keonjhar. had supplied about 3 tonnes of lean grade BHJ ore for the laboratory investigations. Physical characterization studies following size analysis were carried out to identify the association of iron-bearing phases with respect to different particle sizes. Chemical analysis showed that the major components present in the BHJ ore are 51.9% Fe2O3 [36.3%Fe], 44.1% SiO2, 1.5% Al2O3, and 0.5% LOI. X-ray diffraction analysis indicated that the feed material contains hematite, and quartz minerals as major phases. Investigations were carried out on gravity, magnetic separation, and flotation studies by varying different parameters and particle sizes. Based on the investigations, a process flowsheet has been developed incorporating three-stage crushers, two-stage ball mills, and two-stage wet high-intensity magnetic separators. The process flowsheet can generate a concentrate of 61% Fe with a product yield of 23.5%.

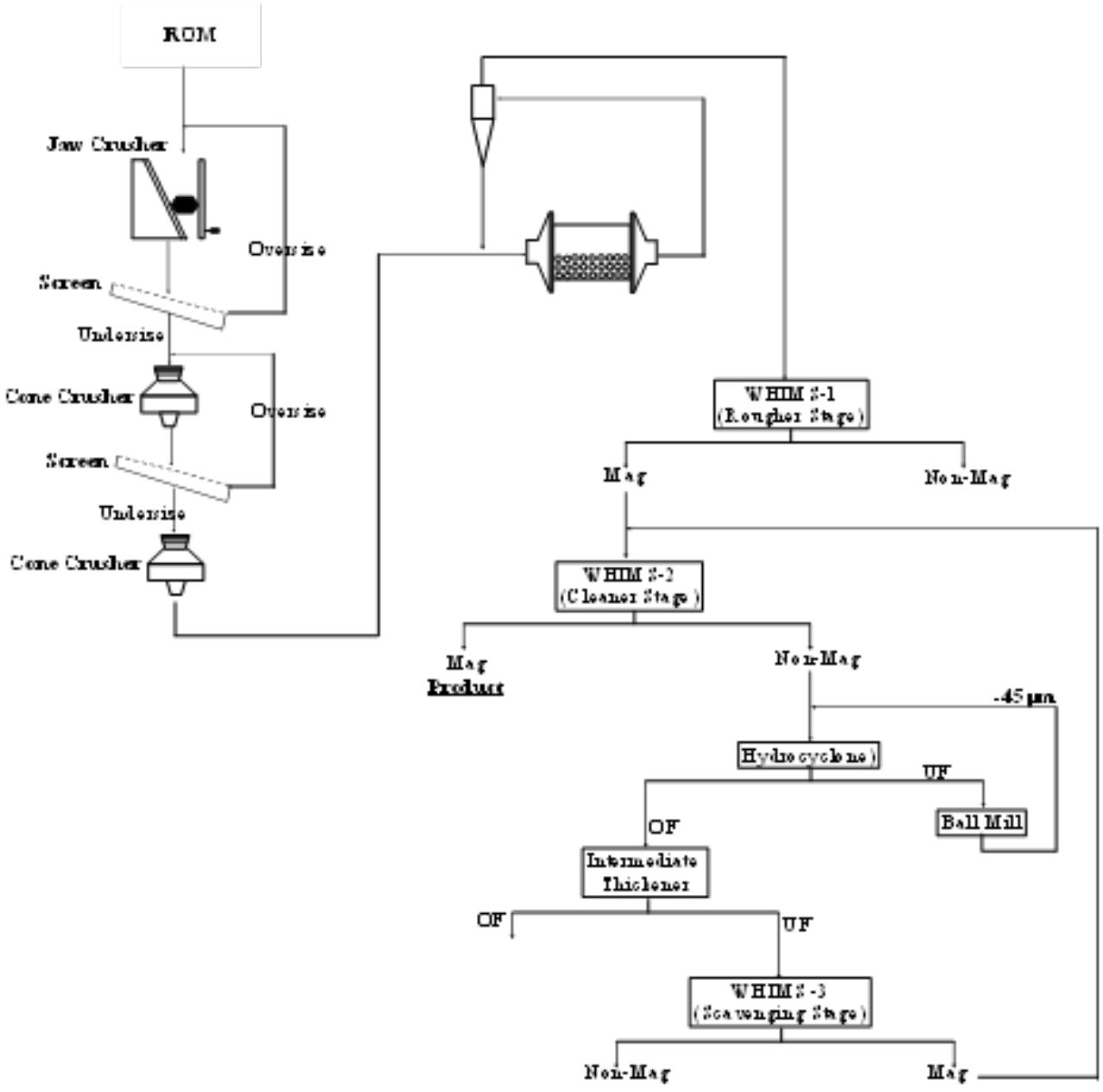


Figure: Flow sheet development for beneficiation of banded iron ore

ADVANCED MATERIALS TECHNOLOGY

FOCUS

To develop suitable processes for the production of industrial and strategic materials and conduct basic research in advanced materials areas.

CORE AREA EXPERTISE

- Plasma processing of minerals, wastes and special materials.
- Metals & alloy making through powder processing and other novel routes
- Production of carbide, oxide and nitride powders including ultrafine and nano powders by plasma method.
- Preparation of electronic and high pure materials.
- Microstructural and physical properties studies of defect reduced natural gems.
- Advanced characterisations of special and advanced materials.

Thermal stability of AlCoCrNiSi high entropy alloy

AlCoCrSiNi HEA has been successfully prepared by ball milling route and consolidated by spark plasma sintering. The differential scanning calorimetry and dilatometry experiments were carried out. It is observed that AlCoCrSiNi HEA is thermally stable up to 850°C (Fig. 1). The microstructure of A AlCoCrSiNi HEA is shown in Fig. 2. Elemental mappings of Al, Co, Cr, Si, Ni along with C, N, and O show there are three distinct phases: Si rich, Ni-rich, and Cr-oxide phases. Upon isothermal oxidation study at 800 and 900°C up to 100 h, it is seen that the alloy has robust oxidation resistance at 800°C (Fig. 3) as mass gain per unit surface area remains constant irrespective of holding time. Elemental mappings after oxidation shows that the oxide film is mainly composed of stable alumina layer.

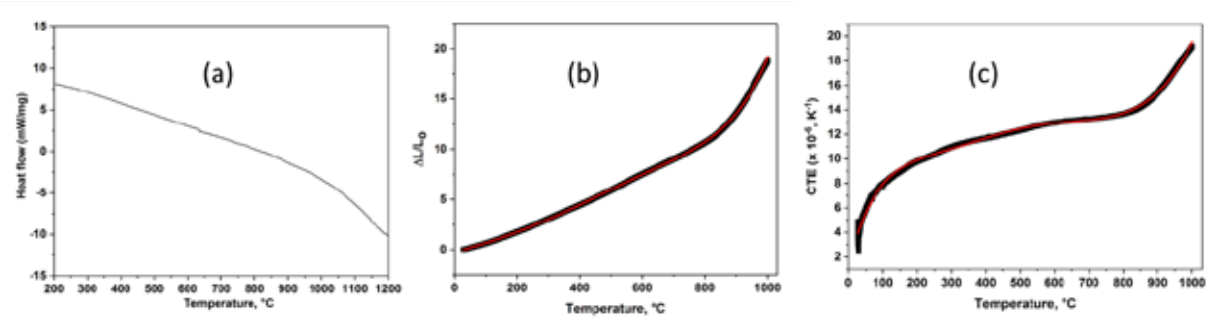


Figure 1: (a) DSC curve of AlCoCrSiNi HEA, (b) & (c) thermal strain and CTE plots from dilatometry.

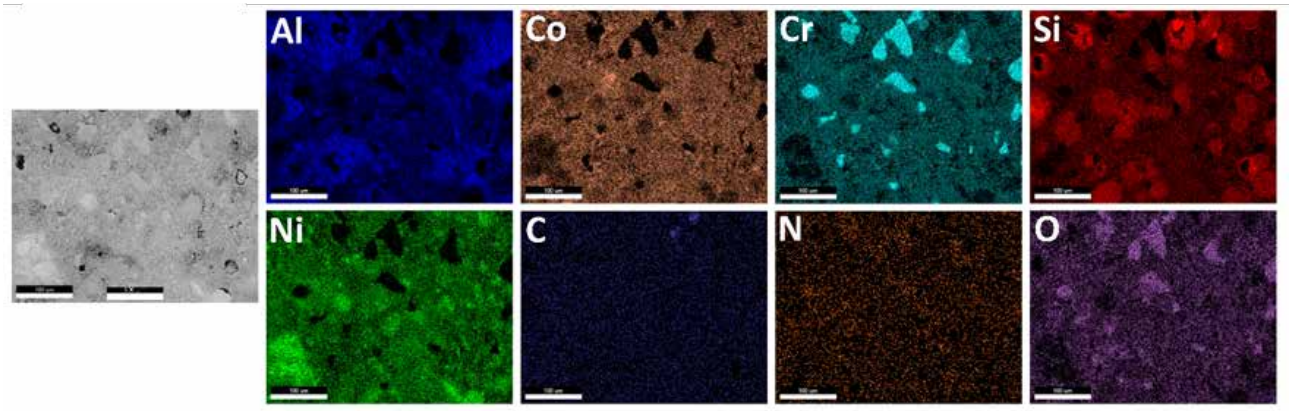


Figure 2: Elemental mappings of AlCoCrSiNi HEA.

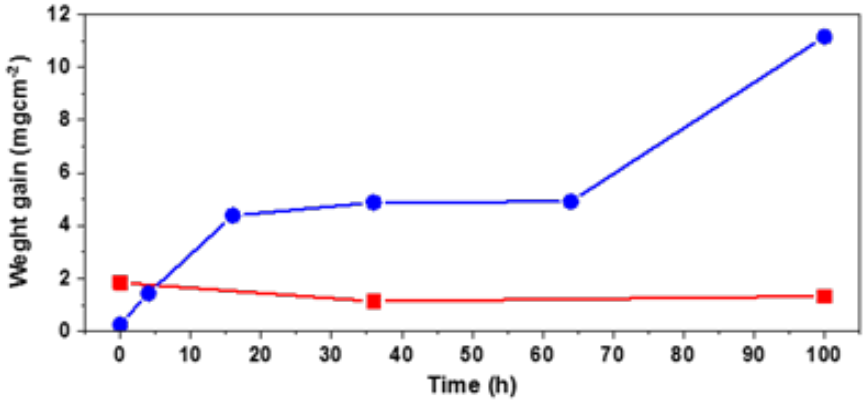
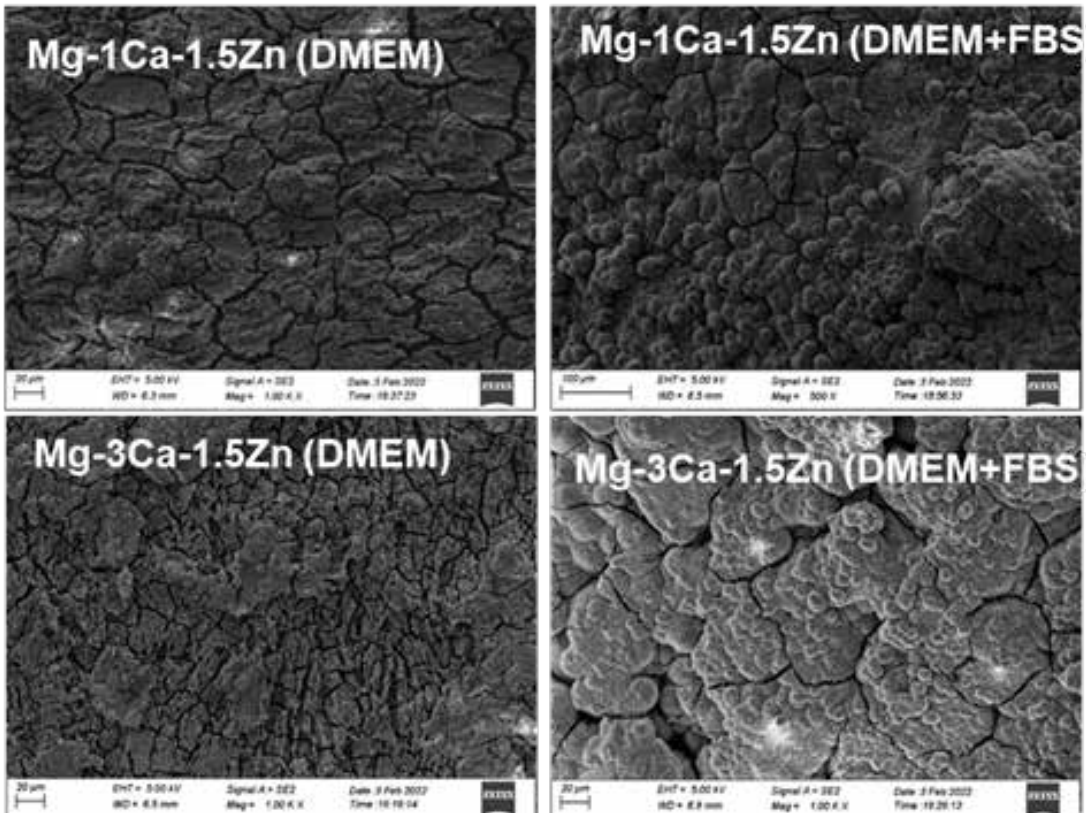


Figure 3: Weight gain plot showing robust oxidation resistance at 800°C in comparison to that of 900°C.

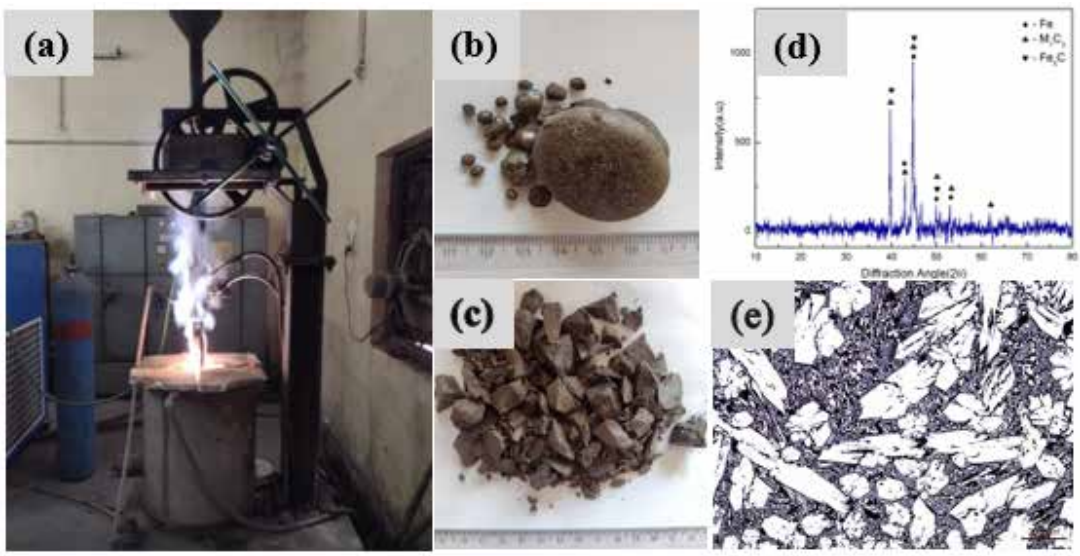
Development of biodegradable magnesium alloy for orthopedic applications

In the present work Mg-Ca-Zn alloys was fabricated with varying Ca and Zn content by squeeze casting process. The effect of Ca and Zn content on mechanical, corrosion and biodegradable properties was studied. The alloy was prepared in controlled argon atmosphere and casting was done in closed argon pressurised chamber in the form of ingot. The alloys were extensively characterized for micro-structural and mechanical property. The results showed that increasing Ca content decreased grain size (from 60 µm to 8 µm) led to improved hardness values (from 30 HV to 68HV) and also higher Ca content led to an increase in the amount of Mg_2Ca phase at grain boundaries resulted in higher corrosion rates. However, addition of Zn redoes the mechanical property of the alloy but it increases the corrosion resistance of the alloy. The combine effect of the Zn and Ca was also studied and found more suitable for the orthopaedic implant applications.



Direct production of Fe-Cr-Ni-Mn stainless alloy from mine waste by thermal plasma process

Over the past few years, the consumption of stainless steel is gradually increasing in all applications like industries, automobiles, aerospace, and structural. It is one of the most useful materials due to its remarkable properties like better corrosion resistance, high strength, high hardness, and durability, etc. The main alloying elements in stainless steel are chromium, nickel and some other trace elements. The conventional method of producing stainless steel was by melting ferrochrome and ferronickel in an Electric arc furnace (EAF). The ferrochrome and ferronickel were produced by using rich grade lumpy ores. The rapid consumption of ferrochrome and ferronickel in the production of stainless steels leads to the depletion of rich grade lumpy ores. By using low-grades ores was the alternate raw material for stainless steel. These low grade ores were produced during the mining operations. In this work we have taken Chromite overburden (COB), low-grade chrome ore and, low-grade manganese ore as a raw material for crude stainless steel production by thermal plasma process. The granules were prepared by the raw materials on a 500 g scale of (COB, Chrome ore and Mn ore according to the 4:3:3 ratios) and the reducing agent coke, which was taken up to 122 g and the CaO was used as a flux that is varied according to the desired basicity from 0.4 to 1.2. The prepared granules were smelted in the argon plasma furnace for 32 min at current (300A) and voltage (50-60V). The obtained metal and slag are further characterized with XRD, GDOES, XRF and FESEM to determine the composition and the metal recovery. The metal recovery approximately 70% achieved in this process.

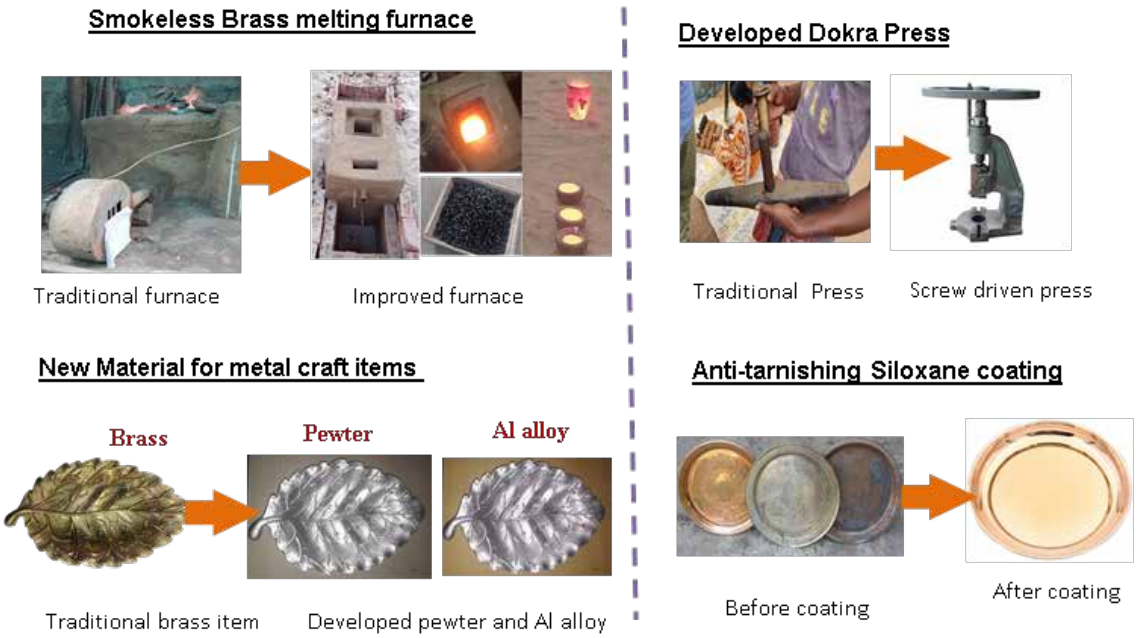


(a) Argon Plasma Furnace (b) Obtained metal (c) Obtained slag (d) XRD of obtained metal and (e) Optical microstructure of obtained metal

S&T intervention for revitalizing metal handicraft

The objectives of the work are many folds. (i) Identification of clusters of bell metal, brass sectors of Odisha and Interaction with artisans, (ii) Design and innovation in the metal craft, (iii) digitization of traditional knowledge of the metal crafts of Odisha, (iv) Improving sustainability of the artisans' activity, etc. In this regard, several activities have been carried out by CSIR-IMMT team. Modified brass melting furnace was set-up at CSIR-IMMT, Bhubaneswar with the help of CSIR-NML Jamshedpur.

- Structure property co-relation
- Proving solution of present process of melting casting (smokeless melting, dross loss, reduction of energy consumption casting defects)
- Alternate light metals (Al-alloy & Pewter) for Metal Crafts
- Lacquering and corrosion resistant coating on the metal handicrafts



Technology Development for Advanced Plasma Processing of Indian Cultural heritage and Archaeological artefacts for Conservation and Feature enhancement

Cleaning is the most prominent step for restoration and conservation of the archaeological objects. Vandalism caused by graffiti paints is considered to be one of the major threats to artefacts. IMMT has developed plasma based cleaning techniques that can be an optimal solution in removing graffiti which is composed of complex organic molecules, from the surface of different archaeological materials and cultural heritage objects made of glass, paper, stone and metal by mechanism of diffusion and etching.

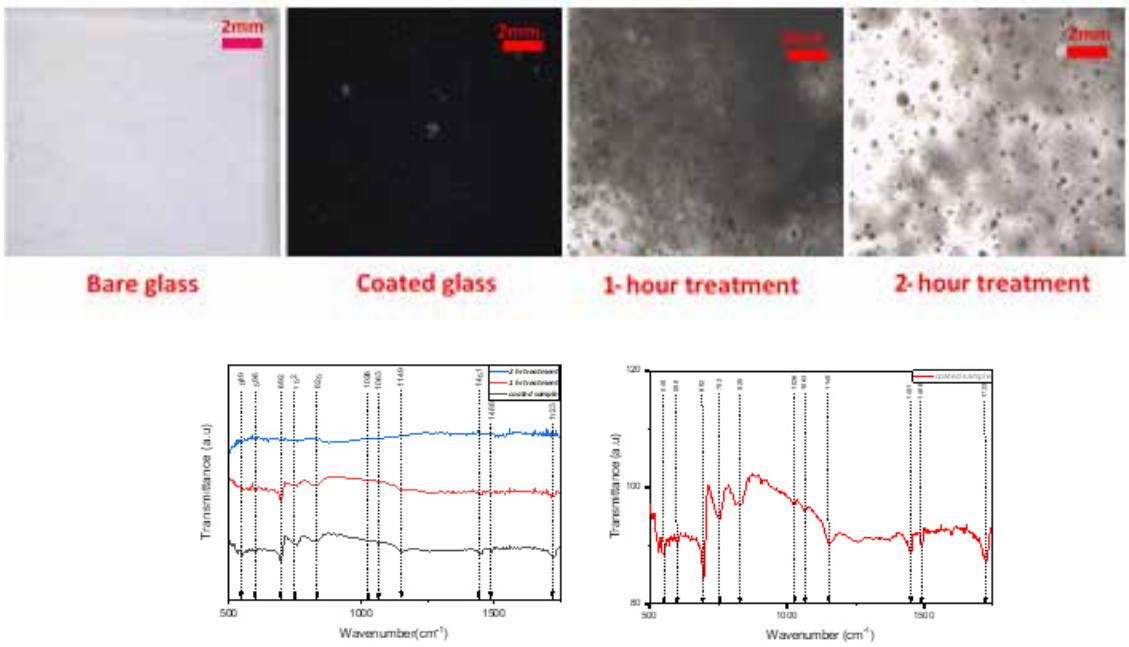


Figure: Stereo-micrographs and FTIR analysis indicating removal of graffiti from a model artefact.

DBD Plasma can efficiently inactivate pathogens such as bacteria, fungi and viruses. It finds applications ranging from sterilising therapeutic medical devices to improving crop yields & grain preservation. It is an effective tool for the improvement of germination, shoot, and root growth. The application of cold plasma can be an additive-free, and environmentally beneficial food processing technology, such as non-thermal plasma-based ozone treatment. IMMT has developed an extensive knowledge base in this domain to identify scalable processes.

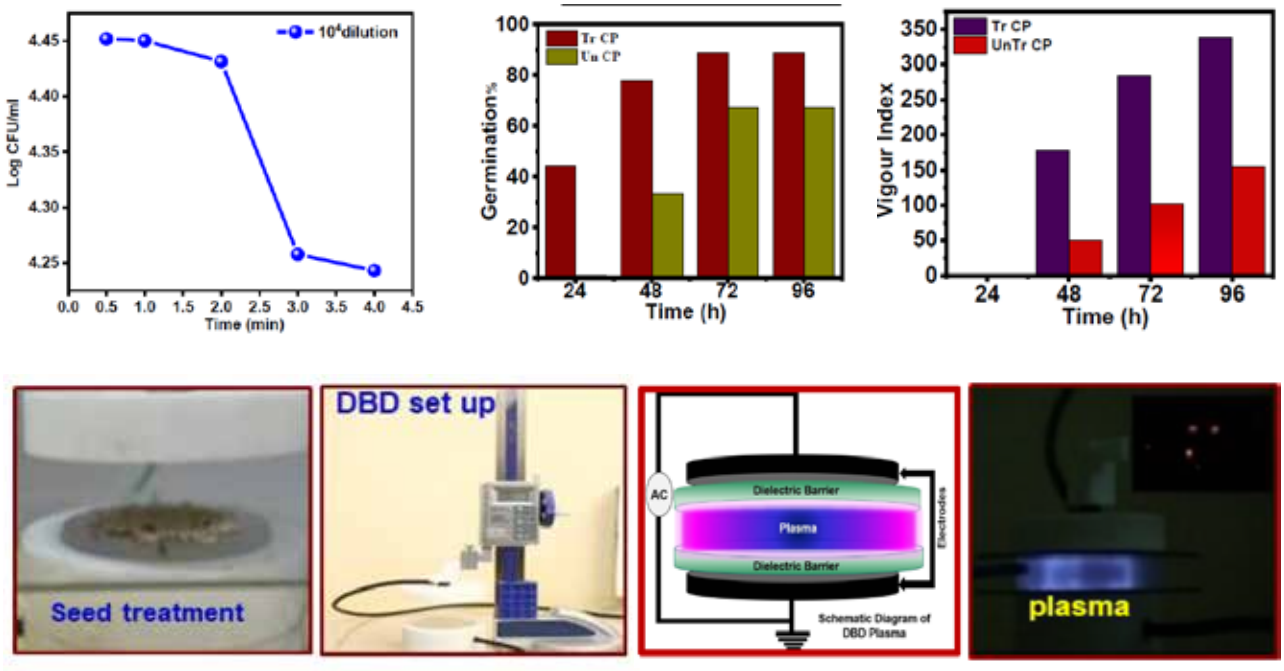


Figure: Indication of significant reduction in microbial content after treatment and improvement in germination of seeds after plasma treatment; schematic of plasma treatment device prototype developed.

Development of oxide-dispersed tungsten heavy alloys

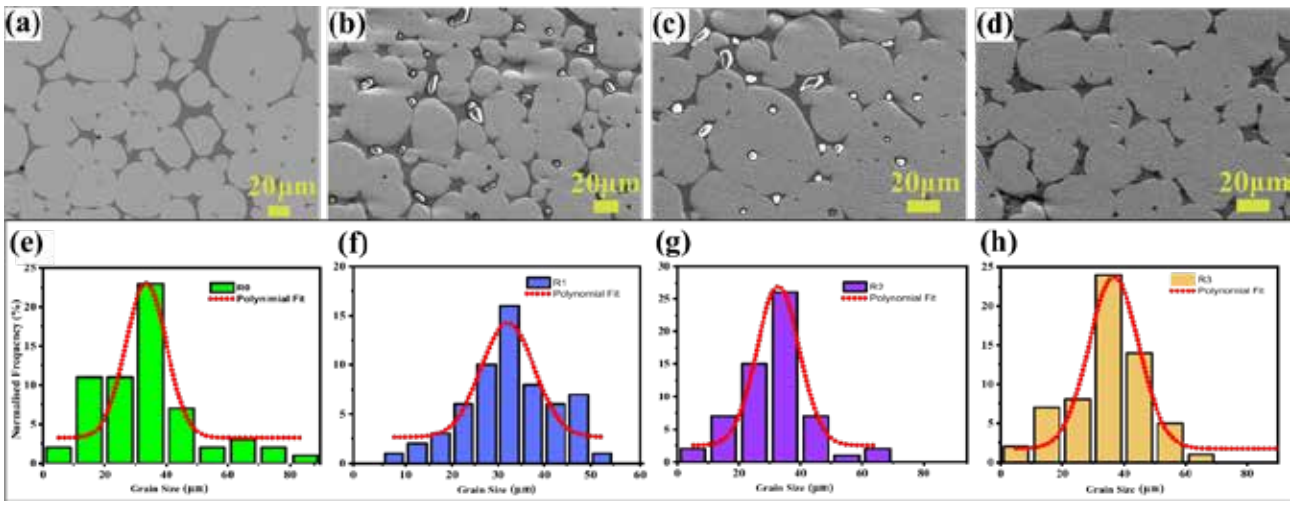


Figure: SEM images of as-sintered (a) R0, (b) R1, (c) R2 and (d) R3; particle size distribution of (e) R0, (f) R1, (g) R2 and (h) R3

The effect of three different oxide dispersoids (Y_2O_3, La_2O_3, ZrO_2) addition on densification, phase, microstructure evolution and high-temperature stability has been investigated thoroughly and compared with that of 95W-3.5Ni-1.5Fe (wt.%) heavy alloy (WHA). The heavy alloys were prepared by powder metallurgy process and consolidated by conventional sintering at 1500 in hydrogen atmosphere. The oxide additives did not improve the densification, however, enhanced the hardness of the sintered heavy alloys. Upon exposure to ultra-high temperature (2300) for 10 s, the base alloy suffered significant damage and experienced mass loss due to evaporation of W-oxide. On the other hand, Y_2O_3, La_2O_3 and ZrO_2-dispersed heavy alloys exhibit protective oxide layer formation. Furthermore, the XRD and FESEM analyses of the exposed surface affirm that no significant damage has incurred in the oxide dispersed WHAs despite identical experimental condition. Owing to the thermal stability of W-Y-O, W-La-O and W-Zr-O systems, the oxide-dispersed heavy alloys offer better structural stability at ultra-high temperature.

In order to evaluate the effect of oxide addition on the structural evolution, microstructure of the sintered samples was studied in detail. Fig. 1 a-d represent the secondary electron micrographs of the sintered R0 (95W-3.5Ni-1.5Fe), R1 (94W-3.5Ni-1.5Fe-1Y_2O_3), R2 (94W-3.5Ni-1.5Fe-1La_2O_3) and R3 (94W-3.5Ni-1.5Fe-1ZrO_2) samples. In all samples, there are two visually distinguishable phases i.e., darker matrix and rounded light W grains. These micrographs resemble with typical liquid phase sintered WHAs where the matrix phase (fcc) encapsulates surrounding tungsten spheroids (bcc). Fig 1e-h show the grain size distribution of the corresponding WHA positions. Fig. 1e represents the particle size distribution of W grains in R0, the base WHA; the average size of W grains is 34.22 ± 10.21 µm. It can be observed that there is a wide variation in the grain size distribution ranging from ~5 to 100 µm. The larger grains are formed due to coalescence of smaller ones as a consequence of Ostwald ripening phenomenon occurred during liquid phase sintering. In Fig. 1b, c and d, it can be observed that the dispersion of Y_2O_3, La_2O_3 and ZrO_2, has a marked effect on the sintered microstructure. Firstly, the oxide dispersoids are found to be interspersed uniformly in the microstructure, elucidating the effectiveness of powder blending process. The grain size of W in R1, R2 and R3 is 32.10 ± 9.46 µm, 32.27 ± 11.85 µm and 36.39 ± 14.0 µm respectively, with oxide particles of nearly 1-5 µm diameter entrapped either at the W-matrix interface or in between adjacent W grains. In the case of oxide dispersed WHAs i.e., R1, R2 and R3 it can be observed that Y_2O_3, La_2O_3 and ZrO_2 are distributed either at the W-matrix interface or in between adjacent W grains.

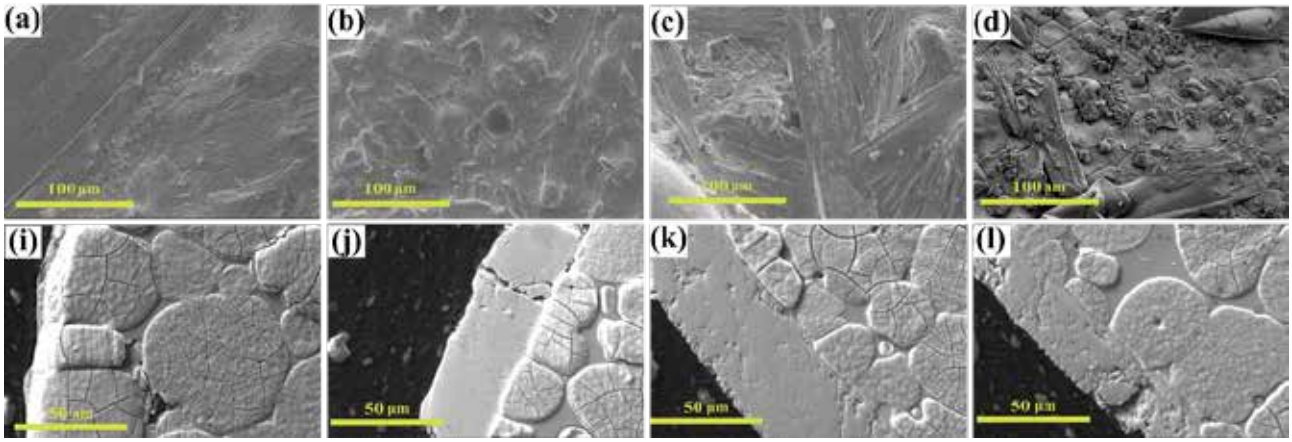


Figure 2: SEM image of high temperature exposed surface of (a) R0, (b) R1, (c) R2 and (d) R3. Image of cross-section of high temperature exposed (e) R0, (f) R1, (g) R2, (h) R3.

Fig. 2 shows effect of high temperature exposure on the surface and cross-section of WHA. Fig 2a highlights the image of high temperature exposed surface of R0. The absence of any scales is to be noticed. The surface of high temperature exposed R1 sample shows continuous layers of oxides with small circular patches (see Fig 2b) whereas the R2 shows columnar structures covering the whole surface (see Fig. 2c). Fig. 2d shows the surface of R3 which clearly indicates that the protective oxide layer is not continuous in this case. Here, hexagonal W particles are visible with small amount of irregular oxides forming over the W grains. Fig. 2e-h shows the cross-section of the high temperature ablated samples. It can be observed that the layer formed on the surface over R0 is

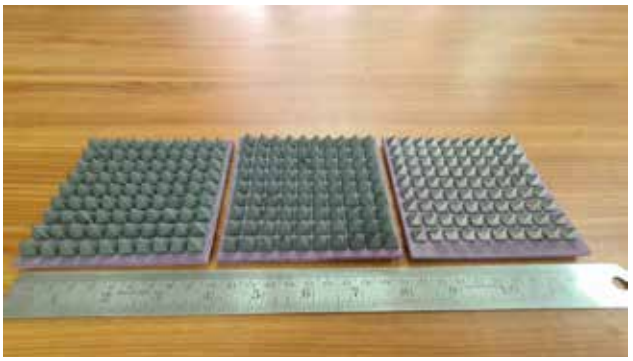
9.67 ± 1.78 µm thick whereas for R1 it is 32.46 ± 1.24 µm, for R2 it is 44.04 ± 1.5 µm and for R3 it is 25.91 ± 1.82 µm thick. In the SEM analysis of the samples subjected to ultra-high temperature for 10 s, the presence of intragranular crack is observed in W grains. In contrast, no crack was observed in matrix region. The formation of crack in W grain may be ascribed to the combined effect of thermal shock and thermal residual stress. During ultra-high temperature exposure, the matrix region underwent melting. Subsequently, the matrix solidified upon sudden cooling, which resulted in thermal stress in the adjoining W grains.

Consequent upon incorporation of Y_2O_3, La_2O_3 and ZrO_2, the thermal strain and biaxial residual stress of WHAs decreased. The best resistance to high-temperature degradation was offered by ZrO_2-dispersed W-Ni-Fe alloy. Overall, the oxide dispersed WHAs open up a new avenue of developing newer heavy alloys for strategic application at ultra-high temperature for short duration (~10 s).

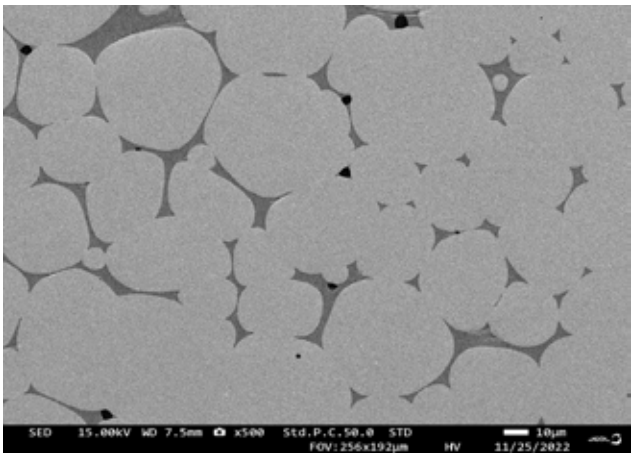
Development of high density tungsten alloy square pyramids for Defence applications

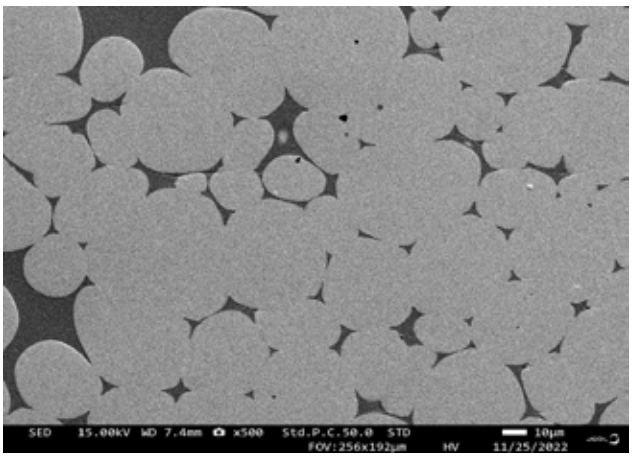
CSIR-IMMT has demonstrated its expertise in Tungsten alloy product development for strategic applications. Based on the requirements of defence, 100 kg (~50,000 nos.) of a difficult to make projectile (square pyramidal) was successfully developed using the powder metallurgy processing facilities and supplied to DRDL, Hyderabad. Efforts were made to fabricate the complex shaped projectiles as per the stringent material specifications. W-alloy composition of 95W-3.5Ni-1.5Fe (wt. %) was selected for the intended end application.

Photograph of 45 kg sintered pyramids (3rd batch) packed in 36 nos. of containers (1.25 kg per container). The same was supplied in Jan-2023.



Photograph of Tungsten alloy square pyramids in the order of processing (compaction, de-binding and sintering).





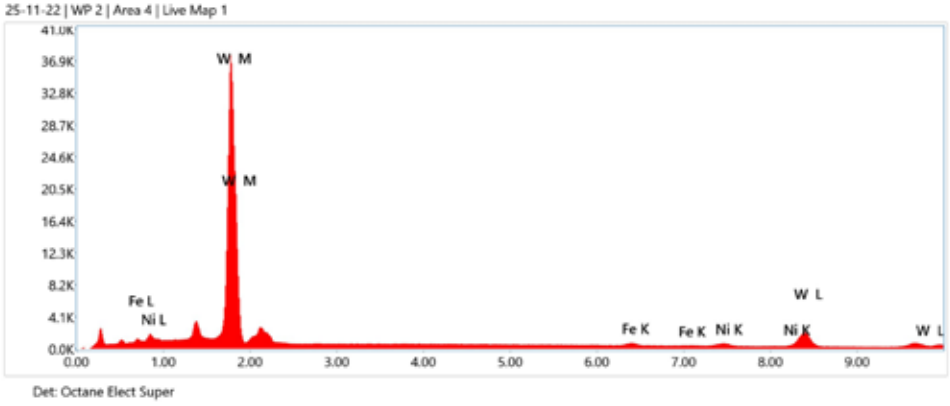


Figure 4: EDS spectrum confirming the presence of W, Ni and Fe in the sintered pyramid.

A promising material for next generation permanent magnets

Permanent magnets (PM) find widespread application in energy conversion, telecommunication, data storage, sensors, electronic gadgets, etc. Even though the market for PM is dominated by rare earth (RE) based magnets like Nd-Fe-B and Sm-Co, the recent crisis of RE elements and supply constraints have evoked the necessity of new PM materials for sustainable development. Owing to the predicted high value of $(BH)_{max}$, the abundant availability of constituent elements (Fe, Ni), and presence in natural meteorites, $L1_0$ FeNi has drawn the attraction of the scientific community. This work highlights $L1_0$ FeNi (tetrataenite) as one of the most suitable candidates for future permanent magnetic material. Fig. (a)-(c) show the comparison of intrinsic magnetic properties such as magnetic saturation (M_s), magnetic anisotropy energy (K_u) and Curie temperature (T_c) of different hard magnetic materials, whereas, Fig(d) shows the comparison of hardness parameter $\left(\kappa = \sqrt{\frac{K_u}{\mu_0 M_s^2}}\right)$ [9] and Fig. (e) depicts the value of energy product $(BH)_{max}$ of different class of magnetic materials. Although $L1_0$ FeNi has shown immense potential for PM application due to its high magnetocrystalline anisotropy and magnetic saturation, the bulk synthesis of this material is not yet achieved. The problems in laboratory synthesis of $L1_0$ FeNi and the technological limitations for practical use are dominated by the slow diffusion of Ni in the FeNi lattice around the low order-disorder temperature (~593 K). Artificial techniques with a low-temperature synthesis of ordered $L1_0$ FeNi are highlighted and the properties of $L1_0$ FeNi thin films are also presented coherently.

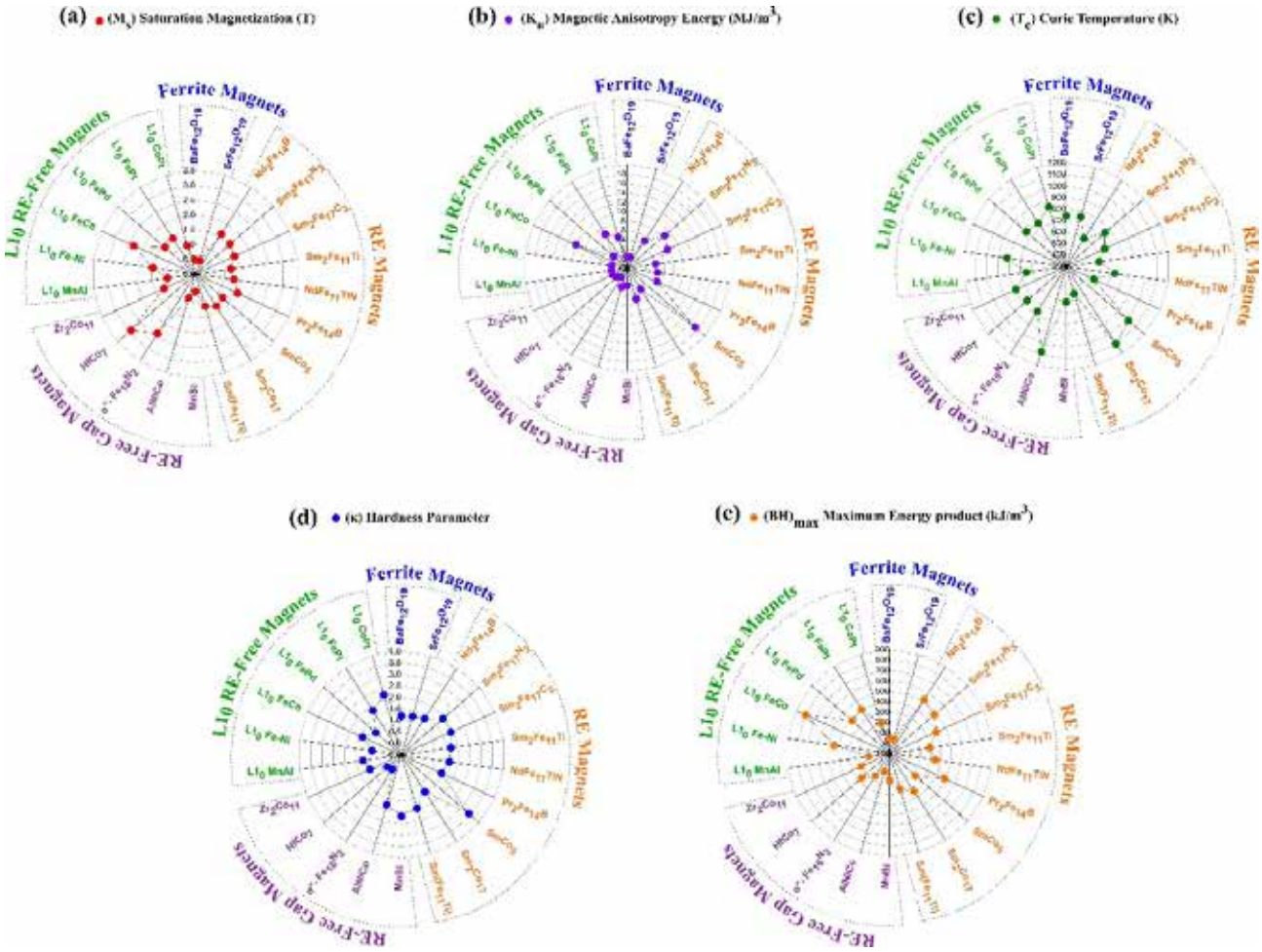


Figure: Comparison of magnetic properties of RE-Magnets, ferrites with RE-free hard magnets (a) saturation magnetization (Ms), (b) Magnetic anisotropic energy (Ku), (c) Curie temperature (Tc), (d) Hardness parameter (κ) and (e) Maximum energy product (BH)max.

PROCESS ENGINEERING AND INSTRUMENTATION

FOCUS

Modeling, simulation, control and instrumentation of minerals and materials engineering processes.

CORE AREA EXPERTISE

- CFD/DEM modeling and simulation of minerals and materials processing units for design and optimization
- Molecular modeling in solvent extraction and material science
- Image processing for monitoring and control
- Vibration analysis based fault monitoring system

Modelling and optimization of gaseous reduction of iron ore

The significant availability of low-grade iron ores needs advanced treatment technologies that are financially and environmentally sustainable. CSIR-IMMT has been testing various natural solid reductants for the reduction of low-grade iron ore. The present activity investigates the gaseous reduction primarily by Carbon Monoxide. The primary focus of the work is to investigate optimal composition of gaseous environment essential for maximal controlled reduction to magnetite and preventive over-reduction to Wustite and metallic iron. Therefore, the process optimization for the gaseous reduction is being studied by means of CFD-DEM coupled modelling and simulation.

Thermal analysis of rotary kiln

Rotary kilns have been widely used for reduction-roasting of the low-grade iron ores. The iron ore along with reducing agent coal is heated in the rotary kiln rotating at a low rpm. Significant deviation of particle temperature from desired range for controlled reduction to magnetite can cause over-reduction to Wustite and metal iron. The analysis shown in Figure concludes that the smaller particles gained higher temperature. The segregation of particles caused upward movement of big particles popularly called "Brazil nut effect" resulting in lesser contact with the wall, and therefore, ineffective heating of bigger particles. Therefore, it is recommended to not operate with wide range of poly-disperse particle feed as the bigger particle may not reduce and smaller particles may over-reduce due to high temperature. A unit operation with improved heat and mass transfer such as fluidized bed reactor can instead be used to handle such poly-dispersed cases, however, the performance of fluidized bed reactors is limited for relatively small particles. The study shows that the different amount of reduction of hematite can be expected for bigger and smaller particles in the rotary kiln. In fact, different product formation can also be expected for different size parties as it is a function of activation energy, and therefore, temperature.

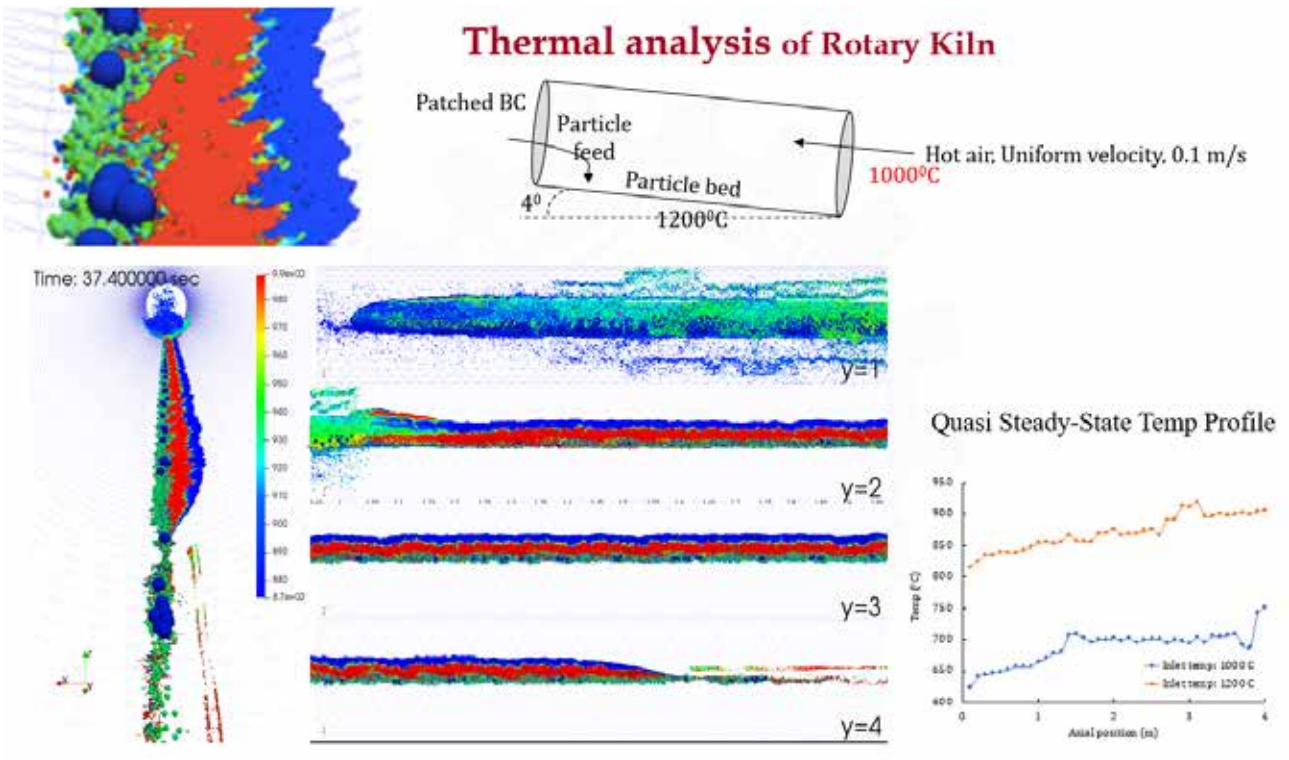


Figure caption: Thermal profiling of the rotary kiln.

Experimental investigation of the granular material velocity field by using Particle image velocimetry (g-PIV)

Granular flows are prominently encountered in the mining industries. Design of the handling equipment to store and transport the fine powder requires the knowledge of powder flowability. The flowability of the granular material has been investigated by using granular particle image velocimetry technique in which granular particles acts as tracers. The experimental apparatus has been fabricated from the plexiglass material. Particle size ranging from 1-1.5 mm have been tested for the validation studies. The image analysis has been carried out in MATLAB to deduce the corresponding cross-correlation function between the images. The objective of the study is to design an insert for ameliorating hopper discharge (Figure 1.1).

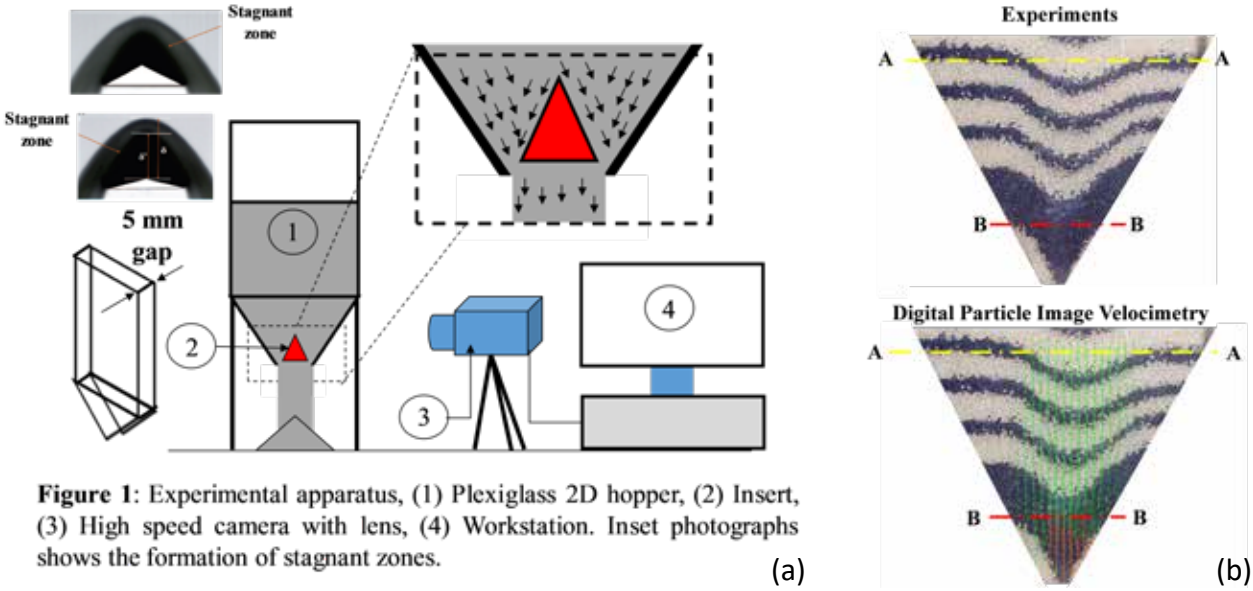


Figure 1.1: (a) Experimental apparatus, 1) 2D Plexiglas hopper, 2) Insert, 3) high speed camera and 4) computer and (b) The velocity field deduced by g-PIV along with the shear bands.

The experimental apparatus has been constructed for the high-resolution photography (Figure 1.1(b)). Initially, only flat configuration hoppers would be tested for validation purpose and tuning the code. Eventually, other conical configurations involving the detachable inserts would be utilized to conduct a complete parametric study. Final target is to test silica sand for its discharge characteristics from the flat bed hopper. Cross correlation between the corresponding images has been utilized to estimate the direction and the magnitude of the velocity field developed inside the hopper during its discharge.

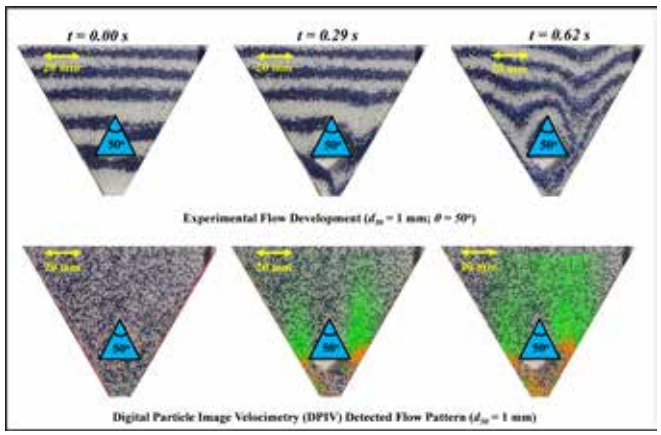


Figure 1.2: Effect of granular insert on the flow field in in a funnel flow discharge model hopper. The deformation of the shear bands could be observed during the hopper discharge.

Figure 1.2 shows the active granular field of 1 mm particle glass beads from the flat bed hopper. The process of velocity field deduction involves identification of the area of investigation under consideration. Masking operation is performed to rule out the areas from the photographs which are not necessary for the investigation. Image filtering and de-noising operation is performed to extract the relevant features from the photographs. These operations are necessary to reduce the signal to noise ratio in the analysis and reduce the spurious results. The investigation window of 16 x 16 pixel size and 8 x 8 pixel size are utilized during the first pass and second pass for predicting the velocity vectors. The investigation window pans over the entire filtered image to provide the velocity field shown in Figure 1.2. Calibration of the velocity vectors is performed to get the velocity scaling. Simultaneously, the validation of the technique would be performed by seeding the colored glass beads and comparing the results from the cross correlation. The quantification of the mass flow rate from the hopper would also be monitored to quantify the effectiveness of providing the inserts/flow modifiers in the flow field.

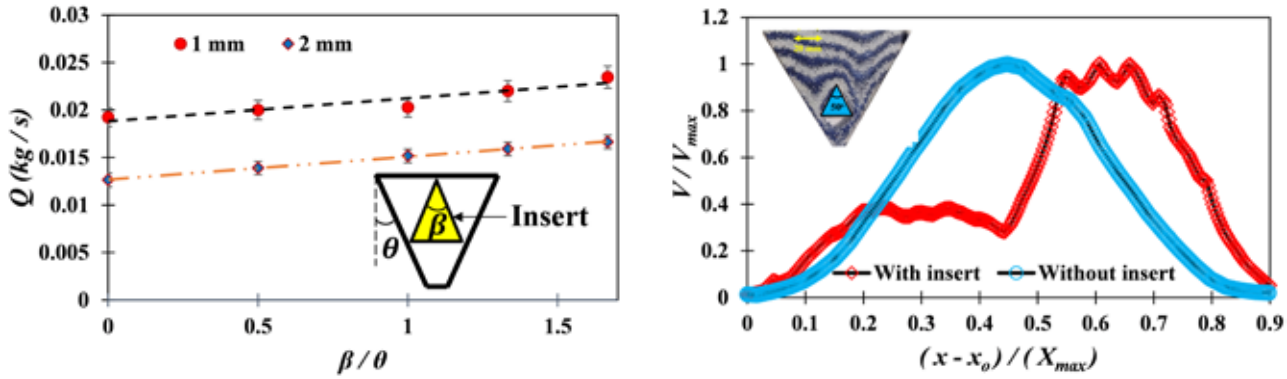


Figure 1.3: (a) Augmentation of the hopper discharge with the insert size in the funnel flow hopper, (b) Scaled velocity magnitude inside the hopper with and without the introduction of the insert.

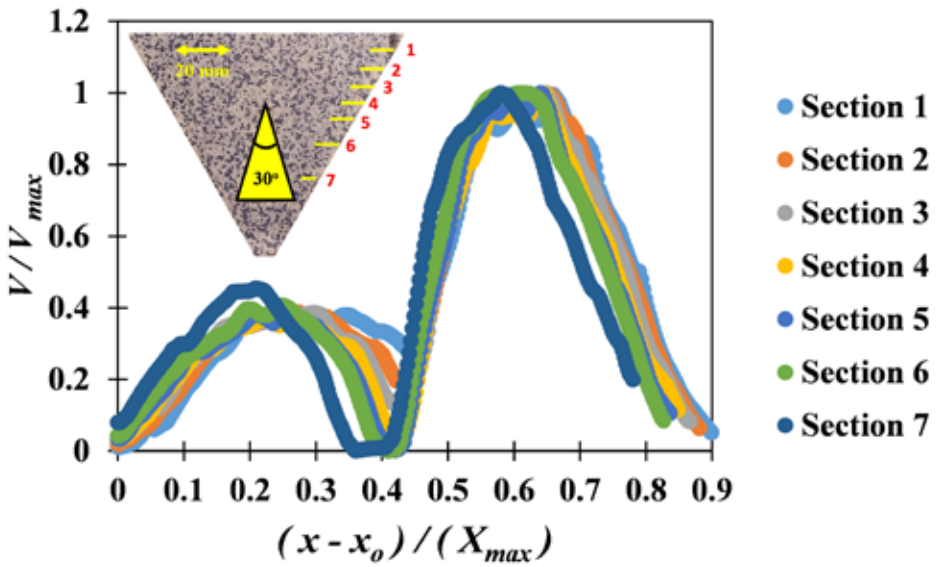


Figure 1.4: The asymmetry introduced in the hopper by the presence of the insert. The frictional force gradient at the hopper walls leads to the asymmetry.

Figure 1.3(a) shows the augmentation of the hopper discharge in the funnel flow hopper with the insert cone angle (β/θ). The introduction of the insert could augment the discharge up to 50 % as compared to the normal hopper. The introduction of the insert bifurcates the flow pattern inside the hopper (Figure 1.3(b)). Figure 1.4 shows the asymmetry introduced in the flow field due to the frictional gradient over the insert surface at different sections of the hopper.

Experimental gas-liquid interface reconstruction during co-current flow

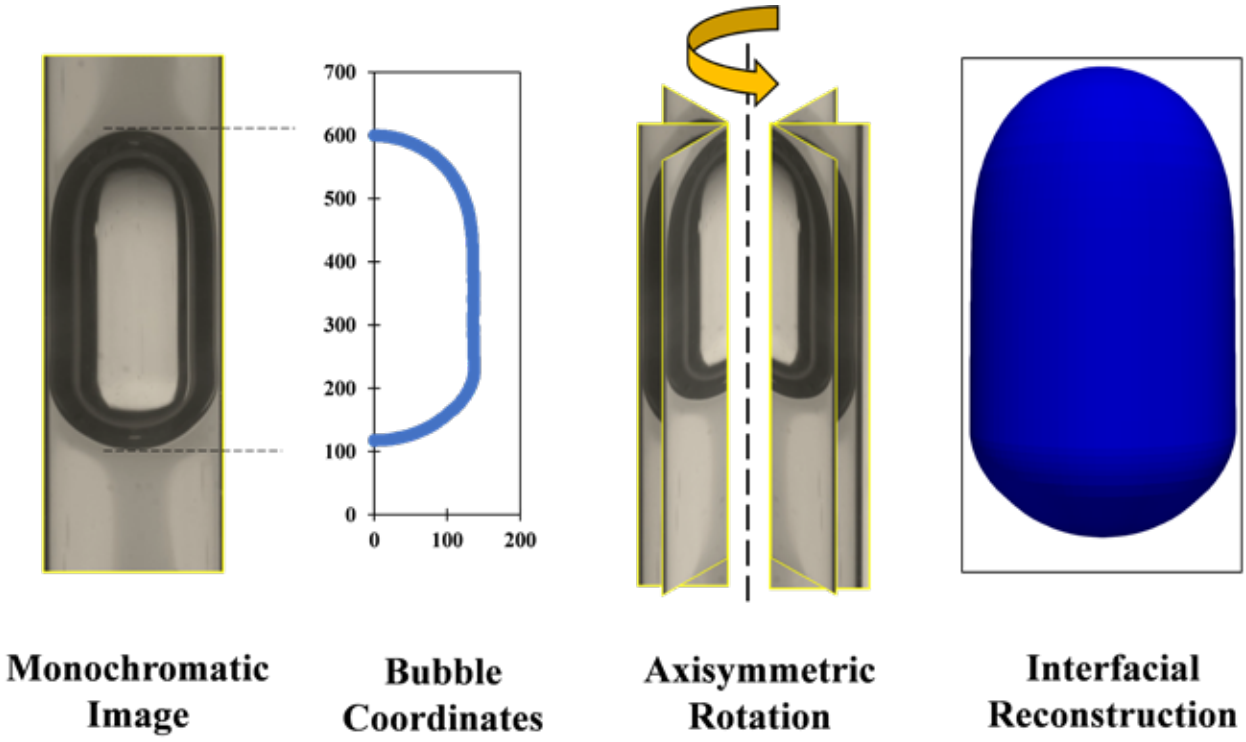


Figure 2.1: Interfacial reconstruction of the gas-liquid interface in the closed conduits by using high speed photography.

Gas liquid flows find prominence in oil rigs, heat exchangers, nuclear reactors and microfluidics, etc. The exchange of heat and mass from the interface depends upon the interfacial area in contact an the estimation of the same is of paramount importance. A numerical code has been written to estimate the gas-liquid interface for the axisymmetric situation found in the monolith reactors (Figure 2.1).

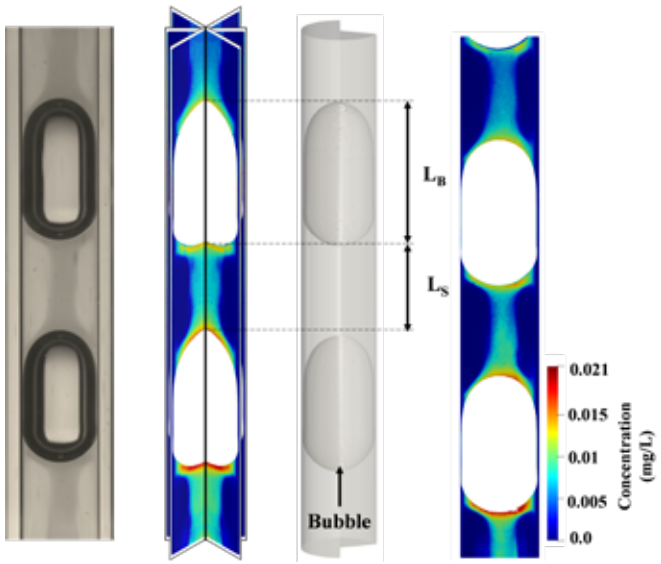


Figure 2.1: The dissolved oxygen concentration along with the reconstructed bubble interface in a 4mm ID tube. The numerical code detects the dissolved oxygen concentration along with the interfacial area necessary to propose the pragmatic correlations for the industrial settings.

Multiscale modeling and computational design of high-performance materials for remediation of polluted water

Many low cost minerals, mines and mineral wastes, activated carbon and carbon based sorbents, bioadsorbents, industrial wastes, agricultural wastes, metal oxides, natural minerals and modified minerals are reported in literature in the adsorption of toxic ions from wastewater. Similarly, for gaseous pollutants removal the current technologies include amine solvent stripping, pressure swing adsorption and capturing of these toxic gases in a variety of materials such as metal-organic frameworks (MOFs), zeolites, organic polymers, low cost minerals etc. However, there is no systematic study that reports a structured way of classifying the materials or design new materials for remediating a particular pollutant. Therefore, a database has to be generated that can guide the industry or any end user to choose a particular material to treat specific pollutant (s). In this project, the focus was to computationally design and simulate different classes of materials for a specific pollutant removal using atomistic scale modeling and thereby aiding bottom up design approach of novel materials.The database and proposed new materials to be developed using the existing knowledge as well as the proposed computational studies were the first of its kind. The main objective of the project is to computationally design and develop the Mineral based adsorbents for Adsorbing anions (F-) and cations (Cd, Pb, Zn, Ni). Additionally, a novel Al/Si/O based zeolite material were developed using the knowledge generated through atomistic investigations and the performance of the adsorbent is very high around 99 % removal of heavy metals. This work was done under Focus Basic Research (FBR) under 4M theme. 3 High Impact Publications along with novel material were achieved under this work.

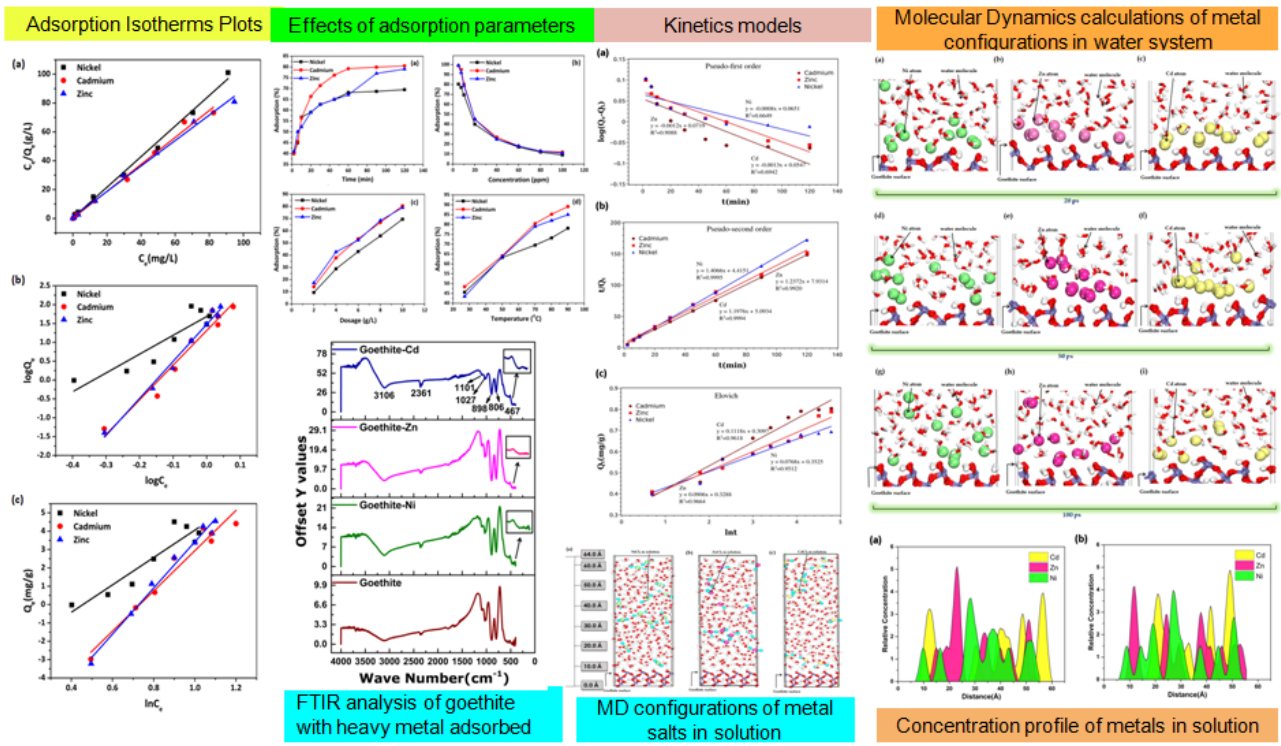


Figure 1: A thorough understanding of the adsorption of Ni (II), Cd (II) and Zn (II) on goethite using experiments and molecular dynamics simulation

Pellet bed thermal mapper

Adequate strength of indurated pellets is required for transpiration and further metal extraction processes. Due to non-uniform heating the strength of all pellets are not uniform and hence breakage and size reduction takes place during transportation. There is hardly any online Pellet bed thermal mapper system available for Indian Pelletization plants. Therefore manual sampling and lab testing of cold crossing strength is a regular activity. IMMT is working on development of an online Pellet Bed Thermal Mapper (PBTM) which can give spatial and temporal distribution of temperature along the height and width of the pellet bed during they are moved inside a straight grate induration furnace of a pellet plant.

Machine learning based pellet size analysis

Online size analysis of green pellets in a Pelletization plants of steel industries is an important requirement. IMMT's Eye-on-Pellet is the technology which is adopted by many steel plants in India. Another way of size classification using machine learning was attempted by IMMT team. In this work, an ensembled convolutional neural network (CNN)-based algorithm is proposed for iron ore pellet size analysis. A new customized CNN is ensembled along with VGG16, MobileNet, and ResNet50. The algorithm uses images captured from the inside area of a pelletizer disk to directly estimate the pellet size class instead of employing a circle fitting method. An image data set is created for different size classes (VERY SMALL, SMALL, GOOD, BIG, and VERY BIG) by using a novel cropping and resizing method, where the mean sizes are 7–19 mm, at a step of 3 mm. Actual industrial images captured using an industrial camera during pellet production are used as the seed images for the data set creation and training, validation, and testing of the proposed model. Through extensive experimentation, it is shown that the proposed classification algorithm can achieve about 96%–99% accuracy, whereas if the custom-designed CNN is not used, the accuracy obtained is about 77%–95% for different classes. In addition to this, the proposed trained network is validated with pellet images of an intermediate mean size to show that the trained model is not overfitted. The work is published in IEEE Industry Applications Magazine in 2023.

Battery health monitoring

Battery driven electric vehicles (EV) are gaining popularity due to its low operational cost and environmental friendly nature. The Range Anxiety is the issue due to which its acceptability in Indian market is limited. A proper battery management system (BMS) is required to remove the range anxiety in EVs. The BMS should estimate accurately the state of charge (SOC) and state of health (SOH). This requires accurate modelling of the cells and battery packs at different operating and thermal conditions. The charging circuit using cell balancing, over voltage and over current protection is also an important aspect of Battery Management System. IMMT is a part of the multi-institute project sponsored by SERB under Intensification of Research in High Priority Areas (IRHPA) where R&D in the area of battery management system for indigenous and commercial batteries is one of the components.

Humidocool: Cooling with high humidity for storing vegetables

To enhance the shelf life of vegetables and fruits a technology named HumidoCool is developed under CRTDH project. It is an Evaporative Cooling with higher humidity based Chamber for improving the Shelf Life of Vegetables and Fruits. In a normal fridge the leafy vegetables gets dried. But in this HumidoCool chamber the leafy vegetables can be kept fresh up to 2 days. CSIR IMMT has transferred Know how of HumidoCool Technology to M/s Ranjeeta's Agrifoods Health And Hygiene Pvt. Ltd., a DPIIT,& Start up Odisha registered MSME company cofounded by Sri Govinda Chandra Swain, Director.

Cathode position detection in a transferred arc plasma using Artificial neural network

In a transferred arc plasma system, the position of the cathode is difficult to detect during the smelting process as it remains inside the cylindrical anode. Real-time and accurate cathode position detection leads to efficient smelting operation with optimal use of electrical energy. A machine learning technique is proposed by CSIR-IMMT to accurately detect the position of the cathode in a direct current (DC) transferred arc plasma system. The measured voltage signal sampled at 20 kHz is processed using a tunable Q-factor wavelet transform (TQWT) followed by statistical features extraction and a machine learning algorithm to provide accurate cathode position information. Two different machine learning algorithms are used in this work, namely, single hidden layer neural network (SHLNN) and single-layer extreme learning machine (SELM). The output of these machine learning algorithms provides accurate position information and is also compared to the traditional voltage-related position information. The experimental signal of a 30-kW DC plasma system and cathode position detection results is shown. The work is published in IEEE Transactions on Plasma Science in 2023.

HYDRO & ELECTROMETALLURGY

FOCUS

Development of environment friendly processes for commercial extraction of metals from ores, concentrates, and other important secondary resources through hydro- and electrometallurgical routes.

CORE AREA EXPERTISE

- Leaching
- Solvent extraction and electro-winning
- Solid-liquid separation
- Industrial waste management
- Project engineering

Extraction of metal values from polymetallic nodules

CSIR-Institute of Minerals and Materials Technology (CSIR-IMMT), Bhubaneswar is working on the development of technology for extractive metallurgy of polymetallic nodules (PMN) , supported by the Ministry of Earth Sciences, Govt. of India. The primary objective of this programme is to recover four metals, Cu, Ni, Co, and Mn from polymetallic nodules. Two processing routes having specific advantages are being explored to minimise energy, emissions, waste generation, while targeting the recovery of Cu, Ni, Co and Mn from polymetallic nodules with wide variety of product portfolio.

The hydrometallurgical processing route based on acid leaching is studied for the efficient removal of iron from the acid sulphate solution for the efficient recovery of Cu, Ni, Co and Mn with minimum generation of waste. During the year, successful reduction of metal losses during iron removal step was achieved. The second route is related to gaseous reduction roasting-melting process for the recovery of Cu, Ni, Co and Mn from polymetallic nodules. Subsequent to the gaseous reduction roasting of polymetallic nodules, melting of the reduced material resulted in separation of Cu, Ni, Co in the form of an alloy from the Mn-bearing slag, which is suitable to be used as a feed material for the production of silicomanganese alloy. The process of recovering Mn as the silicomanganese alloy from Mn-bearing slag has been established. Following the establishment of both these processing routes, one process flowsheet will be selected for pilot scale testing and its validation considering recovery of metal value, sustainable product portfolio, energy consumption, and waste generation.

Figure 1: Polymetallic nodules received as such, pelletized nodules and reduced pellets

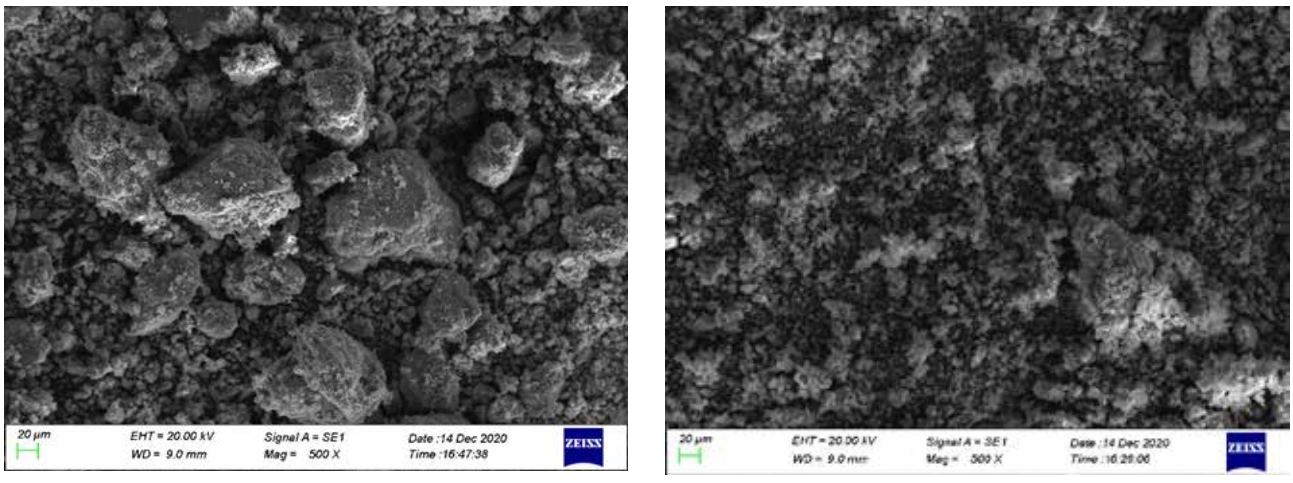


Figure 2: SEM images of raw and reduced nodules

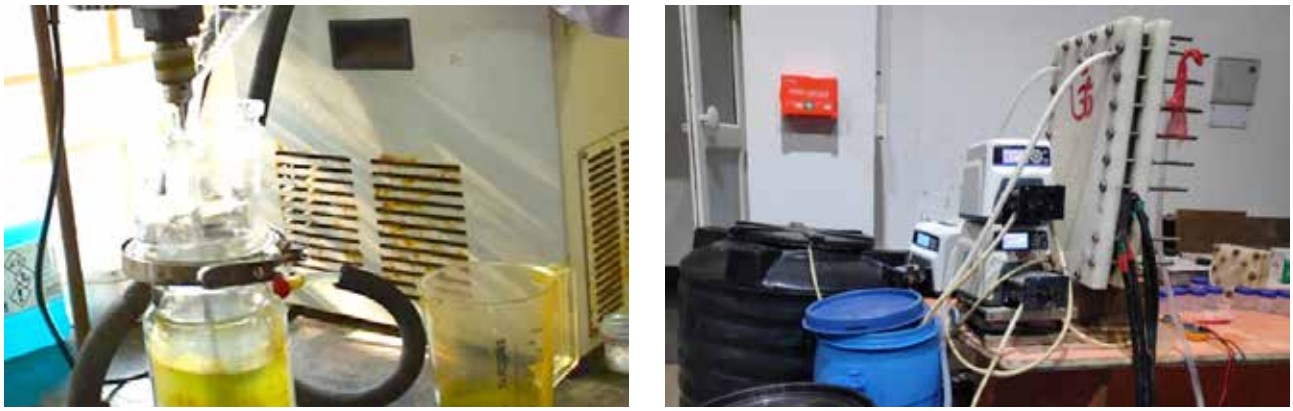


Figure 3: Removal of iron from acidic solution and ammonium sulphate splitting with 1000 cm2 cell

Technology development for holistic utilization of red mud for extraction of metallic values and residue utilization

Red mud is a potential source of several metal values such as iron, alumina, titanium, and REEs, which need to be recovered in order to develop a sustainable technology for its utilization. With NITI Aayog's directive, a consortium of alumina industries (NALCO, VEDANTA & HINDALCO) and R&D organizations (CSIR-IMMT, CSIR-NML and JNARDDC) is presently working on the development of a technology for holistic utilization of red mud to recover iron, alumina, titania and REEs in the form of mixed rare earth oxides. Chemical and mineralogical characterization of all three industrial red mud samples were carried out. Bench scale studies on recovery of iron values from red mud were conducted for all three samples through reduction roasting and low intensity magnetic separation after converting into micro-pellets for both non-beneficiated samples and the beneficiated samples provided by JNARDDC.

Subsequent to the recovery of iron values, the non-magnetic fractions of red mud samples of NALCO, HINDALCO and VEDANTA were characterized for phase distribution, chemical composition, and then processed through hydrometallurgical route for the recovery of alumina. The non-magnetic fractions of red mud samples were processed for the selective dissolution of alumina followed by its recovery as aluminium hydroxide. It was observed that the behaviour of alumina bearing phases in the non-magnetic fractions of three red mud samples are significantly different from each other for which specific conditions for the extraction of alumina from the non-magnetic fractions of red mud were developed independently and demonstrated to the industry partners. The leach residue generated after recovery of alumina will be processed further for the recovery of titania and REEs in the form of mixed rare earth oxides.


Figure 4: Demonstration of the developed process for industry partners

Recovery of electrolytic manganese dioxide (EMD) from manganese ore: Process optimization for existing plant at MOIL, alternate processes development, and basic engineering package preparation

Electrolytic manganese dioxide (EMD) is an important energy material with growing demands driven by electronics, EVs etc. Currently, MOIL Ltd. Nagpur is operating an EMD plant at their Dongri-Buzurg mines area in Bhandara district of Maharashtra with a capacity of 1000 TPA. The EMD produced at the plant is as per BIS standards (15063, 11153) and has been used in dry cell battery industry, chemical and pharmaceutical industries. However, recent market growth in Li-ion and high density alkaline batteries has resulted in demand for high pure EMD. In order to meet the market demand in terms of volume and product specifications such as purity etc., MOIL sought the intervention of CSIR-IMMT and CSIR-National Metallurgical Laboratory, Jamshedpur (CSIR-NML) to optimize its process and expand its facility to 10,000 TPA. The two institutes have jointly carried out R&D activities for possible incorporation of improvements in the new plant. In the first phase of the project, the following activities were completed successfully (1) Development of alternate process for EMD production based on SO2 reduction; (2) Design, MOC selection and optimization of EMD cell with improved efficiency and characterization of EMD for Li-ion battery applications; (3) Bench scale leaching optimization for improving Mn recovery (> 90% targeted); (4) Alternate reduction roasting process development using gaseous reductant. The final phase of the project, namely, Preparation of Basic Engineering Package (BEP) for 10000 TPA EMD plant has also been completed during the year. Two volumes of BEP were prepared – one each for continuous operation and batch operation. Each volume contained the basic equipment specification including capacity, type of equipment, material of construction, number of equipment etc., Equipment Flow Diagram (EFD), Piping and Instrumentation Diagram (PID), Plant Layout, Electrical Single Line Diagram (SLD) and Electrodeposition cell & electrode design drawings.

Urban mining of critical metals as energy materials from spent Lithium ion battery

R&D on the development of energy materials along with process based on close loop recycling is being continued through an innovative approach. For recycling of lithium-ion batteries based on heterogeneity of the starting materials, two processes have been developed and patents are being prepared. In contrast to more conventional processes, regeneration of electrode materials as products such as high crystalline graphite, graphene oxides, NMC and NCA types cathode materials, phosphate materials, aluminum based ceramic electrode material, oxide based electrocatalytic materials have been achieved under HCP-2802, GAP-322, and GAP-331 supported by CSIR, DST and Ministry of Mines, respectively. Product purity evaluation and performance through coin cell testing is periodically evaluated by monitoring the impurities in the product. The feasibility of addressing gaseous emission during the process development has been taken up to minimize the environmental issues. The projects are operated through consortia mode in collaboration with IIT Delhi, IISc Bangalore, CGCRI, ARCI, Chennai, Murdoch University, Australia, and SDU University, Denmark. Various industries are under discussion for the scale up of the process.

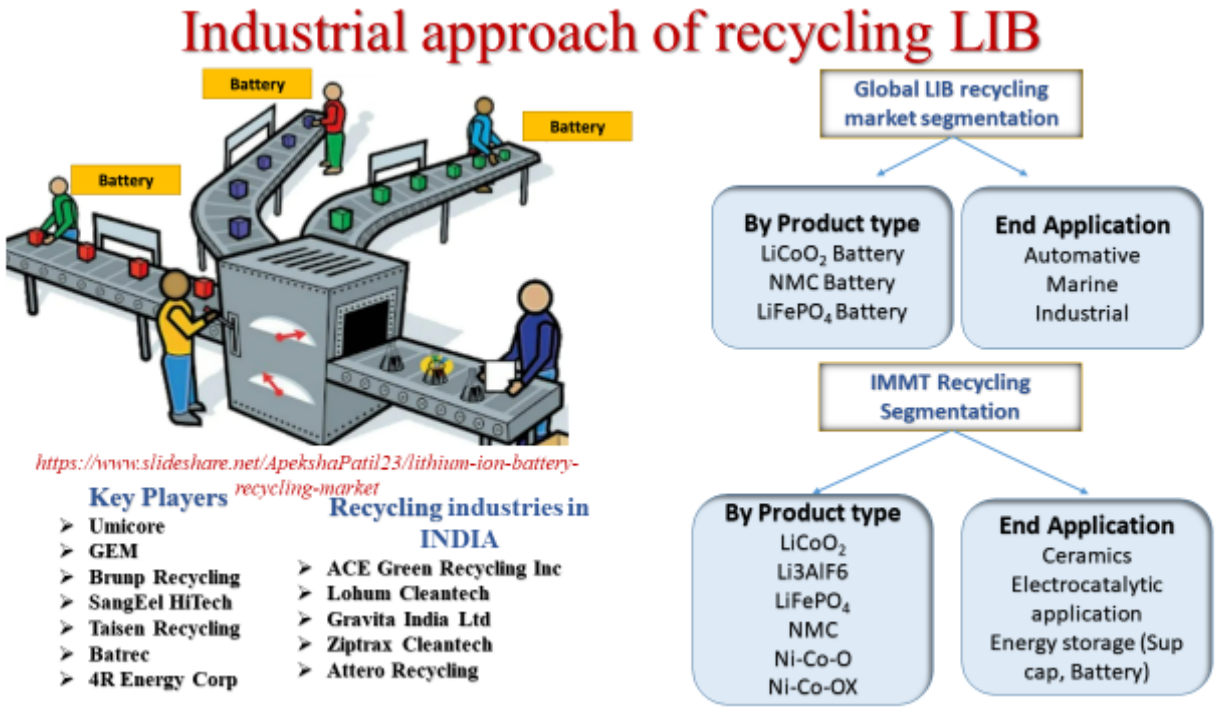


Figure 5: Global and CSIR-IMMT approach for the material development from Spent LIB

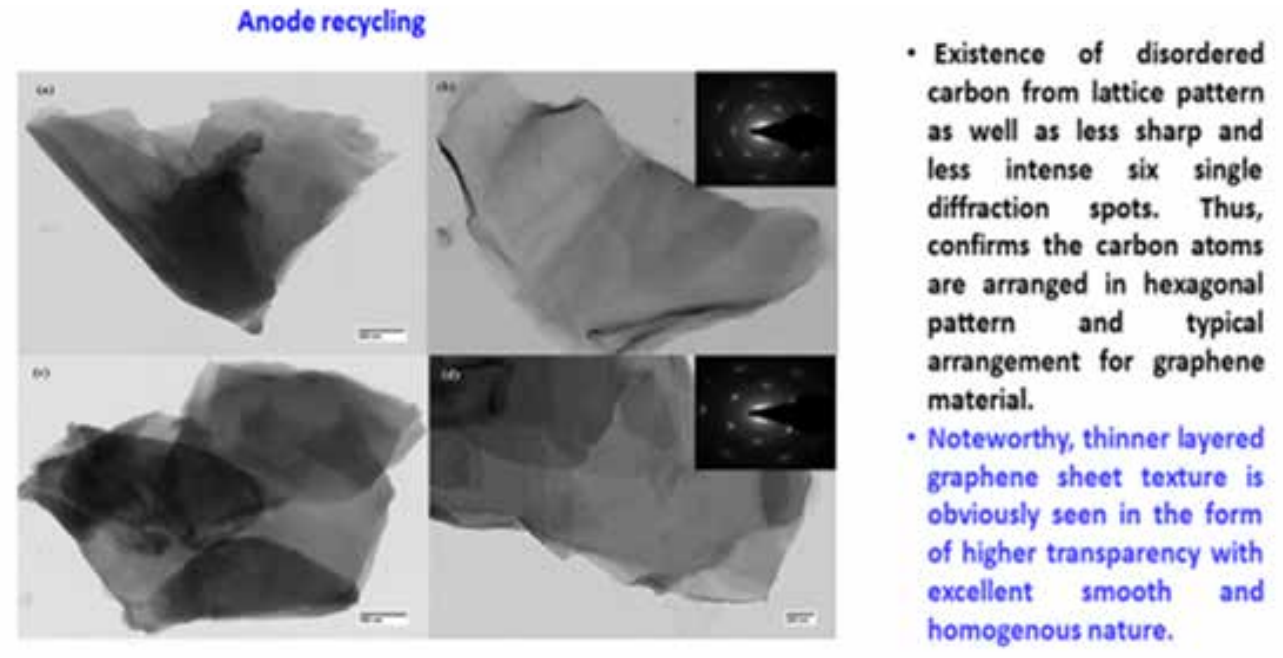


Figure 6: Anode recycling at CSIR-IMMT from Spent LIB

Sedimentation studies, up-scale testing, and basic engineering for thickener for treatment of Mn ore fines

MOIL produces about 10.3 lakh tonnes of Mn ore (as of 2015-16) annually. Of the total ores produced nearly 12-15% are of fine grade. The mine at Balaghat is an open cast mine with approximate production capacity of 3 lakh TPA of manganese dioxide ore that is used in dry battery industry; out of which, the fines amount to a significant quantity (~15%). Currently the fines produced by MOIL are settled in settling ponds, after which they are collected as slimes and dried. In this regard, establishment of a thickener system for fines dewatering will remove operational difficulties with settling ponds and enable systematic and convenient way of collection and storage of fines. The project work covered sample collection and characterization from Dongri-Buzurg mines, sedimentation and flocculation studies on settling of Mn ore fines collected, bench scale testing and preparation of basic engineering package of a thickener system for 400 TPD Mn Ore fines plant - equipment specifications, drawings such as Equipment Flow Diagram (EFD), Process and Instrumentation Diagram (PID) and Plant Layout.

Basic engineering package (BEP) for setting up of pilot/ demonstration plant on use of fly/pond ash for production of wear-resistant ceramic tiles

NALCO generates huge amount of fly ash in their captive power plant. The storage of fly ash is an environmental problem. Fly ash is an excellent raw material for wall tiles and effectively complements clays in the standard tiles raw materials mix. The use of fly ash for tiles significantly reduces waste disposal problems. CSIR-IMMT completed a project on the preparation of BEP for production of wall tiles in pilot scale using fly ash and clay available in Eastern India with the support of IIT Kharagpur and KIIT Bhubaneswar. The project work covered discussion with tiles industry experts, visit to tiles factories, clay mines, vendors in market to develop process flowsheet, technical specifications of equipment, identify Quality Control Lab infrastructure, Equipment Flow Diagram (EFD), Process and Instrumentation Diagram (PID), Electrical Single Line Diagram (SLD) & Plant Layout, costing for 100 kg flyash tiles/day plant.

Recovery of valuables from spent pot lining carbon and bench scale testing

NALCO generates Spent Pot Lining (SPL) from their smelters after the end-of-life of the individual smelter units. CSIR-IMMT has completed a project from NALCO based on in-house R&D carried out at NALCO for the optimization of SPL utilization flow sheet and bench scale testing. The process flow sheet was optimized for removal of fluoride and cyanide while simultaneously recovering by-products such as caustic soda, carbon residue and calcium fluoride. Around 50 kg of SPL was processed in bench scale and the material balance data was used to arrive at process energies and costs.

Figure 7: Hydrometallurgical processing of SPL for removal of hazardous constituents

Extraction and isolation of Al, K, Li, Rb and Cs from Mica

An extension of the ongoing Mica project with separate funding has been sanctioned by the Ministry of Mines, New Delhi for the possible recovery of metal values through hydrometallurgical approach. The Eastern part of India comprises of huge and scattered mica reserves in the north-western part of Odisha, Jharkhand and Chattisgarh. The muscovite and biotite micas are common rock forming minerals. Thus, mica of varied origin was basically collected and subjected to different mineralogical and chemical characterizations before recovery of Li, Rb and Cs. Presence of potassium was also observed in significant amounts in Mica for all the studied regions. There is no Li found in Odisha based Mica but Jharkhand and Chhattisgarh based Mica are found to contain 0.24% and 0.56%, respectively. A comparative study for the extraction of valuable metals will be carried out for the collected samples utilizing hydrometallurgical route.

Recovery of Mn as EMD from low grade ores and secondaries for energy application

CSIR-IMMT carried out a CSIR-funded project under 4M theme, and has developed a process for producing battery-grade Electrolytic Manganese Dioxide (EMD) from low-grade Mn ores rich in iron, from different manganese mines such as Barbil, Dongri etc using lean SO_2 as a reductant. A room temperature leaching process for selective Mn extraction with limited iron dissolution from different low grade ores using SO_2 concentration of 10% (v/v) (lean SO_2 is available as a by-product in smelters or generated from sulphur burners) followed by purification and electrodeposition of EMD has been achieved. An enhanced and selective Mn bioleaching technique was also established using anaerobic microorganisms and novel solid electron shuttles. The EMD produced surpasses the BIS standard IS11153:1996, containing >90% MnO_2 and less than 300 ppm iron.

Liquid- Liquid- Liquid extraction & stripping of metal ions in multi-helical flow reactor

The parallel flow of three liquids in a multi-helical flow reactor is in exploitation with interfacial mass transport of metal ions for achieving the simultaneous process of liquid-liquid-liquid extraction and stripping is supported by CSIR project under 4M theme. The success of this project can result in an alternative reactor to mixer-settlers and for its cascades too.

Functionalized indigenous ion exchange resins for selective separation of Rare Earth Elements

Under other lab project an effort has been made to increase the resin's selectivity for the separation of praseodymium from Neodymium by functionalizing indigenous resin with di-2-ethylhexyl phosphoric acid (D2EHPA). In general, due to the chemical similarities of rare earth elements, it is challenging to separate them into ultrapure form by using resins. An effort has been made to increase the resin's selectivity for the separation of praseodymium from Neodymium by functionalizing resin with di-2-ethylhexyl phosphoric acid (D2EHPA). The potential of macro porous chloromethylated styrene divinyl benzene resin (from M/s. Thermax Pvt. Ltd.) functionalized with D2EHPA to separate rare earth elements like neodymium and praseodymium in acid media has been investigated. Results indicated that neodymium was preferentially extracted as compared to praseodymium. In both hydrochloric acid and sulphuric acid media, stripping of neodymium was much higher than stripping of praseodymium.

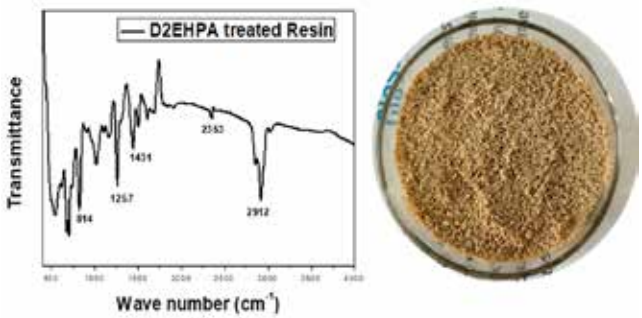


Figure 8: FT-IR spectrum of D2EHPA treated resin and Functionalized Resin

Conversion of emitted CO2 to chemical fuels

Under GAP-302 funded by Ministry of Steel, the lab scale indigenous CO_2 electrolyzers such as H-type, flow and zero gaps were developed and analyzed at CSIR IMMT. CO_2 electrolyzer at current density >150 mA/cm^2 at -1.2 V was observed along with Faradaic efficiency of 69% against HCOOH and the cell performance for 16 hrs has been tested. A tentative techno-economic analysis has been proposed by considering lab scale results using flow cell to upscale the process for 50 kg of HCOOH per day.

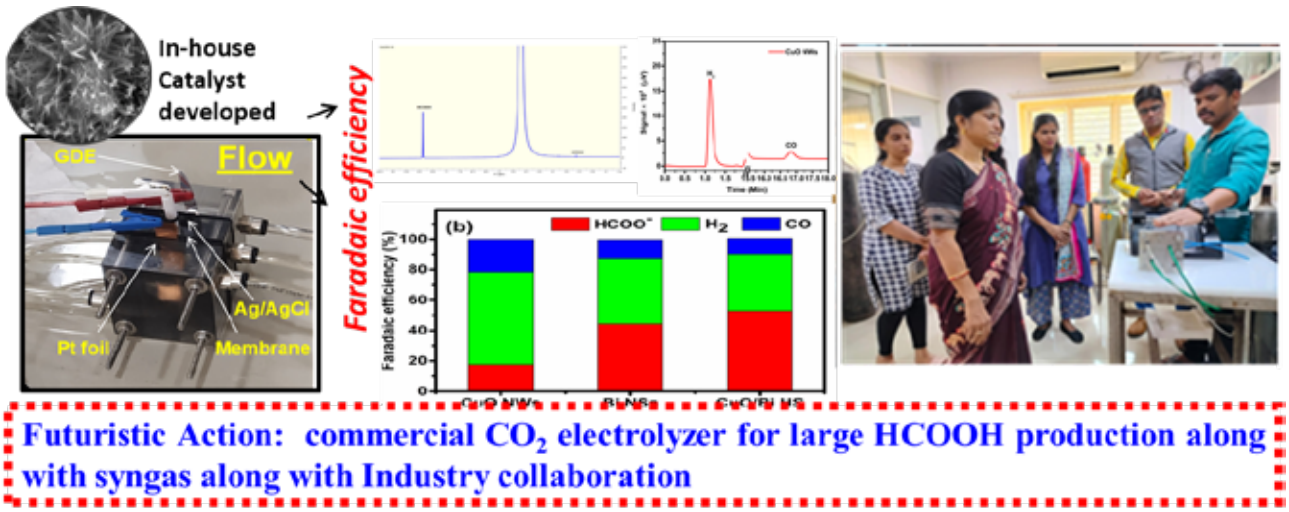


Figure 9: Developed catalyst, fabrication of CO2 electrolyser and demonstration of the developed product to the industry

Materials for stealth and Microwave application

Under joint CSIR funded project, indigenous ferrite and silica based strategic hybrid materials are developed and utilized for fabrication of stealth and microwave components in collaborative mode with CSIR-NAL. Developed Stealth parts for aircraft (CSIR-IMMT contribution towards bulk production of indigenous stealth materials).

Development of energy materials

Advanced and sustainable energy storage technologies with tailorable electrochemically active materials platform are the present research dominancy toward an urgent global need for electrical vehicles and portable electronics. Current and future market demands of such devices with higher levels of performance require competitive electrode materials for developing long-term sustainable energy storage systems

(a) Oxalate materials for development of ASC from low grade resources

The creation of novel electrode materials with improved electrochemical kinetics is the key to efficient charge and energy storage. Bimetallic oxalate phase of Fe-Mn were synthesised from a mixed acid processed leach liquor for fabricating asymmetric solid-state device. Above device showed a specific energy of 3.5 Whkg^{-1} and a specific power of 224 Wkg^{-1} at 0.3 Ag^{-1} with a capacitance retention of 77% for 2000 cycles.

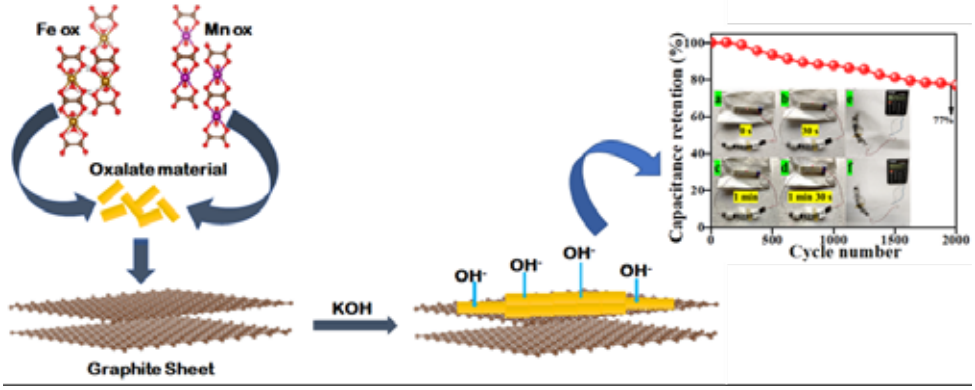


Figure 10: Utilisation of low grade Mn resources for developing asymmetric supercapacitor device (ASC)

(b) Development of low cost hybrid metal oxides for supercapacitive application

Manganese and iron based composites with high surface area have been developed for energy storage application. The composite exhibits high specific capacitance of 387.9 Fg^{-1} at 2.5 Ag^{-1} current density with corresponding specific power density of 1250 Wkg^{-1} and energy density of 146 $Whkg^{-1}$. Further the electrode materials were also demonstrated using Trasatti and Dunn's method revealing the diffusion-controlled storage process as being dominant in the contribution towards the total capacitance for the supercapacitor having great potential as energy storage material.

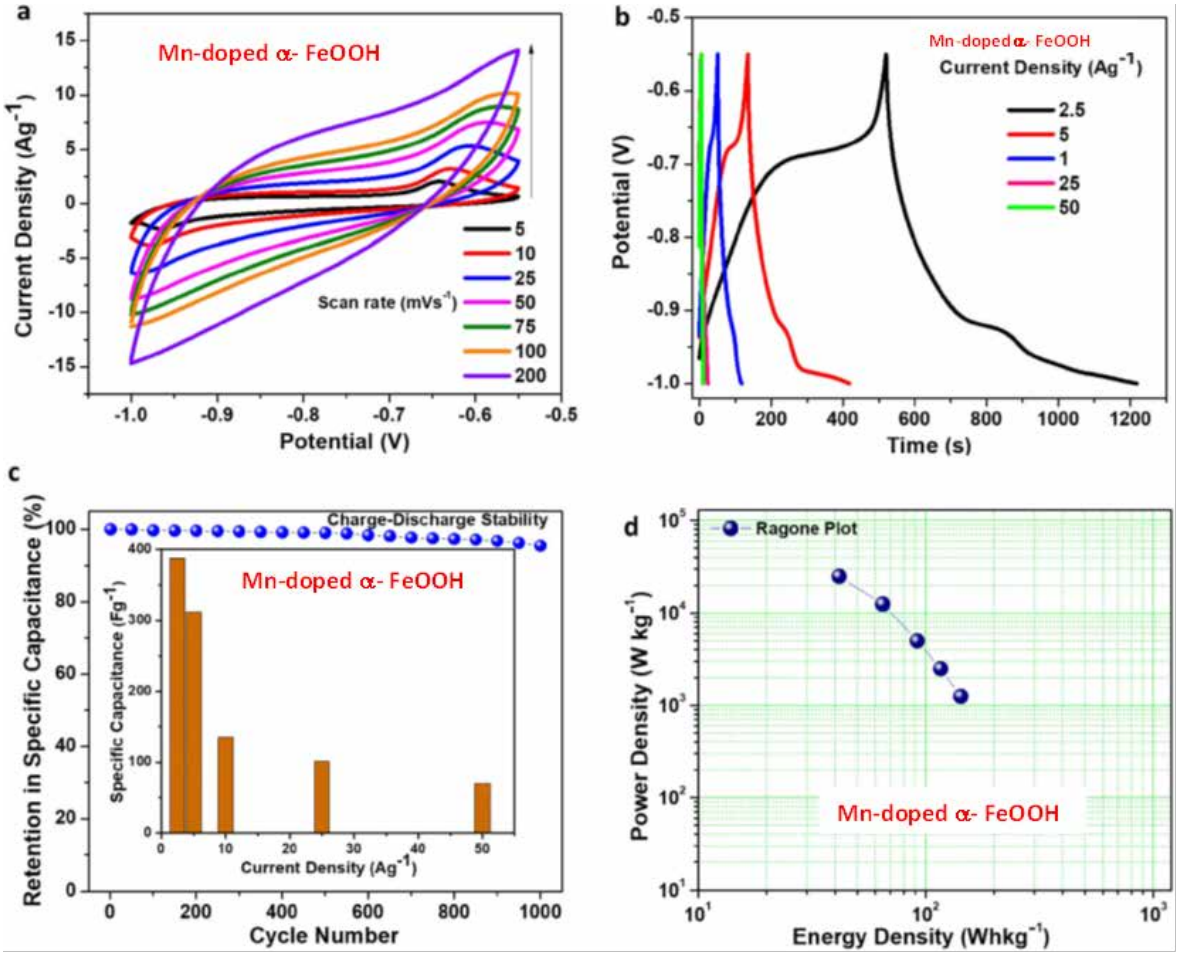


Figure 11: Electrochemical properties of the synthesized Mn doped FeOOH samples

(c) Development of binary and mixed metal sulfides for super capacitive / hybrid

Under Ph.D programme, novel sulfides and their composites using various strategies yielding optimistic productivity in terms of electrical conductivity, morphological support, and robustness for overall performance enhancement as effective electrode materials for SCs. A low-cost and scaled-up controlled microwave synthesis method has been developed for engineering 3D pyramidal faceted Chalcostibite ($CuSbS_2$) architectures towards supercapacitive application. The facets provide plentiful electroactive sites along with easy transport of ions unveiling a high specific capacitance of 172.28 F/g at 0.6 A/g (171.42 F/g at 5 mV/s). A simple time effective novel microwave route of synthesizing 2D SnS was developed. Parameter management of microwave irradiation can meritoriously yield high pure products with desired shape and morphology in few minutes omitting the need of complex operation conditions of conventional methods. The as synthesized 2D SnS polygonal microrods named as polyrods (SPRs) provide large surface area and active sites for high electrochemical activity. 2D SPRs were found to reflect an excellent specific capacitance of 589.6 F/g at a current density of 1.6 A/g with an excellent capacitive retention of 98.2 % after 5000 cycles. A symmetric SC could also exhibit a high capacitive retention of 82.8% at high of 5 A/g after 5000 cycles.

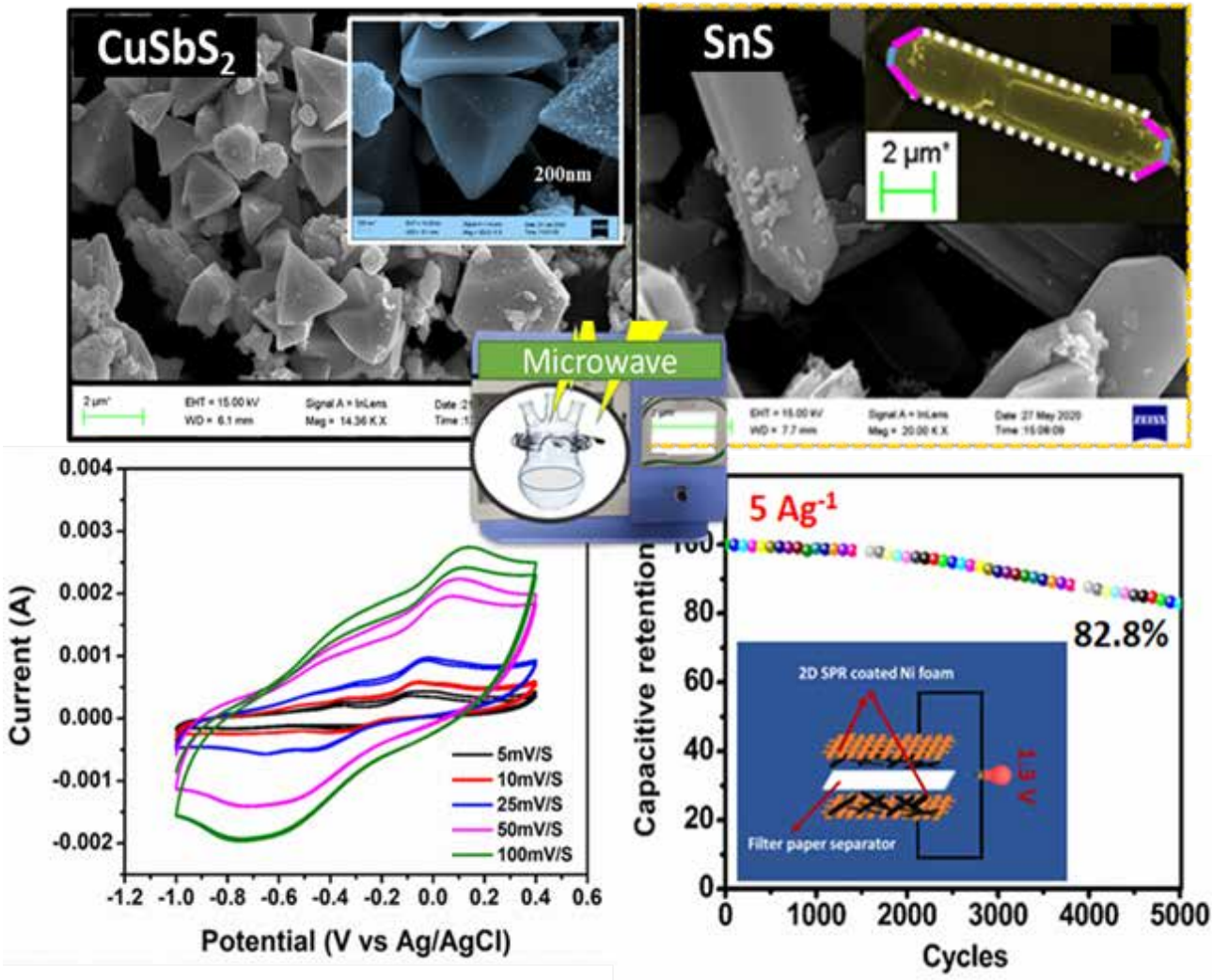
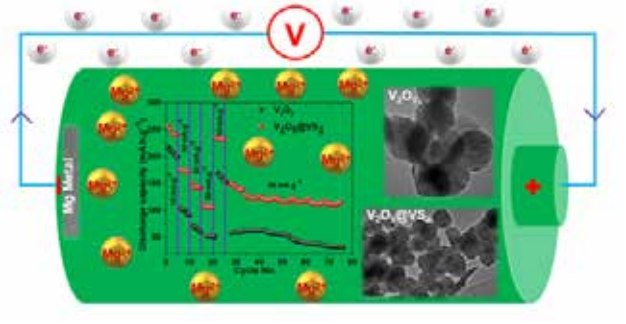


Figure 12: Sulphide materials for super capacitive / hybrid energy storage systems

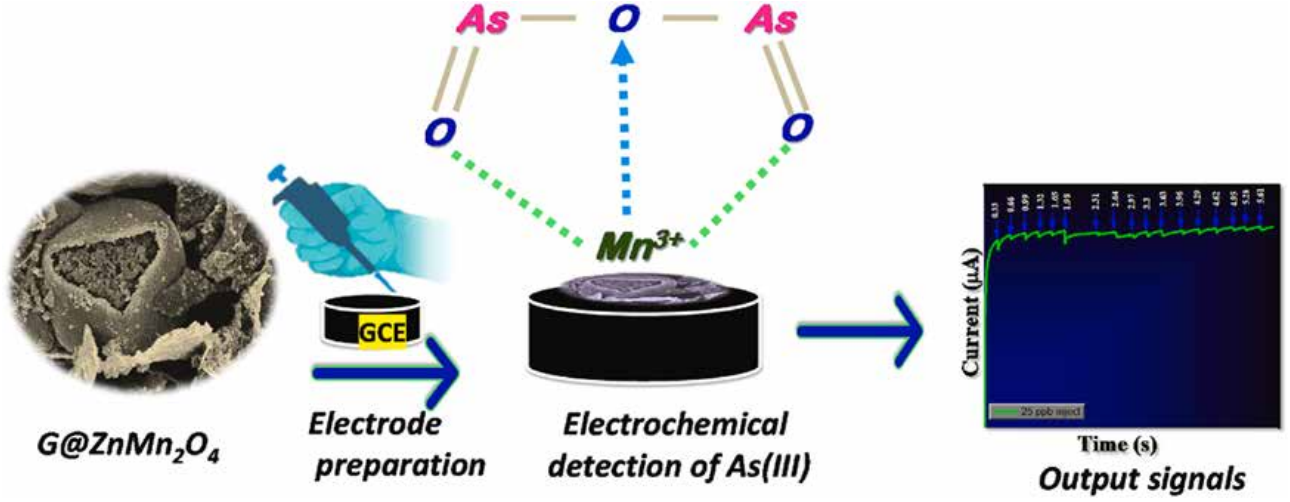
(d) Sacrificial vanadium sulphide encapsulation for rechargeable Mg-ion battery

Rechargeable Mg-ion Batteries (RMB) containing a Mg metal anode offers the promise of higher specific volumetric capacity, energy density, safety, and economic viability than lithium-ion battery technology, but their realization is challenging. The limited availability of suitable inorganic cathodes compatible with electrolytes relevant to Mg metal anode restricts the development of RMBs. Despite the promising capability of some oxides to reversibly intercalate Mg^{2+} ions at high potential, its lack of stability in chloride containing ethereal electrolytes, relevant to Mg metal anode hinders the realization of a full practical RMB.

Here we demonstrated the successful in situ encapsulation of monodispersed spherical V_2O_5 (~200 nm) by a thin layer of VS_2 (~ 12 nm) through a facile surface reduction route. The VS_2 layer protects the surface of V_2O_5 particles in RMB electrolyte solution ($MgCl_2$ + MgTFSI in DME). Both V_2O_5 and V_2O_5@VS_2 particles demonstrated high initial discharge capacity. However, only the V_2O_5@VS_2 material demonstrates superior rate performance, Coulombic efficiency (100%), and stability (138 $mAhg^{-1}$ discharge capacity after 100 cycles), signifying the ability of the thin VS_2 layer to protect the V_2O_5 cathode and facilitate the Mg^{2+} ion intercalation/deintercalation into V_2O_5.



Material development for electrochemical detection of Arsenic



Under Ph.D programme various hybrid composites are synthesised as electrode materials for the electrochemical detection of toxins. For e.g $ZnMn_2O_4$ and $ZnMn_2O_4$ modified with graphite sheets (G@$ZnMn_2O_4$) to detect As (III) have been investigated and reported for the first time. G@$ZnMn_2O_4$/GCE attained a sensitivity of 12.528 $\mu Appb^{-1}cm^{-2}$ with the lower detection limit (LOD) of 0.87 ppb within the range of 0.33 ppb–5.61 ppb. This study also aims to develop low-cost hybrid materials using graphite to modify the metal oxide in place of commonly used rGO, GO, graphene sheets and others. This study will continue for bench and pilot scale production of the above material and market it at negligible cost for a chip-based easy, highly precise sensor which will in real-time help the neediest and most highly impacted people of the society by the arsenic menace.

MATERIALS CHEMISTRY

FOCUS

The main research thrust of the department is on new materials development including synthesis, processing, and characterization of advanced hybrid (inorganic-organic) materials, nanocomposites, nanostructured materials, functionalization of new materials, tunable smart materials, tailoring band-gap of materials, metal organic frameworks, antifouling anti-bacterial materials, superhydrophobic materials, etc by soft chemical synthesis and solid state synthesis for applications in water treatment, energy applications in fuel cells, supercapacitors, solar to hydrogen fuel, photoelectrochemical water splitting, thermoelectric materials, magnetic refrigerant materials, sensors, chemo-biosensors for detection of heavy metal contaminants in water, gas storage and CO2 sequestration applications.

CORE AREA EXPERTISE

- Industrial coatings by electrophoretic deposition (EPD), high-velocity oxy-fuel (HVOF), cold spraying, dip-coating, spin coating, and sol-gel coating
- Thermal barrier coating, corrosion resistant coating, tribological coating (erosion wear and abrasion resistant coating), antibacterial coating, biocompatible coating, functionally graded
  coating, multifunctional and tunable smart materials coating, and self-healing coating.
- Molecular probes for sensing application
- Development of engineered photocatalyst for solar H2 generation/ solar fuels
- Multifunctional, tunable and smart materials for energy storage and conversion
- Hydrophobic and superhydrophobic materials for surface wettability
- Solid oxide fuel cells (SOFC), proton conducting fuel cells (PCFC)
- Self-cleaning gallium ferrite nanocrystals
- Thermoelectric materials & magnetic refrigerant materials
- Porous organic polymer (POP) based sorbents for gas storage application.

Impact of induced disorder on the structural, electrical, and optical properties of $BaTi_{1-x}Hf_xO_3$

Due to the outstanding electrical and mechanical properties, the lead-based ferroelectrics are widely used in actuators, transducers, and multilayer capacitors. Due to toxicity, lead based material are usually avoided, therefore ferroelectric materials with low dielectric loss, tan δ < 0.05, and high d33 values are highly preferred for device fabrication/commercialization. Due to strong ferroelectric and piezoelectric capabilities, Barium Zirconium Titanate (BZT) has come up as an alternative. In the same group of periodic tables, Hf occupies a lower position than Zr, so better performance is expected from Hf-doped BT (BHT). Here the effect of Hf4+ substitution on the structural, dielectric, ferroelectric, piezoelectric, and optical properties of barium titanate (BT) prepared via the modified (low-temperature sintered) solid-state reaction route has been investigated.

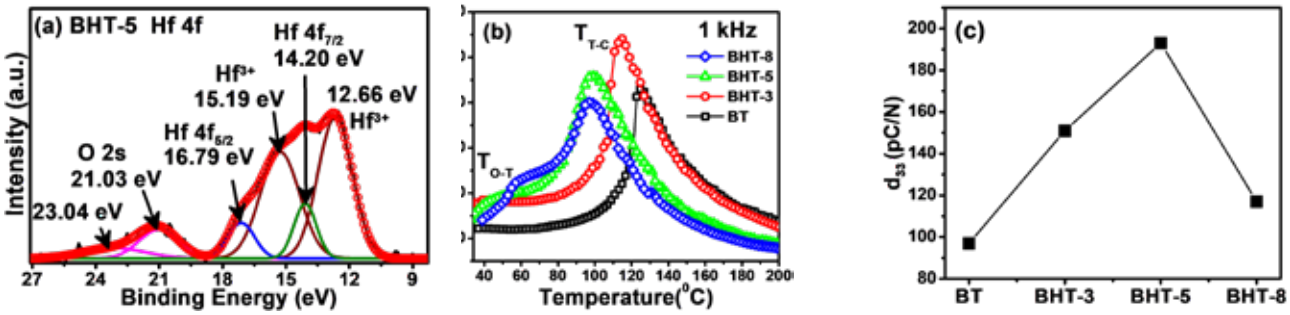


Figure: (a) The XPS peak of Hf 4f and O 2s confirming the presence of under-coordinated Hf3+ and disordering of Ti-O bonds, (b) the variation of dielectric constant with temperature, and (c) the variation of d33 with composition.

Through Rietveld refinement, we confirmed the formation of the tetragonal phase for BT and a mixture of P4mm + Amm2 for BHT-3 and BHT-5, and Amm2 + R3m phase for BHT-8. The content of the orthorhombic phase increased from 38.14% for BHT-3 to 57.89% for BHT-5 and then decreased to 20.27% for BHT-8. The RT micro-Raman spectroscopy of the Hf4+ substituted BT confirmed the presence of two types of octahedra consisting of Ti and Hf in the perovskite structure. The XPS analysis confirms the presence of oxygen vacancies formed due to disordering. The Curie temperature decreased while the orthorhombic to tetragonal and rhombohedral to orthorhombic phase transition temperatures increased with the rise in Hf4+ content in BT. The loss tangent close to RT initially increased until BHT-5 and then fell for BHT-8. The presence of under-coordinated Ti3+ and Hf3+, as confirmed by the XPS analysis, resulted in more leakage current, increasing the loss tangent with Hf -substitution. The maximum piezoelectric charge coefficient = 193 pC/N was obtained for BHT-5. The energy storage efficiency was greater than 65% for all the compositions, making them suitable for high-energy-density capacitors. The optical bandgap increased with the rise in Hf4+ content. The direct optical bandgap varied from 2.783 to 2.892 eV, making them suitable for optoelectronic applications as well. Due to the presence of Ti3+/Hf3+ ions, the bandgap of all the compositions was lower than earlier reported values, making them suitable for optoelectronic applications.

Tunable hysteresis loop with enhanced energy harvesting performance in PVDF films

The search for flexible, eco-friendly renewable energy sources for powering low-energy gadgets is in demand. Materials with versatile properties and applications are the demand of the present era, especially a single material that can be tailored such that, under different conditions and can be used for energy storage, memory applications, etc. With respect to a ferroelectric material, the resistance-dependent change in piezoelectric harvesting has been reported however variation in ferroelectric behavior under different conditions is rarely observed. By the nature of the PE hysteresis loop, the ferroelectric materials can be characterized as (i) energy storage devices having slim PE loop with high value of PS – Pr (difference between saturation and remanent polarization) and (ii) memory devices having rectangular PE loop with large remanent polarization and a low coercive field [6]. Materials for ferroelectric non-volatile memory applications have high Pr value, low coercive field, and they can keep intact the stored information even after power goes off [6]. In contrast to that, large saturation polarization, small remanent polarization, and more electric field are the necessary conditions for a suitable energy storage device. The more the PS – Pr value, the more is energy that can be given off/released when the power is cut off. Hence, more energy can be supplied in the form of capacitive energy.

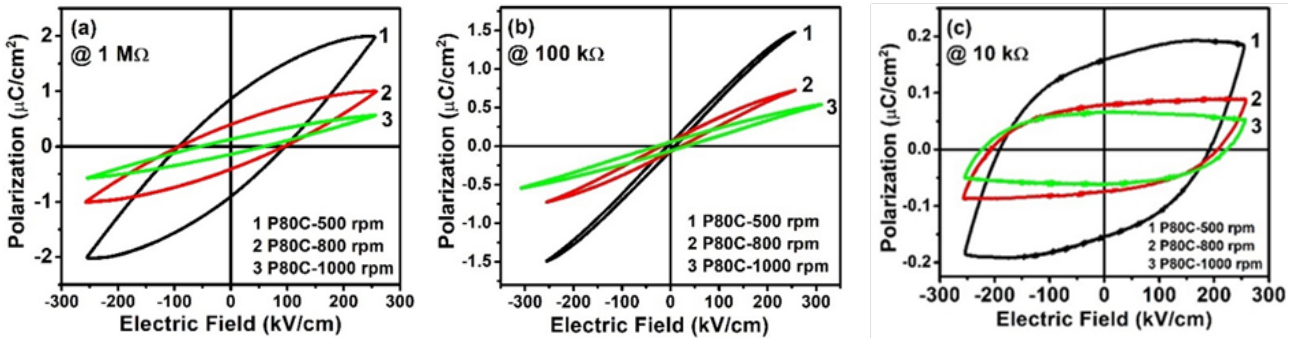


Figure: (a)-(c) variation in the PE hysteresis loop with the change in reference resistance of the Sawyer-Tower circuit.

In view of the above, the spin-coating polyvinylidene difluoride (PVDF) free-standing thin films were prepared and annealed at 80 °C and 100 °C temperatures, then hot-pressed at 150 to attain piezo phase and strength. The XRD patterns and FTIR data confirmed the presence of a mixture of α, β, and γ phases for each annealing temperature. The electroactive phases were found to be greater than 79% for all the films. The variation in PE hysteresis loop as a function of reference resistance of 1 MΩ, 100 kΩ, and 10 kΩ, at a constant capacitance of 47 nF were investigated. Fig. (a)-(c) show the effect of variation of reference resistance on the PVDF films with different spinning rates and annealing temperatures. There is a significant difference between the saturation polarization and remanent polarization (P_s-P_r) for the applied reference resistance of 100 kΩ, making the films suitable for energy storage devices. Also, by changing the reference resistance to 10 kΩ, the rectangular PE loops are obtained, making them suitable for memory devices. The change in PE loop by varying the reference resistance, is due to its behaviour (internal resistance and capacitance of the film) in response to the applied resistance which is due to the impedance mismatch between the applied resistance and the sample's resistance. The variation in polarization curve might be due to the molecular chain response towards the reference resistance under consideration. The varying nature of the PE hysteresis loop of the films with respect to the applied reference resistance, made them suitable for both energy storage and non-volatile memory applications. Apart from this, the PVDF films annealed at 80 °C for 800 rpm showed the maximum output voltage of 24.8 V, making the material suitable for multiple applications.

$La_2Ce_2O_7$ Electrolyte based proton conducting SOFC via EPD technique

It is crucial to carefully choose a proton conducting electrolyte that is both highly conductive and chemically stable in the working environment. The current state of the art electrolytes has various problems such as low conductivity and chemical instability in the working environment. Currently, La2Ce2O7 (LCO) based electrolyte is gaining popularity because of its chemical stability and sufficient protonic conductivity at intermediate temperature (400-700°C). Apart from selection of suitable electrolyte candidates, their processing techniques is one of the critical factors that overall decides the fabrication coat of the solid oxide devices.

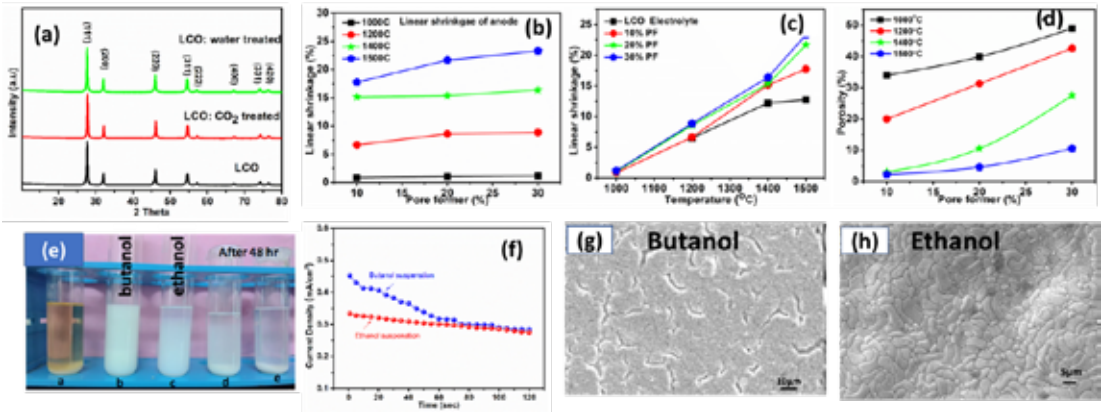


Figure: (a) Chemical stability test of LCO electrolyte, (b-d) linear shrinkage of LCO w.r.t anode, (e) suspension stability test, (f) current density against time during EPD of LCO, (g-h) microstructure of LCO after coating in different media.

We used a solid-state technique to produce $La_2Ce_2O_7$ as an electrolyte and studied its chemical stability in boiling water (100°C) for 24 hrs. and a 100% CO_2 (@ 700°C) environment. There were no phase changes noticed after stability test in different environment as shown in Fig **a**. In order to fabricate the dense and crack free electrolyte, shrinkage of LCO and anode substrate is important consideration. The shrinkage behavior (Fig. (b-d)) of LCO electrolyte and anode indicates that even 10% pore former is sufficient to get the dense coating of LCO, however, to avoid the concentration polarization losses, 20% pore former was utilized for the fabrication of dense LCO electrolyte. The suspension chemistry of LCO dispersed in various solvents and the order of stability was: butanol> ethanol> acetone> acetyl acetone ≈ isopropanol (Fig. e). When EPD performed in butanol media, the surface morphology of LCO appeared crack on it after sintering at 1500C for 2 hrs. whereas in ethanol, the surface of LCO was dense and crack free (Fig. h) It is due to slow decrease in current density with time during deposition (shown in Fig. f).

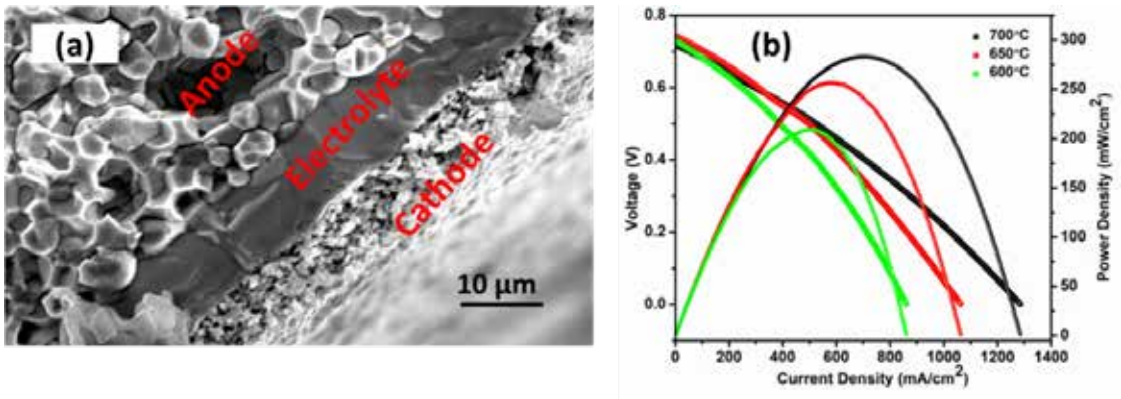


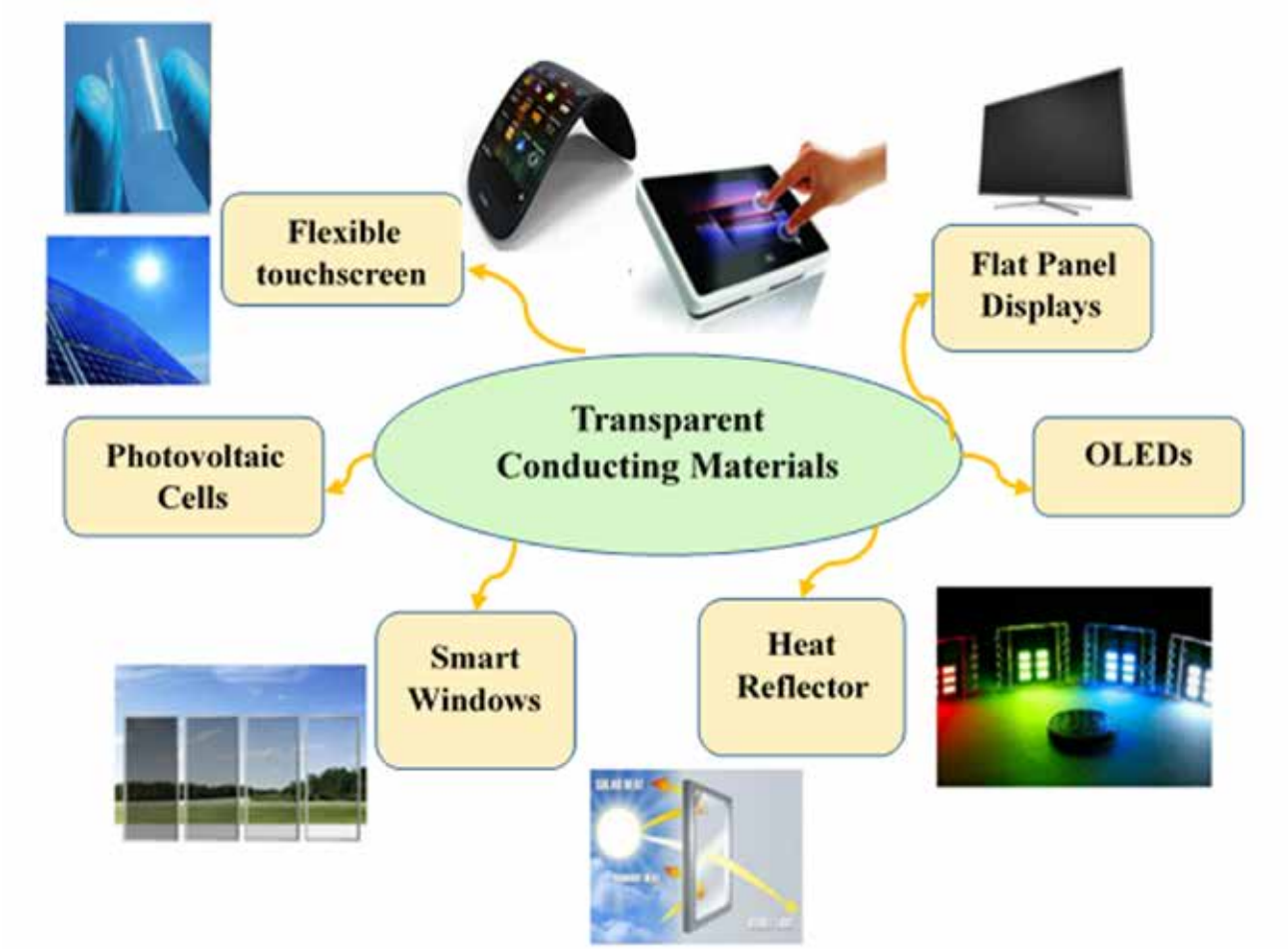
Figure: (a) SEM images of button cell (cross-section) and (b) I-V-P curve of LCO based SOFC at various temperatures.

On applying the cathode layer, a mixture of $La_{0.6}Sr_{0.4}Co_{0.8}Fe_{0.2}O_3$ and LCO (70%LSCF-30%LCO), on surface of the electrolyte followed by sintering at 1100C for 2 hrs., the electrochemical performance of the cell was tested in with wet hydrogen (~3% H_2O) as fuel and static air as oxidant at 600-700°C.

The maximum power density reached was 283 mW/cm^2 at 700°C which is comparable with the $BaZr_{0.9}Y_{0.1}O_3$ based electrolytes. The micrographic image of fabricated SOFC via EPD of LCO and I-V-P curve are shown in Fig. a and Fig. b respectively. Therefore, this study clearly demonstrates that LCO and its related electrolyte can be the potential candidates for proton conducting SOFCs.

New transparent conducting materials for flexible optoelectronic devices

Increasing market demand for larger-area display devices with greater writing speeds and faster graphics has resulted in a pressing demand for developing new and improved materials with advanced functionalities like decreasing the resistivity while maintaining the transparency in materials-a trade off relationship as it is difficult to achieve both the features simultaneously. Such materials form the back bone of the whole market covering display devices, touch screens, digital electronics, opto-electronics etc. Hence developing such new materials using easily available resource materials in India, following easy/low cost processability methods for meeting the present and future technological demands is strategically important. Current transparent conducting materials market and related industries is dominated by the key component-Indium doped Tin Oxide (ITO). But scarcity of indium resources is leading to the increasing market prices and imbalance between increasing market demand and limited supply. Indium is already declared as a critical mineral in the EU list. Also, it has the additional disadvantages of being more brittle with aging and chemical instability in acid/base environments. Furthermore, parasitic leakage may be caused by metallic-ion diffusion from ITO into thin barrier layers. Hence finding a cost-effective alternative to ITO having high performance, abundance, chemical and mechanical stability and easy/low cost processability for meeting the present and future technological demands is crucial.



In this project we intend to (i) Develop materials with high electrical conductivity and high optical transparency- two seemly incompatible properties for conventional solid state materials, simultaneously. (ii) Adopt solution based techniques which are simple, inexpensive and easily adaptable for large area deposition. (iii) Develop new transparent conducting materials using more earth abundant and cheaper materials.

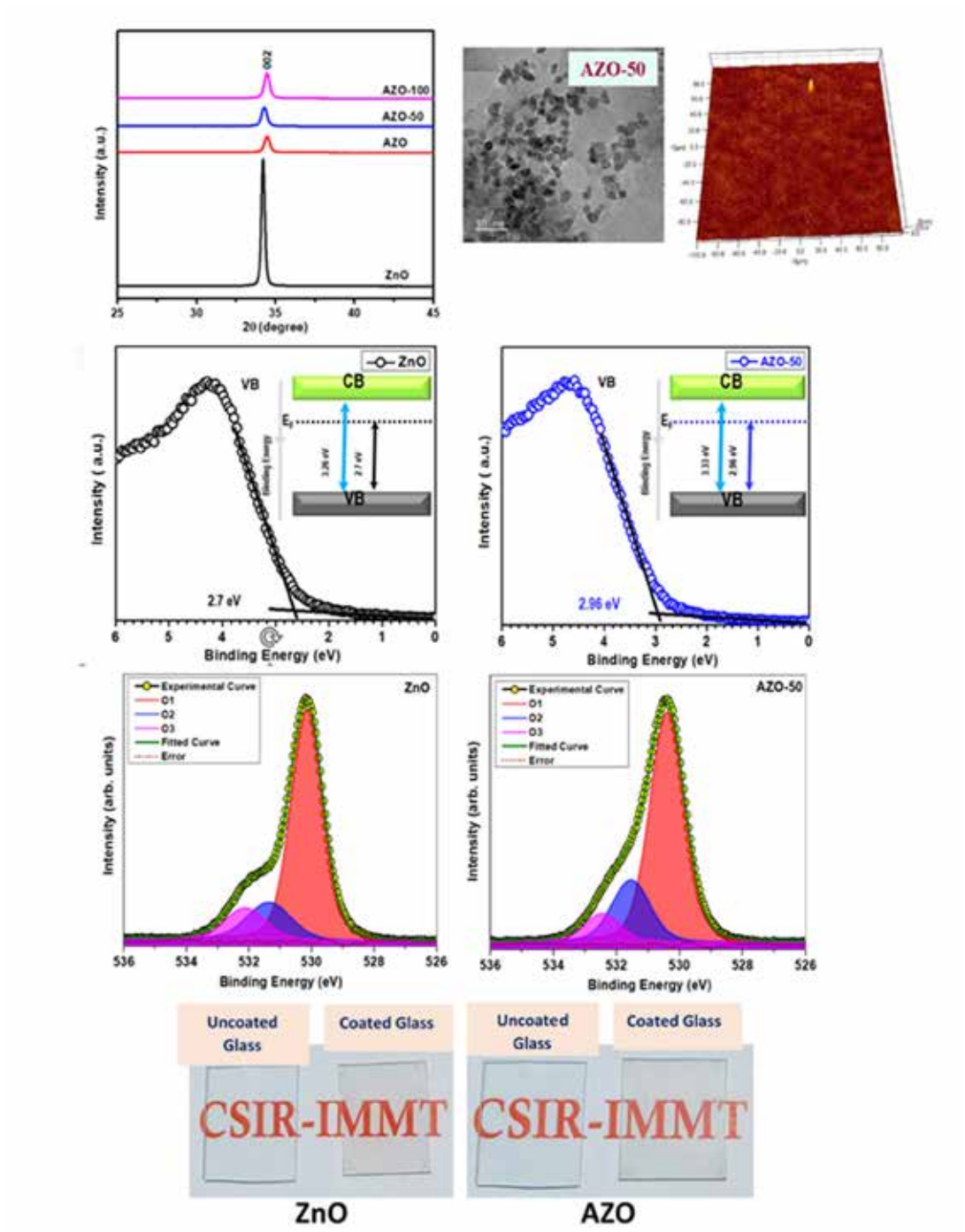


Figure: (a) X-ray diffraction patterns of Al doped ZnO systems synthesized at different pressures clearly showing the formation of high quality, crystalline samples with hexagonal wurtzite structure. (b) TEM images of Al doped ZnO systems subjected to 50 bar pressure showing nearly uniform particle size distribution (c) Surface roughness of the fabricated AZO film evaluated using profilometer. It was observed that the 3D surface roughness of all the films were ~ 0.011 µm. (d) Core-level x-ray photoemission spectroscopy measurements of various systems under investigation. Valence band spectra as well as the schematic of the energy level diagram for undoped and Al doped ZnO combining the results from the optical and electronic structure measurements. O 1s spectra as well as their spectral decomposition showing various O-species present in the system for undoped and Al doped ZnO system (e) Good quality Al doped ZnO films with high transparency (~ 98 %) in the visible region could be fabricated using inexpensive spin coating techniques. Transparent conducting thin films fabricated in the lab.

Flexible piezocomposite materials for self-powered electronics

Future portable electronics require devices that are flexible, lightweight and self-powered for their use in IoT and Industry 4.0. This has led to an increasing interest in sensors based on strain, touch and acceleration with particular emphasis on self-powered sensors or those that can work in combination with energy harvesters. Hence researchers have started exploring the possibilities of harnessing ambient energy from within the vicinity of the sensor device and converting into usable electrical energy leading to self-powered systems which are truly autonomous without human intervention for energy replacement. Piezoelectric materials can lead us towards such a battery-less technology. Additionally, advancements in the field of low power electronics and wireless sensor networks (WSN) have driven the idea of vibrational energy harvesting using piezoelectric generators, especially in ultralow power wireless microcontroller units and ultrasmall power integrated circuits, which can run with only tens of nW to hundreds of µW of power. Due to their relatively simple structure, miniaturization viability, and high energy density, ferroelectric and piezoelectric materials have been in the research vanguard.

In our national scenario, piezoelectric materials based sensors are extensively used for gauging stress, strain, pressure, vibration, temperature etc. in aerospace applications. Materials like ZnO, lead zirconate titanate (PZT), polyvinylidene fluoride (PVDF) etc. are currently being used for fabricating Micro-Electro-Mechanical Systems (MEMS) based acoustic sensors for high sound pressure level measurements during satellite vehicle launching. But they are either imported or fabricated using more complex/expensive techniques like sputter deposition under ultra-high vacuum conditions. Hence, it is important to design and develop such materials and devices indigenously using easier, cost-effective processes.

In this project we intend to *(i) Develop novel, lead-free, non-toxic piezoelectric ceramic filler materials predicted by Materials Science database through Machine Learning/ Density Functional Theory calculations (ii) Develop new class of piezoelectric ceramic-polymer composite materials adopting easy/low cost synthesis techniques for fabricating flexible thin films with possible applications in self-powered electronics and sensors (iii) Design, fabricate and test laboratory prototype piezoelectric nanogenerators using the developed materials.*

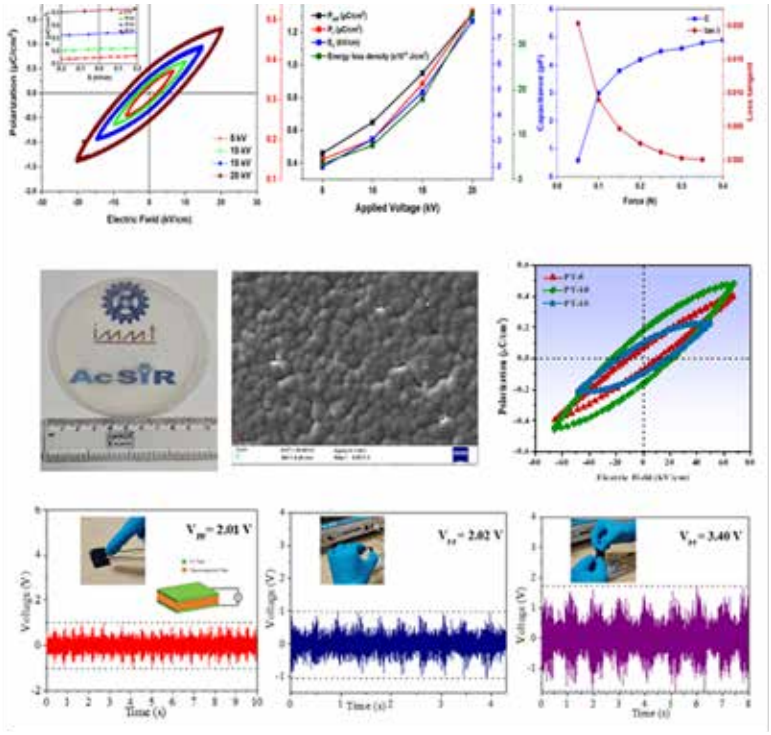


Figure: (a) Polarization Vs. electric field dependence, energy loss density, capacitance and loss tangent values of Zinc Tantalate piezoelectric ceramic fillers. (b) Solvent casted piezocomposite BCZT/PVDF-HFP film, morphology and polarization vs electric field responses for TiO2 nanoparticles embedded PVDF-HFP for various weight percentages. (c) Output voltages generated by finger tapping motion, bending and stretching in TiO2 embedded PVDF-HFP film, respectively. The inset shows the schematic of the fabricated nanogenerator.

Metal-free Triazine-based porous organic polymer-derived N-doped porous carbons as effective electrocatalysts for oxygen reduction reaction

In recent years, porous heteroatom-doped carbon materials have been very promising for energy conversion. A newly designed porous organic polymer (POPQ) has been synthesized using two organic monomers, i.e., 2,6-diaminoanthraquinone and cyanuric chloride, under reflux conditions for 72 h in an inert atmosphere. The triazine-containing porous organic polymers undergo pyrolysis, which produces two nitrogen-doped porous carbon materials, N/POPQ600 and N/POPQ800, at 600 and 800 °C temperatures, respectively. Since the resultant N-doped porous materials have a higher surface area than the parent porous organic polymer and the materials have a synergistic effect due to the enriched nitrogen content throughout the matrix, the metal-free N/POPQ600 and N/POPQ800 materials exhibit good electrocatalytic activity toward oxygen reduction reaction (ORR). Among these, the N/POPQ800 material shows excellent ORR activity with a nearly four-electron oxygen reduction pathway where the half-wave potential is estimated to be 0.728 V vs reversible hydrogen electrode (RHE), comparable with the commercially available Pt/C catalyst. Most interestingly, the N/POPQ800 catalyst displays outstanding long-lasting stability. It shows a better methanol tolerance capability than Pt/C, which can be attributed to the high specific surface area and N-doped well-defined crystalline porous structure. Also, the homogeneously distributed active sites throughout the carbon framework are the most precious for the electrochemical oxygen reduction reaction. (Figure). This work provides a highly effective and stable electrocatalyst for ORR applications and opens up a promising and straightforward strategy to develop catalysts for other applications.

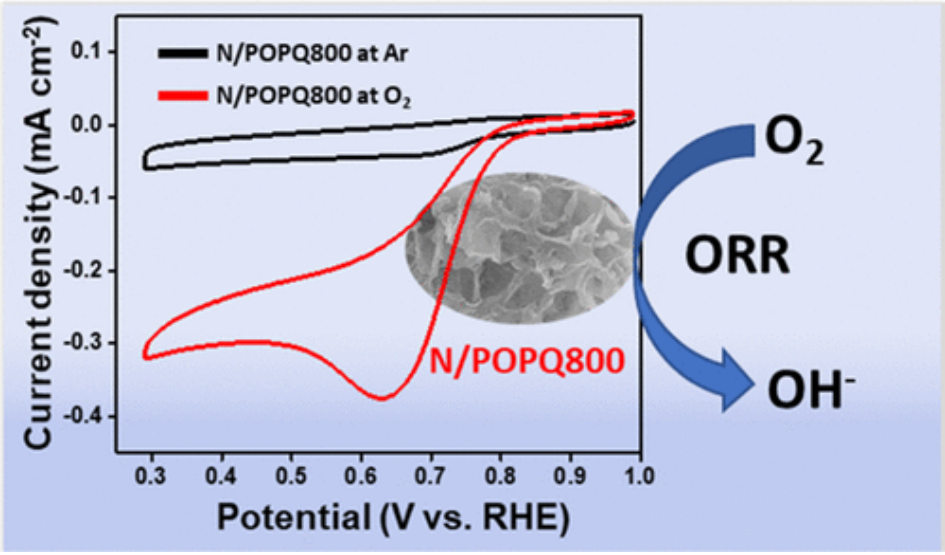


Figure: Scheme showing the ORR activity of as synthesized N/POPQ800

Catalytic behaviour of noble metal nanoparticle-metal oxide assemblies: An effect of interfacial ligands

The surface plasmonic resonance and catalytic properties exhibited by noble metal nanoparticles have allured great attention for their application, particularly in the catalysis. Gold nanoparticles (Au NPs) exhibit high catalytic activity in contrast to bulk gold and hence are being exploited to catalyse various reactions such as propylene oxidation, water gas shift reaction, olefin epoxidation and CO oxidation etc. However, the noble metal NPs are not stable and tend to collapse over a short period of time (few hours) due to their high surface energy. An alternative approach developed to improve stability while retaining their catalytic activity is based on the dispersion of NPs on support materials. For example, Au NPs have been dispersed in both reducible oxides (TiO_2, ZnO, Fe_2O_3, CeO_2, ZrO_2 etc.) and inert oxides (MgO, Al_2O_3, SiO_2). Such Au NPs supports are conventionally synthesized from single-atom gold precursors using aqueous chemistry: by co-precipitation or deposition-precipitation methods. Nonetheless, these approaches do not offer precise control over the size, size- distribution and degree of dispersion of Au NPs on the support.

The improved catalytic activity exhibited by such Au NPs-metal oxide support materials has been attributed to the

size of Au NPs, NPs–metal oxide support interface and the surface defects of the support. Although the literature suggest that NPs-metal oxide support interface is the most active site for catalytic reactions, but, the role of interfacial interactions between NPs-metal oxide support has not been explored extensively.

To investigate the role of interfacial ligands/interactions between NPs-oxide support, the Au NPs were grafted on silica spheres using various kind of interfacial functionalities such as amine, polyelectrolyte, CTABr. These functionalities offer different nature of interfacial interactions ranging from electrostatic to coordination. SiO_2 is known to be a less active support for catalysis, however, we used SiO_2 in this study as support so that the catalytic activity is predominantly influenced by the interfacial interactions rather that the inherent activity of the support. The anchoring of Au nanoparticles on silica spheres was confirmed by TEM (Figure 1) and UV-Vis spectrum. Au nanoparticles anchored on amine functionalized silica shows CO oxidation at much lower temperature (starts at 100 °C) than that of other samples and the reported values (i.e. ~ 270 °C) in the literature for non-reducing silica supports. The presence of Au^{1+}, as shown by XPS analysis, appears to govern the catalytic activity.

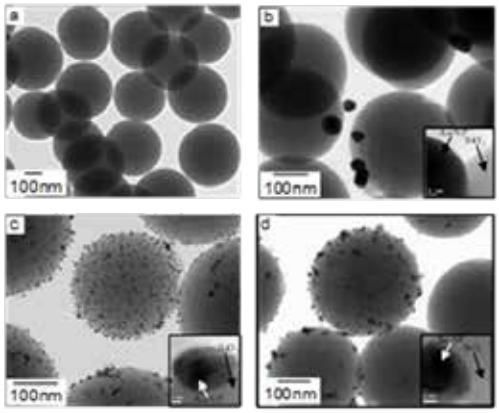


Figure 1: TEM image of (a) silica spheres, (b) S-CTABr-Au, (c) S-NH2-Au (d) S-PE-Au and inset shows their high magnification image of Au NP – support interface

To examine the catalytic activity and the effect of interfacial ligands of Au NPs grafted SiO_2 samples, CO oxidation was undertaken. The S-NH_2-Au shows CO oxidation at much lower temperature (starts at 100 °C) than that of reported in literature on non-reducing silica supports (ca ~ 270 °C) and lead to overall ~63 % CO oxidation at 225°C, Fig. 2. Whereas, in the case of both S-CTABr-Au and S-PE-Au, the CO oxidation starts at ca 180 °C and lead to ~ 25 % CO oxidation at 225 °C, Fig. 2.

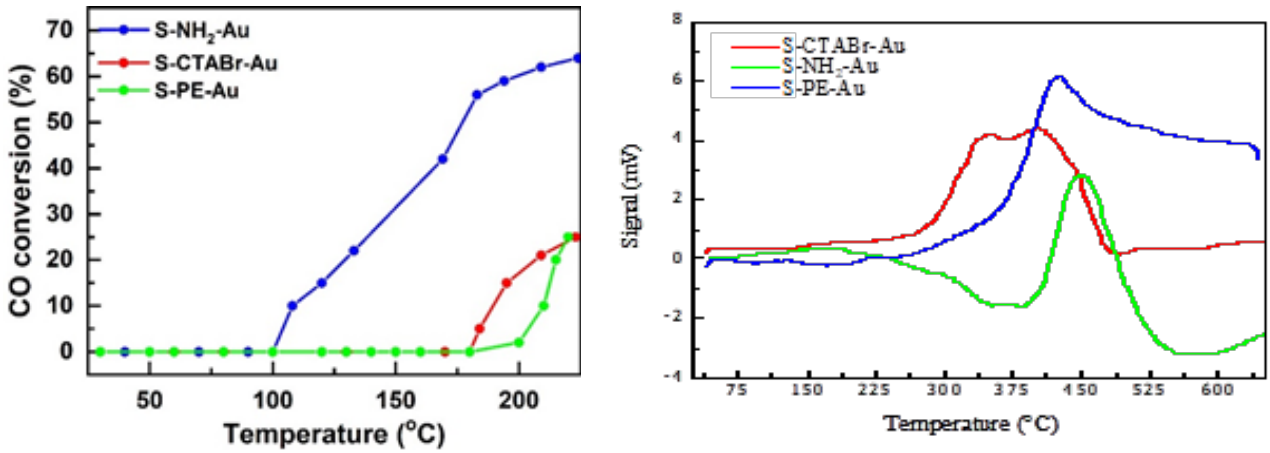


Figure 2: a) CO oxidation as a function of temperature for Au NPs anchored silica sphere samples, b) Hydrogen TPR profile of Au NPs anchored silica sphere samples

The TPR profile of S-CTABr-Au demonstrate that the reduction of Au NPs initiate at lower temperature ca 259 °C than that of S-NH_2-Au (392 °C) samples, Fig. 2b. The maximum reduction for these samples was observed at 346-403, 424 and 450 °C, respectively. The reduction taking place at higher temperature for S-NH_2-Au suggests strong binding of Au on silica spheres. Whereas, the S-CTABr-Au seems to have weekly bound Au NPs. The reduction taking place at moderate temperature 307 °C observed for S-PE-Au sample suggest weaker binding of Au NPs than that of S-NH_2-Au and stronger than that of S-CTABr-Au. The CO oxidation observed at lower temperature for S- NH_2-Au is possibly due to better interaction of Au NPs with silica sphere supports which forms active interface. The presence of Au^{+1} species, as suggested by XPS data, plays an important role. It appears that it forms AuO-species at the interface which subsequently leads to significantly improved catalysis at lower temperature. The strong interfacial interaction between the Au NPs and the SiO_2 supports is also in compliance with the TPR data. The formation of such AuO- and consequently improved catalytic activity has also been observed with other oxide supports. The catalytic activity initiation at higher temperature that is 180 °C for S-CTABr-Au and S-PE-Au may be ascribed to weak interactions (as suggested by TPR data). S-CTABr exhibits very low catalytic activity at 180°C which increases gradually till 200 °C and then increases exponentially. Such dual catalytic activity rate exhibited by S-CTABr-Au is complementary to the reduction behavior as shown by a broad peak having two maxima at 347 and 403 °C in TPR profile and may be attributed to the Au NPs shape effect. The synthesis of CTABr-Au NPs leads to elongated nanoparticles, as shown by the appearance of weak shoulder along with prominent peak in the absorption spectrum of CTABr-Au NPs. Therefore, Au NPs with such elongated shape may anchor in two different orientations and thus may show different interface activity and consequently different catalytic activity. These results on the interface tuning might have great implications on designing the catalysts for various commercially viable reactions.

Oxygen reduction on a zinc hydroxide model corrosion product

The electrochemical oxygen reduction reaction (ORR), is an important electron transfer reaction. Among others, it is often rate-determining in corrosion processes, metal air batteries, or fuel cells. While the ORR on noble metals has been extensively studied, its mechanism on practically important oxides has been much less investigated. The practical importance stems from the fact that many metals are covered with an oxide layer under ORR-relevant conditions. For example, on chromium oxide, electrocatalytic activity toward ORR has been suggested in a computational study to depend strongly on doping with other metals. The presence of Zn2+ and especially Mg2+ modifies significantly the ORR activity on iron oxides, which is important for corrosion inhibition at cut edges. Because of the tremendous importance of zinc and zinc alloys in corrosion protection as galvanizing coatings, this work looks deeper into the mechanism of the ORR on (hydr)oxide based model corrosion products of zinc. To that end, we used electrodeposited zinc (hydr)oxide experimentally to mimic (hydr)oxide layers on zinc. Zinc passivated by zinc oxide shows a significantly slower ORR compared to actively corroding zinc. In general, the ORR activity of an oxide-covered zinc surface strongly depends on the nature of the formed oxidation product, also for zinc alloy-based metallic coatings.

ORR kinetics plays a special role in under paint corrosion, where cathodic delamination is usually the fastest mechanism on zinc-based surfaces, including galvanized steel. On pure zinc, the confinement in combination with the relatively fast ORR rate can lead to a depletion of water and an effective stop of ORR. Mechanistically, the ORR on electrodeposited ZnO showed much less peroxide production in alkaline KCl than Pt. On the other hand, a number of earlier studies showed the presence of peroxide in the ORR on zinc by rotating ring disk electrode (RRDE) experiments under many conditions. The corrosion product layer in alkaline solution, which participates in the ORR, was found to be semi-metallic; defects in the solid participate in the reduction reaction. The ORR mechanism on zinc is potential dependent; at potentials near the open circuit potential, where the zinc is hydroxide-covered, peroxide is the dominating product. While the kinetics has been well characterized and products have been detected by RRDE, there has been no in situ or operando study of the ORR mechanism on the electrode surfaces, which serves as the main motivation for this work.

Model corrosion products of zinc hydroxide and zinc oxide containing layers have been electrodeposited on germanium Ge(100) internal reflection elements for use in multiple internal reflection attenuated total reflection (ATR) infrared (IR) spectroscopy. The electrodeposited layers have been characterized by scanning electron microscopy (SEM) with energy dispersive xray microanalysis (EDX), atomic force microscopy (AFM), and grazing incidence x-ray diffraction (GI-XRD); their surfaces were analyzed by x-ray photoelectron spectroscopy (XPS). To complement the experimental work, density functional theory (DFT) calculations of important ORR intermediates bound to ZnO surfaces have been carried out using a cluster model including solvation effects. For the computations, ZnO was selected as the substrate because of its known atomistic structure and well-studied interface with aqueous solutions. The ZnO/water interface was represented by ZnO/($10^{-}10$) or (0001) crystal facets covered with water molecules. The non-polar ($10^{-}10$) facet is the most abundant ZnO crystal facet in humid environments. The zinc-terminated polar facet (0001) was included to assess the impact of different adsorption environments.

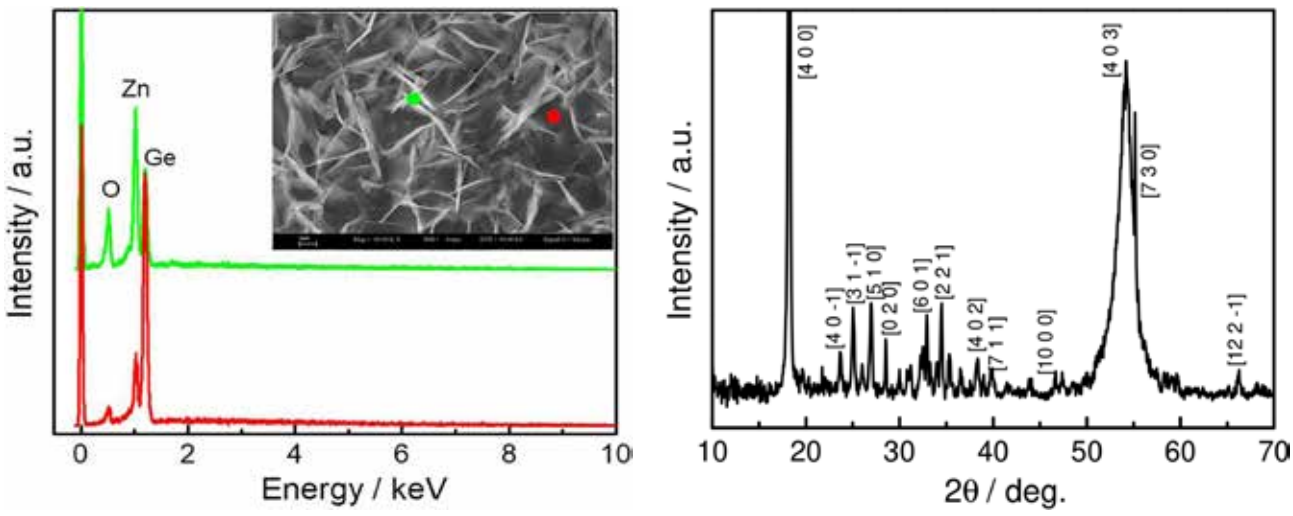


Figure 1. EDX analysis (10 keV incidence energy) of deposited ZnO films on Ge substrate, b) GI-XRD analysis of the deposited thin film on a Ge substrate. All the peaks can be assigned to $Zn_5(NO_3)_2(OH)_8$.

The approach used here, i.e., the deposition of zinc hydroxide model corrosion products on a germanium surface, is successful for studying the ORR on these model corrosion products. An ORR intermediate with an IR absorption of 1180 cm^{-1} has been found on the surfaces of the model corrosion products. The peak was assigned to the O–O stretching mode of a surface-bound superoxide. The absorbance of the detected superoxide is proportional to the cathodic current, indicating a larger surface coverage of the intermediate at higher reaction rates. DFT calculations point to a binding of the superoxide to an undercoordinated tetrahedral Zn^{2+} site on the surface as the active center for ORR. The DFT calculations give hints on the design of successful corrosion inhibitors for zinc: such inhibitors should interact with the active site more strongly than reported here for the adsorbed superoxide.

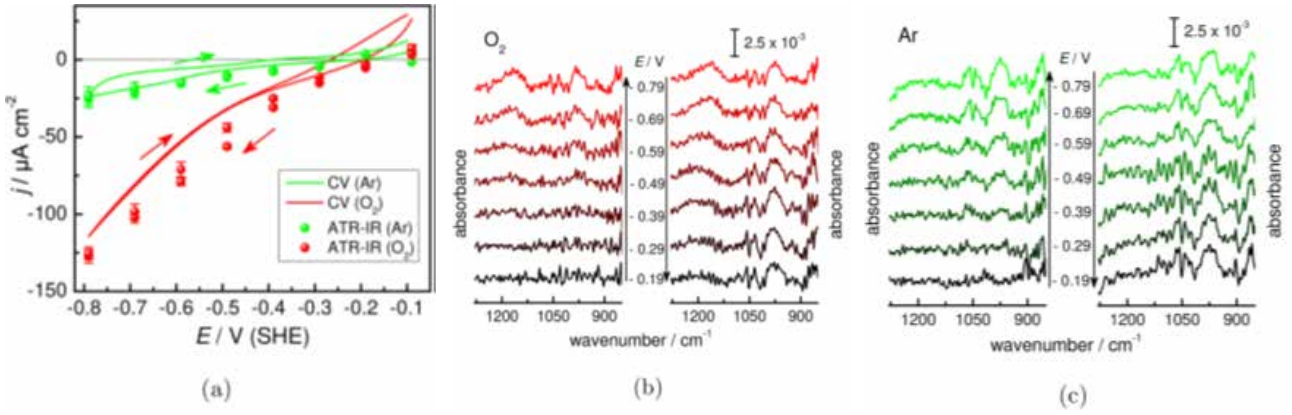
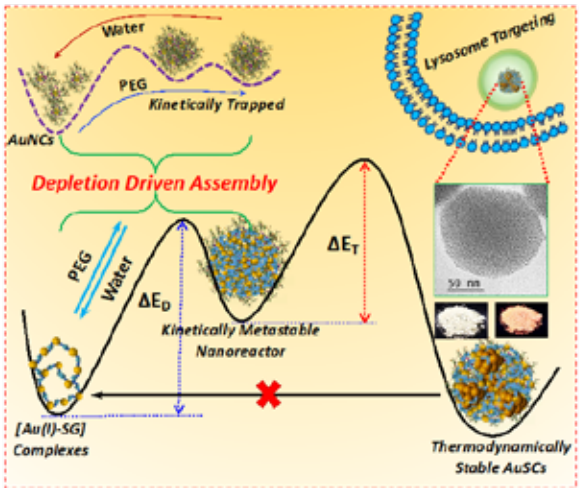


Figure 2. EDX analysis (10 keV incidence energy) of deposited ZnO films on Ge substrate, b) GI-XRD analysis of the deposited thin film on a Ge substrate. All the peaks can be assigned to $Zn_5(NO_3)_2(OH)_8$.

Luminescent gold nanocluster assembly for biomedical applications

Nanoscale assembly of ultra-small metal nanoclusters (MNCs) by means of molecular forces has proven to be a powerful strategy to engineer their molecule-like properties in multi-scale dimensions. By leveraging depletion attraction as the guiding force, we have demonstrated the formation of kinetically trapped NCs assemblies with enhanced photoluminescence (PL) and excited-state lifetimes, and extend the principle to cluster impregnated cationic nanogels, non-luminescent Au(I)-thiolate complexes and weakly luminescent copper NCs. We further demonstrated a thermal energy-driven kinetic barrier breaking process to isolate these assemblies (Scheme 1). These isolated assemblies are thermodynamically stable, built from a strong network among several discrete, ultra-small AuNCs and exhibit several unusual properties such as high stability in various pH, strong PL, microsecond lifetimes, large Stocks shifts, and higher accumulation in the lysosome of cancer cells (Figure 1)



Scheme1. Depletion driven assembly process of luminescent gold nanoclusters.

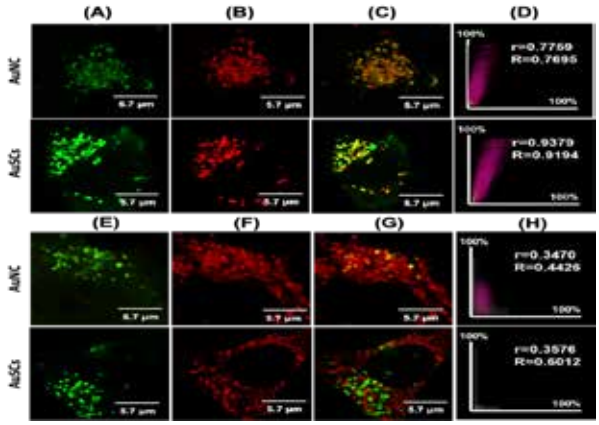


Figure: Confocal images of the co-localization experiment with Lyso Tracker Deep Red and Mito Tracker Red. Column A, E- AuNCs and gold superclusters (AuSCs), respectively; Column B-Lyso Tracker Deep Red (ex 640 nm); Column C, G-Merged; Column D, H-Pearson's Co-efficient (r) and Manders' overlap coefficient (R); Column F-Mito Tracker Red.

Development of phosphonium decatungstate complexes

Sodium tungstate reacted with tetramethyl- and tetrabutyl phosphonium bromide in presence of hydrochloric acid to afford two new phosphonium decatungstate compounds $((CH_3)_4P)_4W_{10}O_{32}$, and $((CH_3CH_2CH_2CH_2)_4P)_4W_{10}O_{32}$, respectively. Under similar conditions, sodium tungstate reacted with methyltriphenyl-, allyltriphenyl-, and butyltriphenyl- and benzyltriphenyl-phosphonium bromides to yield four new phosphonium hexatungstate compounds $((CH_3Ph_3P)_4W_{10}O_{32}$, $((CH_2CHCH_2Ph_3P)_4W_{10}O_{32}$, $((CH_3CH_2CH_2CH_2Ph_3P)_4W_{10}O_{32}$, and $((C_6H_5CH_2Ph_3P)_4W_{10}O_{32}$, respectively. All six compounds appeared to be stable in air, and were structurally characterized by a combination of FTIR, scanning electron microscope and powder X-ray diffraction analyses. The steric effect of the phosphonium cation was investigated and found to cause no significant change on the average bond distances of the decatungstate anion. Moreover, thermal stability and heat absorption of all six compounds were evaluated using thermogravimetric analysis and differential scanning calorimetry.

Tungsten-based polyoxometalate complexes for photocatalytic degradation of toxic chemical dyes

Dye degradation employing polyoxometalate cluster complex has been a research focus for several years. The photocatalytic approach for the degradation of dyes is one such technique. Various parameters (time, pH, concentration) were changed for further enhancement of degradation. Herein we demonstrate an intermediate of Lindqvist polyoxometalate and a Keggin polyoxometalate that degrades toxic chemical dyes methyl orange and methylene blue, respectively. The Lindqvist polyoxometalate $Na_2W_6O_{19}$ degrades methyl orange in ultraviolet light, whereas the Keggin polyoxometalate $Ag_4PW_{11}VO_{40}$ degrades methylene blue in a visible light source. Both the polyoxometalate were prepared in a less intensive method. The effect of various operating parameters, such as photocatalyst concentration, dye concentration, pH, and time dependence are also assessed.

Phosphonium based perovksites materials for ferroelectric applications

Recently we have develped phosphonium based semiconductor materials, antimony based semiconductor materials which can be used for ferroelectric apllications and photovoltaic applications. We have made one dimentional microstructures that shows ferroelctric domains and that can be measured via piezo response force microscopy. Following is the one dimentional crystal structure of phosphonium based halide perovskites that shows room temperature ferroelectric behavior.

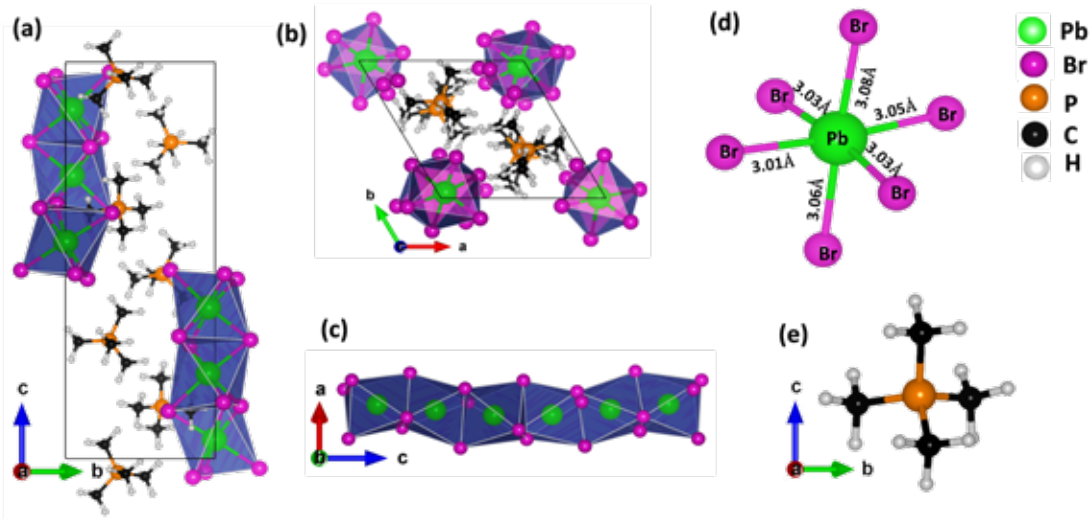


Figure 1: One dimensional crystal structure of phosphonium based halide perovskites that shows room temperature ferroelectric behaviour.

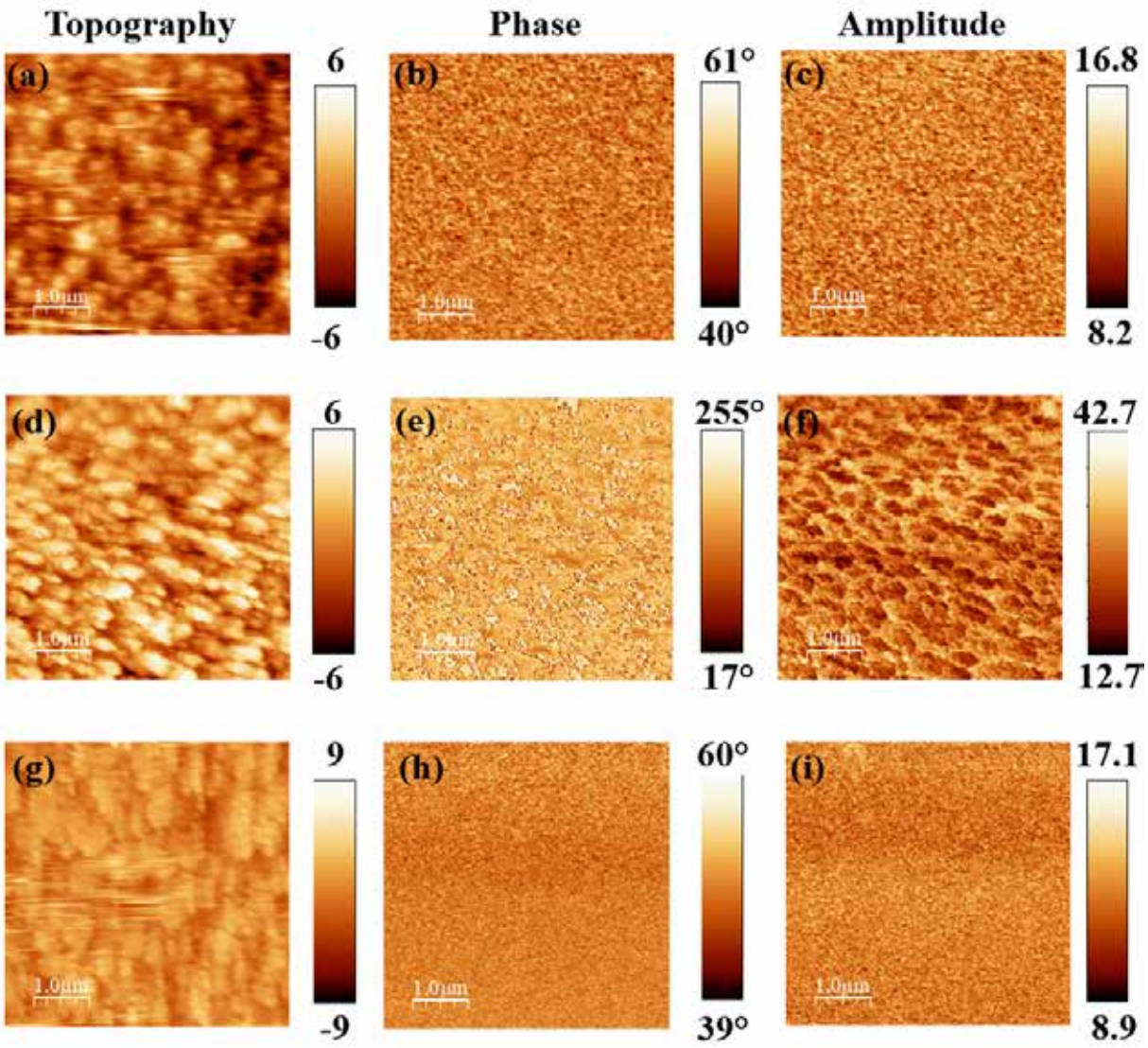
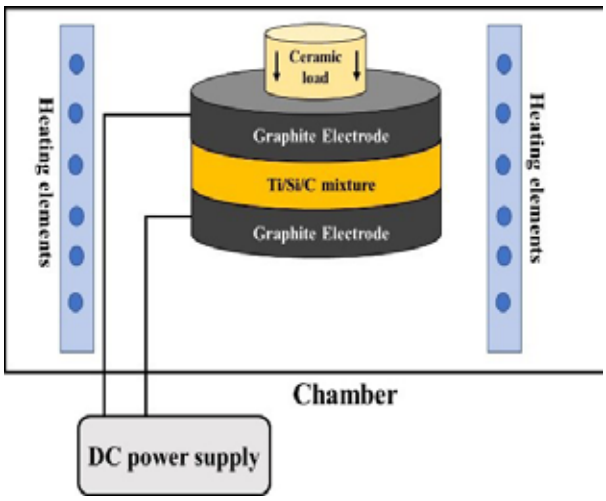


Figure 2: Topography, Phase and Amplitude under (a, b, c) 0V, (d, e, f) +4V and (g, h, i) -4V tip voltage (Topography values are in nm and amplitude values in pm)

Scaling up synthesis and characterization of Ti_3SiC_2 MAX phases and Ti_3C_2Tx MXene

2D materials like MXenes, provide very attractive building blocks for a very large variety of applications, such as energy storage, including super capacitors, lithium-ion batteries, oxygen evolution reaction, heavy metal adsorption, water purification, electrocatalysis for H2 generation, medicine, and transparent coatings etc. MXenes are widely researched for their high metallic conductivity. MXenes have added metallically conductive 2D building blocks to the available list of 2D materials. More than 30 different MXenes have been reported, but most research is done of Ti3C2 and Ti2C. However, availability and cost are the key factors limiting applications of this advanced nanomaterials in industry. Production of MXene is still at a very early stage. One of the limiting factors for large-scale and low-cost manufacturing of MXenes is the cost and limited availability of MAX phases. However, making good-quality MXene in large quantities requires not just "a MAX", but also a MAX phase with appropriate properties optimized for MXene synthesis. The present work addresses the synthesis of Ti_3SiC_2 and Ti_3AlC_2 MAX phases in 1 Kg scale using our patented flash sintering technique, and their use for preparing MXenes in 100 g scale by selective etching in various acidic etchants like HF, or combination of LiF3 and HCl.



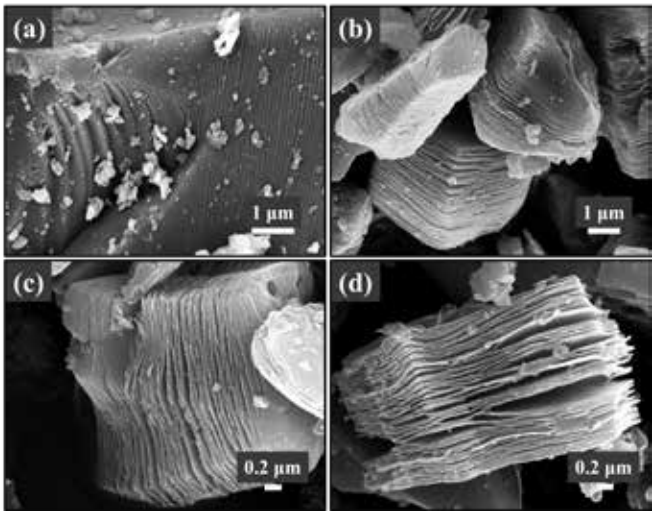


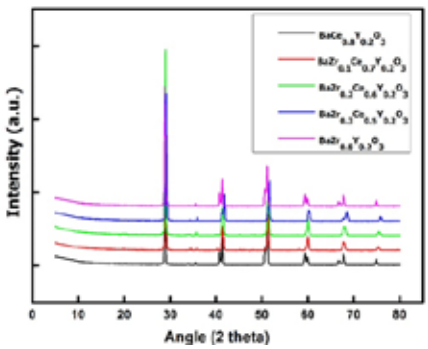
Figure: (A) Schematic representation of the reactive flash sintering setup with green compact Ti/Si/C mixture sandwiched between two graphite electrodes in a heating chamber.; (B) Ti3SiC2 MAX phase (a) and Ti3C2Tx MXene (b-d)

Hybrid electrolytes for H_2 generation by High Temperature Solid Electrolyser (HTSE)

This is a part of the project "Hydrogen Generation through High Temperature Solid Oxide Electrolyser" under H2 Technology Mission of CSIR in which CSIR-IMMT Bhubaneswar and CSIR-CGCRI Kolkata are collaborating to develop HTSE technology for H2 generation. While CGCRI is focusing on stack development and testing of SOEC cells of configuration NiO-YSZ/YSZ/GDC (interlayer/GDC-MIEC-buffer layer/MIEC air electrode) of dimension 10 cm x 10 cm to achieve power output of 1 kW and targeted H_2 output of 0.8-1.0 $Nm^3/h/kW$ and current density of 1.3-1.5 $A.cm^{-2}$ @ 1.4-1.5 V at 800 °C, CSIR-IMMT is focusing on thin and dense layer of YSZ electrolyte (5-10 µm) by Electrophoretic Deposition (EPD) in order to attain ASR < 100 $m\Omega.cm^2$.

The state-of-the-art SOEC comprises of O^{2-} ion conducting electrolyte (O-SOEC) operating at high temperatures (HT) can lead to high corrosion or degradation of cell components hindering long term cell performance. Compared with O-SOECs, proton (H^+) conducting SOEC (H-SOEC) have acquired much attention because of their intermediate temperature (IT: 500 °C-700 °C) operation that improves cell performance. H_2O-electrolysis can ideally occur in both electrodes (at Fuel electrode in O-SOEC and at Air electrode in H-SOEC) depending on the type of ions (O^{2-}or H^+) that permeates the electrolyte. However, this is limited to only one side of electrode in the conventional SOECs, because only one ion can permeate across the single ion conducting electrolyte (e.g., YSZ, $BaZrO_3$, $BaCeO_3$ etc). Hence we are also developing hybrid solid electrolyte (e.g., rare earth (R) doped $BaCe_{1-x}Zr_xR_{0.2}O3_{-\delta}$ (0<x<1) perovskites) which will simultaneously conduct both O^{2-} and H^+ species in a high temperature CO_2/H_2O co-electrolysis (HTCE) for efficient H_2 or syngas production. We are also developing air electrodes based on mixed ionic-electronic conductors $Ba_{0.5}Sr_{0.5}Co_{0.8}0Fe_{0.2}O_{3-\delta}$ (BSCF), $PrBa_{0.5}Sr_{0.5}Co_{2-x}Fe_xO_{5+\delta}$ (PBSCF) and $NdBa_{0.5}Sr_{0.5}Co_{1.5}Fe_{0.5}O_{5+\delta}$ (NBSCF)

Green coating of YSZ on 5 cm x 5 cm NiO-YSZ electrode



BZCY hybrid electrolyte synthesized by Combustion synthesis

Nitrogen reduction to ammonia under ambient condition and their charge carrier dynamics

An electrocatalytic nitrogen reduction reaction is considered a potential approach for green ammonia production- a zero-carbon fertilizer, fuel, and energy storage for renewable energy. To harness the synergistic properties of perovskites- the inherent dipole moment due to their non-centrosymmetric structure (that facilitates better charge separation), oxygen vacancies, and the presence of Ni metal sites that permit activation and reduction of N_2 efficiently, the $NiTiO_3$ based nano-electrocatalysts have been synthesized. Further, these catalysts have been modified with ultra-small metal nanocrystal co-catalysts to form hetero-interfaces that not only aid to improve the charge separation, but also activation of N_2 and the lowering of overpotential requirements. The appearance of peaks corresponding to (012), (104), (110), (11-3), (024), (11-6), (018), (027), and (300) confirm the formation of rhombohedral $NiTiO_3$. The shift in the XRD peak corresponding to the (104) plane to a smaller 2θ value and peak shifting and widening of Raman spectra imply the lattice distortion, that signifies the formation of Pd-$NiTiO_3$ and Pt-$NiTiO_3$ heterojunction electrocatalysts with the loading of 0.4 and 0.3 wt% of Pd and Pt, respectively, as confirmed by the ICP-OES analysis. The detailed XPS analysis reveal the presence of Pd (0), Pd (II) and Pt (0), Pt (II) in respective electrocatalysts. The appearance of XPS peaks at 528.7 eV and 531.1 eV suggest the presence of oxidative oxygen species (O^{2-}/O^-), and the presence of oxygen defects due to oxygen vacancy. The detailed nitrogen reduction (NRR) investigation exhibits a five-fold enhancement in ammonia yield rate (~14.28 $\mu g h^{-1} mg^{-1}$ at -0.003 V vs. RHE), and Faradic efficiency of 27% (at 0.097V vs. RHE) for Pd-$NiTiO_3$ electrocatalysts than that of bare $NiTiO_3$ (3.08 $\mu g h^{-1} mg^{-1}$), and nine folds higher than that of activity shown by the commercial TiO_2 (P_{25}) (1.52 $\mu g h^{-1} mg^{-1}$). The formation of ammonia was further confirmed by using isotopic nitrogen as the feeding gas. Furthermore, the highest NRR is observed at lower cathodic potential (-0.003 V Vs. RHE) in the case of Pd-$NiTiO_3$ electrocatalyst than that of Pt-$NiTiO_3$ electrocatalyst (-0.203 V vs. RHE), implying significantly reduced overpotential requirement. Such enhanced NRR activity with lower overpotential requirement in the case of Pd-$NiTiO_3$ electrocatalyst is due to efficient charge separation as shown by the semicircle Nyquist plot, decreased photoluminescence emission intensity, shorter average lifetime (~29 ns) of excitons, appropriate band bending and improved activation of N_2 by the oxygen vacancies and heterointerface formed between Pd nanocrystals and $NiTiO_3$. Furthermore, no change is observed in the current density, after stabilization in the initial few seconds, even up to 2h, which signifies that these electrocatalysts are stable.

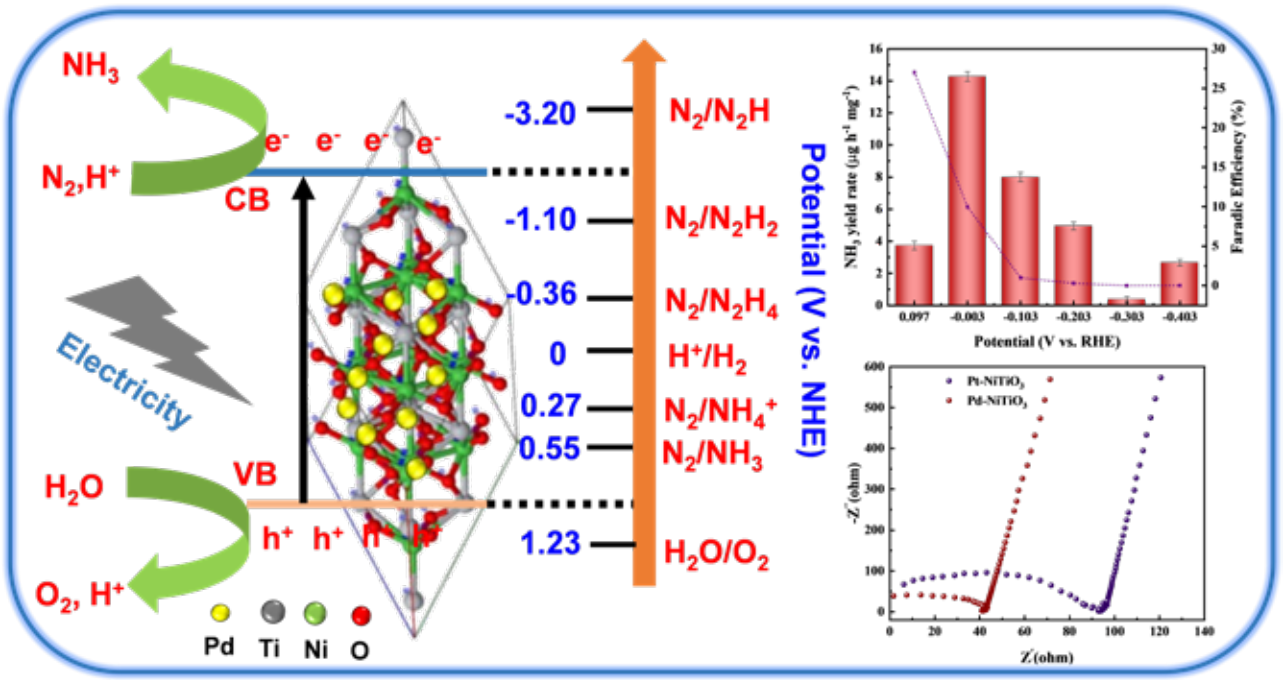


Figure: Schematic showing the nitrogen reduction to ammonia using the modified catalysts

DESIGN AND PROJECT ENGINEERING

FOCUS

To undertake R&D in the area of Designing of Energy efficient processes & equipments, post-harvest technologies & water purification system catering to industrial & societal needs for increase of productivity, up-gradation of environment, employment generation and skill development.

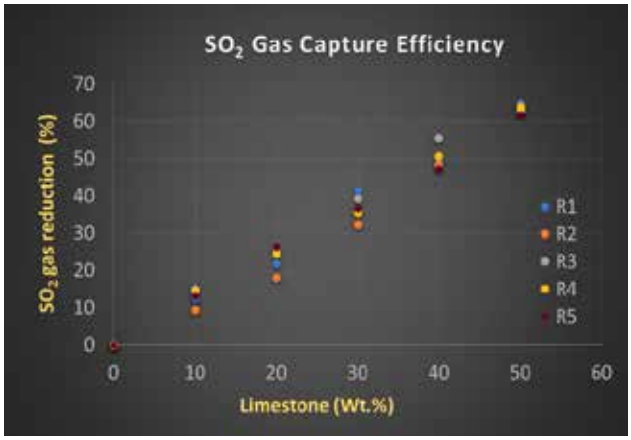
CORE AREA EXPERTISE

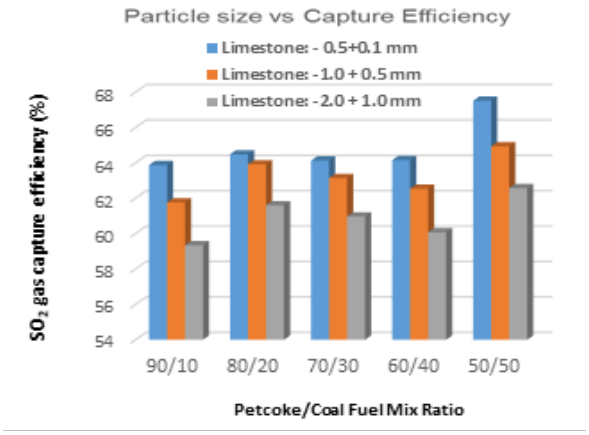
- Hydraulic transportation of minerals, ores, and industrial wastes
- Rheological characterization of minerals, ores, and industrial wastes
- Biomass/coal/industrial waste gasification
- Combustion studies & evaluation of pollution load
- Drinking water purification
- Post-harvest technologies

DESIGN AND PROJECT ENGINEERING

Feasibility study on combustion of pet-coke coal fuel mix in a fluidized bed reactor & reduction of emission through appropriate dosages of chemical reagents during combustion

Studies were carried out to optimize the petcoke-coal fuel mix and capture of Sulfur dioxide gas generated during combustion though appropriate dosage of limestone. Petcoke samples were collected from M/s Hindalco Industries, Sambalpur & IOCL Paradip and limestone samples were procured from M/s Dalmia Mines, Sundergarh for carrying out experimental investigation. High ash Indian coal was used for the present combustion studies. Characterization studies of coal, petcoke & limestone samples were completed. Proximate/Ultimate Analysis of Petcoke & coal, PSD, Particle density and Chemical composition of limestone were determined. Cold model studies for reactor design have been carried out. A fluidized bed reactor of capacity 6-10 kg/hr has been designed and fabricated for experimental studies. Combustion studies are being carried out with different Petcoke/coal fuel mix ratio (1:1, 3:2, 7:3, 4:1, 9:1) in the fluidized bed reactor. SO_2 gas capture data is recorded with varying particle size & weight percentage of limestone. Three different particle size range of limestone was taken for the studies i.e. 2mm to 1mm, 1mm to 0.5mm & 0.5mm to 0.1mm.





A detailed investigation of the erosion and corrosion wear in the presence of chemical/bio-additives to forecast the life-cycle of the industrial pipeline

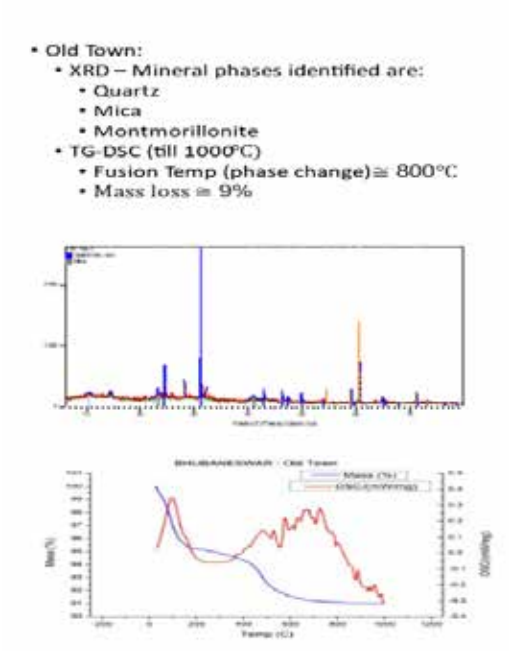
A R&D project has been taken to explore and identify low-cost chemical additives/extract environment-friendly bio-additives from natural plants. Detailed characterization studies, including size distribution, shape and morphology, chemical and elemental composition, and other physical and chemical properties of the iron ore, additives, and mild steel pipe material will be carried out. Attempts will be made to obtain a favorable flow behaviour in terms of low slurry viscosity, yield stress, flow coefficients, head loss, and pumping energy using the rheological tool. A series of erosion, abrasion, and corrosion tests in the presence and absence of appropriate dosage of suitable additives to obtain real-time data on wear rate of mild steel specimens will be done. Experimental studies will be done for optimization of slurry and flow parameters to minimize the wear rate in the pipeline.

Implementation of TERAFIL water filtration systems in Iron Contaminated areas of Jharkhand & Odisha and optimization of TERAFIL raw materials & its process for Eastern region of India JJM Project

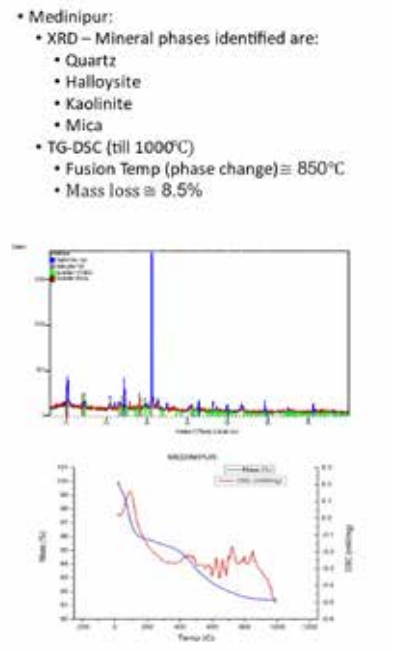
IMMT has taken up a project to optimize the TERAFIL raw materials composition & its process, in Eastern region of the Country (i.e. Bihar, Jharkhand, Odisha and West Bengal). As per one of the objectives of the on-going R&D Project for installation of 60,000 liter/day capacity TERAFIL water purification Plant, the location for installation has been identified by RWSS, PR & DW Dept., Govt. of Odisha at Village: Kanchilo, Block: Balianta, Dist: Khurda, Odisha. The iron contamination in the source water is 12-16 mg/l, which is very high for drinking purpose.

Raw materials for Terafil media (i.e. clay, sand & saw dust) collected from different places of Bihar, Jharkhand, Odisha & West Bengal. Characterization studies have been conducted for the clay samples collected from different locations. The methods/analysis done for clay characterization are PSD (Particle Size Distribution), XRF

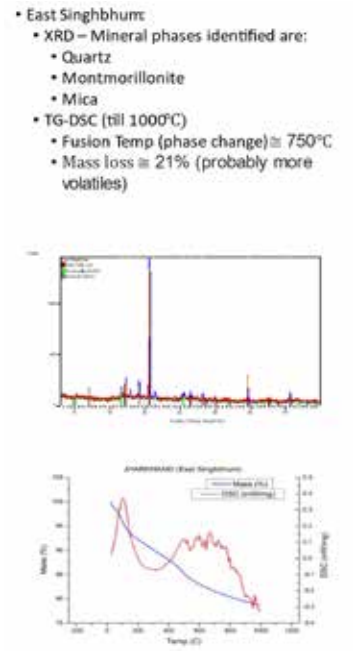
(X-Ray Fluorescence), XRD (X-Ray Diffraction), TG-DSC (Thermal Gravimetric-Differential Scanning Calorimetry), TG/DTA analysis etc. The PSD is done using a laser-scattering particle size analyzer and the result provides us the size distribution of the clay particles in the sample. The XRD studies have been done for the samples to get the data about the concentration of different elements present in the samples. XRD analysis helps us to interpret/ identify the mineral phases in a particular sample while TG-DSC helps us to understand the thermal properties of the samples. These are some of the experimental results of few clay samples.



XRD & TG-DSC Analysis of clay sample collected from Khurdha

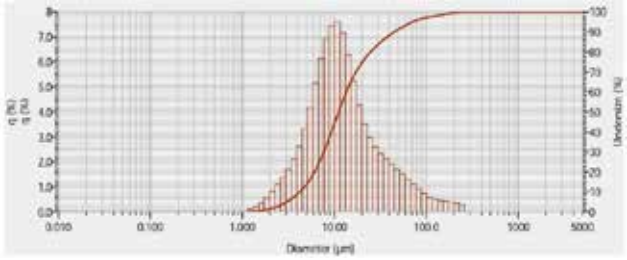


XRD & TG-DSC Analysis of clay sample collected from WB (Medinipur)

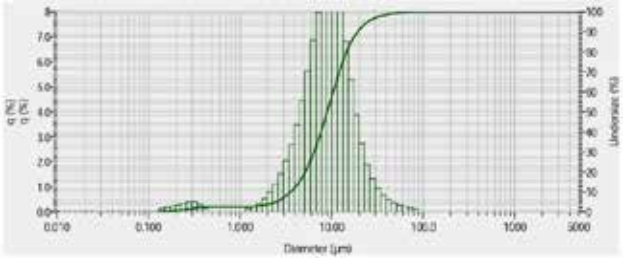


XRD & TG-DSC Analysis of clay sample collected from Jharkhand (East Singbhum)

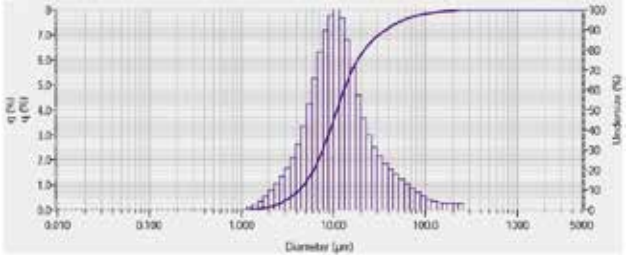
Particle size distribution



Particle Size Distribution result of one clay sample of Jharkhand



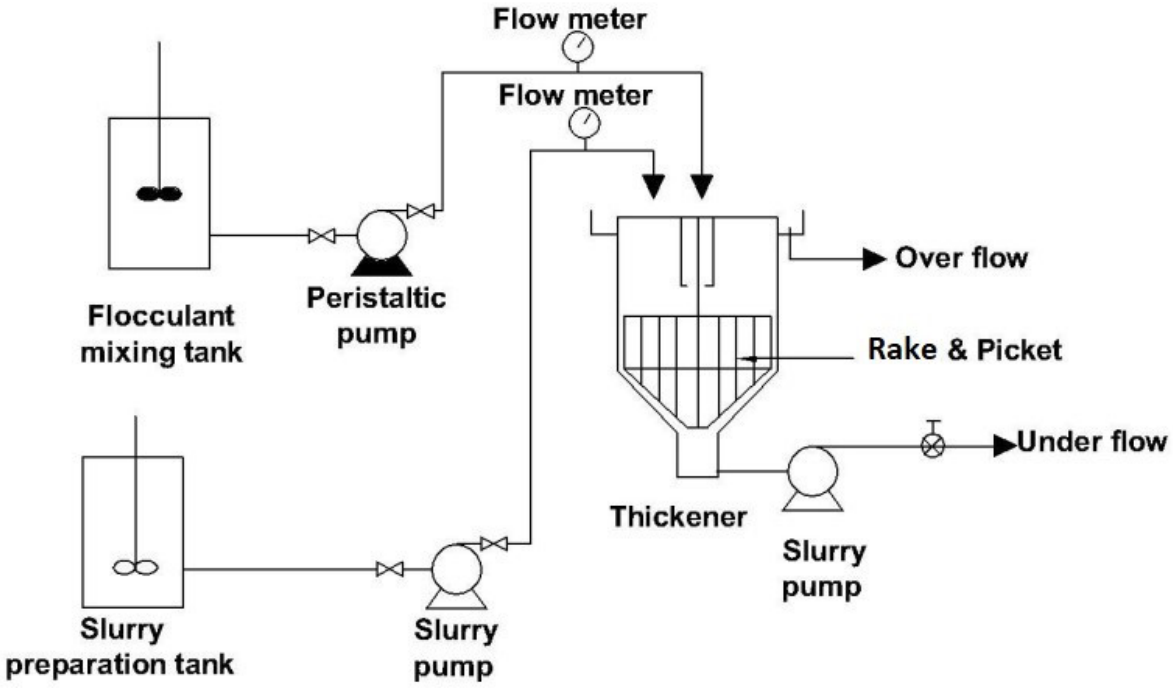
Particle Size Distribution result of one clay sample of Odisha



Particle Size Distribution result of one clay sample of West Bengal

Design and development of a pilot scale paste thickener for eco-friendly tailings disposal in Indian iron and steel industry

A project titled "Design and development of a pilot scale paste thickener for eco-friendly tailings disposal in Indian iron and steel industry" was initiated. Paste thickeners could be used to increase the concentration of slurry dumped into tailings pond. This reduces the volume occupied by the tailings thereby reducing the risk of tailings dam failure. The amount of flocculent required, feed rate, feed slurry concentration varies for different tailings. Development of a pilot scale prototype thickener will enable the Indian mining/mineral processing industry to periodically evaluate these operating parameters for optimum performance with changes in the source of the raw material. Under the said project a pilot scale paste thickener having a tentative dimension of 5-7 m of height, 1 m of diameter and three different floor slope angles of 30, 45 and 60 degree has been designed and the fabrication will be carried out shortly. The proposed line diagram of the paste thickener pilot plant is presented below:



Proposed layout of the paste thickener pilot plant.

Studies on the dense phase pneumatic conveying of bulk solids

Under the in-house project titled "Studies on the dense phase pneumatic conveying of bulk solids", a critical mass flow nozzle bank has been designed for the pneumatic conveying setup. In pneumatic conveying, fluctuation of mass flow rate of air is inevitable. For obtaining the state diagrams for scale-up prediction, the mass flow rate of air should be held constant, which can not be achieved with valves. A critical flow venturi nozzle (CFVN) can maintain a constant mass flow rate of air even if the pressure is fluctuating when operated in choked condition. Hence, a nozzle bank consisting of a total of 8 nozzles which could be operated in the mass flow rate range of 0.1- 0.001 kg/s was designed. The fabrication of the nozzle bank is under progress. The figure below shows a 15 mm throat diameter nozzle manufactured in the central workshop of CSIR-IMMT and a 2 mm throat diameter nozzle manufactured by CTTC, Bhubaneswar as per the design provided by CSIR-IMMT.

2mm and 15 mm throat diameter CFVN for nozzle bank of the pneumatic conveying setup.

S&T intervention for socioeconomic development in Nabarangpur District

Demonstration of IMMT newly design improved Biomass Indirect heated oven and training program at Umerkote of Nabarangpur block 18.04.2022 for for small cottage industry under S&T intervention for socio-economic development programme at Nabarangpur sponsored by RKVY project. CSIR-IMMT, Bhubaneswar developed an effective method of indirect heated biomass bakery oven baking bread and other flour based products and can be used in a small bakery. It is equipped with an improved biomass natural draft cookstove of 2kg/hr capacity, an oven and a chimney, which are connected each other. Biomass burns completely in the coookstove and hot flue gas flows to the GI plated oven wall through the suction effect of the chimney. Bread,cake and other confectionaries can be baked openly in the flue gas free environment at 170 to 2000C.Smoke & pollution are reduced drastically due to complete combustion of fuels in the cookstove. It uses any types of biomass like wood, cow dung, twigs reduces the energy cost of baking bread by 60% compared to the conventional method. It can be operated continuously at constant temperatures because the fire can be maintained without interrupting production. Besides baking, drying and indirect cooking can be done. Apart from that, the floor area needed to install this oven is very small. (Approximately 6 sq.ft.). All sides of this oven is properly insulated which offers a quicker heating up period normally 30 minutes whereas the conventional method needs almost one and half hour to heat up. Consequently, this method reduces the baking time, and there is no way of entering exhaust gases into baking chambers, which results a clean operation. Easy operation methods reduce maintenance and labour requirement. It consumes in average 0.4 kg of wood per kg of baked wheat flour.

Dimensions 77 x 62 x 216 cm.
Capacity: 36 Dough/batch.
Baking time: 1 hour.
Cost: Rs: 25,000/-

"Modifications of different biomass cookstoves which was developed by CSIR-IMMT,Bhubaneswar to achieve Thermal Efficiency of 32% in natural draft biomass cookstoves "bearing project number TSP-CRTDH-1. The cost of the project is Rs 1.18 lakhs sponsored by M/s Meensou India Pvt. Ltd., Sambalpur, Odisha

Participated in a seminar called by M/s Meensou India Pvt. Ltd regarding demonstration and training programme in Bhubaneswar on 29.11.2022 to local stake holder on Improved biomass cookstoves which was designed by CSIR-IMMT

ENVIRONMENT & SUSTAINABILITY

FOCUS

Monitoring and abatement of environmental pollution in the vicinity of industries, mines, ports, ocean including urban & rural areas; Basic and Applied research for utilization of bio-resources

CORE AREA EXPERTISE

- Atmospheric pollution and aerosol monitoring
- Biodiversity assessment
- Bio-fuel from microalgae
- Bioleaching of metals
- Bioremediation
- Construction materials from fly ash, red mud, and other industrial wastes
- Defluoridation of portable water
- Environmental Impact assessment study
- Green synthesis of nanoparticles and their applications
- Industrial solid waste utilization
- Monitoring and assessment of the coastal environment
- Self-assembled DNA nanostructures for biotherapeutics
- Water quality assessment
- Waste water treatment

Comparative study of nitrobenzene degradation in constructed wetland microcosm and constructed wetland integrated microbial fuel cell microcosm

Nitrobenzene (NB), a nitro compound, is released in the effluent of dye, pharmaceuticals, organic solvents, and several other organic compound manufacturing industries. Some common nitrobenzene compounds are nitrobenzene, dinitrobenzene, dinitrotoluene, trinitrotoluene. Presently, several methods such as active carbon adsorption, supercritical water oxidation, and photolysis reaction have been used for treating NB present in wastewater. Whereas, these methods have several drawbacks such as lower rate of degradation, higher energy requirement, and secondary pollutants generation. It is highly required to develop a cost-effective, environment-friendly, easily manageable, and energy-efficient method for the removal of NB from wastewater. The existing wastewater treatment systems can be coupled with the natural ecological landscape for better environmental, ecological, and social benefits. Constructed wetlands mimic the natural wetland with engineered facilities with lesser operational cost, ease of maintenance, robustness, and many more. The wide range of applicability of CWs makes it a viable option to treat different types of wastewaters. Few studies have been reported for treating NB contaminated wastewaters in CWs. Our present study is an attempt to compare the removal and degradation of Nitrobenzene spiked wastewater in earthen membrane-bound CW and CW-MFC.

A dual-chamber earthen membrane-bound constructed wetland microcosm and constructed wetland coupled microbial fuel cell (CW-MFC) microcosm were designed and comparatively evaluated their efficiency for treating nitrobenzene spiked wastewater and bioelectricity generation simultaneously. Two systems were designed with CW as control and CW-MFC as main experimental mesocosm. The spiking of nitrobenzene (NB) caused abrupt changes in physico-chemical and electrical properties within the system. The addition of NB decreased voltage generation and chemical oxygen demand (COD) removal from 90 ± 5 % to 45 ± 5 % in both systems. A negative removal rate of ammonium ions took place with NB indicating a coherent relationship between degradation of nitrobenzene and formation of ammonium ions. The concentration of nitrate ions increases with the addition of NB. Common degradation products of NB, i.e., aniline and nitroso benzene are observed within the systems. Comparatively, all the physico-chemical properties are better maintained and treated in CW-MFC than in CW.

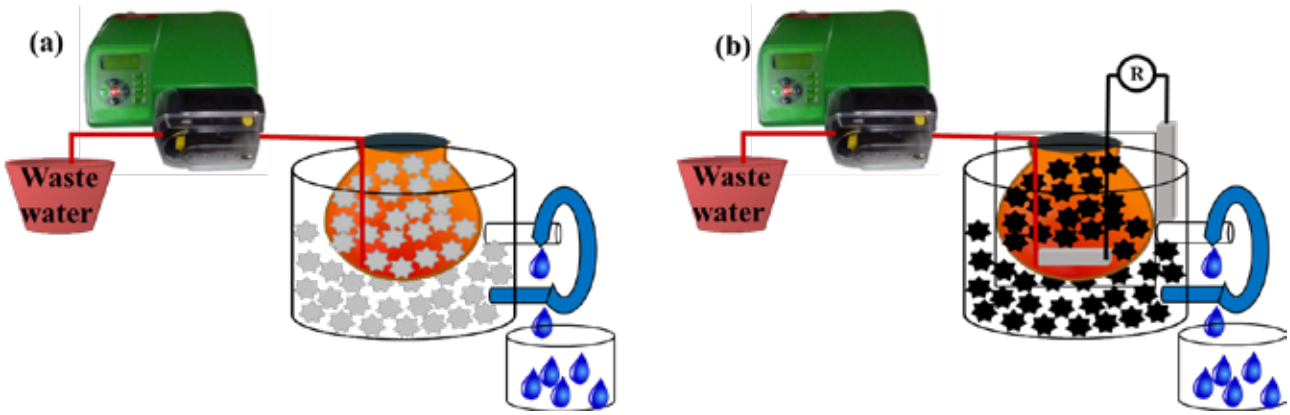
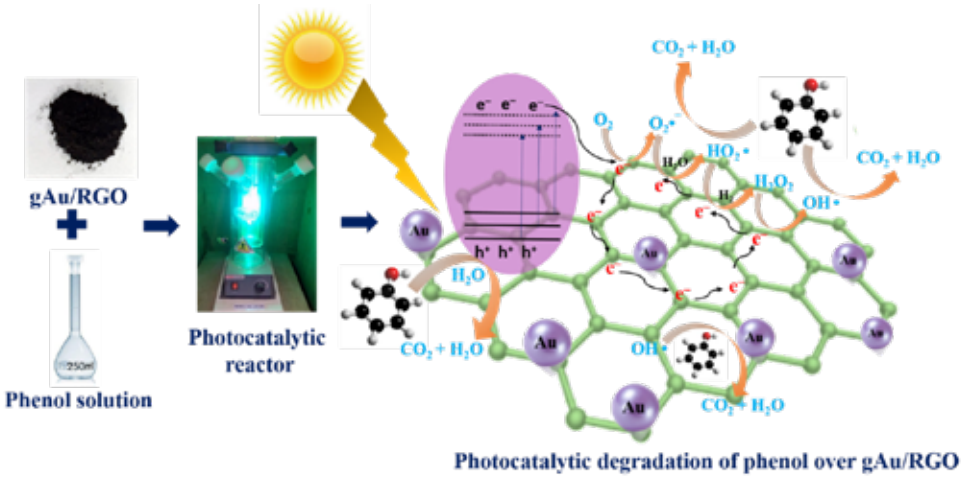


Figure 1: Schematic representation of (a) CW and (b) CW-MFC

Plant biomass driven synthesis of gAu/RGO nanocomposite towards enhanced photocatalytic degradation of phenolic compounds in wastewater

A plant biomass mediated ecofriendly synthesis approach was adopted for designing gold nanoparticles (gAuNPs) on reduced graphene oxide (RGO) using Averrhoa carambola leaf extract at room temperature. Introduction of folded RGO sheets and polar biomolecules of leaf extract collectively enhances growth inhibition effect and magnificently reduces the size of gAuNPs in the nanocomposite. The structure, morphology, optoelectronic properties, and thermogravimetric analysis of the synthesized compound was studied by XRD, TEM, STEM-HAADF, Raman, FT-IR, and UV-Vis DRS spectra. The size of gAuNPs were 8±3 nm on 2D-RGO sheet as per TEM and STEM-HAADF analysis. 2 wt% loaded gAuNPs exhibited photocatalytic degradation of 98.92, 97.64, 92.67, and 89.16% of bisphenol-A, 2-nitrophenol, 2-cholorophenol, and phenol, respectively under visible light irradiation. The degradation dynamics was found to follow pseudo first order kinetic model having highest rate constant of 0.034 min-1 for bisphenol A. The superior photocatalytic efficiency 2gAu/RGO can be attributed to synergistic effect

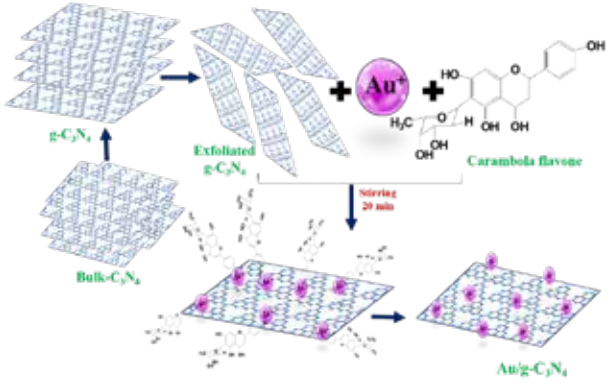
of ultra nano Au and π-conjugated carbon network of RGO sheet. A mechanism was proposed for the degradation of phenol based on the free radical scavenger experiment, fluorescence, and transient photocurrent analysis. The green synthesized gAu/RGO nanocomposite can be reused up to 6th cycle effectively without any leaching of gold for elimination of the priority pollutant phenol and its derivatives.



Proposed mechanism for photocatalytic degradation of phenol over 2 gAu/RGO nanocomposite under visible light irradiation

Bio-surfactant mediated synthesis of Au/g-C3N4 plasmonic hybrid nanocomposite for enhanced photocatalytic reduction of mono-nitrophenols

A bio-surfactant assisted synthesis route has demonstrated in room temperature for decoration of gold nanoparticles (AuNPs) on g-C3N4 using Averrhoa carambola leaf extract towards mono-nitrophenol reduction under visible light irradiation. Biomolecules of the leaf extract and optimised reaction condition played a vital role on tuning the morphology and optoelectronic properties of AuNPs. The size of AuNPs were found to be 15±3 nm on 2D g-C3N4 sheets by TEM and STEM-HAADF analysis. Among the designed plasmonic hybrid photocatalysts 3-wt% loaded AuNPs on g-C3N4 showed 99.01% of 4-nitrophenol, 97.70% of 3-nitrophenol and 98.50% of 2-nitrophenol photoreduction. The photocatalytic efficiency of Au/g-C3N4 was investigated under several parameters such as pH, initial nitrophenol concentration, and in presence of external inorganic anions. The mechanism of photoreduction of nitrophenol to aminophenol by Au/g-C3N4 was proposed based on the intermediate obtained from GCMS analysis. The observed higher catalytic activity of plasmonic hybrid photcatalysts is due to the synergic chemistry between the conduction band of g-C3N4 and AuNP plasmonic band, which is well supported by PL, EIS, and transient photocurrent analysis. Kinetic rate constant for 3Au/g-C3N4 was found to be 0.43 min-1 at pH 3. Moreover, the rate of reaction significantly increased in presence of Cl^-. ICP-OES analysis of as synthesised 3Au/g-C3N4 plasmonic photocatalyst shows there was no gold leaching even after ten cycles confirming the stability and reusability of the catalyst.



Possible mechanism for formation of Au/g-C3N4 nanocomposite

Study on carbon dynamics in estuaries and near shore waters of Dhamra and Mahanadi

The Mahanadi estuary acted as a source for the entire study period except during the high tide of July & February month. The average flux of 56.86±9.09 µmol m^{-2} h^{-1} & 183.8 ± 18.34 µmol m^{-2} h^{-1} has been determined in high tide & low tide respectively in May. The high value of flux during low tide may be because of comparatively higher wind speed in the afternoon. In July, the average value was found to be 9.724 ± 11.59 µmol m^{-2} h^{-1} & -10.04 ± 13.78 µmol m^{-2} h^{-1} in low tide & high tide respectively, which implies it act as sink in high tide and moderate source in low tide. The negative value of flux was due to the lower fCO_2 water. In the month of February, it served as a moderate sink. In October the average CO2 flux of Mahandi river transect was 116.9 µmol m^{-2} h^{-1} & 67.13 µmol m^{-2} h^{-1} in high tide & low tide respectively showing a strong source with the highest fCO_2 of water 7529 & 1576 µatm which shows significant inter tidal variation in air-water CO_2 flux. The Dhamra estuary acted as a source in the month of May with average value of 494.8 µmol m^{-2} h^{-1} in low tide and the highest value was 1164.8 µmol m^{-2} h^{-1} with fCO_2 water 2286.34 µatm, whereas at high tide average flux was 165.8 µmol m^{-2} h^{-1}.

The spatial difference in temperature and salinity along the coast was observed and was driven by East India Coastal Current, a well-developed western boundary current (of the seasonal sub-tropical gyre). In Dhamra river transect salinity was lesser than the Mahanadi transect but turbidity shows opposite trend. Similarly, the average dissolved inorganic phosphate found to be higher in Mahanadi transect than Dhamra except in high tide of both May and July, whereas the average dissolved inorganic nitrogen found to be higher in Dhamra except for May where it's almost same in both the study sites, but no such trend was observed in case of chlorophyll-a overall the study period. The higher value in inorganic phosphate mostly due to the riverine influence in Mahanadi. The distribution of DIC in the surface waters followed the same pattern as total alkalinity and the average in DIC ranged between 1325-2136 µmol/kg in the Mahanadi estuary and 1134-3419 µmol/kg overall the study period. The value of TA was found to be high during October in the Dhamra estuary (3427 µmol/kg), and the high value of TA was observed during May (2335 µmol/kg) during the Mahanadi estuary. The variation of fCO_2 in the air was found to be in a narrow range. The variation in flux was mainly due to the variation in fCO_2 (water). The highest variation in Δ fCO_2 was associated with the high value of CO_2 flux.

Figure 1: Sampling Locations at Mahanadi Estuary Paradeep

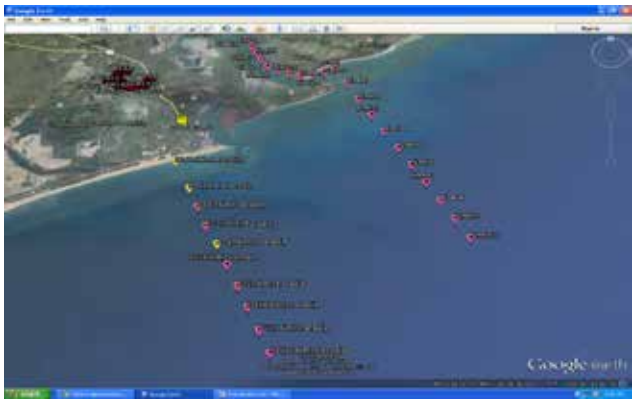


Figure 2: Sampling Locations at Dhamra Estuary

Environmental pollution monitoring in and around Paradip port, Paradip, Odisha

To assess the pollution level in and around the Paradip port, different environmental components such as ambient air quality, water quality, sediment quality, and noise level are being monitored on quarterly basis in various identified stations.

Figure 1: Location map of study area depicting (a) Water and Sediment monitoring stations, (b) Air monitoring stations and (c) Noise monitoring stations inside and outside Paradip Port.

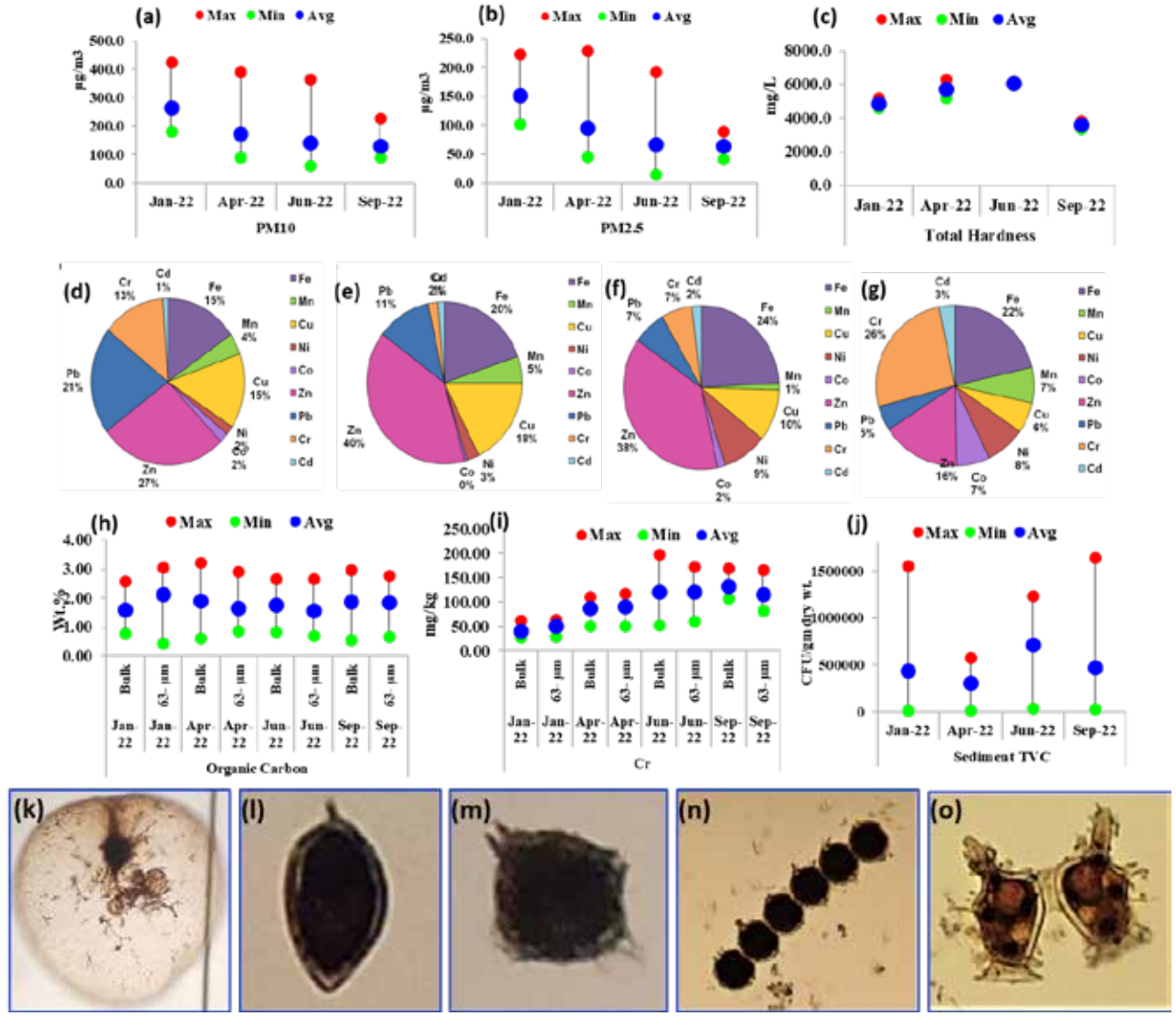


Figure 2 Variation of environmental parameters during the four seasons (a) Particulate Matter (PM10), (b) Particulate Matter (PM2.5) in air, and (c) Total Hardness of surface water. Percentage of dissolved heavy metals in water: (d) January-22, (e) April-22 (f) June-22, and (g) September-22. Variation of parameters in sediment (h) Organic Carbon, (i) Chromium content, and (j) Total Viable Count of the sediment sample. (k)-(o) Some pollution indicating phytoplankton sp. encountered at Paradip port harbour from January to September-2022.

Ambient Air Quality:
The value of PM10 (61.30 to 424.57 µg/m3) and PM2.5 (15.73 to 228.45 µg/m3) exceeded the permissible limit of 100 µg/m3 for PM10 and 60 µg/m3 for PM2.5 in all seasons and, specifically, in January and April. Gaseous pollutants like SO2, NO2, and NH3 concentration were within the central pollution control board (CPCB) permissible limits during the study period.

Water Quality:
Water samples were analysed for pH (7.60-8.48), temperature (24.0-33.1°C), conductance (25.3-49.9 mS/cm), turbidity (0.79-15.50 NTU), salinity, total suspended solids (0.006-0.091 g/L), total dissolved solids (18.41-88.45 g/L), dissolved oxygen (4.77-9.28 mg/L), biochemical oxygen demand (0.9-5.41 mg/L), alkalinity, hardness, inorganic phosphate, nitrate, nitrite, ammonia, sulphate, calcium, magnesium, sodium, potassium, and petroleum hydrocarbon (0.005-30.1 mg/L). Biological parameters such as chlorophyll-a (1.0499-14.6075 µg/m3), phytoplankton (60–38820 count/L), and bacterial population were also estimated for surface water samples.

Sediment Quality:
Sediment samples were analysed for organic carbon (0.19 to 3.19 wt.%), organic matter (0.32 to 5.50 wt.%), and size fraction. Heavy metals such as Fe, Mn, Cu, Ni, Co, Zn, Pb, Cr, and Cd were examined. Also, the Total viable count (11020.33-1639447.5 CFU/gm dry wt.) and total coliform count (1288.9-297117 CFU/gm dry wt.) were included.

Ambient Noise Quality:
The noise levels in the Paradip port area ranged from 59.0 – 82.4 dBA. Outside the port area, the noise level exceeded the prescribed noise limit for most of the sites, ranging from 60.4-79.9 dBA.

Ambient air quality monitoring in and around Paradip port, Paradip, Odisha

The ambient air quality monitoring was carried out on a weekly twice basis at six identified locations in and around Paradip Port. Air quality parameters viz. PM_{10}, $PM_{2.5}$, NO_2, SO_2, and CO were assessed during the monitoring period and is being reported on a monthly periodical basis.

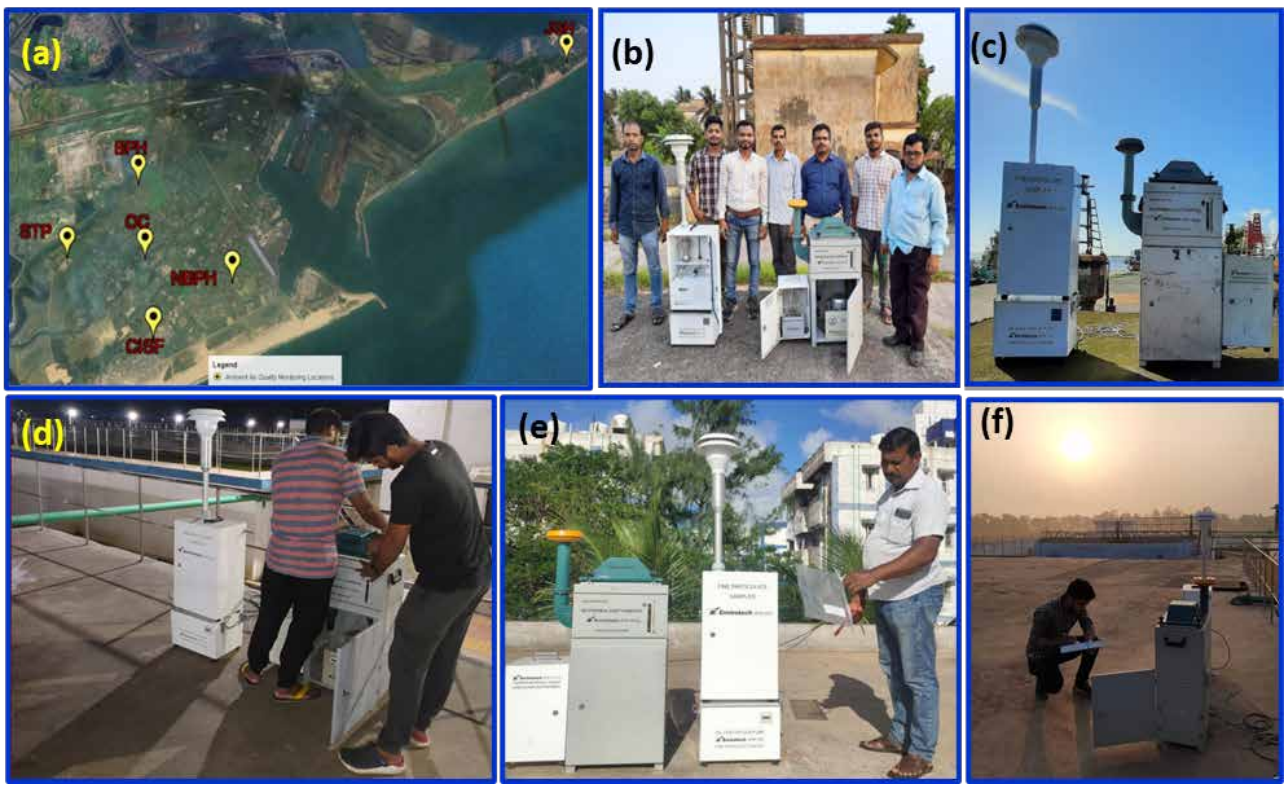


Figure 3 (a) Map depicts the six Ambient Air Quality Monitoring stations in and around Paradip port and (b) - (f) pictures of on-field sampling.

Chemical characteristics and oxidative potential of summertime fine aerosol over an urban location on the east coast of India

The oxidative potential (OP) of summertime fine aerosols ($PM_{2.5}$) using dithiothreitol (DTT) assay is studied for the first time over Bhubaneswar. The collected $PM_{2.5}$ samples were analyzed for metals, water-soluble ions, black carbon (BC) and brown carbon (BrC). Four-year mean (± standard deviation) $PM_{2.5}$ mass loading was 31.93 ± 14.91 µg m^{-3}, with a dominant contribution from $(NH_4)_2SO_4$ (44%). Interestingly, no remarkable yearly variation is observed in DTTv and DTTm concentration between 2017, 2018 and 2021 **(Fig. 1),** indicating inconsequential variation in source strength. However, DTTv and DDTm were reduced by 58% and 37%, respectively, during the quarantine period (2020) with the simultaneous decrement of $PM_{2.5}$ mass loading. Since DTTv is associated with PM emission rate, hence with curtailment of emission sources, it decreases tremendously compared to DTTm.

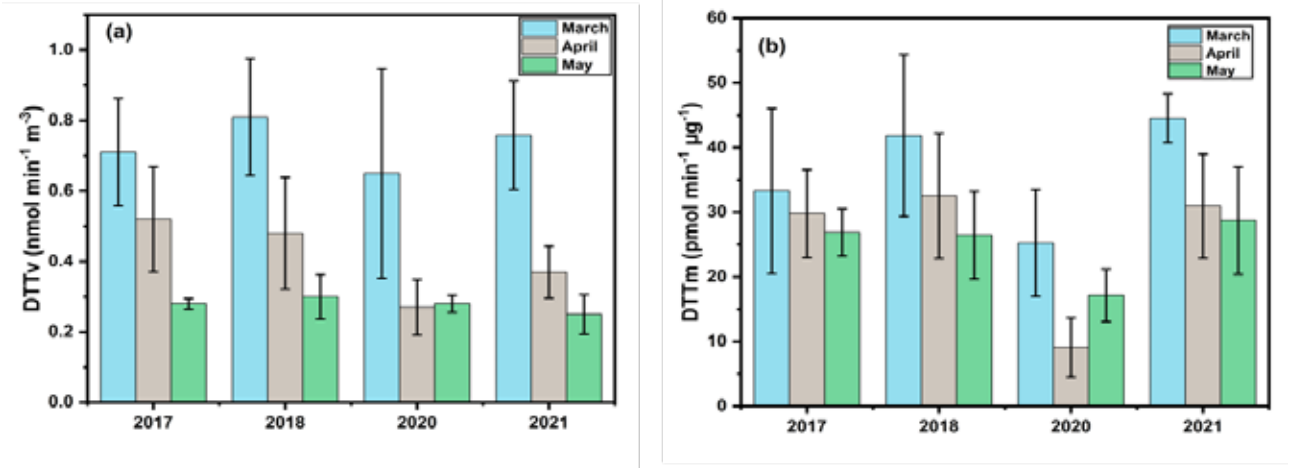


Figure 1. Summertime variation of (a) DTTv and (b) DTTm at Bhubaneswar

Pilot plant continuous rotary pyrolysis system facility at centre for waste utilisation

At Centre for Waste Utilisation, Environment & Sustainability Department, CSIR-Institute of Minerals and Materials Technology, the pilot plant scale "Continuous Rotary Pyrolysis System" facility was erected, installed and commissioned with funding support Department of Science and Technology (DST-India), Paradeep Phosphate Limited (PPL), Paradeep and CSIR-IMMT, Bhubaneswar. The pyrolysis unit has primarily three important sub-units i.e. input auger feeding with hopper, rotary reactor (400 litre capacity) and output collection and storage sub-units (settling chamber, oil tank, gas tank, biochar storage unit etc. The electrical power connection helps in regulating the heating temperature, speed of rotation of rotary reactor, auger feeding and output removal motor etc. The maximum operational temperature of the pyrolysis system is upto 900oC, regulated through PID control system. The pyrolysis system is specially installed to undertake experiments related to DST funded "Biomass Mediated Value Addition to Fertiliser Industries Waste" entitled R & D project (Reference: DST/TDT/WM/2019/51(g)/GAP-335). The input materials usually utilised for experiments are Phosphogypsum waste from phosphate fertiliser industry and selected biomass such as banana and paddy straw. The pyrolysis system is designed and commissioned by M/S Innova Engineering and Fabrication, Thane, Maharashtra, India.

Photo: Continuous Rotary Pyrolysis Pilot Plant at Centre for Waste Utilisation, CSIR-IMMT, Bhubaneswar

The major output from pyrolysis units are shown below

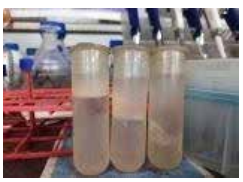
Biochar

Pyroliginous Liquid

Pyrolytic Gas/Syn-Gases

Impact EMF-RF radiation on seed germination, seedling development and biochemical response

Radiofrequency electromagnetic radiation (EMF-RF) is utilized in carrying long range signals in the form of information and establishment of communication between various stations. Cell phone service providers use certain range of frequencies to communicate between its users worldwide. But recently after LTE, VoLTE like technologies evolved with the planning of launching 5G technologies in future, frequency ranges and energy of the wave gradually increasing in order to avail higher resolution in communication. That in turn increases possibilityof major RF radiation pollution in the environment for both plants and animals, but being a stationary immovable living thing which is required for the sustenance of both animals and humans it's a necessity to do research on this field. Bioremediation lab, E&S Dept. of CSIR- IMMT is actively engaged in conducting experiments to ascertain the impact of EMF-RF radiation on plants. Cellular phones were kept inside a box and wrapped with aluminum foil in order to prevent some amount of radiation leakage. Then seeds (*Vigna radiata*) were kept inside the box with petriplates, cotton and tissue paper for germination. 2,4,6hrs of mobile phone exposure in talking mode were given to the seeds in different modes in three different chambers for 2G, 4G and control respectively. Seedlings were transferred to green house after four days of treatment for further growth without any radiation exposures in subsequent days. Germination data of four days, seedling height, root length, shoot length, primary leaf diameter were recorded. After the growth inside the green house biochemical parameters were taken into considerations like chlorophyll content, carbohydrate and lipid content, protein content, MDA and H_2O_2 concentration with antioxidant enzymes activity (SOD, POD, APX, GPX, and GR) for monitoring the extent of oxidative damage to plant an surprising effects of radiation were noted. Chlorophyll contents and carbohydrate amount were found in lesser amount than control ones. Production of MDA with lipid peroxidation and upregulated response of antioxidant enzyme also points out the extent of oxidative damge due to RF radiation. The response found to be increased radiation dose and time.



Development & demonstration of 70% content pond ash brick

Water mixture of fly ash and bottom ash disposed in slurry form to pond is termed as pond ash. Due to pre-hydration, the pozzolanic property of ash disposed in pond is lost in comparison to the dry fly ash collected in hoppers of the thermal power plant. Pozzolanic property is an essential requirement for the use of thermal plant ash in the building material industry. Due to the poor pozzolanic property of pond ash, its utilization in building material industry is less significant. Therefore, the use of pond ash in manufacture of building brick by conventional manufacturing process (Cement-Lime-Gypsum) is not very effective.

CSIR-IMMT, Bhubaneswar has developed an innovative

process of mineral polymerization for effective utilization of various industrial and mining wastes in manufacture of cold setting building brick and block. The mineral polymerization reaction develops cementation property which is very effective to develop the binding strength in the product. This process has been adopted commercially in MSME sector and major industries for manufacture of cold setting building brick containing up to 70 % fly ash.

Compromised conformation and catalytic activity of catalase in the presence of propylthiouracil: A biophysical study and alleviation by Curcumin

Propylthiouracil (PTU) is recommended as a treatment for hyperthyroidism during pregnancy. However, the negative consequences of its potential downregulation of catalase activity outweigh the benefits of controlling hyperthyroidism with PTU. In the present study, the inhibitory effect of PTU on bovine liver catalase (BLC) activity was studied in the presence of curcumin (CUR). The results suggest that the PTU-induced decrease in BLC activity was caused by a change in BLC conformation with reduced helical content and decrease in zeta potential. Nevertheless, temperature-dependent activation of CUR alleviates the activity of BLC by restoring secondary conformation and zeta potential. CUR inhibited the time-induced reduction in BLC activity and the protection was increased with increasing concentration of CUR and found to be significant even from 1:0.1 molar ratios. The high catalytic efficiency of 1043.5 and the low Km value of BLC with CUR favoured BLC stability with CUR over PTU. The protective role of CUR was due to the formation of a more stabilized complex as demonstrated by molecular docking, and Fourier-transform infrared spectroscopy (FTIR) study. Isothermal titration calorimetric (ITC) study supports for a favourable reaction between BLC and PTU or CUR due to the negative ΔH, and TΔS. Secondly, the binding affinity of CUR is 3.5-fold stronger for BLC as compared to PTU. The increased melting temperature of BLC was noticed in presence of CUR suggesting the protective potential of curcumin towards biomolecules. These findings provide insights into the potential use of CUR as a therapeutic agent to counteract the negative effects of PTU on catalase activity.

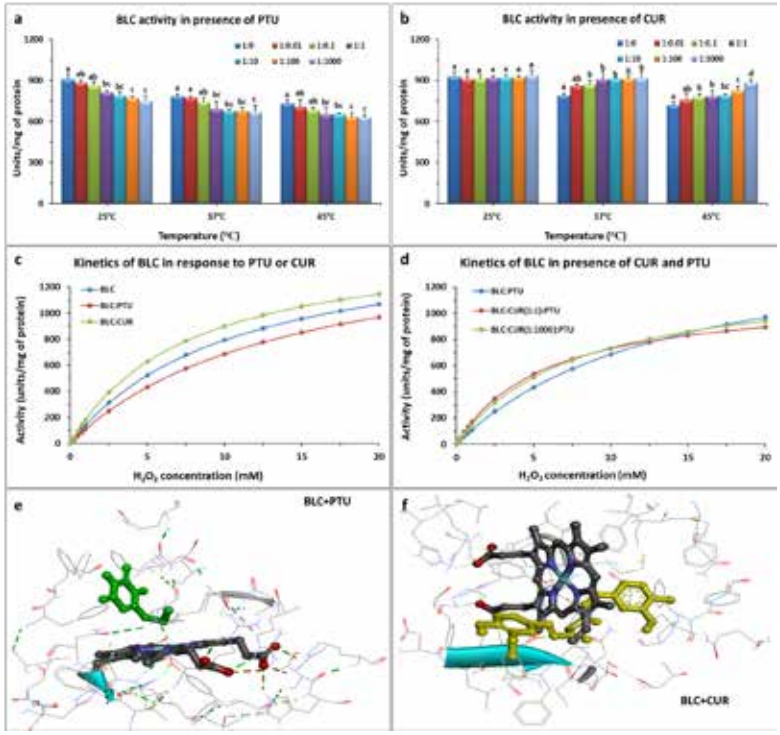


Fig. 1. The result shows the (a) compromised enzymatic activity of BLC in presence of PTU (b) protection of BLC activity by CUR against temperature dependent degradation (c) kinetics of BLC in presence of PTU and CUR (d) prior effect of CUR (e) binding site of PTU and (f) CUR.

Self assembled DNA nanostructure containing oncogenic miRNA mediated cell proliferation by downregulation of FOXO1 expression

FOXO1 transcription factor not only limits the cell cycle progression but also promotes cell death as a tumor suppressor protein. Though the expression of FOXO1 is largely examined in breast cancer, the regulation of FOXO1 by miRNA is yet to be explored. In the current study, self-assembled branched DNA (bDNA) nanostructures containing oncogenic miRNAs were designed and transfected to the MCF7 cell line to decipher the FOXO1 expression. bDNA containing oncogenic miRNAs 27a, 96, and 182 synergistically downregulate the expression of FOXO1 in MCF7 cells. The down-regulation is evident both in mRNA and protein levels suggesting that bDNA having miRNA sequences can selectively bind to mRNA and inhibit translation. Secondly, the downstream gene expression of p21 and p27 was also significantly downregulated in presence of miR-bDNA nanostructures. The cell proliferation activity was progressively increased in presence of miR-bDNA nanostructures which confirms the reduced tumor suppression activity of FOXO1 and the downstream gene expression. This finding can be explored to design novel bDNA structures which can downregulate the tumor suppressor proteins in normal cells and induce cell proliferation activity to identify early phase markers of cancer.

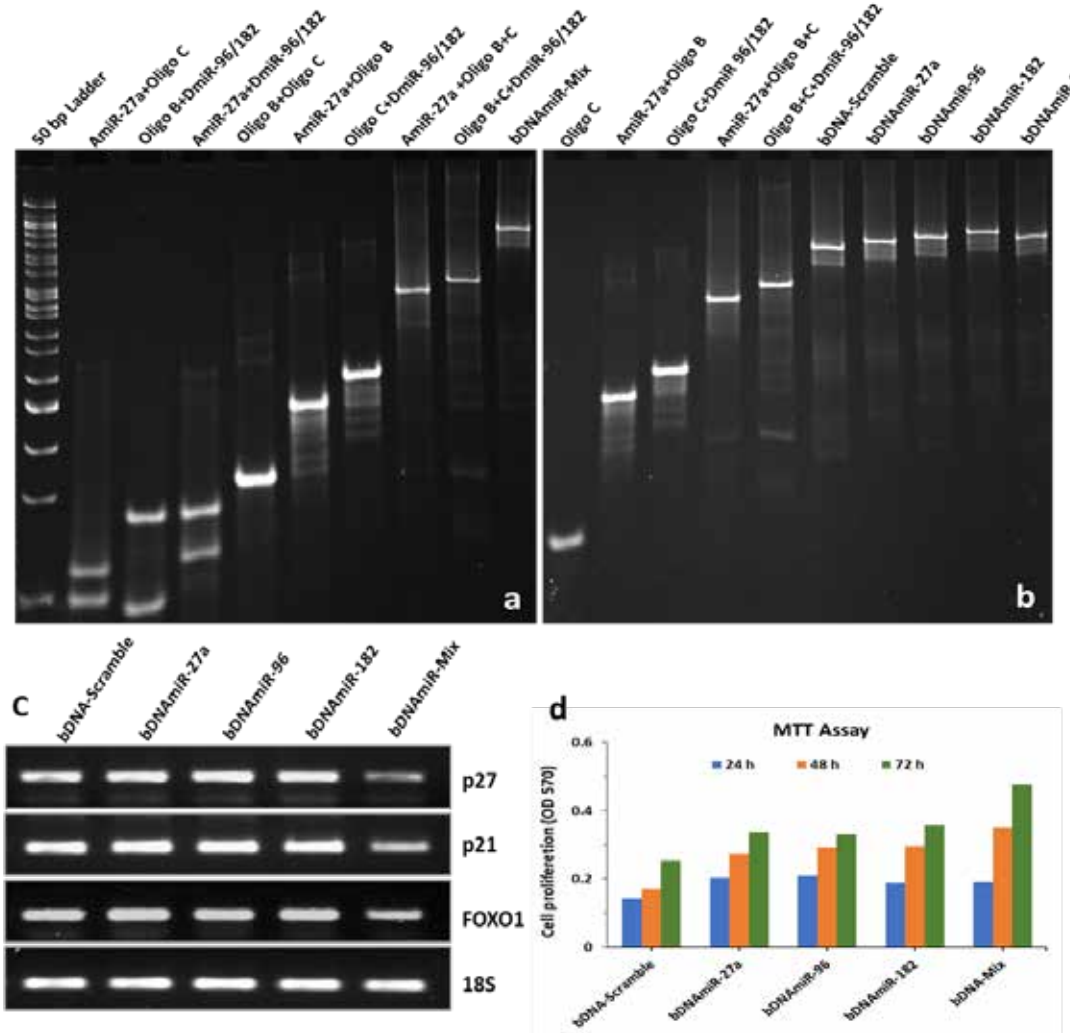


Fig. 1 Characterization of bDNA structures and expression profile of target gene with transfection of bDNA-miRs. Gel image display the binding of oligonucleotides to form bDNAmiR-Mix (a) and bDNA structures (bDNAmiR-27a, bDNAmiR-96, bDNAmiR-182, bDNAmiR-Mix) shows less electrophoretic mobility with respect to mono, di and tri-oligo complexes formation in 10% nPAGE (b). Agarose gel shows the expression of FOXO1, p21, p27 transfected with bDNAmiRs (c) and MTT assay reveled the effect of bDNAmiR on cell proliferation in MCF7 breast cancer cell line.

CENTRAL CHARACTERIZATION

FOCUS

The Central Characterization Department (CCD) hosts a series of sophisticated and state-of-the-art analytical facilities that includes various types of spectrophotometers, optical and electron microscopes and sample preparation units. There are seven numbers of highly qualified scientists and nine technical officers in CCD. The Department caters to the need of all kinds of R & D projects of the laboratory in extending the analytical support to characterize the minerals and various materials. It also extends analytical support to external industries, other government organizations, academic institutes and even individuals on payment basis. Apart from this, the Department carries out R&D projects related to economic minerals, coal, specific nanostructured materials and catalysis. It draws external cash flow through technical and consultancy services. The department receives all the internal and external bookings of equipment through an on-line portal developed by CSIR, i.e., AnalytiCSIR which showcases the details of all the available routine analytical facilities and provides access to them via online booking and payment. Active monitoring and disposal of all internal/external orders are being carried out through AnalytiCSIR online portal.

The R&D focus of the Department is on economic minerals, coal, photofunctional and catalytic material, synthetic nano-structured materials, transition metal oxides, 2D materials etc. It also provides physicochemical analytical support to all R & D projects of the laboratory and to the external customer through precise analysis of minerals and materials using sophisticated analytical equipment.

CORE AREA EXPERTISE

- Minerals and Materials characterization
- Ore and Coal Petrography
- Photocatalytic and photofunctional materials, spectroscopic studies
- Functional nanostructured and 2D materials; structure-property correlation
- Optical and Electron Microscopy

Photofunctional Materials for Industrial Dye Mineralisation

In this year, the team of GAP 323 had only concentrated on the synthesis of Ascorbic acid based CQD-MgAl layered double hydroxide. The surface area of the photocatalyst is evaluated to be 348 cm2/g which is 6 fold as compared to pristine MgAl-LDH. The particle size distribution of C-MgAl-LDH (Fig. 1) shows the maximum particles are in the 10-100 micron range. So, we chose the 10 micron membrane close for large scale experiments so that we can avoid the loss the catalysts during separation of photocatalyst, after photocatalytic experiments.

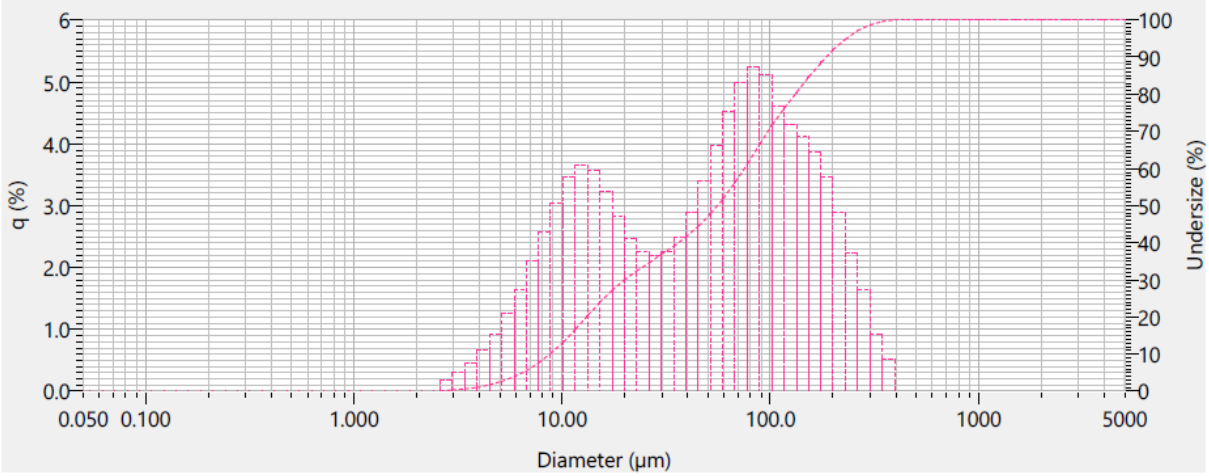


Figure 1: Particle size distribution of CQD-MgAl LDH (AA).

The main objective of the project is to develop a process for the textile industries basically to treat their waste water before discharging it to nearest water stream or river. Since, CQD-MgAl LDH is exhibiting very superior activities towards mineralisation of not only single or 02 mixed conventional dyes, it is effective in mineralising mixture of 06/07 dyes even in higher concentration upto 1000 ppm under visible/solar light. So, in the last phase of the project, CSIR-IMMT team received the real VAT dyes from Sambalpuri Vastralaya to study the effectiveness of the said catalyst under solar light.

Figure 2: (a) Photodegradation experiment of 250 L VAT brown (536 ppm) over 130 g of used CQD-MgAl LDH (AA) (b) results after 4 h.

130 g of used photocatalyst (from previous experiments) is added to 250 L dye solution and exposed to solar light of intensity of 537.44 W for 4 h. Fig. 2 represents the picture of the experiment (Fig. 2 (a)) and the difference after 4 h (Fig. 2(b)). 80% degradation happened in 4 h. After 1 h of reaction, absorbance centered at 476 nm was observed, this might be due to formation of intermediate which disappeared with increase in the time from 1 to 2 h. The maximum COD reduction was observed to be 93.67% in case of reactive blue, but less reduction was observed to be 12.61% in case of mixed dye solution during photocatalytic experiments. The process is also economically viable; the treatment cost is approx. 10-12 paise/L.

Phase engineering of Two-dimensional (2D) layered heterostructures for device applications

Two-dimensional materials have significant potential in electrochemical and device applications and they rely on their intrinsic properties and highly depend on tunability. Thus, it is essential to fabricate these materials in their stoichiometric state and understand their structure-property correlation. 2D MoS2 has three polytypic, including 2H, 1T, and 1T'. The trigonal prismatic structure of 2H-MoS2 makes it semiconductor, whereas the Octahedral structure of 1T-MoS2 makes it Metallic. 2H MoS2 is thermodynamically stable and thus easily

synthesized in its semiconducting 2H phase. On the other hand, the growth of its metastable 1T phase is hampered by its higher formation energy. As a result, it must exercise control over the polytypic expression of MoS2. In this work, we have synthesized 2d MoS2 using chemical vapour deposition (CVD) in different growth conditions. The as-fabricated samples were scrutinized with a repertoire of materials characterization techniques such as Raman spectroscopy, X-ray diffraction (XRD), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Our long-term objective is to fabricate different 2D metal chalcogenides materials and their heterointerfaces using CVD and conduct atomic-scale interfacial studies of multilayered structures in order to obtain highly effective and flexible modules for device applications.

- Three independent temperature gradient zone chemical vapor deposition(CVD) equipment is successfully customized to fabricate Mono layered MoS2
- 2D MoS2 of various phases are successfully synthesized using the CVD method (as shown in the figure 1).
- Atomic scales investigations have been performed using newly installed JEOL JEM-F200 TEM at IMMT

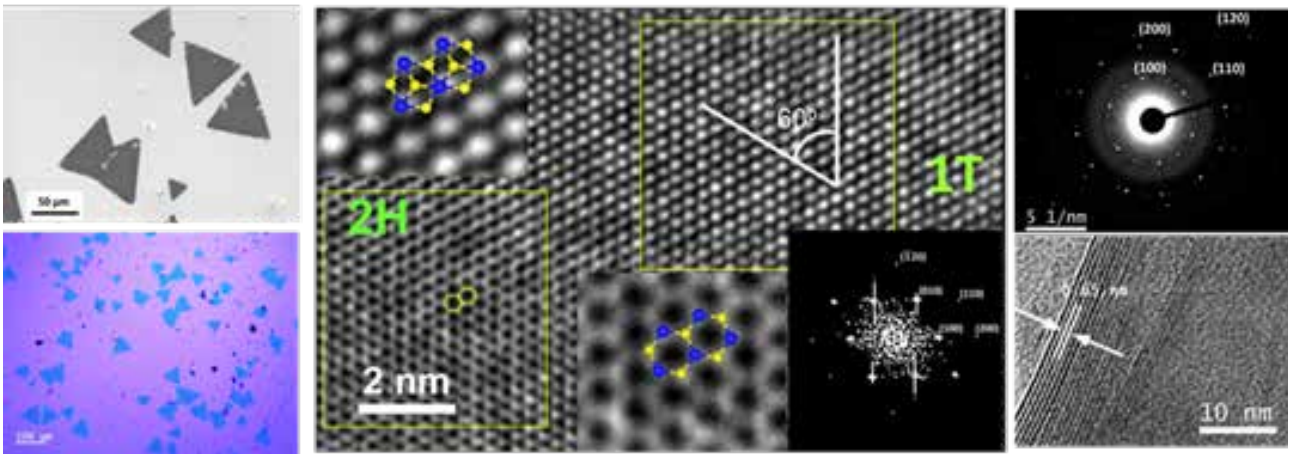
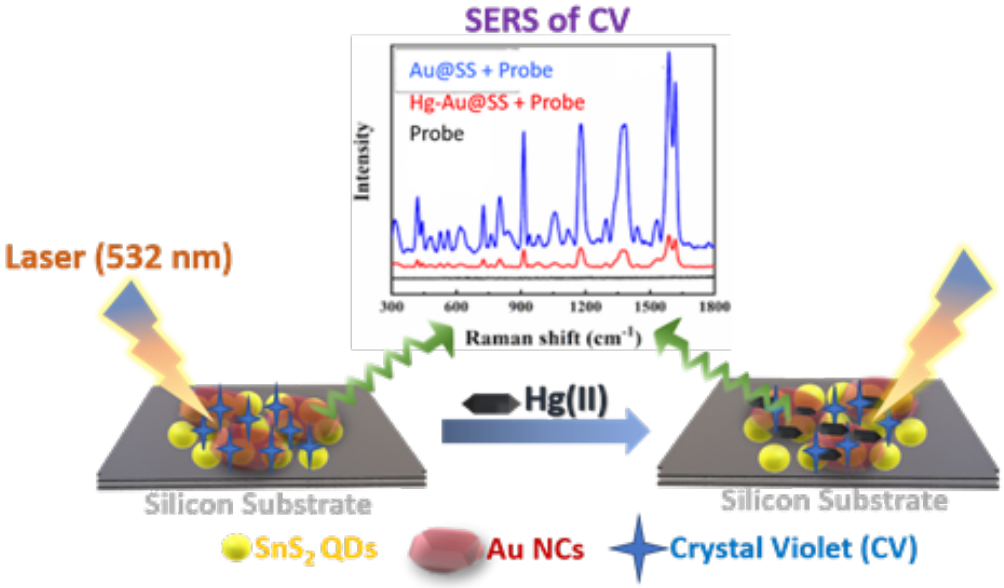


Figure 1: (a) SEM and optical image of CVD-grown 2D MoS2 flakes. (b) HRTEM image, corresponding FFT images (inset), (c) selected area electron diffraction (SAED) and cross-sectional view flake show the presence of 2H and 1T phase in the monolayered 2D materials.

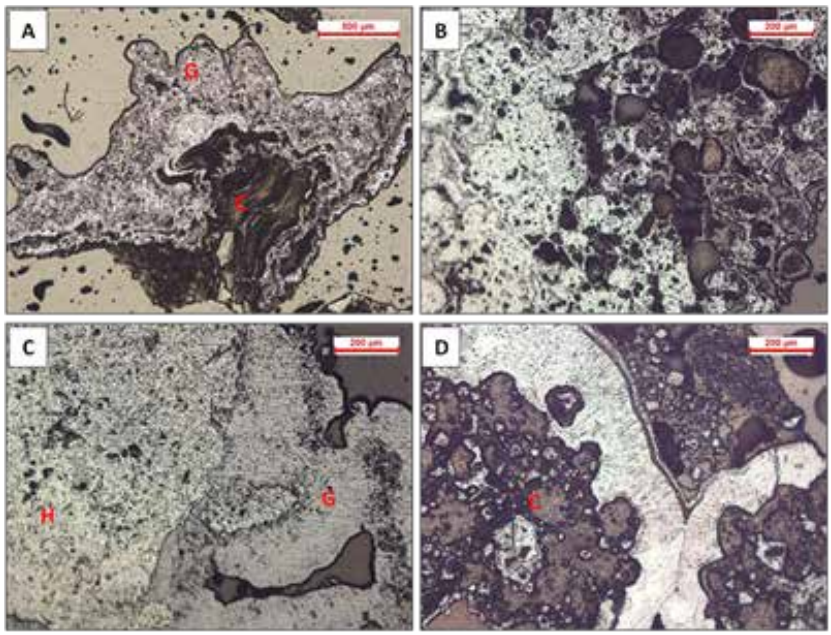
Development of novel SERS substrate for detection and removal of environmentally toxic mercury heavy metal ion

Mercury ions (Hg^{2+}), one of the most toxic heavy metals, have long been a matter of concern due to the serious hazards it poses to human health and the environment. Given this, the development of a rapid and sensitive approach for monitoring these ions to the lowest possible detection level is essential. Conventional and analytical methods, while successful, possess intrinsic pitfalls. Surface-enhanced Raman spectroscopy (SERS) has evolved as a cutting-edge tool for ultrasensitive analyte identification in a wide range of matrices. Further, plasmonic metal/semiconductor-based hybrid sensors are shown to be superior to their moieties. In this work, we have developed Au-functionalized SnS_2 quantum dots (Au/SnS_2 QDs), enabling excellent SERS enhancement, owing to the synergistic effect of electromagnetic and chemical enhancement. Crystal violet (CV) molecule is used as the indirect Raman probe. The pristine-SnS_2 shows sensitivity up to 10^{-7} M of CV with an enhancement factor (EF) of ≈1.8×10^2 but displays a poor SERS performance towards Hg^{2+} with a limit of detection (LoD) of only 10 µM. To investigate the impact of the spatial position of Au, two types of Au-hybrids are constructed: Au-emb@SnS_2 and Au-surf@SnS_2. The Au-surf@SnS_2 is shown to outpace the embedded sample. The Au-hybrids show much better SERS activity than the pristine samples with a sensitivity of 10^{-10} M for CV and an EF of ≈2.3×10^6. The LoD obtained for Hg^{2+} is shown to be in the ppb level (≈10 ppb). The Au-hybrids achieve remarkable selectivity and reproducibility. A "turn-off" based SERS mechanism is hypothesized, with the interaction between Au and Hg^{2+} playing a key role. Finally, the self-cleaning ability of the SERS substrate is demonstrated using visible-light-driven photodegradation of the Raman probe with a catalytic load of 0.5 mg/mL. Thus, our findings demonstrate notable prospects in the fields of SERS and photocatalysis, paving the way for the development of numerous substrates for the green technology-based treatment of environmental pollution.



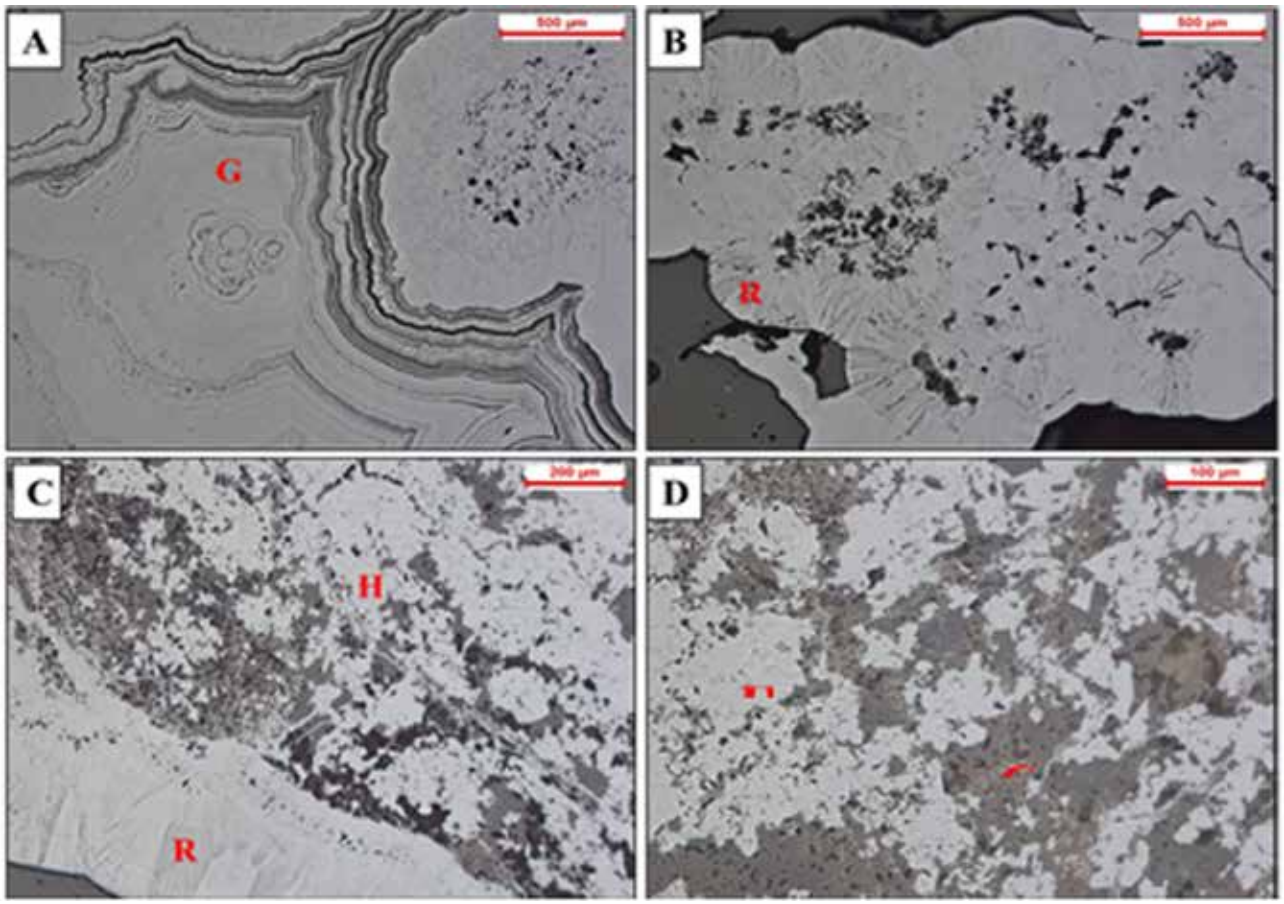
Characterization and process flowsheet development for the recovery of iron values from the low-grade ore

M/s. Sandur Manganese and Iron Ores Limited, Karnataka sponsored a project to characterize different varieties of iron ores (lateritic, hematitic, manganiferous, siliceous etc.) with an objective to know the mineralogy and its upgradation potential. The iron ores such as Ferro-manganese ore, limonitised hematite, limonite, shale etc were studied under XRD, optical microscope, SEM and the mineral assemblages like hematite, goethite, gibbsite, kaolinite, quartz, Romanechite, Cryptomelane, Lithiophorite were incorporated both texturally and mineralogically. The feed samples were subjected to various beneficiation practices like spiral followed by WHIMS and Jigging for the recovery of iron values. The feed value of 52-53 % Fe could be upgraded to 58-60% Fe with 60-70 % recovery.



Petrographic, mineralogical and bulk density studies of iron and manganese ores from the exploration blocks of OMC ltd., Odisha

Petrographic, mineralogical, and bulk density studies were carried out on the iron and manganese samples received from the Balita, Lashi, and Jajang exploration block of OMC, Odisha with an objective to know the mineralogy and textural characteristics. The iron ore found in this block are mostly consisting of goethite and hematite as major minerals while the gangue are mostly clay and quartz. The manganese ores are mainly contributed by the cryptomelane, pyrolusite, romanechite and some lithiophorite which are associated with iron minerals and gangue like clay and quartz.



A- A typical coloform structure shown by goethite (G)
B- Romanechite (R) mineral showing radiating structure
C- Romanechite bounding the goethite and hematite (H) minerals
D- A close association of hematite, goethite and clay minerals.

SCIENCE & TECHNOLOGY MANAGEMENT

COMPUTER NETWORKING & E-MANAGEMENT

FOCUS

Providing IT services and information resources in support of different S&T activities by developing or customizing application software and managing electronic information repositories.

CORE AREA EXPERTISE

- Implementation and maintenance of various IT services
- Application Software development and Customisation
- Decision Support Expert system
- Wireless Sensor Network
- Information Processing & Management
- Digital Repository Services

COMPUTERNETWORKING&E-MANAGEMENT

Computer Networking & e-Management (CNeM) division at CSIR-Institute of Minerals & Materials Technology facilitates the S&T activities of the institute by providing IT services and applications development. The department is also involved in research activities related to information processing and management.

During the year 2022-23 different activites such as designing of posters & banners for events, websites for events and activities and software for office automation. Major activities highlighted herein:

CNeM department maintains a widely used CSIR-IMMT Intranet Portal with the addition of new features. An instrumentation e-Ticketing System and Triannual Work Report Submission system were also launched during the period. Calendar 2022 was designed and circulated among colleagues to make them aware of holidays and events. The department also actively involved in computer application-oriented research activities in association with other R&D departments.

Activities & Services

- Implementation and maintenance of various IT services. e.g., E-mail service, FTP service, LAN management, Security management, etc
- Application Software development & Customisation as per the departmental / projects need.
- Implementation and maintenance of the e-management facility.
- Updating & maintenance of web portal.
- Development and Implementation of the online knowledge repository.
- Conducting periodic IT training/ colloquium/ seminars/ symposium.

Research Areas

- Wireless Sensor Network
- Decision Support system
- Geomatics & Remote Sensing
- Digital Image Analysis
- Information Processing & Management


World Environment Day - 2022
5th June 2022, 9:00 AM
Theme: "Only One Earth"
Venue: SS, Bhatnagar Hall, CSIR-IMMT, Bhubaneswar
Jointly Organized by
Environment & Sustainability Department & JIGYASA Team
CSIR-Institute of Minerals and Materials Technology, Bhubaneswar, Odisha-751013, India.
Azadi Ka Amrit Mahotsav
Jigyasa
immt


FIMTA 2022
August 03-05
Frontiers in Materials for Technological Applications
Azadi Ka Amrit Mahotsav
Important Dates
Abstract Submission Start Date : 01.06.2022
Deadline of Abstract Submission has extended : 10.07.2022
Notification of Abstract Accepatance date : 15.07.2022
http://fimta.immt.res.in
CSIR-Institute of Minerals & Materials Technology, Bhubaneswar - 751 013, Odisha, INDIA
Email: fimta.immt@gmail.com, Mob: +91 8277459184 / +91 7708639831

CSIR-IMMT: InTEC

Innovative Technology Enabling Center

(Established in 2020 & Recognized from Startup Odisha as a Nodal Incubator)

InTEC offers an omnibus support (i) Lab facilities, (ii) overhead operational charges-internet, library, water, electricity, security and (iii) mentoring support, for incubation facilities through Startups in the field of Minerals, Materials, Metals & allied sectors. The Incubation also offers resident and virtual support besides offering the use of various institutional facilities and instrument access at discounted rates.

- InTEC as an Incubation – cum-innovation hub would create support ecosystem for nurturing young entrepreneurs in molding Start-Ups.
- Facilitate in providing incubation support and specialized knowledge and technology framework for translating innovative developments in the space of minerals, materials and other technologies for sustainable utilization of natural resources.
- Provide conducive environment for scientists to work with external partners for product developments and their commercial exploitation.

Startup Associated:

Innocule Process Innovation Chemicality | INDTECH | Jigsan | TECHNO ENVIRO SERVICES | M/s Indian Plant Feeds | M/s Spine Care

- Innocule is a manufacturing startup that offers specialty chemicals and additives for the Indian mineral industry, presently testing of products for flotation, beneficiation of coal, on line moisture measurement in belt conveyor and for slurry transportation.

- LNIndtech for development of HYPOGEN generator can produce sodium hypochlorite solutions. The capacity of this equipment ranges from 100 liters to 500 liters in batch.

- Jigsan for joint development of the floor cleaner segment & especially catering to hospitals, Floor cleaner with infection control properties is the right choice.

- "TESPL. has set out itself to be a major Steel Plant Solid Waste Management firm in India. It has approached InTEC for Value Addition to Steel Plant Solid Waste through Eco-friendly Green Technology and has been working on development of technologies for steel plant solid waste recycle/reuse back in the steel making process to assist in achieving goals for environmental and sustainability commitments.
- M/s Indian Plant Feeds will be working on POTASH (K) ENRICHED BIOCHAR FROM WASTE BIOMASS.

- Spine Care a start up under Scientist Entrepreneur Scheme of CSIR-CGCRI/AIM-PRIME PROGRAM of VC, Pune is to produce hybrid Osteoconductive spinal cage implant that can lead to faster healing via enhanced vertebral fusion over existing technology.

Programs Organized:

➢ National e-Workshop on Innovation and Intellectual Property Rights (NeW IPR-2021 & 2022) In the month of June to bring-in awareness on IPRs and related aspects among academia / research, MSME / Start-ups. More than 22 experts in this area have delivered lectures. About 1200 participants from all over India have participated in this e-workshop.

➢ National e-Awareness cum Training on IPR (NeAT IPR-2021/2022) programs (15 in numbers) are conducted in Joint association with HEIs from J&K, Tamilnadu, Telangana, MP & AP) and few other are in pipeline.

MAITRI:

InTEC has recently started a initiative: Mentoring Academic Interventions for Technological Research & Innovation (MAITRI) to facilitate the interested organization/s to associate with us to enhance the academic-research-industry connect and thereby contribute to the innovation ecosystem very effectively.

About 40 HEIs from different states (Odisha, Maharashtra, MP, AP, Telangana, Tamilnadu, and Kerala etc.,) have already joined us under this initiative.

InTEC activities in last two year

- E Webinar on Startup awareness program in association with Start-UP Odisha on 22nd Jan 2021
- IPR programs: A total of 20 programs on IPR are conducted and sensitized about 15000 enthusiasts on various aspects of IP and Innovation
- MAITRI = Mentoring Academic Interventions for Technological Research and Innovation is initiated by InTEC and about 40 HEIs are associated till date
- Startup/Incubatee Associated = 13 (5 old + 8 new)
- Dr Ashok K Sahu, Chief scientist & CEO-InTEC; Dr T Pavan Kumar, Sr. Scientist & Manager-InTEC got trained through AI-PRIME program of AIM/NITI Aayog
- Received two grants of Rs 5 lakh each from MSME to organize Professional Development Programs on Technology/ Innovation & Incubation – (i) Mineral and Material Innovations for Sustainable Future, from Feb 13-18, 2023; (ii) Innovation, Incubation and IPR, from March 13-18, 2023; and both these programs are attended with about 60 participants each from various parts of the country spanning from J&K to Kerala and received a great feedback on its fruitful completions.

Details of IPR Programs in last two year:

- National e-Workshop on Innovation & Intellectual Property Rights - NeWIPR-2021 & 2022 = 2 (2000 Registrations)
- IP MAXIMA = 2 (with Registrations = 8000)
- National Training Program on Patent Search and Analytics - NTP PSA = 1 (250 Registrations)
- Joint program with Higher Educational Institutes (HEIs) -National e-Awareness cum Training program on Intellectual Property Rights - NeAT IPR = 15 (with Registrations = 8000)


One Week National e-Workshop on
Innovation & Intellectual Property Rights
(NeW IPR-2021), June 14 - 19, 2021
CSIR-Institute of Minerals & Materials Technology, Bhubaneswar, India
URL: www.immt.res.in
Organizing Structure
PATRON
Prof. Suddhasatwa Basu
Director, CSIR-IMMT
CO-PATRON
Dr Ashok K Sahu
Chief Scientist & CEO-InTEC
Dr B S Jena
Chief Scientist Head-PME
CONVENER
Dr T Pavan Kumar
Senior Scientist & Manager-InTEC
Virtual - MS-Teams
4 Sessions a day
(2 FN & 2 AN)
Lectures
Interactions
Hands-on Exercises
e-Support
CNeM
CSIR-IMMT
Inaugural
June 14, 2021
10:00 – 11:00 AM
CHIEF GUEST
Dr. Premnath Venugopalan
Chief Scientist & Head,
NCL Innovation, CSIR-NCL &
Director, Venture Centre, Pune
Inaugural talk
INTELLECTUAL PROPERTY & INNOVATION
Experts from:
Academia/Research – Industry/MSME
Patent Office & IP firms
CSIR-IMMT: InTEC
for
NeW IPR 2021
IP
LEARN
PROMOTE
PRACTICE
PROTECT
PROFIT
ALL
an inclusive & interactive event...
6 Days
22 Experts
4 h/day
REGISTRATION fee: Rs 200/- only
IP & INNOVATION
What-Why-How of IPRS
Types of IPR
Basics & Importance
Examples
Day-1 14/6
ALL about- PATENTS
Structure, Significance
CLAIMS
Scope & Limitations
PATENT FILING
Day-2 15/6
COVERAGE
Biodiversity
IPR &
Vaccination
Facilitation
CAREER
PROSPECTS
Day-6 19/6
PATENT
SEARCH
Why-How?
Databases
Case studies
IP to
MARKET
Day-3 16/6
TAKEAWAY
Day-5 18/6
Day-4 17/6
MAKE IP INDIA
Technology Transfer
IP STRATEGIES
Entrepreneurship
ACADEMIC IMPORTANCE
PATENT DRAFTING
e-Filing at IPO
Do it yourself
IDEA to PATENTS
Impact of IP – Case studies
CONNECT & NETWORK
with
IP ECOSYSTEM
E-Certificate
&
Reference Material
will be provide
after the Workshop
Step - 1
Pay Registration Fee of Rs 200/- at
A/C NAME : IMMT
ACCOUNT NO : 30267734773
BANK : SBI
ACCOUNT TYPE : SAVINGS
IFSC CODE : SBIN0007499
BANK BRANCH: RRL CAMPUS
BRANCH
Step - 2
Keep Transaction Number Ready
Step - 3
Fill the form using below
Registration Link
(Don't Forget to Fill Transaction Number)
Submit
Join
Telegram at
CONTACT Dr T Pavan Kumar
Convener , NeW IPR-2021
newipr2021@gmail.com
8008105781


Azadi Ka Amrit Mahotsav
VENTURE CENTER
InTEC
Innovative Technology Enabling Centre
AIMprime
Innovative Technology Enabling Centre (InTEC) has been established for translation of Innovative Technologies into successful business ventures through intervention of science & technology.
Vision: Contributing to generate earnings through innovative entrepreneurships
Mission: To nurture the innovating ideas in the areas of minerals, materials, metals & allied technologies to successful business ventures.
ORGANOGRAM
Management Committee (MC-InTEC)
Startup Odisha
CEO
Manager
Members
Technical & Business Advisory Committee (TBAC- InTEC)
MENTORS
Areas where entrepreneurs can be mentored
Adv. Materials Technology
Hydro & Electrometallurgy
Design & Project Engineering
Material Chemistry
InTEC
Mineral Processing
Environmental & Sustainability
Process Engineering & Instrumentation
Allied Technologies
Support Services
Mentoring
Capacity Building
IPR Facilitation
Networking with all CSIR Labs for technology sourcing
Office, Workspace, Library, High speed Internet, Computation facilities
Certification
Facilities
InTEC Discussion Room
Seating Capacity 08
Conference Room
Seating Capacity 40
Mini-Conference Room
Seating Capacity 10
CNC Turning M/C
CNC Milling M/C
Wire EDM M/C
Programs Organized
MAITRI
One Week National e-Workshop on Innovation & Intellectual Property Rights (NeW IPR)
2000 Participations
Ten National e-Awareness cum Training on IPR -Joint Program (NeAT IPR)
8000 Participations
IP MAXIMA –IPR Awareness for Maximum Reach..
6000 Participations
Our Incubatees
Innocule
INDTECH
Jigsan
M/s Spine Care
M/s Indian Plant Feeds
8 more inducted on May 11, 2022
Dr. Ashok K Sahu
Chief Scientist & CEO-InTEC
Dr. T Pavan Kumar
Senior Scientist & Manager-InTEC
Contact us
CSIR - Institute of Minerals and Materials Technology

KNOWLEDGE RESOURCE CENTRE (LIBRARY)

Scholarly information plays a vital role in a Research and Development (R&D) institute. The Knowledge Resource Centre (Library) of IMMT facilitates the information needs of researchers in the institute. The Knowledge Resource Centre (Library) of IMMT has created a knowledge resource base of more than 31,900 volumes of Books and Bound Journals in the subject areas of Extractive Metallurgy, Materials Science, Mineral Processing, Geology, Organic Chemistry, Inorganic Chemistry, Natural Products, Energy and Environment. Under CSIR-DST National Knowledge Resource Consortium, this center provides online access to more than 4500 full-text Journals from about 15 leading publishers of S&T Journals, Web of Science database, ASTM & Bureau of Indian Standards. Detailed online resources are available on the institute website under the KRC page. An e-learning center became a reality during 2021-22 inside the library as per the future needs and demands.

The current collection of IMMT Library stands as follows:

Library Holdings:

- Books: 14297
- Bound journals-17626
- Current Indian Journals Subscribed-20

Activities & Services:

- Organization and maintenance of library collections as well as dissemination of Knowledge & Information
- Providing library & Information services to the scientists and research scholars
- Technical processing of library collection and Resources (Acquisition, Classification, Cataloguing & Circulation)
- Updating & Processing of CSIR Knowledge gate database (OPAC)
- Manage & Processing of IMMT Pre-publications
- Access and Manage of library e-resources
- Reference services, Current Awareness Services, and Literature Search
- Document procurement and supply, Reprography services, and other routine work of the KRC
- Manage of Pathani Samanta e-learning centre (Arranging scientific discussion & group meetings, PhD related presentation, scientific lectures and other R&D activities, etc.

CENTRAL WORKSHOP

The Central Workshop at CSIR-IMMT is capable to cater the day to day requirements of the Scientists and Technologists relating to fabrication/modification, design, assemblies, structural works, repair of machines and all mechanical maintance works etc. It is well equipped with various types of CNC machines, Conventional machines, Welding machines, Hand tools, Measuring instruments and Glass blowing equipments etc. for enhance the R&D output in a time bound manner.

For development of the product design and manufacturing process, we use CAD (CATIA-V6), CAM (MASTER CAM X6 & L-CAM) & CNC machines are being used in central workshop to help in development of the product design and manufacturing process. The use of computer aided design systems helps in betterment of the designing because it improves the design analysis process. Design analysis with CAD systems helps in achieving optimum design and reducing overall time for designing the product. The CAD systems are equipped with not only the designing tools but also the analysis tools.

Different types of structural set up (Pilot plant etc.), equipments and machinery parts related to different projects/departments have been carried out in the Central Workshop. For years together Workshop is catering the needs of Scientists / Technologists to do high end research.

Achievements

To develop a modern infrastructure of mechanical workshop

Workshop is capable to help in meeting the day-to-day requirements of the Scientists and Technologists relating to fabrication/modification, design, assemblies, structural works & repair of machines etc. It is well equipped with various type of measuring tools, cutting tools; mechanical equipments, CNC equipments etc. for enhance the R&D output in a time bound manner. For development of the product design and manufacturing process, we use CAD (CATIA-V6), CAM (MASTER CAM X6 & L-CAM) & CNC machines in central workshop.

FACILITIES IN CENTRAL WORKSHOP

Facility in CNC section

1) CNC Turning m/c-
Specification:-
Make: - ACE Designer
Model: - JOBBER XL
Control System: - FANUC Oi Mate-TD
Accuracy: - 0.01 mm

CNC TURNING M/C

CNC MILLING M/C

2) CNC Milling m/c-
Specification:-
Make: - BFW
Model: - BMV 45 TC20
CONTROL SYSTEM: - FANUC Oi -TD
Accuracy: - 0.01 mm

3) WIRE EDM m/c-
Specification:
Make: - ELECTRONICA MACHINE TOOLS LTD
Model: - ECOCUT- ELPULS15
Control System: - P MAC
Accuracy: - 0.01 mm

WIRE EDM M/C

Facility in welding section

1.	Digitally Controlled Linux based CC/CV MMA Welding m/c -	FRONIUS- NEW
2.	Portable welding rectifier-	ESAB & KEMPI
3.	Welding Rectifier-	ADOR.
4.	TIG Arc welding m/c-	KEMPI
5.	MIG ARC welding m/c-	FRONIUS – NEW
6.	Air plasma cutting m/c-	VICTOR
7.	Resistance spot welding m/c-	ELECTROWELD
8.	Oxy-Acetylene gas welding and cutting plant	

MMAW

TIG WELDING

ARC WELDING

SPOT WELDING

GAS WELDING PLANT

AIR PLASMA CUTTING

Facility in Machine section

1.	Air Compressor-	Make- ELGI.
2.	Modgil Heavy Duty Shearing Machine. –	Make - Modgil.
3.	Surface Grinding m/c-	Make -HMT.
4.	Universal Milling m/c- BFW-UF2-	Make- BFW
6.	Horizontal Milling Machine–	Make- HMT.
7.	Centre Lathe – Type- Lb25-	Make- HMT.
8.	Conventional Lathe m/c-	Make-NEWMAX.
9.	Shaping Machine, Type – AS 24.	Make- Cooper Engineering Ltd.
10.	Redial Drilling Machine – Universal - RM- 63-	Make-HMT.
11.	Hydraulic Power Hacksaw m/c-	Make-
12.	Manual Sheet & Plate Bending Machine-	Make -International
13.	Hydraulic Shearing m/c-	Make- Energy Mission.
14.	Hydraulic Sheet rolling m/c-	Make- Devraj
15.	Fume Extraction for welding works	Make-Mogora

HYDRAULIC SHEARING

SURFACE GRINDING M/C

SHEET/PLATE ROLLING

SHAPER

LATHE

UNIVERSAL MILLING

RADIAL DRILL

HYDRAULIC PRESS

Fume Extraction

Compressor for Paint Shop

Fitting Hand Tools

1. Jig Saw, Model - GST-8.
2. Drill machine 1/4" cap (Kulkarni black decker)
3. Drill machine 30mm cap (Wolf)
4. Metal cutting, GCO2400J
5. Rotary Drill (GBM13-2)
6. Mini Angle Grinder, - Bosch make.
7. Angle Pipe Cutter, Model – GCM-12.
8. Electric Impact Wrench, Model – GDS18E.
9. Heavy Duty Angle Grinder, Model – GWJ 26 -180H.

Glass Blowing Section

1. Lathe glass working machine (Glass tube dia01mm to300mm works)
2. Rotary compressor vacuum pump
3. Glass cutting machine (glass tube dia01mm to300mm works)
4. Adco grinding & polishing with1/2 hp motor.

GLASS LATHE M/C

GLASS TUBE CUTTING M/C

Materials Handling Facilities

1. Hand Pallet Trolley, Make- Godrej.
2. Godrej 2Ton Fork Lift Truck, Model – GX200E.
3. Salter Hanging Balance

Achievement: 2022-23

Total 112 nos of work order has been completed during the Year 2022-2023 in Welding & Fitting section. R.O.I value is- Rs.92, 500/- from Welding & Fitting section only.
Total 94 nos of work order has been completed during the Year 2022-2023 in CNC section. In addition, R.O.I value is- Rs.5, 34,682/- from CNC section only.
Total 95 nos of work order has been completed during the Year 2022-2023 in Glass blowing section. In addition, R.O.I value is- Rs.1, 78, 000/- from Glass blowing section only
Total R.O.I value about in the FY-2022-2023 from workshop is = Rs.8, 05,183/-







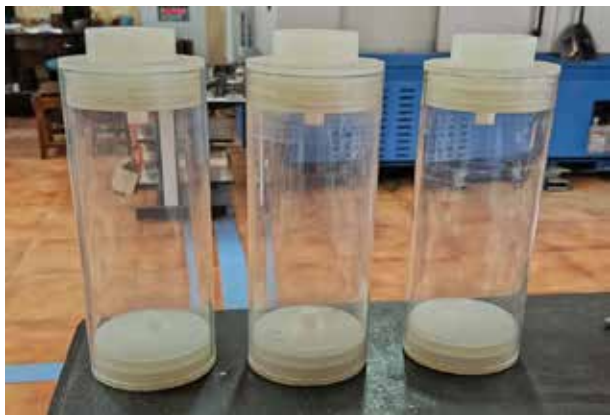





















Stir casting set-up

Stir casting set-up having bottom pouring facility- 3 kg meliting and casting facility in inert atmosphere has been established for non-ferrorus alloys.

The 1 TPH batch type mineral processing pilot plant

The 1 TPH batch type mineral processing pilot plant is being converted to a continuous type by incorporating belt conveyor. The design, fabrication, and erection of the structural unit for belt conveyor was done by the Central Workshop, CSIR-IMMT. The developed facility can handle 1 TPH ore/ material as continuous process. (Belt conveyor for 1 TPH Mineral Processing Pilot Plant)

Monochromatic high speed camera

Monochromatic high speed camera provides the facility to observe the engineering phenomenon occurring at microseconds to millisecond time scale. The equipment has been deployed to study dense granular flows and gas-liquid flows.

Crucible Furnace

Crucible Furnace- for melting of non-ferrous metals and alloys.

Electro-spin

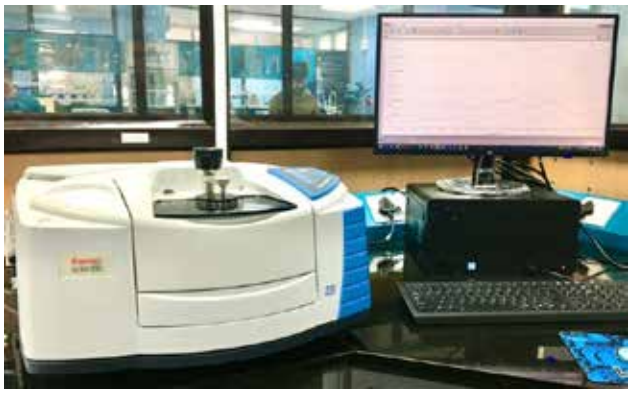
Glove Box

Planetary mixture

Automatic Film Coater with Vacuum Chuck and Doctor Blade

Calendaring machine

Infrastructure developed for the synthesis of fibre and fabrication of coin cell for battery application



ATR-FTIR Spectrometer

Fourier-Transform Infrared Spectrometer (FTIR) with state-of-the-art technology, coupled with Diamond ATR, with future upgradation provision of smart accessories like TGA-IR Module and FTIR Microscope. It is useful to (i) identify unknown materials (solid, liquid, gas, thin-film, gels, polymer), (ii) conduct contaminant analysis, and (iii) verify chemical structure and mixture compositions.

Make: Thermo Scientific, USA
Model: Nicolet iS20
This facility was inaugurated on 15/05/2022.

Chemical Vapor Deposition Techniques (CVD)

CVD provide insights for the formation of thin films out of solid form any materials and vapor phase of that material is deposited on any substrate depending upon the choice of applications.

This facility started functioning on 15/09/2022.

Bio-Atomic Force Microscope (AFM)

Bio-Atomic Force Microscope provides high resolution imaging in Thin Films, Polymers, single molecules, biological samples like Bacteria, DNA, RNA, Protein, Nano Particle, etc. The system should include all accessories to allow operation in air & liquids along with temperature controller.

High resolution mode for imaging delicate soft samples in both air & liquid environment while maintaining resolution & clarity. The system is capable of achieving high resolution imaging in air and liquid using most advanced techniques such as the cantilever resonance frequency by photo thermal (not by piezo)/ imaging at off-resonance frequency by driving the z scanner sinusoidally without the need to tune the cantilever or by equivalent such advanced techniques.

This facility started functioning on 13.01.2023.

Vacuum Glove-Box

Vacuum glove-box is used for various synthesis, electrochemical testing and device fabrication of non-aqueous based energy storage and pseudocapacitor applications.

This facility started functioning on 01.09.2022.

Slurry Pot Erosion Tester

Slurry pot erosion tester allows to investigate the erosion wear of pipe materials under varying slurry velocity, contact time and slurry temperature.

This facility was inaugurated on 29/03/2022

Rheometer

Rheometer allows to quantify the flow characteristic of various fluids under varying time, temperature and shearing conditions. This advanced rheometer is capable of analysing the slurries/suspensions containing coarse particles.

This facility was inaugurated on 06/01/2023

Pilot Scale Study of different Resin/Media for ground water

ECL has supported state of Bihar, Assam, West Bengal, Uttar Pradesh, Odisha, Andhra Pradesh, Maharashtra for commissioning the water treatment plant for common people under Jal Sakti Mission.

Miller Apparatus

Miller apparatus helps to investigate the abrasion wear in terms of Miller number and SAR number. It helps to rank the abrasiveness of slurries and the abrasive response of pipe materials.

This facility was inaugurated on 17/06/2022

Floor model Refrigerated Centrifuge

Provides for separation of biological cells and biomolecules from environmental samples and microbial cultures or DNA/RNA extraction during.

The facility was inaugurated on 2.2.2023 in Environmental Biology Laboratory

Precession wedge Polishing system

Precession wedge Polishing system for XTEM sample (Make: Allied High tech, USA),

Installed on 29th March 2022.

Ion Chromatograph used for water analysis

AAS used for metal estimation for water

Plasma cleaning system

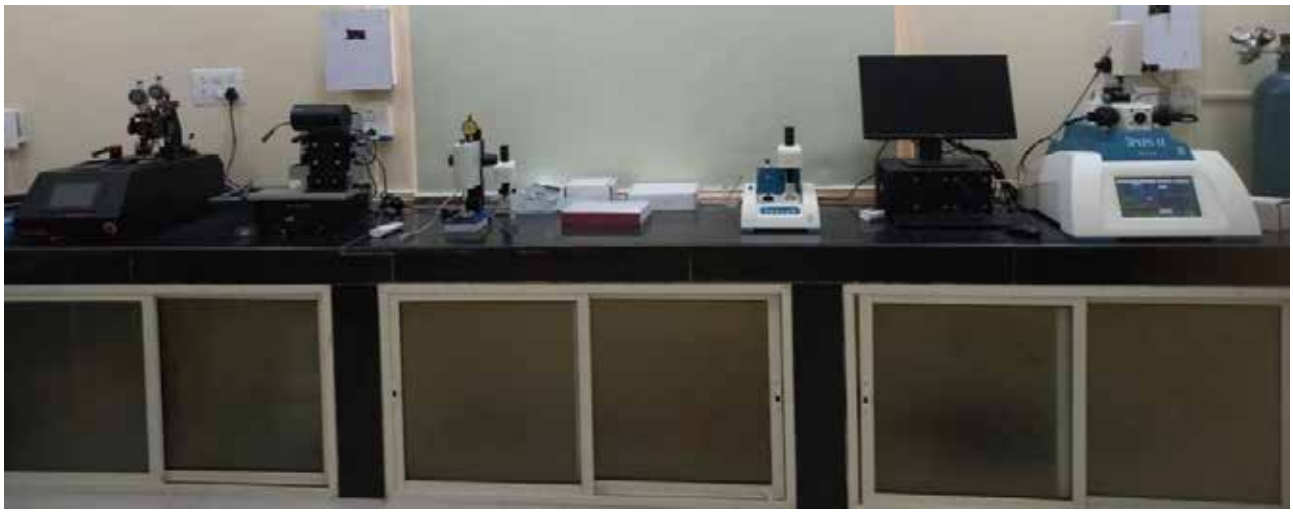
(HPT 001, Make: Henniker Scientific Ltd., UK)

Installed on 14th March 2022

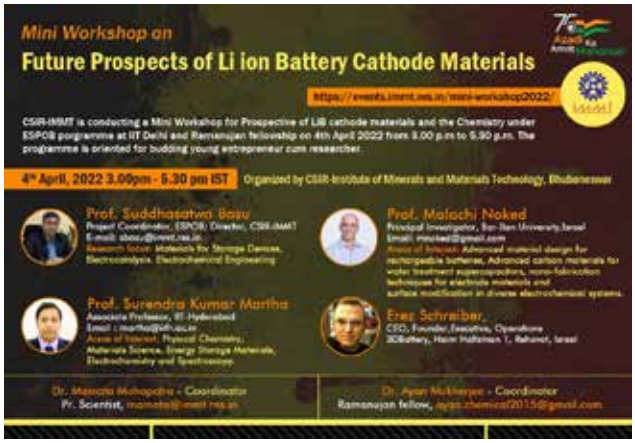
Centre For Waste Utilization

New laboratory has been developed at Centre for Waste utilization for carrying out R&D activities related to solid industrial waste utilization.

TEM sample preparation Unit which includes ion beam milling system (PIPS), Ultrasonic disc cutter, Dimple grinder, Disc puncher, Vertical Diamond Wire saw, Disc grinder with specimen lapping system. (Make: Gatan inc. USA).
Installed on 16th July 2022

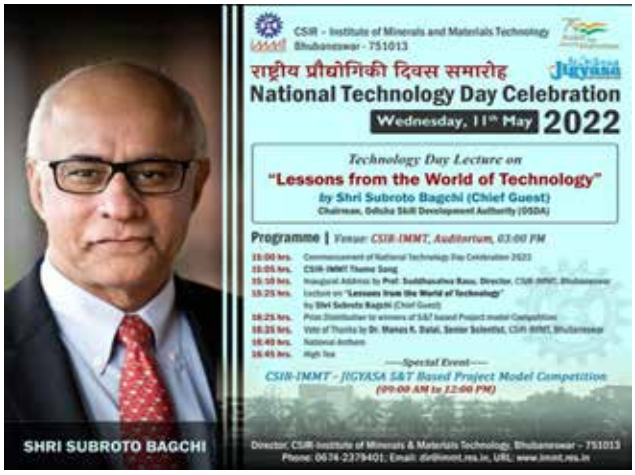


One Day Workshop for Prospective of LiB cathode materials and the Chemistry under ESPOB porgramme at IIT Delhi and Ramanujan fellowship on April 04, 2022



76th Independence Day 2022

National Technology Day on May 11, 2022. Shri Subroto Bagchi will be the Chief Guest and shall deliver the Technology Day Lecture on "Lessons from the World of Technology"

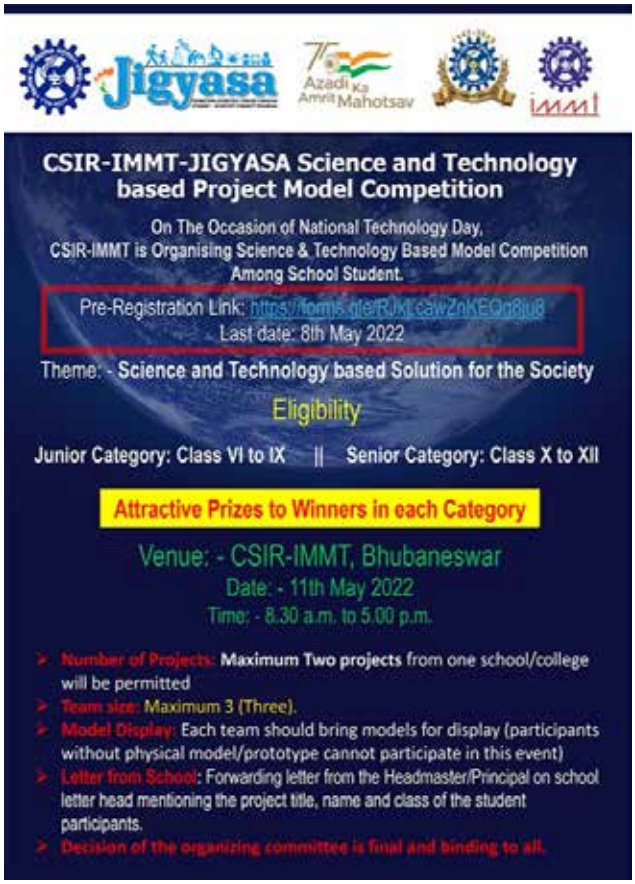


59th CSIR-IMMT Foundation Day on April 13, 2022. Shri. Sridhar Patra, CMD, NALCO will be the Chief Guest

Dr. B.R Ambedkar Jayanti on Thursday, April 14, 2022. Shri Debaraj Senapati Ex-Secretary BDA, Bhubaneswar was the Chief Guest.

CSIR Integrated Skill Initiative Program on "Electrochemical Processing Techniques & Characterization for Industrial Applications- EPCIA" on 21st-22nd April 2022.

CSIR-IMMT-JIGYASA Science and Technology based Project Model Competition. (Venue: CSIR-IMMT, May 11, 2022, 08:30AM - 05:00 PM).



One week National e-Workshop on Innovation and Intellectual Property Rights (NeW IPR-2022) from June 13-18, 2022 . Prof. (Dr.) Unnat P. Pandit will be the Chief guest of the event.

International Day of Yoga on June 20-21, 2022

World Environment Day will be celebrated at IMMT on June 5 with a day long program starting with planting trees, competition and seminars.

Industry Connect Programme (I-Connect):
A mega event was organized on 17th June 2022 on online platform by CSIR-IMMT as a part of Industry Connect Programme (I-Connect) to showcase the technologies under "Waste Utilization from Mineral Processing Industries" to various industries and stakeholders. This was promoted under the aegis of Ministry of Science and Technology and Ministry of Earth Science, Govt. of India towards connecting research with industries. The programme was a part of a series of iconic 75 Industry connect (i-connect) events organized from 12th May to 12th August 2022 to showcase the achievements in various S&T areas and towards celebrating the 75 years of Indian Independence as Azadi Ka Amrit Mahotsav and fostering a strong Atmanirbhar Bharat.

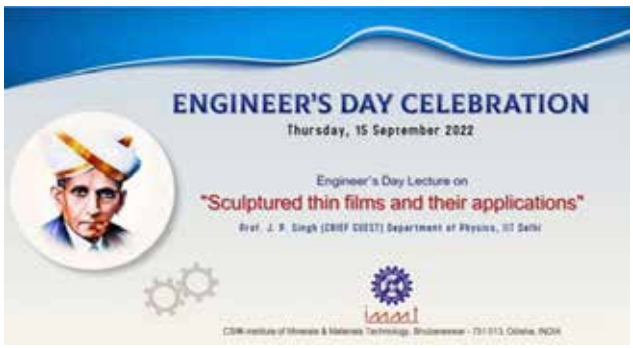
CSIR Integrated Skill Initiative Programme on Mechanical Characterization and Non-Destructive Evaluation of Materials - III Date: 26th – 29th September 2022

76th Independence Day 2022

Visit of former PSA to Govt of India, Dr R Chidambaram to CSIR-IMMT on the occasion of Bhubaneswar Knowledge Cluster (BCKIC) meeting.

51st SSBMT zonal football tournament from Aug 31 to Sept 3. Chef Guest was Ms Shradhanjali Samantaray, former captain of Indian women's football team.

Engineer's Day on 15th September, 2022 - Lecture on "Sculptured thin films and their applications" by prof. J. P. Singh (Chief Guest), Department of Physics, IIT Delhi



7th Ayurveda Day on 11th October 2022

Special Campaign 2.0 for disposal of various pending matters and cleanliness at CSIR-IMMT

Vigilance Awareness Week 2022 is being observed at CSIR-IMMT from 31st October to 6th November 2022 with the theme "Corruption Free India for a Developed Nation.

Demonstration of CSIR-IMMT developed Groundwater De-fluoridation Technology organized by Environment & Sustainability Department CSIR-IMMT at S.S.Bhatnagar Meeting Hall on 22nd November,2022

On January 4, 2023, a MoU was signed between **CSIR IMMT-InTEC and OUTR** (Odisha University of Technology and Research). This collaboration will aid in advancing research and technological growth.

"**One Week One Lab**" Curtain Raiser Programme was held at CSIR-IMMT Auditorium. Dr.(Mrs.) N. Kalaiselvi, Director General, CSIR & Secretary, DSIR and Shri. Hemant Sharma, IAS were the chief guest.

After Prof.(Dr.)Suddhasatwa Basu completed his tenure as Director of CSIR-IMMT on 31st January,2023, Dr. G. Narahari Sastry, present Director of CSIR-NEIST, Jorhat, took over the additional responsibilities as the Director

I**MMT and OUAT 've inked a MoU** on 6th Feb,2023 for enabling collaborative research, technology development and transfer. It is aimed to catalyze knowledge exchange and translation of ideas from lab to industries through S&T intervention

IMMT is conducting 5 days **HRD Training Program** on "Mineral Characterization and Beneficiation" starting from 6th February - 10th February, 2023 for the Technical Officers of Directorate of Mines, Govt. of Odisha.

IMMT hosts His Excellency Michael Lodge, Secretary-General, and a high-level delegation from International Seabed Authority

Celebrating International Day of Women & Girls in Science. Jigyasa Talk on "Research Brief by Women Scientists of CSIR-IMMT" on 11th Feb 2023 at 3pm in YouTube lives

Sri Nagendra Nath Sinha, IAS , Secretary, Ministry of Steel visited the CSIR-Institute of Minerals & Materials Technology (IMMT) on 16th February 2023.

In a significant step towards Atmanirbhar Bharat, NMDC signed an Agreement for Collaborative Research with CSIR-IMMT, Bhubaneswar in the presence of Director (Production)Shri Dilip Kumar Mohanty at its Head Office today.

ACM Distinguished Lecture on "Machine Learning Approach to control an Autonomous Underwater Vehicle" by Prof.Bidhyadhar Subudhi, School of Electrical Sciences, IIT Goa to be held on Monday March 06,2023


ACM
DISTINGUISHED LECTURE
Machine Learning Approach to Control an Autonomous Underwater Vehicle
Prof. Bidyadhar Subudhi, School of Electrical Sciences, IIT Goa
Monday March 06, 2023 (03:00 PM)
ABSTRACT
Autonomous Underwater Vehicles (AUVs) find many interesting applications such as in Defence organisations for underwater mine detection, region surveillance, oceanography studies, oil/gas industries for inspection of underwater pipelines and other marine related industries. However, for these applications effective motion control algorithms need to be developed. These motion control algorithms necessitate accurate representation of AUV dynamics involving hydrodynamic damping, Coriolis terms, mass and inertia terms etc. Control design for an AUV is challenging owing parametric uncertainties arising from hydrodynamic parameters and external disturbances due to variation in oceanic currents. In this talk, we will discuss on design of Adaptive control schemes for an AUV. Further, in order to realize the proposed control algorithms, a prototype AUV is developed in the laboratory. Adaptive control strategies are designed for an AUV by using its identified Nonlinear Autoregressive Moving Average eXogenous (NARMAX) model. The parameters of this NARMAX model structure are identified on-line using Recursive Extended Least Square (RELS) method. To obtain dynamics of an AUV, a system identification technique using Extreme Learning Machine (ELM) structure is considered. Then a robust model predictive adaptive control algorithm is designed for accomplishing efficient path following control of an AUV. The proposed control algorithms are verified first through simulation and then through experimentation on the prototype AUV.
BIOGRAPHY: Prof. Bidyadhar Subudhi received the Bachelor of Electrical Engineering from the National Institute of Technology, Rourkela in 1988, MTech degree in Control and Instrumentation from IIT Delhi and PhD degree in Control System Engg. from the University of Sheffield. Currently he is a Professor, School of Electrical Sciences and Dean (R&D) in IIT Goa. He was a recipient of the Prestigious Samanta Chandra Sekhar Award of the Odisha Bigyan Academy, Govt. of Odisha and Distinguished Alumnus Award, NIT Rourkela. He is a Fellow of the Indian National Academy of Engineering, Asia-Pacific Artificial Intelligence Association, IET (UK). He serves as a Technical Committee Member of the IEEE Intelligent Control, IEEE Consumer Power and Energy, Steering Committee Member of the Asian Control Association, Council Member of IFAC. He is associated as an Editor with IEEE Trans. on Sustainable Energy, IEEE Systems Journal, and IET Electronics Letter. He has been appointed as Distinguished Speaker by ACM. His research interests include System & Control, Control of PV & Microgrid Systems and Underwater Vehicles. He supervised 40 PhD students, published 164 peer reviewed journal papers, 110 papers in conference proceedings, 14 book chapters and 8 books.
CSIR-Institute of Minerals and Materials Technology, Bhubaneswar

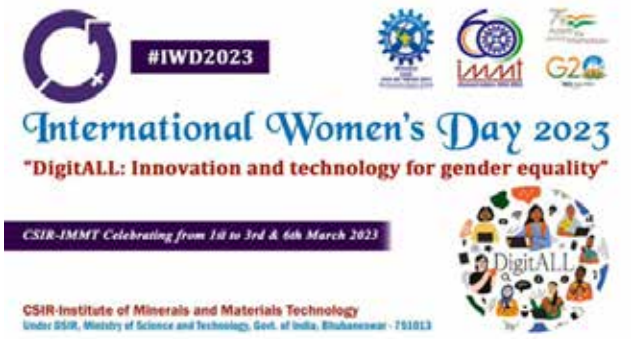
National Science Day 2023 is being celebrated by CSIR-IMMT on Tuesday, Feb 28, 2023 under the theme of 'Global Science for Global Wellbeing', with Dr. Sanghamitra Pati, Director of ICMR-RMRC, Bhubaneswar as the Chief Guest

Sir SS Bhatnagar Birth Anniversary Memorial Lecture on "Collaborations and team work" will be delivered by Dr. G. Narahari Shastri, SS Bhatnagar Awardee

24 February, 2023: Co-organizer of **one-day National Conference** on Recent Advancements in Iron and Steel industries and Emerging areas (RAISE-2023), jointly organized by CSIR-IMMT Bhubaneswar and IIM Bhubaneswar chapter at CSIR-IMMT Bhubaneswar.

Environment & Sustainability Department of CSIR-IMMT is conducting Skill Development Training Program on "**Techniques in Environmental Microbiology (TEM)** " from 13th -17th March 2023 at Environmental Biology Lab (EBL) E&S Dept.

CSIR-IMMT is celebrating **International Women's Day** 2023 from 1st to 3rd & 6th March, 2023 with the theme "DigitALL: Innovation and technology for gender equality".



CSIR-IMMT JIGYASA Team conducted RSC Professional Development Program for Science Teachers during 17-18, March 2023.

CSIR-IMMT & Oxfam, India jointly organized a State Level Sharing Meet on safe drinking water at IMMT, Bhubaneswar.

A state level sharing meet "Ensuring access to safe drinking water for the disaster vulnerable communities in the coastal Odisha" has been organized on 8th July 2022 at CSIR-IMMT, Bhubaneswar in collaboration with Oxfam India. The Director, CSIR-IMMT inaugurated the event as Chief Guest. Representatives of from various govt. & private agencies have participated in the event.

Fire and Safety Program for the year 2022-2023

A Fire and Safety training program was being arranged for the staff, Students, contract workers and security personnel of CSIR-IMMT at Odisha Fire and Disaster Response Academy (OFDRA), BBSR on every Saturday afternoon. 277 members from IMMT have undergone the said training.

Members attended Fire and safety training at OFDRA, Fire station on 02.07.2022

Some random clicks during training : Members from IMMT were using different tools and implementing different methods as instructed by Dy. Fire officer and station officer of OFDRA.

Training on SAFETY AND FIRST AID

- Safety Team of CSIR-IMMT also conducted a Safety workshop during January 04-05,2023 named "Training on SAFETY AND FIRST AID", where 50 nos of Permanent staff of CSIR-IMMT participated.
- This safety workshop was imparted by experts of Challengers Academy of S.H.E.
- The experts of Challengers Academy of S.H.E, BBSR visited CSIR-IMMT campus and gave a report on Fire and Safety measures.

A group photo graph of Participants (staff members) of CSIR-IMMT with Director, CSIR-IMMT and experts of challengers Academy.

A group photo graph of Participants (staff members) of CSIR-IMMT with participating certificates at the valedictory of "Training on SAFETY AND FIRST AID programme.

Safety Measures insides CSIR-IMMT campus

- We have placed 18 Sand buckets at different places inside the campus.
- Created 5 safety hubs with safety accessories (heavy quality aluminium extension ladder 20ft and extended up to 40 ft, rope ladder, fire and safety helmet, insulated Axe handle tested to 3000V, fire beter with bamboo handle, Hook with bamboo handle, leather apron, leather gloves, fire jacket etc.) for instant prevention.
- Fire extinguishers are also placed in different places inside the campus.

Director's Opening remarks at the inauguration of the program.

Dr. Shivakumar Angadi, Chairman,
Mr. Bibhudatta Pradhan, Safety Officer. &
Mr. Abinash Prusty, Dy. Safety Officer.
(Fire and Safety Team, CSIR-IMMT)

Women's Day Celebrations at CSIR-IMMT

To honour the contribution of women in various fields of science & technology and to society, Ministry of Women & Child Development instructed to all CSIR Labs to conduct impactful events during 1st week of March 2023 as a part of International Women's Day celebrations.

Accordingly, CSIR-IMMT, Bhubaneswar has celebrated the International women's day with a range of programs during 1st -3rd March 2023. On 1st March, interactive sessions with eminent doctors were conducted for all the staff, scholars and family members of the institute on health management and awareness. Dr Suvendu N. Mishra, Psychiatrist, SUM hospitals, Bhubaneswar spoke on "Anxiety and Stress management" and Dr Soumya Dash, Consultant, IVF, Hi-Tech hospitals, Bhubaneswar addressed in detail about "Gynaecological problems from womb to tomb" with preventive measures. Competitions and extracurricular activities such as extempore elocution, thematic art competition, and Millet themed Food fair were also conducted for students and research scholars which brought out the creative side of the participants. The international women's day celebrations were held on 3rd March with distinguished women professionals from the state as invitees. Prof. Sabita Acharya, Vice Chancellor, Utkal University graced the event as Chief Guest, speaking about the need for feminist approach to policy making to promote gender inclusive culture. Prof. Mira Das, SOA University and Ms. Madhumita Mohanty, former consultant Reliance retail and visiting professor IIM Amritsar were present on the occasion as Guests of honour. Dr. A.K.Sahu, Scientist In-charge and Dr M.G. Sujana, Convenor of the International Women's Day celebrations presided over the program. In this connection, several programmes were arranged for the students of the institute and prizes were distributed to the winners. Ms. Veenapani Behra, Section Officer made the audience aware of various provisions adopted at CSIR-IMMT for preventing any sexual harassment and ensuring a safe working environment for women.

6th March 2023: ACM distinguished lecture

A distinguished lecture on Machine Learning Approach To Control An Autonomous Underwater Vehicle was delivered by Prof. Bidyadhar Subudhi, Professor, School of Electrical Sciences & Dean (Research & Development), Indian Institute of Technology Goa, at CSIR-Institute of Minerals and Materials Technology, Bhubaneswar on 6th March 2023. The lecture was organized in support of the Association for Computing Machinery (ACM) - a global organization that brings together computing professionals, researchers, and educators to advance the field of computing.

Annual Report 2022-23

PERFORMANCE

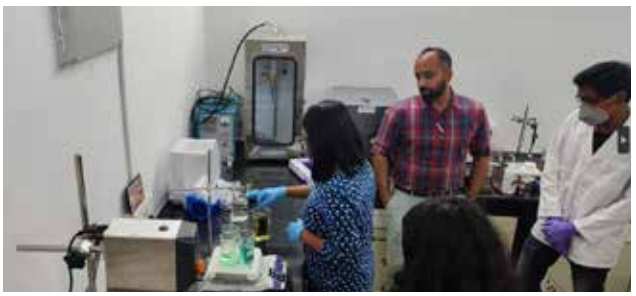
HUMAN RESOURCE DEVELOPMENT

Skill Development Programme at CSIR-IMMT Bhubaneswar

Under CSIR Integrated Skill Initiative twelve skill development programme were conducted during FY 2021-22. The first programme titled "Electrochemical processing techniques and characterization for industrial applications" was conducted during 21-22 April 2022. Following this another programme on "Analytical Equipment" was conducted during 26 May-3 June 2022 exclusively for the KIIT and SOA university students. The Environment and Sustainability Department conducted an Awareness cum Training Program on "Atmospheric Pollution and its Health" impact for Grade 8-10 students in the Sashidevi Girls High School, Chhatia on 30 June 2022. A series of one-day event on "Documentation and conservation techniques of medicinal plants useful to mitigate COVID-19 pandemic" were conducted on various nearby colleges. A programme titled "Training program about basics and applied skills for biochar production" was conducted for farmers of Khorda district. The Mineral Processing Department conducted a five-day programme titled "Fundamentals and Advances in Mineral Engineering" during 19-23 Dec 2022. Following this a SERB Karyashala event was conducted on "NanoMaterials for Energy and Environment" during 22-29 Jan 2023.

Electrochemical Processing Techniques and Characterization for Industrial Applications

About 15 candidates comprising of some postgraduate students from M.Sc, M.Tech backgrounds; some PhD scholars and a young working professionals had participated in this 2-day intense Skill development program. The participants were from institutions like IIT Delhi, CV Raman Global University, Utkal University, Ravenshaw University, CIPET IPT, Reva University, NISER BBSR, North Odisha University and CSIR IMMT. Four resource persons Dr. Bikash Kumar Jena, Dr. Balaji Umapathi, Dr. Mamata Mohapatra and Dr. Chinmaya Kumar Sarangi delivered lectures on fundamentals and applications of electrochemical processes and also provided hands-on demonstration of the concepts discussed in their lectures. Fundamentals as well as applications of Electrochemistry were discussed in detail from fuel cell, supercapacitors, batteries to electrolysis, anodization, electroplating, electroless plating, electrorefining, electrowinning, and other electroanalytical techniques such as CV, LSV, Chronoamperometry, etc. Current industry practices, ongoing research, upcoming technologies and standard operating procedures were highlighted to give a bigger picture about the applied electrochemistry field. An industry visit was also arranged in MECHEM Pvt. Ltd., Mancheswar Industrial Estate to observe and understand how industrial operations such as sample preparation such as zincating, chromate conversion followed by coatings such as powder coating, anodizing, colour anodizing were demonstrated. Students were able to appreciate the link between concepts that were discussed in the laboratory and how it is performed in the industry.



Skill Development Program on Analytical Equipment

A Skill Development Program on Analytical Equipment was jointly organized by Central Characterization Department and Environmental and Sustainability Department during 26th May-3rd June 2022 at CSIR-IMMT, Bhubaneswar under "CSIR Integrated Skill Initiative Program". The skill development program covered the basic principle, operation, sample preparation, data generation and interpretation of analytical equipment such as Raman Spectrometer, CHNS analyzer, Ion Chromatograph, TEM, FTIR, GC-MS & TGA-DSC. 20 numbers of students from KIIT University and SOA University had participated in the skill Development Program.

Awareness cum Training Program on Atmospheric Pollution and its Health Issues

A team of Scientist from the CSIR-IMMT, Aerosol & Trace gases Laboratory, Environment and Sustainability Department, conducted an Awareness cum Training Program on Atmospheric Pollution and its Health impact for Grade 8-10 students in the Sashidevi Girls High School, Chhatia on 30 June 2022. This workshop was conducted to observe Azadi Ka Amrit Mahotsav that is being celebrated across the country. Around 90 young students participated in this workshop which was inaugurated in the Sashidevi Girls High School meeting Hall. The School Head Mistress, Senior Teachers and Officers from the panchayat attended the function along with Dr. N.K. Dhal, Chief Scientist, Dr. R. Boopathy Senior Scientists and Dr. R. Boopathy`s Research group from CSIR-IMMT. Dr. Boopathy`s research group explained in details about the various pollutants in ambient air, their sources and health impacts to the students. Visual PowerPoint presentations was made where the students could see videos that explained about air pollution and its consequences on climate and health along with the various research activities conducted at CSIR-IMMT to study the characteristics of various ambient air pollutants. This was an interactive session and the students participated with lot of enthusiasm. The scientists took up various questions of the young mind and the students were also encouraged to come up with their own ideas and innovations to deal with this challenge called air pollution. Live demonstration was given to the school students about the particulate matter (PM) measurement through the coarse and fine particulate matter from ambient air. The session ended with brief remarks and words of encouragement to the students by the team of scientists.




Documentation And Conservation Techniques of Medicinal Plants Useful To Mitigate Covid-19 Pandemic

A six parts skill development programme titled "Documentation and Conservation Techniques of medicinal plants useful to mitigate covid-19 Pandemic" was conducted by the Environment and Sustainability Dept. The first event was conducted at Gopabandhu Science College, Athagarh on 27th July 2022 where 50 Science students participated. The second event was conducted at Christ College, Cuttack on 3rd August 2022 where 50 students participated. The third event was conducted Dhenkanal Autonomous College, Dhenkanal on 29 Sept 2022 where 35 students participated. The fourth event was conducted at Subhadra Mahatab Mahabidyalaya, Asureswar, Cuttack on 11th Oct 2022 where 50 students participated in the training. The basic techniques of plant collection, identification and preservation was demonstrated to the participants by Dr. N.K. Dhal along with his team members from IMMT Bhubaneswar.


Training Program About Basics and Applied Skills for Biochar Production

Environment and Sustainability Department conducted one-day skill development programme on "Training program about basics and applied skills for biochar production" on 30 Oct 2022 at Balipatna, Khorda to celebrate the Azadi Ka Amrit Mahotsav under the CSIR Integrated Skill Initiative. The main objective of the programme was to demonstrate and train farmers about prospects of agro-biomass waste utilization for biochar production through portable low-cost biochar kiln method. The training program elaborated about agro-residues, processing of biomass residues, size and design of kiln, pyrolysis process, biochar products and their use in agriculture and soil conditioning. The event was attended by 25 farmers. Dr. N.K. Dhal, Head, Environment and Sustainability Department, highlighted the prospects of program to farmers, and the practical session was conducted by Dr. Manish Kumar, Pr. Scientist.

Fundamentals and Advances in Mineral Engineering

The Mineral Processing Dept. conducted a 5-day programme on "Fundamentals and advances in mineral engineering". Demand for ore minerals is increasing enormously due to the increase in world population. High-grade ores are depleting, and to meet the present demand, the utilization of low-grade ores is gaining importance. Mineral processing is a suitable option for the beneficiation of low-grade ores. In view of this, an attempt was made to organize a refresher course on Fundamentals and Advances in Mineral Engineering (FAME-22) for plant Executives/Engineers. This course was conducted by highly experienced resource persons from R & D organizations, Academic Institutions, and Industries. The refresher course covered the fundamentals in mineral characterization, comminution, gravity concentration, magnetic and electrostatic separation, flotation, pelletisation, briquetting, flow sheet developments, value addition, slurry transportation, etc. Dr. S. Angadi and his team organised the event where 22 participants were trained.

KARYASHALA on NanoMaterials for Energy and Environment

This high-end workshop on Nanomaterials for Energy and Environment (NanoMatEn2) funded by SERB-Accelerate Vigyan was organised by Advanced Materials Technology (AMT) Department of CSIR-Institute of Minerals and Materials Technology (IMMT) during 22-29 Jan 2023. Basically 'KARYASHALA' is an effort to improve research productivity of promising PG and PhD students from universities and colleges through high-end workshops on specific themes. Through this program, CSIR-IMMT is looking to take up the challenge of skilling a select group of individuals as it has several years of research and technical experience in the fabrication of advanced nanomaterials using physico-chemical methods for electrochemical supercapacitors, photocatalytic dye degradation, detection of toxic gases, electronic displays etc. The workshop was focussing on educating the PhD and PG students about the fundamentals on the top-down and bottom-up synthesis approaches of advanced nanomaterials using physical and chemical methods and progress of these nanomaterials in the field of energy and environment. Lectures from experienced scientists will included the basics of advanced nanomaterials, energy storage, photocatalytic degradation gas sensing and opto-electronic applications. The practical aspects of synthesis of nanomaterials and hands-on experience on the processing equipment such as field emission scanning electron microscopy, Hall effect measurement, four-probe measurement, microplasma illumination, electrochemical work station, UV-visible spectroscopy and gas sensing equipment were demonstrated. The discussion sessions afforded a fertile atmosphere for brainstorming and creative thinking among students and scientists to compare and contrast the requirements for developing advanced nanomaterials across both domains and apply this knowledge to a real-world problem. This workshop was attended by 25 students who were provided with a vital platform for gaining knowledge based on the several materials synthesis techniques for the development of energy and environmental devices by highly experienced speakers.

Scientific Social Responsibility

JIGYASA Student Visit Program

Model Contest

DD Odia Program

Quiz Contest

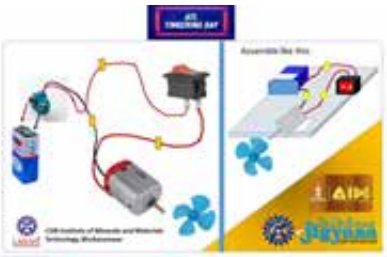
CSIR Directed Events

Global battery Experiments by Royal Society of Chemistry

Students made Coin Cells and glown LED

ATL-World Youth day By NITI Aayog

Students were taught to make LED projects



ATL-Mega Tinkering Day By NITI Aayog

Atal Tinkering Lab (ATL) Adoption

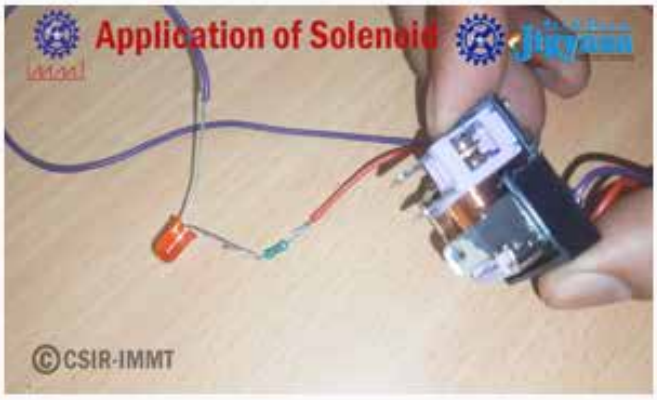
- 10 Schools are adopted
- Conducted Mega Tinkering Day Event – 14th Nov 2022
- Visited 7 schools
- Giving hand-holding support to Three schools Now
  - Sainik School
  - KV-4 Bhubaneswar
  - KV-5 Bhubaneswar

MOU between NITI Aayog and CSIR-JIGYASA

Virtual Lab Integration

CSIR Jigyasa Virtual Lab (jigyasa-csir.in)

https://jigyasa-csir.in/



AN INITIATIVE BY

CSIR

DESIGN PARTNER

IIT BOMBAY

JIGYASA Garden

Plants from CIMAP, NBRI and Local Sources

Medicinal, Aromatic, Floriculture

This is being demonstrated to School Children who ever visit us

Some plants are being produced to be planted in some schools

GARDEN MINT

(*Mentha spicata*)

Uses: -It is a popular herb that people can use fresh or dried in many dishes and infusions. Toothpaste, gum, candy, and beauty products often use mint oil.

Oils are Extracted

Academic Programmes for Students

The R&D Departments of CSIR-IMMT provide shortterm training for 6-8 weeks and long-term training for six months to 1 year to students pursuing B.Tech./M. Tech./M.Sc./ MCA/ Integrated M.Tech./Intgrated M.Sc. in different Colleges, Institutions, and Universities. During the year 2022-23, XX Nos students have carried out their dissertation work in various R & D Departments.

Training/Refresher Courses

Industrial interactive program under hydraulic transportation of iron ore/minerals/ industrial wastes

SK Behera being felicitated after the training at University College of Engineering, Adkavi Nannaya University, Rajamahendravaram, AP

Dr. Santosh Kumar Behera, Principal Scientist conducted two day workshop on design & implementation of Control systems using labVIEW at University College of Engineering, Adkavi Nannaya University, Rajamahendravaram, AP during 16th to 17th February, 2023.

Bibek Dash, Sr. Scientist. PE&I delivered Invited talk at Skill Development Institute, organized by ICT- IOC Bhubaneswar under Govt. of Odisha Skill Development Program in January 1–January 7, 2023.

Bibek Dash, Sr. Scientist, and Lokesh, Scientists of PE&I gave training to researchers and students on AI/ML under DST-Sponsored research cum training programme at CSIR-NEIST, Jorhat in February 26-March 4, 2023.

Dr. Debi Prasad Das, Senior Principal Scientist, PE&I gave training to researchers and students on "Machine Learning: from Math to Code" under DST-Sponsored research cum training programme at CSIR-NEIST, Jorhat in 9-10, March, 2023.

Awards

- **Ms. Shradha Suman** for receiving the best oral presentation award in 10th National Conference on Nanoscience and Instrumentation Technology (NCNIT-2022) held during July 09 -10, 2022.
- **Mr. Santosh Deb Barma**, Sr. Scientist received IEI Young Engineers Award 2021-22
- **Mrs. Pallishree Prusti**, Pr. Scientist received IEI Young Engineers Award 2022-23 under Chemical Engineering Discipline
- Mrs. Pallishree Prusti, Principal Scientist, Mineral Processing Department received Young Innovator's Award under R&D category for the year 2022 from Indian Institute of Mineral Engineers (IIME) Bhubaneswar Chapter during Annual General Body Meeting (AGBM) 2022 held on 25th September 2022 at Bhubaneswar, Odisha.
- **Dr. Sourav Ganguly**, Scientist awarded with the best paper for the symposium on materials and composites in the international conference CORCON 2022
- **Dr. Santosh Kumar Behera**, Principal Scientist, PE&I Dept. has been awarded IETE - Hari Ramji Toshniwal Award (2022)
- Dr. Santosh Kumar Behera, Principal Scientist, received IIME Mineral Excellence award at Bhubaneswar in 2022.
- **Dr. Danda Srinivas Rao**, Chief Scientist - MPD, Head HRD selected to receive the Samanta Chandra Sekhar award for the year 2020, by Govt. of Odisha.
- **Mr. Abdul Rahim Khan** secured first place in Volleyball in event in Senior Men & Women at Aerodrome Area Playground, Bhubaneswar on 4th December, 2022
- **Dr. Priyanka Rajput**, Pr. Scientist, AMT Dept. selected as recipient of IEI Young Engineers Award 2022-23 under the Metallurgical and Materials Engineering Discipline
- **Ms. Manasi Jena**, AcSIR, PhD scholar(NET CSIR-SRF) for winning in DST-AWSAR 2022 for popular science story writing Under Ph.D category
- **Sukanta Kumar Mahanta**, AcSIR Ph.D. Scholar, AMT Dept. for winning the Best Poster Award under Engineering and Technology Category in the National Conference on Science & Technology for Sustainable World for the poster entitled "Preparation of high-purity Graphene variant from spent submerged Arc-furnace Graphite Electrode" organized by Indian Science Congress Association, Bhubaneswar Chapter and KIIT, Bhubaneswar.
- **Monami Mukherjee** and Soumya Prakash Dutta, Project Associates, AMT Dept. for winning the Best Poster Award under Agricultural and Forestry Sciences Category in the National Conference on Science and Technology for Sustainable World for the poster entitled "Self life and germination improvement of seeds through Cold Plasma Processing" organized by Indian Science Congress Association, Bhubaneswar Chapter and KIIT, Bhubaneswar.
- **Priyabrata Nayak**, AcSIR Ph.D. Scholar, AMT Dept. for winning the Best Poster Award under Materials Science Category in the National Conference on Science & Technology for Sustainable World for the poster entitled "Design and Development of Double-Sided Near Perfect Solar Absorber and Selective Emitter to enhance Solar Thermal-Photovoltaic Efficiency" organized by Indian Science Congress Association, Bhubaneswar Chapter and KIIT, Bhubaneswar.
- Dr Trupti Das received The Governor's Award for High Impact Research 2022 from the State of Colorado (https://cobioscience.com/event/2022-governors-awards-for-high-impact-research/)
- Dr Trupti Das Received the Healthy Community Award from Home SOS Team, for exemplifying the mission of Boulder county Public Health and improving the health and well-being of people and environment of Boulder county.
- Dr. Bikash Kumar Jena; Indian Institute of Metals Award (BBSR Chapter) in recognition of contribution to the field of Materials Science on 26th August 2022, Bhubaneswar
- Dr. Sriparna Chatterjee, CSIR-Senior Research Associate (Pool Scientist), received the Society for Materials Chemistry (SMC) Bronze medal-2022 for the contribution in the field of materials chemistry at BARC, Mumbai, INDIA on December 7-10, 2022.
- Dr. Y.S Chaudhary Received the IIM Bhubaneswar Chapter Award-2022 from the Indian Institute of Metals, Kolkata.
- Dr. Bikash Kumar Jena was awarded the "Utkal Pratibha Sanman 2023" along with Padmashree Dr. Debiprasanna Pattanaik, Padmashree Shyamamani Devi, Dr. Itishree Samanta, Dance guru Sri Ratikanta Mohapatra by The ODM educational group, Odisha.
- Dr Chinmaya Kumar Sarangi, Principal Scientist, received National Environmental Science Academy (NESA) Eminent Scientist award for outstanding contribution in the field of materials processing and waste utilization for value-addition in the year 2022.
- Dr Mamata Mohapatra received Prof. Manju Mishra Award for the best female researcher (40 - 60 years of age) of the state in any discipline of chemical sciences in the year 2022 by Odisha Chemical Society.
- Dr Barsha Dash, received a Commendation Award from Hindustan Petroleum Corporation Limited for New Generation Ideation Contest-2022.

- Dr. Kali Sanjay, Chief Scientist & Head, HEM department, received the Eminent Engineering Personality Award by The Institution of Engineers India (IEI) in January 2023.
- Dr. Benjamin Raj, Senior research associate under HCP -2802 has been awarded as "BRICS YOUNG SCIENTIST FORUM 2022" for new material section.

Honours

- **Dr.(Ms.) Mamata Mohapatra**, Principal Scientist, has been selected as State President, Odisha Water Resources Council (Women's Indian Chamber of Commerce & Industry)
- **Dr. Nabin Kumar Dhal**, Chief Scientist has been elected to the Executive Council of the AAT (Indian Association for Angiosperm Taxonomy)
- Dr Nilotpala Pradhan listed in Top 2% scientists in world 2021 by Scopus data 2022 (https://elsevier.digitalcommonsdata.com/datasets/btchxktzyw)
- Dr. Nirmal Goswami of Materials Chemistry department has recognized as one of the Nanoscale (RSC) 2023 Emerging Investigators.
- Dr. Sumit Saha. "Development of Organometallic Cluster Complexes for the Removal of Toxic Chemical Dyes" in the Kaaryashala on NanoMaterials for Energy and Environment (NanoMatEn2) sponsored by SERB, New Delhi under Accelerate Vigyan Scheme at CSIR-IMMT, Bhubaneswar, 2023.
- Dr. Santosh kumar Behera , Principal Scientist, received fellow of Institution of Electronics and Telecommunication Engineers (IETE) in 2022.
- Mr. Arya Das, PhD scholar, received prestigious "Overseas Visiting Doctoral Fellowship" funded by Science and Engineering Research Board (SERB) Government of India. In view of this, he will be carrying out his research on soft landing of molecular sulfide clusters in Purdue University, USA for a tenure of 12 months from January 2022 to July 2023.
- Dr. Sriparna Chatterjee, CSIR-Senior Research Associate (Pool Scientist), elected as Joint secretary of IIM Bhubaneswar Chapter in the Annual General Body meeting held in the year 2022, Bhubaneswar, Odisha.
- Dr. Sriparna Chatterjee of Materials Chemistry department chaired a session in the Technical Symposium on "Basic Science and Technology for Sustainable development (BSSD-2022) on September 16-18, 2022 in association with Bhabha Atomic Research Centre, Mumbai and IIT Delhi to commemorate the international year of Basic Science for sustainable development and 75 years of Azadi ka Amrit Mahotsava.
- Dr. Sriparna Chatterjee of Materials Chemistry department delivered an invited lecture on the topic "Research Work to Patents-A Practical Insight" at NeW IPR-2022, One Week National e-Workshop on Innovation & Intellectual Property Rights at CSIR-Institute of Minerals & Materials Technology, Bhubaneswar, INDIA on June 13 - 18, 2022.
- Dr. Sriparna Chatterjee of Materials Chemistry department delivered an invited lecture on the topic "Story of a STAR: Dr. Bibha Chowdhuri" at a virtual event organized by INSA-Indian National Young Academy of Sciences on "Iconic Women Scientists of India" under its Flagship program WiSDom (Women in Scientific Domain) on July 27, 2022.
- Dr. Sriparna Chatterjee of Materials Chemistry department delivered an invited lecture on the topic "Tailoring of Multifunctional Nanostructured Materials" at International Conference on Emerging Materials for Sustainable Development (EMSD-2022), CSIR-CSIO, Chandigarh, India on October 9-11. 2022.
- Dr. Sriparna Chatterjee of Materials Chemistry department delivered an invited lecture on the topic "Tuning of wetting behavior of nanostructured surfaces towards frontier applications" at DAE-BRNS 9th Interdisciplinary Symposium on Materials Chemistry (ISMC-2022), BARC, Mumbai, INDIA on December 7-10, 2022.
- Dr. Sriparna Chatterjee of Materials Chemistry department delivered a lecture on the topic "Ti3C2/OH MXenes towards vacuum electronic device applications" at International Conference in Asia – 2022 (IUMRS-ICA 2022), IIT Jodhpur, India on December 19-23, 2022.

Fellowship

- **Mr. Abdul Rauf Sheik,** Senior Scientist, Received the prestigious Chevening CRISP fellowship from University of Oxford
- **Dr. Bikash Kumar Jena**, Principal Scientist, Fellow of the Royal Society of Chemistry
- Dr. Manas Kumar Dalai has been awarded with CSIR Raman Research Fellowship 2022-2023.
- Dr. Sisir Mantry received the Raman Research Fellowship to visit University of Nottingham, UK to pursue research in Thermal spray coatings for 4 months

Ph.D. Degrees

AcSIR at CSIR-IMMT, Bhubaneswar

List of students who are being awarded PhD degree in between 01.04.2022 to 31.03.2023

Sl. No.	Name of the Student	Enrolment No.	Title of the Thesis	Supervisor/ Co-supervisor	Date of Award
1.	Ms. Kiran Lata Bhaskar	20EE13A36006	Study on thermal upgrading of chromite overburden for enrichment of Ferro-Nickel.	Dr. Bhagyadhar Bhoi	25. 07. 2022
2.	Mr. Santosh Kumar Rath	10CC13A36026	Synthesis of amide analogues of α-tetralone, betulinic acid and p-coumaric acid and their bioevaluation studies.	Dr. Sanjib Das	07.09.2022
3.	Mr. Suryakanta Dehuri	10CC15A36004	Effect of long chain n-alkyl substituents on metal ion selectivity and chemosensing parameters of rhodamine based probes.	Dr. Bamaprasad Bag	14.09.2022
4.	Ms. Rojali Maharana	10BB16A36001	Development of phosphorus rich organomineral fertilizer and effects on plant growth	Dr. Nabin Kumar Dhal	30.01.2023
5.	Ms. Yamini Mittal	20EE17A36010	Design and development of biotechnological processes for treating selected pollutants of the aqueous environment.	Dr. Asheesh Kumar Yadav	07.03.2023

Ph.D. Degrees

Non-AcSIR at CSIR-IMMT, Bhubaneswar

- Mr. Binod Bihari Palei has been awarded the Ph.D. in Centurion University of Technology and Management.Odisha, for his thesis titled, Synthesis And Characterization Of Graphene And Graphene Reinforced Aluminium Metal Matrix Nanocomposite To Enhance Microhardness And Electrical Properties In Applied Science, in the year 2022.
- Mr. Vighnesh Prasad has been awarded his Ph.D. degree from the Indian Institute of Technology Gandhinagar (IITGN), on July 30, 2022.

Deputation / Visit Abroad:

- Dr. Bamaprasad Bag had visited, Caparica, Lisbon, Portugal during July 3-7, 2022 for presenting an oral communication in the 5th International Caparica Conference on Chromogenic and Emissive Materials 2022.
- Dr. Kamali Kesavan, Scientist, visited Elettra Synchrotron Center, Trieste, Italy from 18th-25th December 2022 by acceptance of research proposal in Indo-Italian Beamline of Elettra (XPRESS) and by availing DST-travel grant to perform high-pressure synchrotron XRD and SERS on novel porous materials.
- Dr Trupti Das awarded a Sabbatical Fellowship by Cooperative Institute for Research in Environmental Science (CIRES), University of Colorado Boulder. 1st June-30th November 2022.
- Dr. Sisir Mantry is visiting University of Nottingham, UK under Raman Research Fellowship to pursue research in Thermal spray coatings for 4 months
- Mr Abdul Rauf Sheik, Principal Scientist from HEM received Chevening Research, Science and Innovation Leadership (CRISP) Fellowship at Oxford University, UK

- Dr Benadict Rakesh, Scientist from HEM department visited Institute of Physics of Czech Academy of Sciences (CAS), Prague, Czech Republic from 27th June to 21st July, 2022 under CSIR-CAS Joint Mobility plus project.
- Dr. Dilip Kumar Mishra has been awarded his PhD degree in Chemistry from Ravenshaw, University, Cuttack for the doctoral thesis titled" SILVER NANOWIRE BASED HETEROSTRUCTURES FOR FIELD EMISSION AND OXYGEN REDUCTION APPLICATIONS" under the supervision of Dr. Bikash Kumar Jena on 3rd February 2023.

PATENTS AND PUBLICATIONS 2022-23

PATENTS AND PUBLICATIONS

PATENTS

Filed in India

Chaudhary, Y. S., & Dehury, A. K. (2022). A process for preparation of stable single phase intrinsic white light emitting Phosphors and application thereof (Application No. 202211051217).

Chaudhary, Y. S., Kumar, N., & Mishra, R. P. (2022). Process for preparation of 2-D nanostructured sheet based photocatalyst and application thereof (Application No. 202211034151).

Das, D. P., Naik, M. R., Dey, S., Pothal, J. K., Bag, B. P., Sahoo, A. K., & Jena, B. K. (2022). Carbon quantum dot based MGAL-layered double hydroxides nanocomposites and preparation thereof (Application No. 202211028467).

Dhal, N. K., Maharana, R., Kumar, T. P., & Basu, S. (2022). A Phosphorus enriched organo-mineral fertilizer from organic wastes, rock phosphate and efficient microbial solubilizer and use thereof (Application No. 202211051487).

Kumar, M., Ray, A., Dhal, N. K., & Basu, S. (2022). A process for the production of Potassium-Phosphorus-Sulphur rich biochar fertilizer from waste biomass and fertilizer industry waste (Application No. 202211021972).

Filed in Abroad

Besra, L. D., Kiran, N. U., Choudhary, B., & Chatterjee, S. (2022). Ultrafast synthesis of MAX phases by reactive flash sintering and a method thereof (Application No. PCT/IN2022/050494).

Jena, B. K., Kamila, S., & Pradhan, L. (2023). Electrochromic supercapacitor application of Vanadium doped Cobalt chloride carbonate hydroxide: Process for preparation thereof (Application No. PCT/IN2023/050096).

Marygude, S., Ramalingam, S., Ramasamy, B., Sahoo, A. K., Das, B., Behera, P., Singh, D., & Basu, S. (2022). Metal oxide hydroxides biopolymer composite beads for fluoride removal from groundwater and a process for the preparation thereof (Application No. PCT/IN2022/050700).

Marygude, S., Ramalingam, S., Ramasamy, B., Sahoo, A. K., Das, B., Behera, P., Singh, D., & Basu, S. (2023a). Metal oxide hydroxides biopolymer composite beads for fluoride removal from groundwater and a process for the preparation thereof (Application No. 2022329277).

Marygude, S., Ramalingam, S., Ramasamy, B., Sahoo, A. K., Das, B., Behera, P., Singh, D., & Basu, S. (2023b). Metal oxide hydroxides biopolymer composite beads for fluoride removal from groundwater and a process for the preparation thereof (Application No. 18/247382).

Granted in India

Angadi, S. I., Behera, S. K., Reddy, P. S., & Mishra, B. K. (2022). A novel technique and apparatus for monitoring hydrocyclone spigot choking (Patent No. 400184).

Bhoi, B., Mishra, B. K., Paramguru, R. K., Pradhan, S. K., Mukherjee, P. S., Sahoo, S., Priyadarshini, S., & Das, S. K. (2022). Reduction of iron ore using microwave assisted low-temperature hydrogen plasma (Patent No. 400868).

Dwari, R. K. (2023). Device for physical separation of cenosphere from fly ash (Patent No. 423379).

Ganneboyina, S. R., Jada, N., Sanjay, K., Sheik, A. R., & Sarangi, K. (2023). Multi-helical reactor for liquid—Liquid extraction/stripping and phase seperation and methods thereof (Patent No. 423720).

Nayak, B. B., Dash, T., & Mishra, B. K. (2023). Porosity free powder of Tungsten carbide composites and process for preparation thereof (Patent No. 419491).

Nayak, B. B., Mishra, B. K., Mukherjee, P. S., & Pradhan, S. (2022). A process for producing Niobium metal by carbothermic reduction of its oxide in arc plasma reactor (Patent No. 399232).

Subbaiah, T., Mishra, B. K., Ghosh, M. K., Sanjay, K., Bhattacharya, I. N., Sarangi, C. K., Dash, B., & Sheik, A. R. (2022). A novel hydrometallurgical process for the production of Tellurium from high lead bearing Copper refinery anode slime (Patent No. 406906).

Subbaiah, T., Mishra, B. K., Sanjay, K., Sarangi, C. K., Biswal, A., Mishra, S., Mallika, C., Muduli, U. K., Natarajan, R., & Raj, B. (2022). Design and development of a diaphragm-less electrolytic cell and cathode material for continuous reduction of the concentration of Nitric acid (Patent No. 401942).

PUBLICATIONS

Papers Published in Journal

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Anwar, S., Anwar, S., Nayak, B., & Siva Sankar, R. (2022). Role of nickel in structural and mechanical properties of nc-WNNi sputtered nanocomposite coatings. Materials Science and Engineering: B, 284, 115893. https://doi.org/10.1016/j.mseb.2022.115893

Anwar, S., Anwar, S., Priyadarshini, B., & Sankar, R. S. (2022). Evaluation of structural and mechanical properties of CrAlN single layer coating deposited by reactive magnetron sputtering. Materials Chemistry and Physics, 292, 126873. https://doi.

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Anwar, S., Choudhary, B., Badapanda, T., Barman, R., Chaterjee, S., Jayasri, S., Sharmistha, A., Elorika, P., & Tripathy, S. N. (2022). Structural, dielectric, ferroelectric, and electromechanical performance of Mn modified (BaCa)(ZrTi)O3 ceramics. Materials Chemistry and Physics, 292, 126829. https://doi.org/10.1016/j.matchemphys.2022.126829

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Barik, R., Satpathy, B. K., Nikoloski, A. N., & Mohapatra, M. (2022). One-pot synthesis of Mn-doped goethite composite for enhanced supercapacitor performance and charge storage mechanism. Journal of Materials Science: Materials in Electronics, 33(15), 11661–11675. https://doi.org/10.1007/s10854-022-08123-x

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IMPLEMENTED PROJECTS 2022-23

Grant-in-Aid	62
Sponsored	59
Consultancy	8
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CSIR Mission Mode	7
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GRANT-IN-AID PROJECTS

Sl. No.	Project Title	Sponsor
	Ongoing	
1	Aerosol radiative forcing in India – land campaign for physical characterization of aerosols at Bhubaneswar (Phase-I -IV)	ISRO-GBP, Thiruvananthapuram
2	Monitoring of ozone and its precursor trace gases at Bhubaneswar	ISRO-GBP
3	Technology development (Extractive metallurgy) for polymetallic nodules	MOES, New Delhi
4	Development of a refractory high entropy alloy for high temperature structural application	DST, New Delhi
5	Conversion of emitted CO_2 to chemical fuels	MOS, New Delhi
6	Phytoremediation of radioactive elements (Cesium and Strontium) from contaminated soil and water	Atomic Energy Regulatory Board, AERB, Mumbai
7	Creation of DSIR Common Research and Technology Development Hub (CRTDH) in the area of New Materials/Chemical Process	Department of Scientific & Industrial Research (DSIR), New Delhi and CSIR-IMMT
8	Alumina-graphite composite material for high temperature application	Gandhi Institute for Technology (GIFT), Bhubaneswar
9	Development of CrAlSiN Based Superhard Nanocomposite Coatings	Science & Engineering Research Board (SERB), Vasant Kunj, New Delhi
10	Fault prediction of transferred arc thermal plasma by real-time monitoring of optical, acoustic and electrical signals to avoid extinction	Science & Engineering Research Board (SERB)
11	Phytoremediation of Cr^{6+} from part OB dump at South Kaliapani chromite mines of M/s Odisha Mining Corporation Limited (OMC) located at Jaipur district in Odisha over an area of 10 ha through selected indigenous plant species	Odisha Mining Corporation Ltd (OMC), Bhubaneswar
12	Farm based S&T intervention for socio-economic development in the aspirational district of Nabrangpur, Odisha	Department of Agriculture & Farmers Empowerment Govt. of Odisha, Krushi Bhawan, Bhubaneswar-751001

13	Green synthesis of low-cost, reusable and eco-friendly biobased magnetite nanocomposites for mitigation hexavalent chromium Cr(VI) in drinking water	Department of Science & Technology (DST), Government of India, Technology Bhawan, New Delhi
14	Processing of Spent Lithium Battery	Department of Science & Technology (DST), Government of India, Technology Bhawan, New Delhi (Through IIT Delhi)
15	Photofunctional materials for industrial dye mineralization	Department of Science & Technology (DST), Government of India, New Delhi
16	Development of solar to chemical fuel generation device/process based on earth abundant materials	Department of Science & Technology (DST), Government of India
17	Development of earth abundant heterostructured photocatalyst based solar H_2 generation reactor/process	Department of Science & Technology (DST), Government of India
18	Development of Iron Aluminide Coated High Performance Steels	Department of Science & Technology (DST), Government of India
19	Novel bioplastic material from marine microbes for industrial applications through sustainable process	Government of Odisha, Science and Technology Department
20	Source Apportionment Study of Bhubaneswar and Cuttack City	State Pollution Control Board, Government of Odisha, Paribesh Bhawan
21	Direct Production of Fe-Cr-Ni-Mn Stainless Alloy from Mine Waste by Thermal Plasma Process	Ministry of Mines, Government of India, New Delhi
22	Processing of spent and natural graphite for energy and aerospace application	Ministry of Mines, Government of India, New Delhi
23	EXAFS/XANES Study of Transition Metal Based Catalysts for Energy	UGC-DAE Consortium for Scientific Research, Indore, MP
24	Biomass Mediated Value Addition to Fertiliser Industries Waste	Department of Science & Technology (DST), New Delhi, Paradeep Phosphate Limited, Paradeep, Odisha & CSIR-IMMT, Bhubaneswar
25	Direct Laser Writing of Conducting Diamond on Flexibles	Science & Engineering Research Board (SERB), New Delhi
26	Mesoporous bi-functional metal oxide and phosphate/phos- phonates materials for electrochemical energy conversion and storage	SERB, New Delhi
27	Xanthene derivatives as chemosensors for organo-phosphates and nitro-aromatics and their bio-imaging in plant species	SERB, New Delhi
28	Bench Scale Production and Cost Estimation of Silicon Carbide Powder Obtained by Plasma Processing of Rice Husk	Ministry of Steel, Govt. of India, New Delhi
29	An innovative spin to the existing water challenges: Wastewater to energy, clean water and fertilizer through the integration of traditional biological and advanced bioelectrochemical approaches	DST, New Delhi

30	Lead-free Chalcogenides and Halide Perovskites for Optoelectronic Applications	Science & Engineering Research Board (SERB)
31	Development of process flowsheet for the recovery of Individual heavy minerals from the mineral sand plant tailings	IREL (India) Limited, Chatrapur, Odisha
32	Design and Development of Self-Sustainable Zero Discharge Hygienic Toilet	DST, New Delhi
33	Simultaneous removal of CO_2, SO_x and NO_x from flue gas and their catalytic conversion into fuels and value added fertilizers	Ministry of Steel, New Delhi
34	Bioleaching of Lithium from minerals and low grade ores of Indian origin	Ministry of Mines, Govt. of India, New Delhi
35	Production of high pure manganese metal organic frameworks (Mn-MOFs) and their derivatives from low grade manganese ores for supercapacitor applications	Ministry of Mines, Govt. of India, New Delhi
36	Development of Tungsten Alloy Square Based Pyramid	Government of India, Ministry of Defence, Defence Research & Development Lab (DRDL), Hyderabad
37	Implementation of TERAFIL water filtration systems in Iron contaminated areas of Jharkhand & Odisha and optimization of TERAFIL raw materials & its process for Eastern region of India	Ministry of Jal Shakti, National Jal Jeevan Mission, Government of India
38	Process development for the recovery of tungsten values from lean grade Indian resources	Ministry of Mines, Government of India,New Delhi
39	Recovery of galena, sphalerite and valuable minor metals from lead/ zinc tailings by integrated energy efficient ultrafine comminution and classification and novel ultrasonic treated shear floc-flotation and its impact on downstream paste fill	Ministry of Mines, Government of India,New Delhi
40	Innovative approach to recover chromite value from low grade chromite ore, fines & slime by dry and wet beneficiation technique	Ministry of Mines, Government of India,New Delhi
41	Development of High Efficiency Rechargeable Magnesium Battery Mitigating the Challenges Associated with Electrode Materials and Electrolyte	SERB, New Delhi
42	Technology Development for Advanced Plasma Processing of Indian Cultural heritage and Archaeological artefacts for Conservation and Feature Enhancement	Department of Science & Technology (DST), New Delhi,
43	Centre for Electrochemical Energy Storage Design, Development, Fabrication and Evaluation of Utility-Scale High-Performance Batteries (CSIR-IMMT Work Component: Battery-grade Cathode material generation through urban mining and battery health monitoring)	Science & Engineering Research Board (SERB), New Delhi
44	Continuous extraction of magnetite reduced from low-grade iron ores in the Fluidized Bed Reactors for higher productivity	Science & Engineering Research Board (SERB), New Delhi
45	Development of Nano-sized Magnetite from Mill Scale for Printing Application	Ministry of Steel, New Delhi, Government of India
46	Discrete-point control based Adaptive Active Noise regulation System implementation using Deep-Learning regression Techniques.	SERB, New Delhi, Government of India
47	Development of an Advanced Artificial Intelligence based Instrument to Control the Iron Ore Disc Pelletizer	Ministry of Steel, New Delhi, Government of India & M/s JSW Steel Limited, Karnataka, India

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48	Development of Bimetallic Transition Metal Cluster Complexes for Small Molecule Activation	SERB, New Delhi
49	Development of low-cost cellulose based SERC substrate with plasmonic core @ LDH shell nanoparticles for improved environmental monitoring.	UGC-DAE Consortium for Scientific Research
50	The effect of microstructural on the enhancement of electrical properties of diamond films by N and P co-ion implantation for electron emission displays	UGC-DAE Consortium for Scientific Research
51	Training and skill internship (VRITIKA) on development of cathodic materials for microplasma generation at CSIR-IMMT	SERB, New Delhi
52	Ultra fast and single step flash sintering process/technique for proton conducting solid oxide fuel/electrolysers cells	Science & Engineering Research Board (SERB), New Delhi
53	Recovery of metallic values from the discarded copper slag	Ministry of Mines, Government of India, New Delhi
54	Characterization of Iron-Nickel based Rare Earth free permanent magnets	UGC-DAE Consortium for Scientific Research
55	Nanostructured Diamond Hybrid Emission Sources for Optoelectronic Applications	Department of Science & Technology (DST), New Delhi
56	Preparation of TiB_2 powder from rutile through thermal plasma process	Government of Odisha, Science and Technology Department
57	Two-dimensional nanostructured pH-universal catalysts for efficient and durable electrocatalytic hydrogen evolution	Science & Engineering Research Board (SERB), New Delhi
58	Documentation of floristic diversity of four reserve forest (Sulia RF, Sapua RF, Pokharigochha RF and Gochha RF) floral diversity	Divisional Forest Officer, Nayagarh, Odisha
59	Design and development of flotation column system for the recovery of monazite from IREL mineral separation plant	IREL (India) Limited, Chatrapur, Odisha
60	High-End workshop (KARYASHALA) on Karyashala on Nanomaterials for Energy and Environment (NanoMatEn2)	SERB, New Delhi
61	Training and skill internship (VRITIKA) on novel ionic liquids For the separation of rare earth elements	SERB, New Delhi
62	A detailed investigation of the erosion and corrosion wear in the presence of chemical/bio-additives to forecast the life-cycle of the industrial pipeline.	Science & Engineering Research Board (SERB), New Delhi, Government of India

SPONSORED PROJECTS

Sl. No.	Project Title	Sponsor
	Ongoing	
1	Recovery of Electrolytic Manganese Dioxide (EMD) from Manganese Ore: Process Optimization for existing plant at MOIL, Alternate process development and basic engineering package preparation.	MOIL, Maharashtra
2	Evaluation of suitability of nano iron/iron oxide powders of energy and sensor applications	NMDC, Hyderabad, in collaboration with IIT, Kharagpur

3	Technology transfer for Cobalt manufacture	M/s. Mishra Dhatu Nigam Ltd. (MIIDHANI), Hyderabad
4	Sedimentation studies, up-scale testing and basic engineering for thickener for treatment of Mn ore fines	M/s MOIL, Madhya Pradesh
5	Cobalt technology from impure cobalt hydroxide: Process flow sheet development	M/s MIDHANI, Hyderabad
6	Laboratory scale studies on Iron , Fluoride and Arsenic removal efficiency from Ground water individually on supplied FLUROX media based unit for fluoride, IREX media for iron and ISOLUX media for Arsenic removal efficiency from contaminated water by M/s Atus International	M/s. Autus International, Maharashtra
7	Laboratory scale studies on Fluoride, Iron and arsenic removal efficiency from Ground water individually on supplied Purolite resin by M/s. Cleanflo India Pvt. Ltd	M/s. Cleanflo India Pvt. Ltd., Delhi
8	Laboratory Scale Beneficiation on studies for different grade Iron Ores	Atha group, Roida-II Iron Ore Mines, Odisha
9	Characterization of Coal Core samples of CMPDIL, Bhubaneswar for resource evaluation	CMPDIL, Bhubaneswar
10	Quality assessment for referee samples of Indian Power Coal	Coal India Limited, Kolkata (through CIL subsidiaries & Nodal CSIR Lab CSIR-CIMFR, Dhanbad
11	Optimization of process for the treatment of Spent Pot Lining carbon for the recovery of valuables and bench scale testing	M/s NALCO, Bhubaneswar
12	Characterization and Beneficiation of Low-grade Bauxite Ores from Gujrat	M/s Geological Survey of India, Nagpur
13	Beneficiation of Silica Sand for Solar wafer Applications	M/s Geological Survey of India, Nagpur
14	Studies on the Characterisation and Beneficiation of Tensa Iron Ore Fines to develop an Iron Ore process flowsheet	M/s Jindal steel & Power Ltd, Angul, Odisha
15	Environmental Pollution Monitoring in and around Paradip Port	M/s Paradip Port Trust, Odisha
16	Characterization and beneficiation of Iron Values from Lean-grade BHJ Ore	M/s Thriveni Earthmovers Pvt. Ltd , Odisha
17	Rheological testing of Fly ash samples for pipelines transportation at Reliance Power project, Singrauli, M.P	Sasan, (Reliance Power), Mumbai, Maharashtra
18	Development of innovative and robust process of antimicrobial coating on Aluminium substrate	KIIT Bhubaneswar, (Work Order from NALCO)
19	Mineralogical characterization of Iron ore sample	M/s Euro Pratik Ispat Pvt. Ltd, (EPIPL), Jabalpur, Madhya Pradesh
20	Studies on improvement of lime content of the Alkali Bypass Dust	M/s. Ultra Tech Cement Ltd, Unit: Sewagram Cement Works, Gujrat
21	Pilot Scale Test Work for Beneficiation of Iron Ore Fines samples from Dalli Mines of Bhilai Steel Plant	M/s. BSBK Pvt. Ltd., Bhilai, Chhattisgarh

22	Sintering of iron ore using Sinter Aid of M/s Innocule: An optimization study	M/s. Innocule, Bhubaneswar
23	Preparation of basic engineering package (BEP) for setting up of pilot/ demonstration plant of fly/pond ash for production of wear resistant ceramic tiles.	NALCO, Bhubaneswar
24	Pre-feasibility studies to concentrate the minor metals and REE from Pb-Zn ore tailings of HZL	M/s Hindustan Zinc Ltd., Rajasthan
New		
25	Characterisation and pilot scale beneficiation studies of low grade Banded Magnetite (BMQ) for preparation of pellet feed material	Godawari Power & Ispat Ltd. , Raipur, Chhattisgarh
26	Process Flowsheet Development for the Recovery of Iron Values from Lean-grade BHQ Ore	Praveen Chandra Group, Jayanagar, Bengaluru
27	Recovery of Graphite and Cryolite from Spent Pot Lining – A feasibility study	Vedant Aluminium Ltd., Jharsuguda, Odisha
28	Feasibility studies on Recovery of Iron values from a Sub-grade Iron Ore	Arcelor Mittal Nippon Steel India Ltd., Odisha
29	Grindability studies of the nickel-lateritic ore	M/s. TATA STEEL Ltd, Jamshedpur, Jharkhand
30	Study the effect of process parameters on physical and metallurgical characteristics of iron ore pellets	M/s. Brahmani River Pellet Ltd (BRPL), Odisha
31	Flowsheet Development for Processing of Beach Sand Minerals from Tailings of Srikakulam District, Andhara Pradesh	M/s The APMDC Ltd, Andhra Pradesh
32	Bench-Scale dry beneficiation studies of the Wollastonite ore for achieving the desired product quality and yield as mentioned herein	M/s Wolkem Industries Ltd, Udaipur, Rajasthan (WIND)
33	Optimization of palletization parameters to obtain good quality pellets from lateritic ores and chromite overburden	M/s TATA Steel Ltd., Jamshedpur
34	Pellet making using different grades of Tata Steel Iron Ores for gas based DRI	M/s TATA Steel Ltd, Jamshedpur
35	Remediation of hazardous chromium contaminated site of M/s Krebs International Ltd. Located at Kalama Mayurbhanj district in Odisha	M/s Krebs International Ltd., Mayurbhanj , Odisha
36	Technology development for holistic utilization of red mud for extraction of metallic values & residue utilization	NALCO, Bhubaneswar, Hindalco, Dahej (Maharashtra), Vedanta, Lanjigarh
37	Development of an innovative and viable process for recovery of iron values from red mud	NALCO, Bhubaneswar, Hindalco, Dahej (Maharashtra), Vedanta, Lanjigarh
38	Phytoremediation of Hexa-valent Chromium from the contaminated areas of Jindal Chromites mines	M/s Jindal Stainless limited , Bhubaneswar
39	Characterization and Process Flowsheet Development for the recovery of Iron values from Low-grade Ore	M/s Sandar Manganese and Iron Ores Ltd, Bangaluru
40	Recovery of graphite from shot blast anode dust – a feasibility study	M/s BALCO Karba, Chhattisgarh
41	Mineralogical characterization of bauxite ore sample	M/s. Anand Mining Corporation,Madhya Pradesh
42	Beneficiation and Characterization studies of Sagasahi iron ore fines of Arcelor Mittal Nippon Steel (AM/NS) India Ltd	M/s. ArcelorMittal Nippon Steel (AM/NS), India Ltd, Odisha
43	Characterization study of low grade iron ore and tailings	M/s. 4Mann Industries Pvt. Ltd. Jabalpur

44	Characterization & Beneficiation studies studies on BHQ ore from Surjagarh Iron Ore Mines, Gadchiroli for developing the flow sheet of Iron ore beneficiation plant for pellet feed	M/s. Lloyds Metals and Energy Ltd., Gadchiroli, Maharashtra
45	Characterization, Beneficiation / Desliming and palletization studies on three different Iron Ore samples (Blue dust/ High Grade flaky ore, Crushed fines & Low grade fines) of Surrjagarh Mines, Gadchiroli for developing the flowsheet of Iron ore beneficiation plant for pellet feed and palletization plant	M/s Lloyds Metals and Energy Ltd., Maharashtra
46	Feasibility studies on recovering valuable and rare earth elements from coal gasification	M/s Jindal Steel & Power Ltd, Angul, Odisha
47	Petrographic, Mineralogical, Bulk Density Studies Iron and Manganese ores from government allocated exploration blocks to OMC, Odisha	M/s Odisha Mining Corporation Ltd.,Odisha
48	Towards high-quality crystal diamond for GEM and semiconducting applications	M/s. Gemlight LLP, Surat, Gujurat, India
49	Feasibility Studies for metal sulfide and oxides reduction using hydrogen plasma	M/s. Hindustan Zinc Ltd, Udaipur, Rajasthan
50	Mineralogical study of Iron ore from Koira block, Sundergarh, Odisha	M/s ESL. Steel Ltd , Vedanta Ltd, Sundergarh
51	Pelletization and DRI studies of a low-grade overburden	M/s TATA Steel Ltd , Jamshedpur, Jharkhand
52	Development of comprehensive process flowsheet for upstream and downstream feed preparation plant for iron ore slurry transportation	M/s Tata Steel Limited , Jamshedpur
53	Development of a process flowsheet for the recovery of iron values from low-grade fines	M/s Odisha Alloys Pvt. Ltd., Kharagpur
54	Phytoremediation of Hexa-valent Chromium of Ostapal Chromite mines of FACCOR Ltd. Jajpur, Odisha	M/s FACCOR Ltd., Jajpur, Odisha
55	Beneficiation study of low grade Iron ore and Slimes by reduction roasting process	M/s TATA STEEL, Jamshedpur, Jharkhand
56	Feasibility laboratory studies for liberator cake quality improvement and copper electrowinning process optimization in Cu refinery at Dahej	M/s HINDALCO Industries Ltd, Birla Copper Dahej, Gujrat
57	Studies on chemical characteristics of PGE ores of Bangur ML of OMC Ltd	M/s Odisha Mining Corporation Ltd, Bhubaneswar
58	Beneficiation studies of chromite ores to develop process flowsheet	M/s Shyam Ferro Alloys Ltd., Kolkata
59	Characterization study on Magnetite samples of Gorumahisani Iron ore Mines	M/s Ghanashyam Misra & Sons Pvt. Ltd. (GMSPL), Odisha

CONSULTANCY PROJECTS

Sl. No.	Project Title	Sponsor
01	Studies on facilities of existing Iron Ore Pellet plant to enhance the capacity from 2.4 MTPA to 2.6 MTPA based on provided data by M/s GPIL for No increase of Specific Environmental Load as a third party Environmental Auditor	M/s. Godawari Power and Ispat Ltd Raipur, Chhattisgarh
02	Ambient Air Quality Monitoring in and around Paradip Port on weekly twice basis	Paradip Port Trust, Paradip

03	Training (HR) Program for HINDALCO graduate trainees (Phase-I).	M/s HINDALCO through Central Tool Room & Training Centre (CTTC), Bhubaneswar
04	Training (HR) Program to the Technical Officers of Directorate of Mines, Govt. of Odisha (Phase-1)	M/s Directorate of Mines, Govt. of Odisha
05	Training (HR) Program for HINDALCO graduate trainees (Phase-II).	M/s HINDALCO through Central Tool Room & Training Centre (CTTC), Bhubaneswar
06	Technical Support and customized design for installation and commissioning of 3 sets of Expert Eye-on-pellet systems against PO No. PO/PLT-I/FY22/C045 Dated 04.02.2022 received from M/S BMM ISPAT Ltd., Karnataka	M/s. SVNT INFOTECH PVT. Ltd, Telengana
07	Training (HR) Program to the Technical Officers of Directorate of Mines, Govt. of Odisha (Phase-II)	M/s Directorate of Mines, Govt. of Odisha
08	Training (HR) Program to the Technical Officers of Directorate of Mines, Govt. of Odisha (Phase-III)	M/s Directorate of Mines, Govt. of Odisha

CSIR YOUNG SCIENTIST AWARDEE PROJECTS

Sl. No.	Project Title	Sponsor
01	Designing of DNA nanostructures for nucleic acid therapeutics	EMR-HRDG, New Delhi

TECHNICAL SERVICE PROJECTS

Sl. No.	Project Title	Sponsor
01	Testing and analysis of MCL ash samples for chemical composition and TCLP study	M/s. Maamba Collieries Ltd. (MCL), Hyderabad, Teleganga
02	Testing of Silicon Carbide samples of SAIL Refractoty Unit, Bokaro, Jharkhand	M/s. SAIL Rfractory Unit, Bokaro, Jharkhand
03	Crushing and Screening of iron ore Bore-hole sample	M/s. OMC Ltd. , Odisha
04	Determination of the wet bulk density of the dredged materials from Paradip Port	M/s. Project Office, Paradeep
05	Metallurgical Characterization of Indurated Pellets	M/s. ArcelorMittal Nippon Steel Ltd., Paradeep, Odisha
06	Laboratory scale studies on Iron removal efficiency individually on supplied HIX-1 Nano 100 resin by Drinkwell Systems	M/s Wist Water Solutions Pvt. Ltd., Kolkota
07	Laboratory scale studies on testing of Alkaline water purifier-Zero B Hydrolife and NGMF20 by M/s Ion Exchange	M/s Ion Exchange (India) Ltd, Mumbai, Maharashtra
08	Determination of the Physical characteristics of filter media	M/s. GVPR Engg. Ltd., Odisha
09	Laboratory scale studies on Fluoride removal efficiency individually on supplied Purolite SSTC-60 media by M/s Watertech Engineers, Hyderabad	M/s Watertech Engineers, Hyderabad
10	Toxicity characteristic leaching study of solid waste samples of JSL, Jajpur	JSL, Jajpur, Odisha

11	Analysis of Surface and Ground Water by M/s Tata Steel BSL, Ltd	M/s Tata Steel BSL, Ltd., Dhenkanal, Odisha
12	Characterization of Iron ore fines	M/s Thriveni Earthmovers Private Ltd, Odisha
13	Testing of Dolomite to use as SMS grade dolomite in steel plants	M/s Bisra Stone Lime Company Ltd, Biramitrapur, Odisha
14	Composition & Toxicity characteristic leaching study of solid wastes of Aditya Aluminium, Sambalpur Odisha	M/s Aditya Aluminium, Sambalpur Odisha
15	Testing of Fly ash for chemical composition, TCLP study and grou nd water quality assessment near ash disposal sites of M/s.NAVA Ltd.,Odisha	M/s NAVA Limited, Dhenkanal, Odisha
16	Analysis of Surface and Ground Water by M/s TATA STEEL Foundation	M/s TATA STEEL Foundation, Keonjhar, Odisha
17	Study on the chemical/physical aspect of TMT bars	M/s. UMSL Ltd., IMFA Building, Bhubaneswar
18	Analysis of Surface and Ground Water by M/s TATA STEEL BSL Ltd	M/s TATA STEEL BSL Ltd, Dhenkanal, Odisha
19	Modifications of different biomass cookstoves developed by CSIR-IMMT	M/s. Meensou India Pvt Ltd.-Sambalpur
20	Experiments on plasma treatment of ore/slag	M/s. TATA STEEL, Ltd, Jharkhand

CSIR NETWORK PROJECTS

Sl. No.	Project Code	Project Title	Duration
01	NWP-100 Phase II	CSIR Integrated Skill Initiative	April 2020 to March 2025

CSIR MISSION MODE PROJECTS

Sl. No.	Project Code	Project Title	Duration
01	HCP-2802	Extraction of critical metals from used Li-ion Batteries	April 2020 – March 2023
02	HCP-0030	Development of Advanced Materials and Devices for Opto- electronic, Biomedical and Strategic Applications	July 2020 – June 2023
03	HCP-101	Jigyasa 2.0 Programme with the concept of Virtual Lab integration (CJVL) – First Tranche	April 2021 - March 2026
04	HCP-44 FBR 1.2	Catalyst Development for Electrolysers Under Hydrogen Technology (H2T) Mission Ptogram of CSIR	April 2022 – September 2024

05	HCP-44 VERTICAL-1	Hydrogen Generation through High temperature Solid Oxide Electrolyzer under the "CSIR Hydrogen Technology Program".	April 2022 – September 2024
06	HCP-42	"Machine learning based electrode material design for energy storage applications" under CSIR Mission Mode Project on "AI-enabled Technologies & Systems (AITS)"	April 2022 – March 2025
07	HCP-47	Phenome India-CSIR Health Cohort Knowledgebase	3rd August 2022 – 2nd August 2027

IN-HOUSE / CSIR CENTRAL SCHEME PROJECTS

ONGOING MAJOR LABORATORY PROJECTS (MLPS)

Sl. No.	Project Title	Duration	Project Type	Theme
01	Development of ferroalloys using alternate reductants : Syn gas/ producer gas, methane, and hydrogen through pyrometallurgical route	April 2020 March 2023	FBR	4M
02	Recovery of metal values from FeCr slag en route to zero waste	April 2020 March 2023	FBR	4M
03	Feasibility study on combustion of Petcoke-coal fuel mix in a Fluidized bed reactor (FBR) and reduction of emission through appropriate dosages of chemical reagents during combustion	April 2020 March 2023	FBR	4M
04	Recovery of Mn as EMD from low grade ores and secondaries for energy application	April 2020 March 2023	FBR	4M
05	Nanometal engrained Agro waste based dielectric materials for embedded capacitors (NanoDEC)	April 2020 March 2023	FBR	4M
06	Liquid - Liquid extraction and stripping of metal ions in multi-helical flow reactor	April 2020 March 2023	FBR	4M
07	Value addition of bauxite mining waste rocks for refractory applications	April 2020 March 2023	NCP	4M
08	Development of green surfactants for mineral flotation and flocculation: molecular level design, characterization, and synthesis (GSMF)	April 2020 March 2023	FBR	4M
09	Design of novel luminescent materials for white light-emitting devices application	April 2020 March 2023	NCP	4M
10	Development of flexible Piezocomposite materials for self-powered electronics	April 2020 March 2023	FBR	4M

11	Synthesis of calcium sulfoaluminate: An eco-cementing material alternate of Portland cement	April 2020 March 2023	FBR	4M
12	Self-life enhancement of seeds/grains by plasma treatment	July 2020 – March 2023	FBR	ANB
13	Stealth Technologies : Development of Carbon-Ferrite Composites Materials for Microwave Absorbing	April 2020 March 2023	FTT	AEISS
14	Creation of DSIR Common Research and Technology Development Hub (CRTDH) in the area of New Materials/ Chemical Process (CSIR Component)	April 2020 March 2024	CSIR	LRF
15	Development of Process for Reduction Roasting of Low and Lean Grade Iron Ores Using Fluidized Bed Roaster (in Pilot Scale) to Maximize the Recovery of Iron Values	August 2020 March 2023	FTT	4M
16	Rare earth phosphate TBCs for high temperature insulation and hot corrosion protection applications	September 2020 March 2023	FBR	AEISS
	NEW MAJOR LABORATORY PROJECTS (MLPS)			
01	Pellet Bed Thermal Mapper : An Instrument for online thermal mapping of pellet bed on a pellet car of a straight grate induration furnace.	8th September 2022 to 7th September 2024	FTT	4M
02	Development and demonstration of commercial process for manufacture of 70% content pond ash brick	9th September 2022 to 8th September 2024	FTT	CIE
03	Scaling up synthesis and characterization of Ti3SiC2 MAX phases and Ti3C2Tx MXene.	8th September 2022 to 7th September 2024	FTT	4M
04	Design and development of a pilot scale paste thickener for eco-friendly tailings disposal in Indian iron and steel industry.	8th September 2022 to 7th September 2024	FTT	4M
05	Preparation of varieties of calcined alumina as per the demand of ceramic and refractory industries.	8th September 2022 to 7th September 2024	FTT	4M
06	Technology development for holistic utilization of red mud for extraction of metallic values & residue utilization.	8th September 2022 to 7th September 2024	FTT	4M
07	Low dielectric loss materials for indigenous development of microwave component	20th September 2022 to 19th September 2024	FTT	AEISS

ONGOING OTHER LABORATORY PROJECTS (OLPS)

Sl. No.	Project Title	Duration
01	Synthesis and Structural studies of 2D coplanarHeterostructures for Device applications.	15th June2020 to 14th December 2022

02	Synthesis and self-assembly of novel perovskite nanostructures for efficient photovoltaics and optoelectronic devices	15th June2020 to 14th June 2022
03	Development of a microplasma device to explore highly robust cathode materials	15th June2020 to 31st March 2023
04	IP (Patent) Analytics for Strategic Planning and Technology Road-mapping	15th June2020 to 14th June 2022
05	Functionalized Indigenous Ion Exchange Resins for Selective Separation of Rare Earths	15th June2020 to 14th June 2022
06	Bacteria responsive "intelligent" coating to combat dialysis catheter related infection	15th June2020 to 14th June 2022
07	Mineralogical and petrological characterisation of the syenite body, around Rairakhol area, Deogarh District, Odisha for evaluation of its REE potential	15th June2020 to 14th June 2022
08	Bimetallic Cluster Encapsulated Porous Hybrid Materials for Simultaneous Capture and Catalytic Conversion of Gaseous Pollutants	15th June2020 to 14th June 2022
09	Two Dimensional (2D) inorganic semiconductor nanocomposites for surface-enhanced Raman scattering (SERS) sensing in environmental monitoring	15th June2020 to 14th June 2022
10	Optimizing point defects and microstructures of InGaSb immiscible alloys for thermoelectric application	August 2020 to April 2023
11	Capacitive, pseudocapacitive and hybrid energy storage materials: Development, device fabrication and insights of cell degradation mechanisms	August 2020 to December 2022
12	Nano-structured Conductive Boron Doped Diamond Electrodes for Electrochemical Studies	Jul 2021 Jun 2023
13	Development of a novel coal-gasification technology, specific to high ash Indian coal with integrated CO_2 capture.	Aug 2021 Jul 2023
14	Development of lightweight magnesium alloy-based nanocomposites for transmission housing application in automobiles	Aug 2021 Jul 2023
15	Studies on dense phase pneumatic conveying of bulk solids.	Aug 2021 Jul 2023
16	Studies on the influencing parameters of erosion wear in slurry pipeline	Aug 2021 Jul 2023

17	Digital particle image velocimetry (DPIV) of the granular material inside a hopper by using a high speed camera.	Aug 2021 Jul 2023
18	Synthesis of catalyst for hydrogenation of coals to improve their coking potential	Aug 2021 Jul 2023
19	Facility creation of Hand held XRF Analyser for onsite analysis of ores and materials	Aug 2021 Jul 2022
20	Development of microstructurally and functionally graded laser processed composite coating for omproved mechanical, thermal and tribological properties of Ni-base superalloy	Aug 2021 Jul 2023
21	Bulk utilization of textile industry wastewater containing sericin in preparing antimicrobial cement composite	Oct 2021 March 2023
22	Recovery of Tungsten and Molybdenum from Secondary Resources	Aug 2021 Jul 2023
23	Cobalt recovery from Copper slag cleaning Furnace (SCF) slag and Cobalt spent catalyst	Aug 2021 Jul 2023
NEW OTHER LABORATORY PROJECTS (OLPS)		
01	Facility Creation & Maintenance of Central Workshop	2022-23
02	Graphene-Diamond Heterostructures for Electrochemical Supercapacitors and Gas Sensing Applications	15th February 2023 to 14th February 2025

TECHNICAL REPORTS SUBMITTED TO EXTERNAL AGENCIES

Sl.No.	Title	Agency
1	Hydrometallurgical Separation of Metals from Ores/ Ore Concentrates	SERB, New Delhi
2	Development of process for production of pure and white alumina Tri Hydrate (ATH) for solid surface application.	M/s NALCO, Bhubaneswar
3	Hands-on training on advanced plasma processing Techniques for industrial challenges (HAPTIC)	SERB, Govt. of India, New Delhi
4	Technology transfer for Cobalt manufacture	M/s. Mishra Dhatu Nigam Ltd. (MIIDHANI), Hyderabad

5	Cobalt technology from impure cobalt hydroxide: Process flow sheet development	M/s MIDHANI, Hyderabad
6	Studies on facilities of existing Iron Ore Pellet plant to enhance the capacity from 2.4 MTPA to 2.6 MTPA based on provided data by M/s GPIL for No increase of Specific Environmental Load as a third party Environmental Auditor	M/s. Godawari Power and Ispat Ltd Raipur, Chhattisgarh
7	One-dimenstional Cu_2O nanostructures: study of growth mechanism and potential application as field emitter and photocatalyst	DST (INSPIRE Faculty Programme Unit), New Delhi
8	Pelletization study of iron ore fines	M/s Vedanta Limited, Sesa , Goa
9	Development of a refractory high entropy alloy for high temperature structural application.	DST, New Delhi
10	Development and construction of light weight Al-Si-Mg aerospace/automotive components using additive manufacturing and powder metallurgy processes	NALCO, Bhubaneswar, Odisha
11	Preparation of iron ore pellet and pot grate study	M/s. Jindal Steel & Power Ltd, Angul (JSPL)
12	Characterization and beneficiation of low grade PGE ores of Bangur Mine Lease of OMC Ltd	M/s. Odisha Mining Corporation Ltd., Bhubaneswar
13	VSK separator classification studies on iron ore and coal fines	National Mineral Development Corporation (NMDC), Habsiguda, Hyderabad, Telengana-500007
14	Pilot Scale Test Work for Beneficiation of Iron Ore Fines samples from Dalli Mines of Bhilai Steel Plant	M/s. BSBK Pvt. Ltd., Bhilai, Chhattisgarh
15	Characterization and beneficiation of Iron Values from Lean-grade BHJ Ore	M/s Thriveni Earthmovers Pvt. Ltd , Odisha
16	Mineralogical characterization of Iron ore sample	M/s Euro Pratik Ispat Pvt. Ltd, (EPIPL), Jabalpur, Madhya Pradesh
17	Dry beneficiation studies on low-grade manganese ore fines	M/s. Tata Steel Limited, Jamshedpur, Jharkhand
18	Investigations into the austenite to ferrite transformation kinetics in medium Mn steel with different Si content	M/s Tata Steel, Jamshedpur, Jharkhand
19	Pilot scale studies on Iron , Fluoride and Arsenic removal efficiency from Ground water individually on supplied FLUROX media based unit for fluoride, IREX media for iron and ISOLUX media for Arsenic removal efficiency from contaminated water by M/s Atus International	M/s. Autus International, Maharashtra

20	Rheological testing of Fly ash samples for pipelines transportation at Reliance Power project, Singrauli, M.P	Sasan, (Reliance Power), Mumbai, Maharashtra
21	Phytoremediation of radioactive elements (Cesium and Strontium) from contaminated soil and water	Atomic Energy Regulatory Board (AERB), Mumbai
22	Beneficiation of Silica Sand for Solar wafer Applications	M/s Geological Survey of India, Nagpur
23	Photofunctional materials for industrial dye mineralization	Department of Science & Technology (DST), Government of India, New Delhi
24	Preparation of basic engineering package (BEP) for setting up of pilot/demonstration plant of fly/pond ash for production of wear resistant ceramic tiles	NALCO, Bhubaneswar
25	Recovery of Electrolytic Manganese Dioxide (EMD) from Manganese Ore: Process Optimization for existing plant at MOIL, Alternate process development and basic engineering package preparation	MOIL, Nagpur, Maharashtra
26	Manufacture of low cost building brick for rural housing through mineral cementation technology	DST, New Delhi
27	Flowsheet Development for Processing of Beach Sand Minerals from Tailings of Srikakulam District, Andhara Pradesh	M/s The APMDC Ltd, Andhra Pradesh
28	Characterization and Beneficiation of Low-grade Bauxite Ores from Gujrat	M/s Geological Survey of India, Nagpur
29	Pre-feasibility studies to concentrate the minor metals and REE from Pb-Zn ore tailings of HZL	M/s Hindustan Zinc Ltd., Rajasthan
30	Sedimentation studies, up-scale testing and basic engineering for thickener for treatment of Mn ore fines	M/s MOIL, Madhya Pradesh
31	Evaluation of suitability of nano iron/iron oxide powders of energy and sensor applications	NMDC, Hyderabad, in collaboration with IIT, Kharagpur
32	Bench Scale Production and Cost Estimation of Silicon Carbide Powder Obtained by Plasma Processing of Rice Husk	Ministry of Steel, Govt. of India, New Delhi
33	Feasibility studies on Recovery of Iron values from a Sub-grade Iron Ore	Arcelor Mittal Nippon Steel India Ltd., Odisha
34	Environmental Pollution Monitoring in and around Paradip Port	M/s Paradip Port Trust, Odisha

35	Optimization of process for the treatment of Spent Pot Lining carbon for the recovery of valuables and bench scale testing	M/s NALCO, Bhubaneswar
36	Conversion of emitted CO_2 to chemical fuels	Ministry of Steel, New Delhi
37	Studies on the Characterisation and Beneficiation of Tensa Iron Ore Fines to develop an Iron Ore process flowsheet	M/s Jindal steel & Power Ltd, Angul, Odisha
38	An innovative and viable process for recovery of iron values from red mud and processing of non-iron material for developing value added products-complete utilization of red mud	M/s JNARDDC, Nagpur
39	Development of Iron Aluminide Coated High Performance Steels	Department of Science & Technology (DST), Government of India
40	Phytoremediation of Cr^{6+} from part OB dump at South Kaliapani chromite mines of M/s Odisha Mining Corporation Limited (OMC) located at Jaipur district in Odisha over an area of 10 ha through selected indigenous plant species	Odisha Mining Corporation Ltd (OMC), Bhubaneswar
41	Characterization study of low grade iron ore and tailings	M/s. 4Mann Industries Pvt. Ltd. Jabalpur
42	Study the effect of process parameters on physical and metallurgical characteristics of iron ore pellets	M/s. Brahmani River Pellet Ltd (BRPL), Odisha

TECHNOLOGIES TRANSFERRED:2022-23

S.No	Name of Technology Transferred	Agency Name	Date
1	GVK Model Cook stoves	M/S. Meensou India Private Limited, Sambalpur Odisha	25-07-2022
2	Process of production of Potash enriched Biochar from waste Biomass	M/S. Jayadev banana Farmers & Artisans Association, Khurdha Odisha	27-09-2022
3	HumidoCool	M/S. Ranjeeta's Agrifoods Health and Hygiene Pvt. Ltd, Bhubaneswar Odisha	13-12-2022

OUTREACH

MoU 2022-23

Agency Name	Address	Date Of MoU	Validity
Govt. PG College Rajouri, J&K	Jammu & Kashmir,India	04-04-2022	5 Years
National Institute of Technology	Karnataka, Surathkal	11-04-2022	5 Years
Ramakrishna Mission Residential College	Narendrapur, Kolkata	28-04-2022	5 Years
Vedanta Limited	Andheri East, Mumbai ,India	05-07-2022	5 Years
Jawaharlal Nehru Technological University Hyderabad (JNTUH)	Hyderabad, India	12-07-2022	5 Years
Ajay Binay Institute of Technology	Cuttack, Odisha	25-07-2022	5 Years
Assam Down Town University	Gandhinagar, Panikhaiti, Guwaha-ti-781026, Assam	02-08-2022	5 Years
DIT University(DITU)	Mussoorie Diversion Road, Dehradun, Uttarakhand	23-09-2022	5 Years
Berhampur University	Berhampur, Ganjam, Odisha	04-11-2022	5 Years
Excel Industries Ltd.	Mumbai-400102, India	11-11-2022	5 Years
Devanga Arts College	Aruppukottai-626101, Virudhunagar, Tamilnadu	14-11-2022	5 Years
GITA Autonomous College	Bhubaneswar, Odisha	15-12-2022	5 Years
IREL (India) Limited	Mumbai-400028, India	17-12-2022	5 Years
CIPET: Institute of Petrochemicals Technology	Bhubaneswar-751024, Odisha	23-12-2022	5Years
Odisha University of Technology and Research (OUTR)	Bhubaneswar, Odisha	04-01-2023	5 Years
Sri Paramakalyani College	Alwarkurichi, Tamilnadu	29-03-2023	5 Years

ADVISORY COUNCILS

RESEARCH COUNCIL

Chairman
Smt. Soma Mondal
Chairman,Steel Authority of India
Ispat Bhawan, Lodi Road, New Delhi-110003

External Members
Dr. B. B. Dhar
(Former Director, CIMFR),
D-20, Pamposh Enclave
New Delhi - 110 048

Dr. Saswati B. Roy
Former Director, Chemical Engineering Group
Bhabha Atomic Research Centre
Trombay, Mumbai - 400085

Prof. Monica Katiyar
Department of Materials Science and Engineering
Indian Institute of Technology
Kanpur - 208016

Dr. R. N. Patra
(former CMD, IREL, Mumbai)
Akashdeep Housing Society
Sector-18, Kopar Kairane
Navi Mumbai - 400 709

Prof. E. S. Dwarakadasa
Chairman, Karnataka Hybrid Micro Devices Ltd.
74, 8th Cross, R M V Extension
Bangalore - 560080

Shri. Sumit Deb
Chairman & CMD
NMDC Ltd.,
Hyderabad - 500058

Dr. Mukesh Kumar
Director
Steel Research & Technology Mission of India
Bokaro Steel Plant Office
Sth Floor, Steel Plant, Jeevan Vihar Building
Bokaro, 3, Sansad Marg
New Delhi - 110 001

Dr. P.K. Banerjee
Chief Technology Officer and President
Hindalco Industries Limited Birla Centurion
7th floor. Pandurang Budhkar Road Worli
Mumbai - 400030

Agency Representative
Dr. Samir V. Kamat
Distinguished Scientist & Director General
Naval Systems & Materials (NS & M);
Visakhapatnam - 530027

DG's Nominee
Dr. K. Muraleedharan
Ex. Director, CSIR-CGCRI, Kolkata
Flat 3C, Sarang Homes,
East Kuttannkulara Lane
Punkunnam PO
Thrissur, Kerala - 680002

Sister Laboratory
Dr. Indranil Chattoraj
Director
CSIR-National Metallurgical Laboratory
Jamshedpur - 831 007

Director
Prof. Suddhasatwa Basu
Director
CSIR-Institute of Minerals & Materials Technology
Bhubaneswar - 751 013

CSIR Hqrs. Invitee
Dr. R. M. Mohanty
Principal Scientist
Technology Management Directorate (Socio-economic Ministry Interface)
Council of Scientific and Industrial Research
Rafi Marg, New Delhi - 110 001

Secretary
Dr. Bibhuranjan Nayak
Chief Scientist
CSIR-Institute of Minerals & Materials Technology
Bhubaneswar - 751 013

MANAGEMENT COUNCIL

Chairman

Dr. Suddhasatwa Basu
Director
CSIR- Institute of Minerals & Materials Technology
Bhubaneswar- 751 013

Members

Dr. Suman Kumari Mishra
Director
CSIR-CGCRI, Kolkata

Dr. Pradipta Kumar Senapati
Chief Scientist
CSIR- Institute of Minerals and Materials Technology
Bhubaneswar - 751013

Dr. Ashok Kumar Sahu
Chief Scientist
CSIR- Institute of Minerals and Materials Technology
Bhubaneswar - 751013

Dr. Shivakumar Angadi
Principal Scientist
CSIR- Institute of Minerals and Materials Technology
Bhubaneswar - 751013

Dr. Manish Kumar
Principal Scientist
CSIR- Institute of Minerals and Materials Technology
Bhubaneswar - 751 013

Dr. V. Aishvarya
Senior Scientist
CSIR- Institute of Minerals and Materials Technology
Bhubaneswar - 751 013

Shri H.K. Mishra
S.E. (Civil)
CSIR- Institute of Minerals and Materials Technology
Bhubaneswar - 751 013

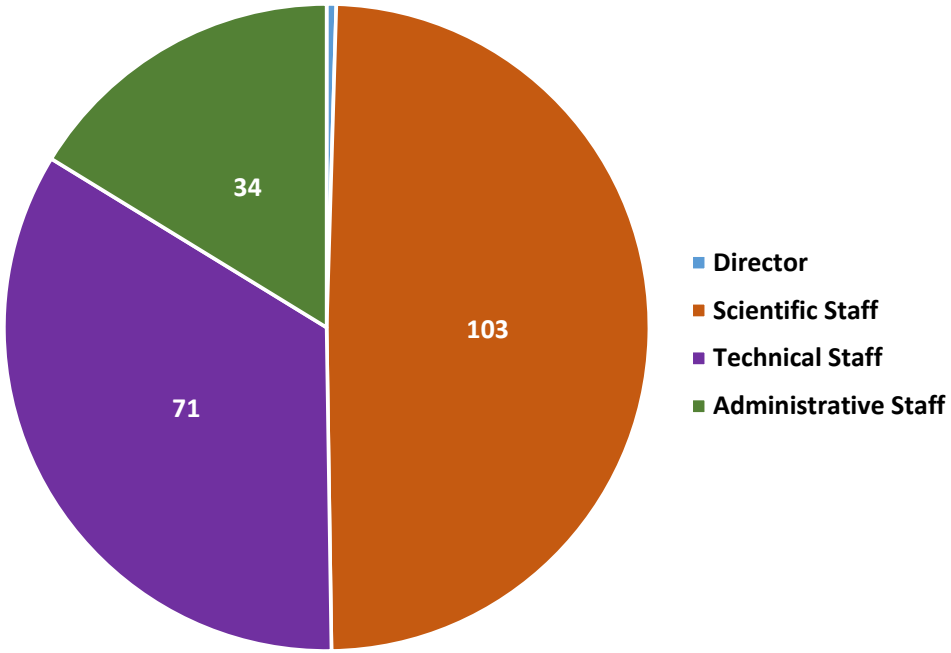
FAO
CSIR- Institute of Minerals and Materials Technology
Bhubaneswar - 751 013

Member Secretary

COA
CSIR- Institute of Minerals and Materials Technology
Bhubaneswar - 751 013

MANPOWER

Staff Position as on 31st March 2023



Director- Additional Charge
Scientist-103
Technical Staff -71
Administrative Staff-34

Dr. G. Narahari Sastry
Director (Additional Charge)

STAFF LIST

DIRECTOR'S SECRETARIAT
Sh. D.K. Tudu, Principal Private Secretary
Sh. Satyajit Sahoo, Senior Stenographer
Sh. Giriraj Dorji, MTS

R&D DEPARTMENTS

Advanced Materials Technology
Dr. R. Sakthivel, Chief Scientist (Head)
Dr. A.K. Chaubey, Sr. Principal Scientist
Dr. S.K. Pradhan, Sr. Pr. Scientist
Dr. (Mrs.) Sharmistha Anwar, Pr. Scientist
Dr. Mayadhar Debata, Pr. Scientist
Sh. P.R. Behera, Pr. Scientist
Sh. Raj Kishore Sahoo, Pr. Scientist
Dr. U. Balaji, Pr. Scientist
Sh. Debidutta Debasish, Pr. Scientist
Sh. Shubhra Bajpai, Pr. Scientist
Dr.(Mrs.) Priyanka Rajput, Pr. Scientist
Mrs. Silani Sahoo, Pr. Scientist
Sh. Satyajit Sarkar, Sr. Scientist
Sh. Pradyut Sengupta, Sr. Scientist
Dr. Ajit Panigrahi, Sr. Scientist
Dr. K.J. Sankaran, Sr. Scientist
Dr. Nirmal Kumar Velu, Scientist
Dr. Sourav Ganguly, Scientist
Sh. Manoj Kumar, Scientist
Dr. M.K. Seth, Sr. Technical Officer (3)
Sh. Tapas K. Sahoo, Sr. Technical Officer (2)
Sh. Sapan K. Kandi, Sr.Tech.Officer (1)
Sh. Santanu Pahari, Technical Assistant

Central Characterization
Dr. Bibhuranjan Nayak, Chief Scientist (Head)
Dr. (Ms.) Dipti Prakasini Das, Pr. Scientist

Dr. Manas Kumar Dalai, Pr. Scientist
Dr. Ashutosh Rath, Sr. Scientist
Dr. (Mrs.) Sasmita Prusty, Sr. Scientist
Dr. (Mrs.) Nilima Dash, Sr. Scientist
Dr. (Mrs.) Kamali Kesavan, Scientist
Dr. S. K. Mishra, Pr. Technical Officer
Dr. Jasobanta Das, Pr. Technical Officer
Ms. Geetikamayee Padhy, Sr. Tech. Ofc (1)
Ms. Swagatika Mohanty, Sr. Tech. Ofc (1)
Sh. Debadatta Sahoo, Sr. Tech. Officer (1)
Sh. Ajit Dash, Sr. Tech. Officer (1)
Sh. Jogeswara Sahu, Sr. Tech. Officer (1)
Sh. Subhendu Kabi, Technical Assistant
Sh. Abinash Prusty, Technical Assistant

Design & Project Engineering
Mr. Snehasis Behera, Chief Sct (Head)
Dr. Jayanta Kumar Pothal, Pr. Scientist
Sh. D. Singh, Pr. Scientist
Sh. Rashmi Ranjan Barik, Pr. Scientist
Sh. Vighnesh Prasad, Scientist
Sh. Anil Dubey, Scientist
Sh. Santosh K. Shanti, Sr.Tech.Officer(1)
Sh. S. K. Mohanty, Sr. Technician (2)
Sh. P. Soren, Sr. Technician (2)

Environment & Sustainability
Dr. N.K. Dhal, Chief Scientist (Head)
Dr. (Mrs.) M.G. Sujana, Chief Scientist
Dr. (Mrs.) Trupti Das, Sr. Principal Scientist
Dr. (Mrs.) Nilotpala Pradhan, Sr. Pr. Sct
Dr. Asheesh Kumar Yadav, Pr. Scientist
Dr. Arakshita Majhi, Pr. Scientist
Dr. (Mrs.) Pravat M. Mishra, Pr. Scientist
Dr. (Mrs.) Sony Pandey, Pr. Scientist
Dr. Manish Kumar, Pr. Scientist
Dr. Umakanta Subudhi, Pr. Scientist
Dr. Boopathy Ramasamy, Scientist
Sh. Sathish R., Scientist
Sh. N.C. Rout, Pr. Technical Officer
Dr. Syed M. Mustakim, Sr. Tech Officer (2)
Dr. D.R. Satapathy, Sr. Technical Officer (2)
Sh. Biswaranjan Das, Sr.Tech.Officer (1)
Sh. Narayan Soren, Lab. Assistant

Hydro & Electro Metallurgy
Dr. K. Sanjay, Chief Scientist (Head)
Dr. B.C. Tripathy, Sr. Principal Scientist
Dr. (Mrs.) Mamata Mohapatra, Sr. Pr. Sct
Sh. C.K. Sarangi, Pr. Scientist
Dr. Sambasiva Rao, Pr. Scientist
Dr. Barsha Dash, Pr. Scientist
Sh. Abdul Rauf Sheikh, Pr. Scientist
Ms. V. Aishvarya, Pr. Scientist
Ms. Binapani Behera, Sr. Scientist
Ms. Barsha Marandi, Sr. Scientist
Ms. Pooja Sahu, Sr. Scientist
Dr. Benadict Rakesh, Scientist
Sh. A.K. Sahoo, Sr.Technical Officer(3)
Sh. Viraj M.Phatarpekar, Sr.Tech.Officer(1)
Sh. Kabir P. Biswal, Sr.Tech.Officer(1)
Dr. Anitha C, Technical Assistant
Sh. M.S. Samal, Lab. Assistant
Sh. G. Bhoi, Lab. Assistant

Materials Chemistry
Dr. L.D. Besra, Chief Scientist (Head)
Dr. Bamaprasad Bag, Sr. Pr. Scientist
Dr. Y.S. Chaudhary, Sr. Pr. Scientist
Dr. Muhammad Shahid Anwar, Sr. Pr. Sct
Dr. B.K. Jena, Sr. Pr. Scientist
Dr. (Mrs.) Manju Unnikrishnan, Sr. Pr. Sct
Dr. Sisir Mantry, Pr. Scientist
Dr. Sanjib Das, Sr. Scientist
Dr. Sumit Saha, Sr. Scientist
Dr. Nirmal Goswami, Scientist
Dr. Biplab Kumar Patra, Scientist
Dr. Simantini Nayak, Scientist
Sh. Sibanam Sahu, Technical Assistant

Mineral Processing Technology
Dr. A.K. Sahu, Chief Scientist (Head)
Sh. H.K. Tripathy, Chief Scientist
Dr. D.S. Rao, Chief Scientist
Dr. S.P. Das, Sr. Principal Scientist
Dr. P.C. Beuria, Sr. Principal Scientist
Dr. C. Eswaraiah, Sr. Pr. Scientist
Dr. S.K. Angadi, Pr. Scientist
Dr. Murali Sekhar Jena, Pr. Scientist
Dr. Swagat Satyagopal Rath, Pr. Scientist
Dr. Ranjan Kumar Dwari, Pr. Scientist
Sh. Sachida Nanda Sahu, Pr. Scientist
Mrs. Pallishree Prusti, Pr. Scientist
Dr. Alok Tripathy, Pr. Scientist
Sh. Rakesh Saini, Sr. Scientist
Sh. Nigamananda Ray, Sr. Scientist
Dr. (Mrs.) Nilima Dash, Sr. Scientist
Sh. Prasanta Kumar Baskey, Sr. Scientist
Sh. Deepak Nayak, Sr. Scientist
Sh. Deepak Kumar Sahu, Sr. Scientist

Sh. Santosh Deb Barma, Sr. Scientist
Sh. Tonmoy Kundu, Sr. Scientist
Sh. Jeetendra Nath Panda, Scientist
Dr. Binod B. Palei, Pr. Technical Officer
Sh. M.C. Tudu, Pr. Technical Officer
Sh. K.C. Beshra, Pr. Technical Officer
Dr. Debashis Satapathy, Sr. Tech Officer (3)
Sh. Sandeep K. Jena, Sr.Tech.Officer (1)
Sh. Swadhin Behera, Technical Assistant
Sh. Dilip Kumar Gouda, MTS

Process Engineering & Instrumentation
Dr. Debi Prasad Das, Sr. Pr. Sct (Head)
Dr. Santosh Kumar Behera, Pr. Scientist
Ms. Swagatika Dash, Pr. Scientist
Sh. Rahul Kumar Soni, Scientist
Sh. Bibek Dash, Scientist
Sh. Lokesh, Scientist
Sh. Bibhudatta Pradhan, Pr. Tech Officer
Sh. P.K. Sahoo, Pr. Technical Officer
Sh. Santosh Kumar Panda, Technician (1)

S&T MANAGEMENT
Computer Networking & e-Management
Dr. Satyajit Rath, Sr. Pr. Scientist (Head)
Dr. Satya Ranjan Sahu, Pr. Scientist
Sh. S.K. Pandey, Pr. Technical Officer
Sh. Bikram K. Parida, Sr. Tech. Officer (1)
Ms. Annapurna Sundarray, Tech. Assistant

Knowledge Resource Centre (Library) & Pathani Samanta e-learning Centre
Dr. B.K. Dalai, Pr. Technical Officer (Head)
Sh. Akash Padhan, Technical Assistant

Strategy Planning & Business Development (SPBD)
Dr. A.K. Sahu, Chief Scientist (Head)
Dr. P.K. Senapati, Chief Scientist
Dr. Snehasish Behera, Chief Scientist
Dr. K. Sanjay, Chief Scientist
Dr. Bibhuranjan Nayak, Chief Scientist
Dr. S.P. Das, Sr. Pr. Scientist
Dr. P. C. Beuria, Sr. Pr. Scientist
Dr. (Ms.) Trupti Das, Sr. Pr. Scientist
Dr. Y.S. Chaudhury, Sr. Pr. Scientist
Dr. D.P. Das, Sr. Pr. Scientist
Dr.(Ms.) Mamata Mohapatra, Pr. Scientist
Shri Debidutta Debashish, Pr. Scientist
Dr. Pavan Kumar, Sr. Scientist
Shri Bibhudutta Pradhan, Pr. Technical Officer
Dr. S.M. Mustakim, Sr. Technical Officer (3)

Project Monitoring and Evaluation
Dr. B.S. Jena, Chief Scientist (Head)
Sh. Jayanta Mallick, Sr. Pr. Scientist
Mrs. Deeptanjali Sahoo, Sr. Scientist
Dr. Togapur Pavan Kumar, Sr. Scientist
Sh. Rakesh Kumar Patra, SSA (S&P)
Sh. Suresh Mohanty, Lab. Assistant

Human Resource Development
Dr. D.S. Rao, Chief Scientist (Head-HRD)
Dr. B.P. Bag, Sr. Pr. Scientist (Coordinator -AcSIR)
Dr. S.K. Pradhan, Sr. Pr. Scientist (Coordinator-Skill Development)
Dr. Barsha Dash, Principal Scientist (Coordinator-Training)
Dr. Umakanta Subudhi, Pr. Scientist (Coordinator -Jigyasa Programme)

Public Relations Officer
Sh. Bibhudatta Pradhan, Pr. Tech. Officer

ENGINEERING SERVICES
Sh. H.K. Mishra, Sr. Superintending Engineer (Head)

Civil Engineering (Lab. & Staff Qtrs.)
Sh. M.K. Sahoo, Exec. Engineer (Civil)
Sh. D.R. Nayak, Exec. Engineer (Civil)
Sh. Anil K. Rath, Asst. Exe. Engg. (Civil)
Sh. Kishor Kumar Barik, Technician (2)
Sh. Jogendra Behera, Technician (2)
Sh. K.C. Jena, Lab. Assistant
Sh. B.B. Pani, Lab. Assistant
Sh. D.D. Parida, Lab. Assistant
Sh. C. Bhoi, Lab. Attendant (2)

Electrical Engineering (Lab & Staff Quarters)
Sh. Himanshu Shekhar Sahoo, Exe. Engineer (E)
Sh. Girish Kumar Samal, Asst. Exe. Engr (E)
Sh. Rasmiranjan Rout, Jr. Engineer (E)
Sh. A.K. Behera, Sr. Technician (3)
Sh. Bibhu Prasad Mahapatra, Technician (2)
Sh. Santosh Kisan, Technician (2)
Sh. Bihari Pradhan, Lab. Assistant
Sh. R.K. Sahoo, Lab. Assistant

Horticulture
Sh. Anil Kumar Rath, Asst. Exe. Engr (Civil)

House Keeping & Refrigeration
Sh. Ranajit Sahoo, Technician (2)
Sh. Pratap Kumar Nayak, MTS

Telephone Maintenance
Sh. Santosh Kumar Panda, Technician (2)

WORKSHOP
Dr. P.C. Beuria, Sr. Principal Scientist (Head)
Sh. Rajesh K. Mandal, Sr.Tech.Officer(1)
Sh. N. Chinnadurai, Technician (2)
Sh. Satyaranjan Patra, Technician (2)
Sh. Rabindra Nath Kisku, Technician (2)
Sh. Ajit Kumar Pradhan, Technician (2)
Sh. A.B. Nayak, Lab. Assistant

GENERAL ADMINISTRATION
Sh. B.C. Sahoo, Controller of Administration
Sh. P.K. Dash, Administrative Officer
Sh. R.K. Dash, Administrative Officer

COA's Secretariat
Ms. Sasmita Samal, Jr. Stenographer
Sh. Y.M. Rao, Lab. Assistant

E-I (Recruitment &Assessment)/ Vigilance Section
Sh. R.K. Mishra, Section Officer (G)
Sh. Biranchi Narayan Parida, SSA (G)
Ms Nibedita Das, SSA (G)
Ms. Sasmita Samal, Jr. Stenographer

E-II (Personal file) Section
Mrs. Veenapani Behera, SO (G)
Sh. Bijan Kumar Pradhan, SSA (G)

E-III (Legal & Medical) Section
Sh. Oj Kandulna, Section Officer (G)
Sh. R.K. Mishra, SO (G) (Legal)
Sh. D. Gochhayat, SO (G) [Ad-hoc]
Ms. Suchitra Hembram, ASO (G)
Mrs. Mamata Sahoo, MTS

E-IV (Bills) Section
Sh. D. Gochhayat, SO (G) [Ad-hoc]
Sh. P.K. Nayak, ASO (G)

CR Cell
Sh. R.K. Mishra, Section Officer (G)
Ms. Sasmita Samal, Jr. Stenographer

Official Language Cell
Mrs. Veenapani Behera, SO (G)
Mrs. Suchitra Hembram, ASO (G)

Transport
Sh. Lambodar Bihari, Sr. Tech Officer (3)
Sh. Indrajit Pradhan, Driver, Sr. Technician (1)
Sh. S. Maharana, Driver, Sr. Technician (1)
Sh. Bijay K. Sahoo, Driver, Sr. Tech (1)

Watch & Ward
Sh. Bibhudatta Pradhan, Pr. Technical Officer /Security In-charge
Sh. P.K. Srichandan, Jr. Security Guard (MACP)
Sh. A.C. Nayak, Jr. Security Guard (MACP)

FINANCE & ACCOUNTS
Sh. Ratnakar Behera, COFA
Sh. Robert Barla, F&AO
Sh. A.R. Khan, ASO (F&A)
Sh. Yalala Anil Kumar, SSA (F&A)
Ms. Swarnalata Kabi, Jr. Stenographer
Sh. S. Digal, Sr. Technician (2)

STORES & PURCHASE
Md. Salaudin Ansari, SPO
Sh. Kul kiran Singh, Section Officer (S&P)

Purchase Section
Sh. B. C. Dhurua, ASO (S&P) (MACP)
Sh. Satyajit Sahoo, Sr. Stenographer

Stores Section
Sh. Kamal Kanta Pradhan, SSA (S&P)
Sh. S.K. Mohanty, Sr. Technician (2)

HEALTH CENTRE
Dr. (Mrs.) Uma Patnaik, Sr. Medical Officer (3)

PROMOTIONS

SCIENTISTS PROMOTED

Sl. No.	Name	Post to which promoted	Effective Date	Date of OM
01	Dr. Mamata Mohapatra	Sr. Pr. Scientist	06-10-2020	13-06-2022
02	Dr. M. S Anwar	Sr. Pr. Scientist	28-02-2021	13-06-2022
03	Dr. Debabrata Singh	Pr. Scientist	12-09-2020	13-06-2022
04	Sh. Rasmi Ranjan Barik	Pr. Scientist	17-09-2020	13-06-2022
05	Sh. Abdul Rauf Sheik	Pr. Scientist	11-11-2020	13-06-2022
06	Dr. V Aishvarya	Pr. Scientist	11-11-2020	13-06-2022
07	Dr. U. Balaji	Pr. Scientist	11-11-2021	13-06-2022
08	Dr. Pravas Ranjan Behera	Pr. Scientist	14-11-2020	13-06-2022
09	Dr. Swagatika Dash	Pr. Scientist	12-12-2020	13-06-2022
10	Mrs. Pallishree Prusti	Pr. Scientist	14-12-2020	13-06-2022
11	Sh. Satyajit Sarkar	Sr. Scientist	30-12-2021	13-06-2022
12	Dr. Ajit Panigrahi	Sr. Scientist	07-10-2020	13-06-2022
13	Dr. M.G. Sujana	Chief Scientist	07-04-2019	01-09-2022
14	Dr. Nilotpala Pradhan	Sr. Pr. Scientist	15-04-2021	30-01-2023
15	Dr. Satyajit Rath	Sr. Pr. Scientist	23-04-2021	30-01-2023
16	Dr. Manju Unnikrishnan	Sr. Pr. Scientist	21-05-2021	30-01-2023
17	Dr. Bikash Kumar Jena	Sr. Pr. Scientist	03-12-2021	30-01-2023
18	Sh. Jayant Mallick	Sr. Pr. Scientist	04-01-2023	30-01-2023
19	Dr. Manas Kumar Dalai	Pr. Scientist	06-10-2022	30-01-2023
20	Sh. Debidutta Debasish	Pr. Scientist	12-12-2021	30-01-2023
21	Sh. Shubhra Bajapi	Pr. Scientist	18-12-2021	30-01-2023
22	Dr. Silani Sahoo	Pr. Scientist	26-08-2021	30-01-2023

TECHNICAL STAFF PROMOTED

Sl. No	Name	Post to which promoted	Effective Date	Date of OM
01	Shri K. B. Behera (Retired)	Sr. Superd Eng.(E)	06-09-2019	30-12-2022
02	Shri Anil Kumar Rath	Asst. Exe. Engg. (Civil)	06-08-2019	30-12-2022
03	Shri K.C. Beshra	Pr. Tech. Officer	03-10-2020	30-12-2022
04	Shri M. C. Tudu	Pr. Tech. Officer	21-02-2021	30-12-2022
05	Shri N. C. Rout	Pr. Tech. Officer	28-02-2019	30-12-2022
06	Shri Abhaya Kumar Sahoo	Sr. Tech. Officer (3)	22-01-2021	30-12-2022
07	Shri Lambodar Bihari	Sr. Tech. Officer (3)	09-02-2021	30-12-2022
08	Shri M. K. Sahoo	Exe. Engineer (Civil)	18-08-2020	30-12-2022
09	Shri Bibhudatta Pradhan	Pr. Tech. Officer	31-05-2021	30-12-2022
10	Shri P.K. Sahoo	Pr. Tech. Officer	26-02-2022	30-12-2022
11	Dr. S.M.Mustakim	Sr. Tech. Officer (3)	10-06-2021	30-12-2022

12	Dr. Debashish Satapathy	Sr. Tech. Officer (3)	28-10-2021	30-12-2022
13	Sh. Tapas Kumar Sahoo	Sr. Tech. Officer (2)	03-02-2022	30-12-2022
14	Sh. Dipti Ranjan Nayak	Exe. Engineer (Civil)	01-09-2021	30-12-2022
15	Sh. Bikram Kumar Parida	Sr. Tech. Officer (1)	25-04-2021	30-12-2022
16	Mrs. Geetikamayee Padhy	Sr. Tech. Officer (1)	03-07-2021	30-12-2022
17	Mrs. Swagatika Mohanty	Sr. Tech. Officer (1)	03-07-2021	30-12-2022
18	Sh. Kabir Prasad Biswal	Sr. Tech. Officer (1)	06-07-2021	30-12-2022
19	Sh. Rajesh Kumar Mandal	Sr. Tech. Officer (1)	06-07-2019	30-12-2022
20	Sh. Debadatta Sahoo	Sr. Tech. Officer (1)	06-07-2021	30-12-2022
21	Sh. Santosh Kumar Shanti	Sr. Tech. Officer (1)	09-07-2021	30-12-2022
22	Sh. Girish Kumar Samal	Asst. Exe. Eng.(Elec)	09-07-2019	30-12-2022
23	Sh. Ajit Dash	Sr. Tech. Officer (1)	10-07-2021	30-12-2022
24	Sh. Biswaranjan Das	Sr. Tech. Officer (1)	10-07-2021	30-12-2022
25	Dr. Sandeep Kumar Jena	Sr. Tech. Officer (1)	22-07-2019	30-12-2022
26	Sh. Sapan Kumar Kandi	Sr. Tech. Officer (1)	27-07-2021	30-12-2022
27	Sh. Jogeshwara Sahu	Sr. Tech. Officer (1)	11-07-2021	30-12-2022
28	Sh. B. C. Patra(Retired)	Sr. Technician (1)	31-12-2021	30-12-2022
29	Sh. Bijaya Kumar Sahoo	Sr. Technician (1)	21-09-2021	30-12-2022
30	Sh. Sribasta Kumar Moharana	Sr. Technician (1)	21-09-2021	30-12-2022
31	Sh. Bharat Bandhu Pani	Lab Assistant	31-12-2021	30-12-2022
32	Sh. Lal Prasad, (Retired)	Lab Assistant	31-12-2021	30-12-2022
33	Sh. Narayan Soren	Lab Assistant	31-12-2021	30-12-2022
34	Sh. Dharani Dhar Parida	Lab Assistant	31-12-2021	30-12-2022
35	Sh. Gajendra Bhoi	Lab Assistant	31-12-2021	30-12-2022
36	Sh. Suresh Mohanty	Lab Assistant	31-12-2021	30-12-2022
37	Sh. Raj Kishore Sahoo	Lab Assistant	31-12-2021	30-12-2022
38	Sh. Y. Mohan Rao	Lab Assistant	13-02-2022	30-12-2022
39	Sh. Madhusudan Samal	Lab Assistant	13-02-2022	30-12-2022

ADMINISTRATIVE PERSONNEL PROMOTED				
Sl No.	**Name**	**Post to which promoted**	**Effective Date**	**Date of OM**
01	Sh. Lokanath Patnayak	Administrative Officer	01-12-2022	CSIR OM dtd 07-11-2022

NEW APPOINTMENTS			
Sl No.	**Name**	**Position**	**Date of Joining**
01	Sh. Swadhin Behera	Technical Assistant	04-04-2022
02	Ms. Annapurna Sundarray	Technical Assistant	06-04-2022
03	Dr. Anitha C	Technical Assistant	25-05-2022
04	Sh. Rasmiranjan Rout	Technical Assistant	04-11-2022

NEW STAFFS JOINED ON TRANSFER/ADDITIONAL CHARGE FROM OTHER LABS.				
Sl No.	**Name**	**Position**	**Date of Joining IMMT**	**LAB NAME**
01	Sh. Ramendra Kumar Mishra	Section Officer (G)	01-04-2022	NEERI, Nagpur
02	Sh. Ramakanta Dash	Administrative Officer	14-11-2022	NPL, New Delhi
03	Sh. Ratnakar Behera	COFA	21-11-2022	NML, Jamshedpur
04	Dr. G. Narahari Sastry	Director (Additional Charge)	31-01-2023(A/N)	NEIST, Jorhat

	RETIREMENT/RESIGNATION/TRANSFER/Etc.			
Sl No.	**Name**	**Designation**	**Date**	**Remarks**
01	Sh. Durga Prasad Choudhury	Section Officer (G)	01-04-2022	Transferred to NEERI, Nagpur
02	Sh. Shreenath Jena	Administrative Officer	31-05-2022	Superannuation
03	Sh. S. C. Reddy	Gr. C (MTS)	30-06-2022	Superannuation
04	Sh. B. C. Patra	Sr. Technician (1)	30-06-2022	Superannuation
05	Sh. S. C. Nayak	Gr. C (MTS)	31-07-2022	Superannuation
06	Sh. Jageshwar Mahto	Section Officer (F&A)	18-11-2022	Transferred to NPL, New Delhi
07	Sh. Lokanath Patnayak	Section Officer (G)	30-11-2022	Transferred to SERC, Chennai on Promotion to the post of AO.
08	Shri Pradipta Kumar Senapati	Chief Scientist	30-11-2022	Superannuation
09	Prof. Suddhasatwa Basu	Director	31-01-2023	Repatriated to his Parent Organization IIT, Delhi