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A ABVANCED RESEARCH

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Annual Report 2022-2023

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ARCI is an autonomous R&D centre of Department of Science and Technology (DST), Government of India, set-up with a mission to develop unique, novel and techno-commercially viable technologies in the area of advanced materials and subsequently transfer them to industries.

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Organizational Structure



International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

Governing Council (as on March 31, 2023)

Dr. Anil Kakodkar (Chairman)

Chancellor, Homi Bhabha National Institute, Chairman, Rajiv Gandhi Science & Technology Commission, Former Chairman, Atomic Energy Commission

Dr. S. Chandrasekhar Secretary Department of Science and Technology

Professor Indranil Manna Vice Chancellor Birla Institute of Technology Mesra

Mr. Vishvajit Sahay Additional Secretary & Financial Adviser Department of Science & Technology

Dr. R. Balamuralikrishnan Outstanding Scientist & Director Defence Metallurgical Research Laboratory

Dr. Jaiteerth R. Joshi Programme Director - LR SAM (IN & IAF) Defence Research & Development Laboratory

Prof. Shatendra K Sharma Emeritus Professor Netaji Subhas University of Technology New Delhi

Professor Satish V. Kailas Department of Mechanical Engineering Indian Institute of Science

Shri. S. K. Varshney Head, International Cooperation Department of Science and Technology

Dr. (Mrs.) Anita Gupta Head, National S & T Entrepreneurship Development Board, Department of Science and Technology

Dr. Tata Narasinga Rao Director, ARCI Member Secretary

Dr. Roy Johnson Associate Director, ARCI Non-Member Secretary Technical Advisory Groups (as on March 31, 2023)

Chairman and Members of Technical Advisory Group (TAG) of Each Centre of Excellence

Centre for Automotive Energy Materials and Centre for Fuel Cell Technology

Prof. Suddhasatwa Basu (Chairman) Director, CSIR – Institute of Minerals & Materials Technology (CSIR-IMMT), Bhubaneswar

Dr. Ajay Dhar Associate Director (Student Affairs), Academy of Scientific & Innovative Research (AcSIR), CSIR- Human Resource Development Centre Campus, Ghaziabad

Prof. Sreenivas Jayanthi Professor, Department of Chemical Engineering, New Academic Complex IIT Madras

Prof. Aninda J. Bhattacharyya Professor, Solid State & Structural Chemistry Unit, Indian Institute of Science, Bengaluru

Dr. N. Lakshminarasamma Professor, Department of Electrical Engineering, IIT Madras

Mr. NS Ramanathan GM, Lucas-TVS "AALIM" Centre, Chennai

Dr. V. Natarajan Scientist G and Head, Material Science & Engineering Group & Project Director, MEMS Regional Centre, Defence Research & Development Organization, Naval Physical & Oceanographic Laboratory, Kochi

Centre for Ceramic Processing, Centre for Non Oxide Ceramics & Centre for Sol-Gel Coatings

Prof. Vikram Jayaram (Chairman) Chair Division of Mechanical Sciences, Department of Materials Engineering, Indian Institute of Science, Bengaluru

Prof. K. V. Shriram Director, LEOS, ISRO Bengaluru

Prof. H. S. Maiti Govt.College of Engineering & Ceramic Technology, Kolkata

Dr. K. G. K. Warrier Emeritus Scientist, National Institute for Interdisplinary Science & Technology- Retd. Thiruvananthapuram

Dr. V. V. Bhanuprasad Scientist G & Head, Ceramics Division Defence Metallurgical Research Laboratory, Hyderabad

Dr. Vivekanand Kain Outstanding Scientist & Head, Materials Processing & Corrosion Engineering Division Bhabha Atomic Research Centre, Mumbai

Centre for Solar Energy Materials

Prof. A. Subrahmanyam (Chairman) Dean of Sciences, GITAM University, Vishakhapatnam (Former Professor at IIT Madras)

Dr. O. S. Sastry Senior Consultant at International Solar Alliance (ISA) (Ex-Director, General National Institute of Solar Energy)

Prof. Kiran Deshpande Chair Professor- Bank of Maharashtra, Savitribai Phule Pune University, Pune

Prof. K. Srinivas Reddy Department of Mechanical Engineering, IIT Madras

Prof. Monica Katiyar Department of Material Science & Engineering, IIT Kanpur

Centre for Nanomaterials & Centre for Carbon Materials

Dr. Ashok K. Ganguli (Chairman) Deputy Director (Strategy & Planning), Institute Chair Professor, IIT Delhi

Prof. Lakshmi Kantam Mannepalli Dr. B. P. Godrej Distinguished Professor, Department of Chemical Engineering, Institute of Chemical Technology, Mumbai

Dr. Sagar Mitra Professor, Department of Energy Science & Engineering, IIT Bombay

Dr. B. L .V Prasad Director, Centre for Nano & Soft Matter Sciences, Bengaluru

Prof. Amlan J. Pal Director, UGC-DAE Consortium for Scientific Research University Campus, Indore

Prof. Vivek Polshettiwar Professor, Department of Chemical Sciences (DCS), Tata Institute of Fundamental Research (TIFR), Mumbai

Centre for Engineered Coatings

Dr. Indranil Chattoraj (Chairman) Director, National Metallurgical Laboratory, Jamshedpur

Dr. M. Kamaraj Professor, Dept. of Metallurgical & Materials Engineering IIT Madras

Dr. V. S. Raja Institute Chair Professor, Dept. of Metallurgical Engineering & Materials Science, IIT Bombay

Dr. Deepak K. Das Scientist H, Defence Metallurgical Research Laboratory, Hyderabad

Dr. D. A. Karandikar Chief Executive cum Technical Officer, Kinetic Surface Technologies, Pune

Centre for Laser Processing of Materials

Prof. Indranil Manna (Chairman) Vice Chancellor, Birla Institute of Technology Mesra

Dr. T. Jayakumar Visiting Professor, Department of Metallurgical & Materials Engineering, National Institute of Technology, Warangal

Prof. Amitava De Professor, Department of Mechanical Engineering, IIT Bombay

Prof. J. E. Diwakar Professor, Centre for Product Design & Manufacturing, Indian Institute of Science, Bengaluru

Prof. Jyotsna Dutta Mujumdar Professor, Department of Metallurgical & Materials Engineering, IIT Kharagpur

Centre for Material Characterization & Testing

Prof. Indradev Samajdar (Chairman) Department of Metallurgical Engineering & Materials Science, IIT Bombay

Dr. R. Balamuralikrishnan Outstanding Scientist & Director Defence Metallurgical Research Laboratory, Hyderabad

Dr. G. K. Dey Raja Ramanna Fellow & Former Director of Materials Group, Bhabha Atomic Research Centre, Mumbai

Dr. Avanish Srivastava Director, CSIR-AMPRI Bhopal

Prof. Satyam Suwas Department of Materials Engineering Indian Institute of Science, Bengaluru

Prof. P. Venkata Satyam School of Basic Sciences, IIT Bhuvneshwar

Centre for Technology Acquisition & Transfer

Prof. Rishikesha T. Krishnan (Chairman) Director and Professor of Strategy, Indian Institute of Management Bangalore

Dr. Aravind Chinchure CEO Deshpande Startups, Hubballi

Dr. Premnath Venugopalan Head, NCL Innovations, National Chemical Laboratory, Pune

Ms. Poyni Bhatt Chief Executive Officer, Society for Innovation & Entrepreneurship (SINE), IIT Bombay

Dr. Anita Gupta Scientist-G /Adviser & Head National Science & Technology Entrepreneurship Development Board, Department of Science & Technology, New Delhi

Director's Report



It gives me immense pleasure to present the annual performance report of ARCI for the year 2022-23. Throughout this year, our institute has remained dedicated to its research objectives, placing significant emphasis on both fundamental and applied research while closely tracking the latest technological advancements in strategic and civil sectors. This annual report vividly reflects, comprehensive overview of the advancements made in newly launched and ongoing research initiatives, significant milestones reached, and the development and transfer of cutting-edge technologies during this reporting period.

ARCI being known for its translational research and technology demonstration, a good number of patents are filed/granted, while keeping the fundamental strength intact with a large number of publications with very good impact factor. The technologies transferred during this year reflect the enrichment in the scientific activities in various areas including energy storage & conversion, solar & hydrogen technologies, aerospace, biomedical, strategic and defence. The Hyderabad and Chennai centers, under the DST-sponsored Technical Research Centre (TRC), have shown remarkable progress in their research and technology transfer is currently in progress for our domestically developed, cost-effective single-step synthesis process for carbon-coated Lithium Iron Phosphate (C-LFP) battery cathode material. This transfer is being negotiated with an Indian industry based in Hyderabad on a non-exclusive basis, allowing for production and sale in territories outside of India.

The C-LFP technology receiver is in the process of signing an agreement for establishing a pilot-plant facility at Advanced Materials Technology Incubator (AMTI) facility on ARCI campus. A technology demonstration for dispersion strengthened tungsten plates by spark plasma sintering for their use as weight balancing components has been completed, and transferred to an industry on a non-exclusive basis, which includes training on operation of process equipment, testing and quality control of the process. Yet another technology transfer for scratch, abrasion resistant Sol-Gel nanocomposite coatings on PVC and acrylic laminates for architectural applications is completed and the know-how is transferred to the technology receiver. Further, several technologies have progressed to higher TRLs and are ready for transfer. A major achievement in the year is installation of facility for making glass ceramics, which is being commissioned at present at ARCI. Demonstration of thermal barrier coatings on strategically and structurally important large components is another significant achievement. This report also provides an overview of the extensive spectrum of research and development activities conducted across all Centers of Excellence (CoEs). Concise summaries of significant achievements throughout the year, including those that have resulted in publications or patent filings are also presented in the report.

ARCI is boldly venturing into novel domains with the aim of achieving self-reliance in critical technologies. We are actively proposing substantial projects in carbon fiber technology, rare earth metal extraction (with a focus on Nd metal), and large-scale E-beam additive manufacturing for crafting sizeable oxygen-sensitive materials like Ti-alloys. In addition, we have secured substantial funding for the development of solid oxide fuel cell (SOFC) stacks through collaborations with CGCRI and HPCL. Furthermore, we have established a PEM fuel cell assembly facility at our Chennai centre. These initiatives align with the nation's evolving needs, where self-sufficiency is a top priority, and ARCI is committed to playing a pivotal role in realizing these ambitions through our unwavering efforts.

I extend my sincere thanks to DST, the Chairman and Members of the Governing Council, and the technnical advisory groups (TAGs) for their invaluable guidance and unwavering support. My sincere appreciation goes to our dedicated scientists, engineers, technical, administrative, financial personnel and other support staff, as well as the enthusiastic students. It is through their unwavering contributions and steadfast support that we have achieved the continued success of ARCI.

T. Narang Par

Dr. Tata Narasinga Rao Director, ARCI

Technology Transfers

Technologies under Transfer (In Progress)

Technology Transfer of Carbon Coated Lithium Iron Phosphate Cathode Powder Material Technology (Exclusivity for All Territories Other than India)

ARCI has indigenously developed battery grade carbon coated nano size Lithium Iron Phosphate (LFP) Cathode Powder Material suitable for Electric Vehicles (EVs) application by adopting a cost-effective high energy milling process. After large-scale demonstration of the developed process, 18650 cylindrical Li-ion cells were fabricated using indigenous LFP cathode material as part of third party validation. The resulting Li-ion cell exhibited a discharge capacity of 0.93 Ah, which is at par with the cell made from commercial LFP cathode material (1 Ah). After successful third party validation, the technology transfer agreement was signed with M/s. ALTMIN Pvt. Ltd., Hyderabad on 17th Feb. 2023 for the production of battery grade carbon coated lithium iron phosphate (C-LFP) cathode material for Li-ion batteries on "**exclusive rights for territories other than India**". The company also plans to sign an agreement with ARCI for availing the incubation services at ARCI's Advanced Material Technology Incubator (AMTI) for the production of LFP Cathode Powder Material with the production capacity of 50 kg/day.





a) Schematic of carbon coated LFP cathode material developed by ARCI used for making LFP- Graphite cells; b) Agreement signing with ALTMIN Private Limited

Transfer of Technology for Dispersion Strengthened Tungsten Plates by Spark Plasma Sintering

A technology transfer agreement for dispersion strengthened tungsten plates by spark plasma sintering was signed with Innomet Advanced Materials Private Limited, Hyderabad on a non-exclusive basis in June 2021. During the year 2022-23, the technology was demonstrated and training on operation of process equipment, testing and quality control was imparted to personnel from the technology receiver. A supply order was executed for delivering 100 numbers of tungsten-based weight balancing components having density \geq 18.85 g/cc, hardness \geq 400 HV₁₀ and fracture strength \geq 750 MPa involving the technology receivers. All the equipment required for carrying out the supply order were calibrated.



Tungsten balancing weights: Size: 90 x 55 x 10 mm³; R20



Training imparted to personnel from technology receiver

Technology Transfers Completed

Scratch, Abrasion Resistant Sol-Gel Nanocomposite Coatings on PVC and Acrylic Laminates for Architectural Applications

PVC, acrylic laminates and aluminium composite panels are used to improve aesthetic appeal of the commercial and residential buildings elevation and interior partitions. Since the materials are soft, they are prone to scratches and abrasion during installation as well as prolonged use. ARCI developed sol-gel nano composite coatings, which are economical, transparent and impart scratch and abrasion resistance to the PVC and acrylic sheets at low curing conditions. Coated sheets exhibit a pencil scratch hardness of 5H, excellent adhesion strength of 5B, solvent resistance and weathering resistance. Further, multi functionalities such as easy to clean and antifinger print could be imparted to the coatings.



Signing of technology transfer agreement

ARCI signed a Technology Transfer Agreement with M/s Reynobond India, New Delhi for synthesis of sol as well as scratch and abrasion resistant coatings of sol on acrylic and PVC laminates on 5th May, 2022 and handed over the know-how document by completing all the technology transfer related milestones on 31st May, 2022.

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Sol-gel coated acrylic and PVC laminates

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Know-how Document handing over to Reynobond India Pvt. Ltd.

Technology Transfers Undertaken

Based on the perceived market size of products/ services associated with ARCI technologies, ARCI has adopted exclusive and non-exclusive modes of technology transfer to facilitate healthy competition in the market. So far, ARCI has successfully transferred 31 technologies to 45 receivers (Know-How Document has been handed over) and few technologies are under transfer. The following table depicts the technologies transferred:

S.No	Technology	Applications (Proven/Targeted)	Status
1-8	Electro Spark Coating (ESC) Equipment	Hard, wear resistant coatings	Transferred to 8 companies on nonexclusive basis
9	Magnesia Aluminate Spinel (MAS)	Steel, cement and power plants	Transferred on exclusive basis
10	Ceramic Crucibles	Carbon and Sulphur analysis	Transferred on exclusive basis
11	Energy Efficient Air Heaters from Ceramic Honeycombs	Industrial heating	Transferred on exclusive basis
12-15	Detonation Spray Coating (DSC)	Wear and corrosion resistant coatings on various components	Transferred to 4 companies on region exclusive basis
16	Reinforced Graphite Sheets and Seals	Automotive sector	Transferred on exclusive basis
17	Heat Pipes Heat Sinks	Waste heat recovery systems, solar energy applications, power electronics	Transferred on exclusive basis
18	Evaporation Boats	Metallization	Transferred on exclusive basis
19	Ceramic Honeycomb Molten Metal Filters	Molten metal filtration	Transferred on exclusive basis
20	Calcium Aluminate Cements and Furnace Sealants	Refractory castables	Transferred on exclusive basis
21-23	Micro Arc Oxidation (MAO)	Hard (1800 VHN) wear resistant coatings on Aluminum and Titanium alloys	Transferred to 3 companies on region exclusive basis
24	ESC Equipment Manufacturing	Diverse segments	Transferred on non-exclusive basis
25	Nanosilver Impregnated Ceramic Water Filter Candles to Impart Antibacterial Function	Water purification	Transferred on non-exclusive basis
26	Nanosilver based Textile Finishes for Antibacterial Applications	Anti-bacterial applications	Transferred on exclusive basis
27	Nanotitaniumdioxide based Textile Finishes for Self Cleaning Applications	Self-cleaning applications	Transferred on exclusive basis
28	Decorative Coatings on Glass	Aesthetic applications	Transferred on non-exclusive basis

S.No	Technology	Applications (Proven/Targeted)	Status
29	Aerogel Flexible Sheet Technology	Thermal Insulation applications	Transferred on exclusive basis
30	Ceramic Honeycomb Based Energy Efficient Air Heaters and Eco-friendly Sanitary Napkin Incinerators	Incinerator Applications	Transferred on exclusive basis.
31	Laser Cladding Technology for burner tip nozzles	Thermal Power Plants Applications	Transfer Complete
32	LWIR ZnS Domes	IR Seeker Application	Transfer Complete
33	MWIR ZnS Domes	IR Seeker Application	Transfer Complete
34	Ceramic Inserts for Anti-mine Boots	Strategic Application	Transfer Complete
35-37	Development of super hydrophobic easy to clean coatings	Solar PV Panels	Transfer Complete to 3 companies
38	High temperature complaint glass sealants	For missile applications	Transfer complete
39	UVC based tunnel baggage disinfection system for disinfection of baggage to fight COVID-19	Commercial Complexes, Hospitals etc.	Transfer complete
40	UVC based disinfection trolley to fight against COVID-19 by rapid cleaning of hospital environment.	Hospitals, Medical Care Centres etc.	Transfer complete
41	UVC based disinfection cabinet (UVC Safe box and UVC Safe Blade Handheld) to fight against COVID-19	Offices, Hospitals etc.	Transfer complete
42	Lithium Iron Phosphate (LFP) Cathode Materials technology for Li-ion Batteries	Li-ion Batteries for Electric Vehicles	Transfer complete
43	Synthesis of Electrocatalysts for use in Fuel Cells	Fuel Cells	Transfer Complete
44	Anti-reflective sol from organic solvent based composition for solar PV glass	Solar PV glass	Transfer Complete
45	Transfer of know-how for a) synthesis of sol and b) scratch and abrasion resistant coatings of sol on acrylic and PVC laminates	Acrylic and PVC Laminates	Transfer Complete
46	Exclusive rights in territories other than India for the transfer of know-how for making lithium iron phosphate cathode material for li-ion batteries	Li-ion Batteries for Electric Vehicles	Transfer Ongoing
47	Transfer of know-how for novel powder metallurgy (PM) process for fabricating dispersion strengthened tungsten plates technology	Jet vanes	Transfer Ongoing

Technologies Available for Adaptation / Transfer

S.N	Technology	Key Features	Possible Applications
01	Lithium Ion Battery (LIB) cell (LFP/graphite) fabrication technology	 Cylindrical/Prismatic cells with 3.2V, 2–50 Ah fabricated Cyclic stability > 1200 cycles with > 85% capacity retention at 1C Energy density 100-110 Wh/kg 	Electric Mobility and Energy Storage Systems
02	Fe-P soft magnetic materials	• Bs (saturation induction) > 2 T • μ_{max} (Permeability) ~ 1.5x10 ⁴ • Coercivity < 1 Oe • Core loss ~ 170 - 200 W/kg	 Motors, Alternators, Relay and other electromagnetic devices
03	Repair and refurbishment of critical components using laser cladding	 Negligible porosity Controlled heat input Precise and controlled process No distortion 	 Aerospace Automotive Energy General engineering sectors
04	 Broad-band Anti-reflective (AR) coating development by using organic solvent based composition >2 % Transmission enhancement on Photo Voltaic (PV) cover glass on a single side The coating demonstrated through industrial roller coating process and validated to meet industrial standards. 		 AR Coating on Photovoltaic (PV) and Concentrated Solar Power (CSP) cover glasses, Optical lenses, Displays, etc.
05	Broad-band Anti-reflective coating development by using cost-effective and environmentally friendly aqueous solvent composition	 < 2 % Transmission enhancement on PV cover glass on a single side Coating demonstrated through industrial roller coating process and validated to meet the industrial standards 	 AR Coating on PV and CSP cover glasses, Optical lenses, Displays, etc.
06	Quantum-sized TiO2 particles based super-hydrophilic and self-cleaning anti-soiling coating for photovoltaic application	 High Omni transparency with no transmittance / power loss after coating Excellent photo induced super hydrophilicity and self-clean property High weather and mechanical stabilities 	 Anti-soiling coating for PV Modules & Architectural glasses
07	Carbon nanoparticles based lubricants	 >50% reduction in Coefficient of Friction (CoF) with the incorporation of Carbon nanoparticles into base lubricant oil. Observed no significant change in the density and viscosity of the base lubricant oil after incorporation of nanoparticles. 	 Nano lubricants for bearings, automobiles, heavy vehicles and machineries, etc.
08	Exfoliated graphite and its value-added products	 Binder-free compaction of material Shape-tailored material Very light weight Density-controlled compaction Sandwich or reinforced material with better mechanical properties Efficient and cost-effective 	 Flexible sheets Flexible tapes Bipolar plates Seals Reinforced seals, sheets and tapes Ultra-light weight boards
09	PEM fuel cell based power supply systems	 Grid independent fuel cell systems in the range of 1-20kW power PEM fuel cells continuously operated for 500 hrs and intermittently for several thousand hours with stable performance Suitable control systems for load following cycle, cell monitoring characteristics, power conditioners and thermal management 	 Nano lubricants for bearings, automobiles, heavy vehicles and machineries, etc.
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S.N	Technology	Key Features	Possible Applications
10	Platinum (Pt) based electrocatalysts	 High durability On par efficiency with commercially available electrocatalysts Facile synthetic route High corrosion resistance 	 Fuel cells, hydrogenation reactions
11	Advanced detonation spray coating technology	 High productivity due to high pulse frequency Less maintenance: absence of mechanically moving parts Good adhesion strength (>10000 psi) Dense microstructure (< 1%) Negligible thermal degradation and excellent tribological properties Ability to coat wide range of powders, carbide, oxide, metal powders Lower substrate temperature & low oxide content Coatings with 50-2000 microns thickness can be produced 	 Steel industry application such as Bridle rolls Textile & Paper industry applications such as wire passing pulleys, plungers, steeped cone pulleys, bearing stopper plates, guide rolls Gas compressor applications such as spindle valve, compressor disc, compressor shaft HP & LP turbine blades, compressor discs, LCA nozzles, thrust beating sleeves, propeller shaft seals. Power and Energy applications such as guide vanes, spindle valves, hydro turbine blades.
12	Cold gas dynamic spray coating technology	 Indigenously developed state-of-the-art PLC based automated portable control panel (Max Pressure -20 bar) Different set of nozzles Coatings for Wear, Corrosion, Thermal insulation and Fatigue tolerance High deposition rate or coverage area Low deposition rate or coverage area For Ni based materials, Steels (Optional) Max Pressure-20 bar; Maximum Temperature-600°C Cu, Al, Ag, Zn, Sn,Ni, SS, Ta, Nb, Ti and alloys and composites 	 Repair and refurbishment applications Coatings for electrical contacts, lugs, EMI shielding, heat sinks Coatings for high temperature corrosion resistance, Bio medica sputter target applications Cathodic protection coatings Anodic protection coatings Wear resistant coatings Nanostructured / amorphous coatings High Entropy Alloy coatings for high temperature applications
13	Pulse electro deposition	 Non line of site process, economical and ecofriendly Porosity free finished product, higher production rates Facile synthetic route High corrosion resistance 	 Corrosion resistance and decorative coatings: automobiles include car, truck trim, motorcycle, kitchen and bathroom appliances Wear resistance: hydraulic actuators, railway engine shafts, aircraft landing gears, shaft journals, farm machinery, earth movers, snow plows, road repair equipment, mining equipment, automobile engine valves Industrial tools such as rolls for AI and steel manufacturing, stamping tools and dies, molds for plastic manufacturing utilized chrome plating for increasing its (tool) life

S.N	Technology	Key Features	Possible Applications
14	High performance varietors	Break down voltage 10-33 k\//cm	Power distribution
14	made from doped ZnO nanopowders	 Break down voltage 10-35 kV/cm² Low leakage current density 0.7μA/cm² Coefficient of non-linearity (70-160) Superior to the commercially available varistors 	Automobiles and Electronics
15	Bio-friendly self-disinfecting coating on fabric against COVID-19, H1N1 and bacteria	 Efficacy > 99.9% against gram positive and negative bacteria. Efficacy ≥ 99.2% and≥ 99.997% against SARS-CoV-2 (CCMB) and H1N1 (BUREAU VERITAS), respectively (ISO18184). The four layered mask exhibited bacterial filtration efficiency ≥ 99.7% (ASTM F2101), particulate filtration efficiency at 0.3 microns : ≥ 99.3 (ASTM F 2299/F2299M-03: 2017) Breathability: 61.2 Pa/cm2 (EN 14683: 2019). Splash resistance and water repellent and classified as class 1 in flammability test Technology developed in collaboration with Centre for Cellular and Molecular Biology (CCMB) and Resil Chemicals Pvt. Ltd. 	 Self-disinfection masks Medical suits Medical textiles Sports textiles
16	Large-scale synthesis of Hydroxyapatite (HAP) nanopowders for biomedical applications	 Ca₁₀(PO₄)₆ (OH)₂ particle size having less than 23 nm with narrow size distribution Phase purity greater than 99% Breathability: 61.2 Pa/cm2 (EN 14683: 2019). Splash resistance and water repellent and classified as class 1 in flammability test Process parameters for production of phase pureHAP and mixture of HAP and Ca₃(PO4)₂ nanopowders of different sizes at 1 Kg level have been optimized 	 Bone tissue engineering; Bone void fillers for orthopedic, traumatology, spine, maxillofacial & dental surgery Orthopedic and dental implant coating; Restoration of periodontal defects Desensitizing agent in post teeth bleaching; Remineralizing agent in toothpastes
17	Nano-sized Lithium Titanium Oxide (LTO) anode material for high power Li-ion battery application	 Process for the large-scale production (15 kg/batch) of LTO developed. LTO delivers a superior rate capability of 145 mAh/g at 4C withgood cyclic stability Patents in India, USA, and China for this invention were granted 	 Electrode material for rechargeable batteries in electric vehicles Stationary storage applications
18	Nano-sized Lithium Iron Phosphate (LFP) cathode material for high power Li-ion battery application	 Identified sources of lithium and iron precursors Designing of suitable large capacity furnace and optimum heating cycles with less time LFP's electrochemical performance in terms of specific capacity, cyclic stability and rate capability is at par with the performance of the commercially available LFP Very safe and reliable (No thermal runaway) Very low toxicity for environment Suitable to Indian climate Calendar life > 10 years 	 Electrode material for rechargeable batteries in electric vehicles Stationary storage applications

S.N	Technology	Key Features	Possible Applications
19	Petcoke-based high energy Supercapacitor for EV application	 Process for the production of supercapacitor grade porous carbon. Indigenous supercapacitor devices of 1200 F, 2.7V and 1.2Wh produced. Supercapacitor module of 75F, 43V, 19.2 Wh demonstrated Technology developed in collaboration with Hindustan Petroleum Corporation Limited (HPCL), Bengaluru 	 Automotive (E-bicycle, public transportation) Sationary energy storage applications Smart grid applications
20	Large-scale low-cost production of two-dimensional tungsten disulfide and molybdenum disulfide powder	 Production capability: 1 kg per day (scalable up to 2 kg per day) using the existing pilot-scale reactor. Particle size: Can be customized based on required use or properties. Typical size: thickness = 8 to 12nm, lateral dimension = 800 to 1200 nm. Supercapacitor module of 75F, 43V, 19.2 Wh demonstrated Thermal stability: Upto 350°C in air for free standing 2D-WS2 powder (Up to 450°C in composite form); Up to 250°C in air for free standing 2D-MoS2 powder. 	 As a solid lubricant. As a nano-additive to automotive lube oil for enhanced performance. As a nano-additive to EP-grease for improved performance. As a casting and forging mould release lubricant additive. For polymer bonded lubricating coatings. As a candidate for petrochemical and hydrogen evolution reaction catalyst.
21	Sol-gel product developed to impart anti-bacterial (AB) property to abrasive pad made of non-woven nylon fabric	 AB sol-gel formulation can be deposited as a top coat on finished abrasive pad AB composite powder product can be used as additive to resin and abrasives mix to apply on a semi-finished abrasive pad AB composite powder can be added to any paint formulation to impart anti-bacterial property on working surfaces AB properties with zone of inhibition > 5 mm and > 95% log reduction of bacterial strains, E.coli, 	 Scrub pads for domestic and industrial application. Paints and lacquer.

- 22 Sol-gel coating formulation for imparting anti-bacterial property by inhibiting the biofilm formation
- Aqueous formulation
- Room temperature curable coating

S.aureus and K.pneumoniae

- · Anti-bacterial
- Hydrophobic
- Improved mechanical properties at 80°C curing temperature
- Surgical sutures
- Contact lens case, hernia
 repair mesh
- Hearing aids and surgical appliances



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ARCI Patent Portfolio

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National Patents Granted

S.N	Title of Patent	Patent Number	Date of Grant	Application Number	Date of Filing
01	An improved gas and coolant flow field plate for use in polymer electrolyte membrane fuel cells.	423285	27/02/2023	1449/DEL/2010	22/06/2010
02	Solar selective coating for solar energy collector / absorber tubes with improved performance and a method of producing the same	421064	09/02/2023	2142/DEL/2015	15/07/2015
03	Method of preparation of carbon supported platinum electrode catalyst for PEM fuel cells and product thereof	418482	18/01/2023	202011035825	20/08/2020
04	A process for in-situ carbon coating on alkali transition metal oxides	416052	29/12/2023	201611007451	03/03/2016
05	Method of producing in-situ carbon coated lithium iron phosphate cathode material for lithium ion batteries	412586	28/11/2022	202011056608	28/12/2020
06	An improved aqueous method for producing transparent aluminium oxy nitride (ALON) articles	412454	25/11/2022	1409/DEL/2012	08/05/2012
07	Antimicrobial aqueous based sol-gel composition for coating on substrate and process of preparing the same	411262	11/11/2022	201911045386	07/11/2019
08	Process of electroless nickel/nickel phosphide (EN) deposition on graphite substrates	408686	10/10/2022	201811041418	01/11/2018
09	Method of producing carbon nanostructure materials for heat transfer, lubrication and energy storage applications	404762	28/08/2022	202011017775	25/04/2020
10	Method of producing porous MgF ₂ nanoparticles, antireflection coating suspension and coatings for solar optical UV and IR transparent window applications	394551	08/04/2022	4041/DEL/2014	31/12/2014
11	Method of producing graphene like structured nanoporous carbon material from jute stick based bio-waste for energy storage applications and the product thereof	394477	07/04/2022	201711006697	24/02/2017
12	Process for producing the nano Boron by cryo-milling	391804	11/03/2022	201911025690	27/06/2019
13	A system for treating a surface of bearing components and a process thereof	388398	03/02/2022	201711046511	23/12/2017
14	A super hydrophobic coating with high optical properties having easy to clean property, UV and corrosion resistance properties, a process of preparation and application of the same	382971	29/11/2021	402/DEL/2014	13/02/2014
15	A process and a multi-piston hot press for producing powder metallurgy component, such as cerametallic friction composite	379250	13/10/2021	3844/DEL/2011	28/12/ 2011
16	An improved method for making sintered polycrystalline transparent sub-micron alumina article	378836	07/10/2021	1358/DEL/2011	10/05/2011
17	An improved process of carbon - metal oxide composites prepared by nano casting of wood and the product thereof	376509	06/09/2021	201611034531	07/10/2016
18	Multi-track laser surface hardening of low carbon cold rolled closely annealed (CRCA) grades of steels	375427	26/08/2021	1411/KOL/2013	13/12/2013
19	An improved coating composition to provide prolonged corrosion protection to anodizable metal surfaces and process of preparing the same	370802	30/06/2021	3082/DEL/2015	28/09/ 2015
20	A device for and a method of cooling fuel cells	370365	25/06/2021	1408/DEL/2012	08/05/2012
21	Exfoliated graphite separator-based electrolyzer for hydrogen generation	369206	14/06/2021	3073/DEL/2013	17/10/2013
22	An improved test control system useful for fuel cell stack monitoring and controlling	366702	14/05/2021	269/DEL/2013	31/01/2013
23	An improved process for preparing durable multifunctional coatings on metal/alloy substrates	366262	06/05/2021	201711020529	12/06/2017
24	A method of preparing of anti-tarnishing organic-inorganic hybrid sol-gel and coating the same	366131	05/05/2021	2049/DEL/2015	07/07/2015
25	A method of producing high performance lithium titanate anode material for lithium ion battery applications	365560	28/04/2021	201711006147	21/02/2017

S.N	Title of Patent	Patent Number	Date of Grant	Application Number	Date of Filing
26	Ambient condition curable transparent super hydrophobic coating for easy to clean applications and method of producing the same	361991	18/03/2021	201911009429	11/03/2019
27	Method of deposition of double perovskite of Sr-Fe Niobium oxide film on a substrate by spray coating technique and the coated substrate thereof	356708	27/01/2021	1151/DEL/2014	29/04/2014
28	Electronically and ionically conducting multi-layer fuel cell electrode and a method for making the same	351830	20/11/2020	2198/DEL/2012	17/07/2012
29	A method of preparation of supported platinum nano particle catalyst in tubular flow reactor via polycol process	350276	28/10/2020	1571/DEL/2013	24/05/2013
30	A process to improve strength and fatigue life of HR grade low carbon steel sheet by laser surface hardening adaptable to produce automotive component	349560	19/10/2020	600/KOL/2012	25/05/2012
31	Method of producing hollow MgF_2 nanoparticles, anti-reflection coating sols and coatings for optical and solar applications	348807	07/10/2020	201611041804	07/12/2016
32	An improved performance of nanocomposite oxide selective absorber coating with excellent optical and thermal resistant properties and method of manufacturing the same	345443	28/08/2020	1111/DEL/2015	22/04/2015
33	A novel laser surface modification technique for hardening steel	343960	12/08/2020	337/DEL/2013	06/02/2013
34	An improved process for obtaining a transparent, protective coating on bi-aspheric / plano-convex lenses made of optical grade plastics for use in indirect ophthalmoscopy	343375	05/08/2020	3072/DEL/2013	17/10/2013
35	An improved composition for antireflective coating with improved mechanical properties and a process of coating the same	342046	20/07/2020	2330/DEL/2013	05/08/2013
36	Method of producing nano structured C-TiO ₂ composite material for visible light active photocatalytic self-cleaning applications	340592	06/07/2020	201811011478	28/03/2018
37	An improved composition for solar selective coatings on metallic surfaces and a process for its preparation and a process for coating using the composition	340426	03/07/2020	3324/DEL/2011	22/11/ 2011
38	An improved composition for coating anodizable metal surfaces and a process of coating the same	339945	30/06/2020	1310/DEL/2013	03/05/2013
39	Enhanced thermal management systems for fuel cell applications using nanofluid coolant	339836	30/06/2020	1745/DEL/2012	07/06/2012
40	Process for producing anti-reflective coatings with anti-fogging (super hydrophilic), UV, weather and scratch resistance properties	339326	25/06/2020	2919/DEL/2013	03/10/2013
41	Methods of preparation of high performance ZnO varistors and improved compositions	339072	22/06/2020	2765/DEL/2015	03/09/2015
42	A polymer electrolyte membrane (PEM) cell and a method of producing hydrogen from aqueous organic solutions	338862	19/06/2020	3313/DEL/2012	29/10/2012
43	An improved process to make coating compositions for transparent, UV blocking coatings on glass and a process of coating the same	338641	17/06/2020	1152/DEL/2014	29/04/2014
44	A novel electrochemical method for manufacturing CIGS thin film containing nanomesh like structure	337455	28/05/2020	426/DEL/2015	16/02/2015
45	A method and an apparatus for preparing nickel tungsten based nanocomposite coating deposition	337108	20/05/2020	201611001190	13/01/2016
46	Method of producing multifunctional self-assembled mixed phase titania spheres	335724	22/04/2020	3777/DEL/2014	19/12/2014
47	Production of graphene-based materials by thermal spray	335723	22/04/2020	2626/DEL/2015	25/08/2015
48	An improved gas flow field plate for use in polymer electrolyte membrane fuel cells (PEMFC)	332242	18/02/2020	2339/DEL/2008	13/10/2008
49	An improved process for preparation of nanosilver coated ceramic candle filter	327532	17/12/2019	1249/DEL/2011	28/04/2011
50	Catalytically and chemically modified carbon nanostructures for storage of hydrogen	323653	24/10/2019	405/CHE/2013	30/01/2013

S.N	Title of Patent	Patent Num <u>ber</u>	Date of Grant	Application Number	Date of Filing
51	A high thermal stable selective solar absorber layer with low emissive barrier coating over a substrate and a process of producing the same	323497	23/10/2019	3312/DEL/2012	29/10/2012
52	An improved hybrid methodology for producing composite multilayered and graded coatings by plasma spraying utilizing powder and solution precursor feedstock	323443	22/10/2019	2965/DEL/2011	17/10/2011
53	Fuel cell system equipped with oxygen enrichment system using magnet	321825	27/09/2019	2985/DEL/2012	25/09/2012
54	Improved magnetron cathode and a process for depositing thin films on surfaces using the said cathode	320582	16/09/2019	21/DEL/2008	03/01/2008
55	A method for synthesis of tungsten disulphide nanosheets	320209	11/09/2019	1703/DEL/2012	04/08/2012
56	Process for producing anti-reflective coatings with scratch resistance property	314900	27/06/2019	1777/DEL/2012	11/06/2012
57	A process for preparing nanocrystalline olivine structure transition metal phosphate material	310620	31/03/2019	405/DEL/2012	14/02/2012
58	Novel copper foils having high hardness and conductivity and a pulse reverse electrodeposition method for their preparation	306501	29/01/2019	1028/DEL/2009	19/05/2009
59	An improved process for producing silica aerogel thermal insulation product with increased efficiency	305898	18/01/2019	2141/DEL/2015	15/07/2015
60	An improved coating composition to provide flame retardant property to fabrics and process of preparing the same	305214	01/01/2019	201611040091	23/11/2016
61	An improved method of preparing porous silicon compacts	304349	12/12/2018	912/DEL/2011	31/03/2011
62	An improved solar selective multilayer coating and a method of depositing the same	303791	30/11/2018	1567/DEL/2012	22/05/2012
63	An improved process for preparing nanotungsten carbide powder useful for fuel cells	303338	22/11/2018	81/DEL/2007	12/01/2007
64	Improved fuel cell having enhanced performance	301158	19/09/2018	606/DEL/2007	20/03/2007
65	An improved abrasion resistant and hydrophobic composition for coating plastic surfaces and a process for its preparation	297072	24/05/2018	1278/DEL/2011	02/05/2011
66	Improved scratch and abrasion resistant compositions for coating plastic surfaces, a process for their preparation and a process for coating using the compositions	295221	28/03/2018	2427/DEL/2010	12/10/2010
67	An improved method for producing ZnO nanorods	293775	05/03/2018	2759/DEL/2010	19/11/2010
68	A hydrophilic membrane based humidifier useful for fuel cells	291871	18/01/2018	95/DEL/2007	16/01/2007
69	Improved process for the preparation of bi-functional silica particles useful for antibacterial and self-cleaning surfaces	291408	04/01/2018	3071/DEL/2010	22/12/2010
70	Improved catalyst ink for catalyst coated membrane of electrode membrane assembly and the process thereof	290765	18/12/2017	631/DEL/2008	13/03/2008
71	An improved composition for coating metallic surfaces, and a process for coating such surfaces using the composition	290592	14/12/2017	620/DEL/2010	17/03/2010
72	Improved method for producing carbon containing silica aerogel granules	290370	07/12/2017	2406/DEL/2010	08/10/2010
73	Improved process for the preparation of stable suspension of nano silver particles having antibacterial activity	289543	14/11/2017	1835/DEL/2010	04/08/2010
74	An improved method for the generation of hydrogen from a metal borohydride and a device thereof	285257	17/07/2017	1106/DEL/2007	23/05/2007
75	An improved method for preparing nickel electrodeposited having predetermined hardness gradient	285178	14/07/2017	1455/DEL/2009	15/07/2009
76	A process for the preparation of nanosilver and nanosilver-coated ceramic powders	284812	30/06/2017	2786/DEL/2005	19/10/2005
77	Improved method of producing highly stable aqueous nano titania suspension	282988	28/04/2017	730/DEL/2009	09/04/2009
78	An improved process for the preparation of exfoliated graphite separator plates useful in fuel cells, the plates prepared by the process and a fuel cell incorporating the said plates	281504	20/03/2017	1206/DEL/2006	17/05/2006

S.N	Title of Patent	Patent Number	Date of Grant	Application Number	Date of Filing
79	An improved catalyst ink useful for preparing gas diffusion electrode and an improved PEM fuel cell	277778	30/11/2016	680/DEL/2008	18/03/2008
80	A device for controlling the on & off time of the metal oxide semiconductor field effect transistor (MOSFET), a device for spark coating the surfaces of metal workpiece incorporating the said control device and a method of coating metal surfaces using the said device	262189	05/08/2014	1610/DEL/2005	21/06/2005
81	An improved process for the preparation of doped zinc oxide nanopowder useful for the preparation of varistors	254913	03/01/2013	1669/DEL/2006	20/07/2006
82	A method of and an apparatus for continuous humidification of hydrogen delivered to fuel cells	247547	19/04/2011	670/CHE/2007	30/03/2007
83	An improved method of forming holes on a substrate using laser beams	239647	29/03/2010	3205/DEL/2005	29/11/2005
84	Titanium based biocomposite material useful for orthopedic and other implants and a process for its preparation	228353	03/02/2009	2490/DEL/2005	14/09/2005
85	An improved boronizing composition	220370	27/05/2008	289/MAS/2001	03/04/2001
86	A method and a device for applying a protective carbon coating on metallic surfaces	211922	13/11/2007	719/MAS/1999	08/07/1999
87	A process for forming coatings on metallic bodies and an apparatus for carrying out the process	209817	06/09/2007	945/MAS/2001	22/11/2001
88	A process for preparing ceramic crucibles	207700	20/06/2007	806/MAS/2000	26/09/2000
89	Process for carbothermic reduction of iron oxide in an immiscible flow with constant descent in vertical retort of silicon carbide	205728	09/04/2007	546/CHE/2003	01/07/2003
90	An evaporation boat useful for metallization and a process for the preparation of such boats	201511	01/03/2007	882/CHE/2003	31/10/2003
91	Device for gas dynamic deposition of powder materials	198651	25/01/2006	944/MAS/2001	22/11/2001
92	An improved method for making honeycomb extrusion die and a process for producing ceramic honeycomb structure using the said die	198045	13/01/2006	538/MAS/2001	03/07/2001
93	A process for the production of dense magnesium aluminate spinel grains	198208	16/02/2006	520/MAS/2000	06/07/2000
94	A process for the preparation of improved alumina based abrasive material, an additive composition and a process for the preparation of the composition	198068	16/02/2006	122/MAS/2000	18/02/2000
95	Ceramic honey comb based energy efficient air heater	200787	02/06/2006	30/MAS/1999	07/01/1999
96	Improved process for the preparation of magnesium aluminate spinel grains	200272	02/05/2006	29/MAS/1999	07/01/1999
97	New composite material having good shock attenuating properties and a process for the preparation of said material	194524	02/01/2006	976/MAS/1998	06/05/1998
98	A process for preparation of reaction bonded silicon carbide components	195429	31/08/2006	1886/MAS/1996	28/10/1996
99	A process of producing chemically treated expanded graphite and a device having such graphite	187654	05/12/2002	562/MAS/1994	07/06/1995
100	A process for the preparation of short ceramic fibres	186751	07/06/2002	537/MAS/1994	20/05/1994
101	An indirect heated catalytic converter for use with vehicles	185433	10/08/2001	809/MAS/1994	25/08/1994
102	A solar cooker	184675	25/05/2001	498/MAS/1994	13/06/1994
103	A solar drier	184674	23/09/2000	487/MAS/1994	08/06/1994

National Patent Applications Awaiting Grant

S.N	Title of Patent Application	Application Number	Date of Filing
01	Bi-layered dental implant and process for the preparation thereof	202341014475	03/03/2023
02	Fabrication of tab-less and high power cylindrical LFP-LTO cell for fast charging lithium ion battery applications	202341004527	23/01/2023
03	Method of producing spinel nanostructured materials and spinel-PCM nanocomposites for thermal energy storage applications	202241064003	09/11/2022
04	Method of producing highly crystalline ${\rm TiO}_{\rm 2}$ nanoparticles suspension and its use in perovskite solar cell	202241054454	22/09/2022
05	A superhydrophilic, omni transparent antisoiling coating for photovoltaics, and a method for synthesizing the same	202241052009	12/09/2022
06	System and method for fast charging of lithium-ion batteries	202241044449	03/08/2022
07	An automated spray coating deposition system	202241037966	01/07/2022
08	A method for the fabrication of web-reinforced EPDM rubber- ZrO_2 composite membrane for separating H_2 and O_2 gases formed in water electrolysis reaction	202241028888	19/05/2022
09	A process for fabricating a polypropylene cloth web-reinforced EPDM rubber-CaCO ₃ composite membrane and an electrochemical cell	202241028889	19/05/2022
10	Anti-clogging cold-spray nozzle to deposit clog-prone materials	202211017972	28/03/2022
11	Autogenous laser welding system and method for joining thick metallic parts without filler wire feeder	202211005404	01/02/2022
12	Method for reducing friction on metallic substrates by preparing micro dimpled textures by ultrafast laser	202111051880	12/11/2021
13	Durable corrosion resistant coating for fuel cell separator and the process thereof	202111051526	10/11/2021
14	Antibacterial scrub pads and process of preparing the same	202111041925	16/09/2021
15	Method of preparation of highly efficient skutterudite thermoelectric materials for thermoelectric modules and the product thereof	202111036278	11/08/2021
16	A method of producing strontium hexaferrite powders having high coercivity suitable for bonded magnets	202111008252	26/02/2021
17	Post-calcination modification of morphology and improvement of coercivity in high energy-milled strontium hexaferrite powders	202111003235	23/01/2021
18	Biofilm inhibiting sol-gel composition for coating on substrates and process of preparing the same	202111001104	11/01/2021
19	Process for the fast formation of solid electrolyte interphase layer on the anode surface in lithium-ion battery	202011052906	04/12/2020
20	Method of producing single layer omnidirectional broadband antireflective and super hydrophilic coatings for solar and other applications	202011051833	27/11/2020
21	Method of manufacturing the catalyst coated membrane for the proton exchange membrane fuel cells	202011046496	25/10/2020
22	Oxide dispersion strengthened iron aluminides with high strength and ductility and method of preparation of the same	202011044124	09/10/2020

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S.N	Title of Patent	Application Number	Date of Filing
23	A device and method for converting sunlight into heat energy using semiconducting materials immersed in a stable organic solvent for electricity generation	202041039082	10/09/2020
24	Method of producing porous particles-fibers carbon composite material for supercapacitor applications and the product thereof	202011027265	26/06/2020
25	Method for preparing multifunctional isotropic and uni-directional super hydrophobic surfaces on substrates using femtosecond laser	202011022242	27/05/2020
26	Method of producing nanoporous graphene sheet-like structured high and low surface area carbon sheets from petroleum coke	202011007399	20/02/2020
27	A method of preparing the thermoelectric module for power generation from automotive exhaust and the thermoelectric module thereof	201911045857	11/11/2019
28	Method of preparing gas diffusion layer for the electrode of ECMR cell for hydrogen generation method of preparing gas diffusion layer for the electrode of ECMR cell for hydrogen generation	201911030852	31/07/2019
29	Transition metal-based solar selective absorber coated substrate and method of manufacturing the same	201911019139	14/05/2019
30	Method of fabricating tungsten based composite sheets by spark plasma sintering technique for making components	201911014933	13/04/2019
31	Microwave assisted sol-gel process for preparing in-situ carbon coated electrode materials and the product thereof	201911008004	28/02/2019
32	Refurbishment of aircraft components using laser cladding	201911007994	28/02/2019
33	A grid independent fuel cell system with a unitized (DC & AC) power conditioner	201911006700	20/02/2019
34	Laser based clad-coatings for protecting the power plant components for life enhancement	201811039663	19/10/2018
35	Process for preparing durable solar control coatings on glass substrates	201811024034	27/06/2018
36	An ecofriendly incinerator to dispose of the used sanitary napkins and bio medical waste	201821021430	07/06/2018
37	A novel equipment to accomplish power metallurgy processing starting from the 'raw materials' to finished product	201711011552	30/03/2017
38	An improved gas dynamic cold spray device and method of coating a substrate	201711006749	26/02/2017
39	A method for producing inorganic bonded silica based eco-friendly artificial marble articles and the product thereof	201611036479	25/10/2016
40	A laser-based surface processing apparatus and a method to process metallic materials and components	201611034362	07/10/2016
41	An improved process for the preparation of stable nano silver suspension having antimicrobial activity	201611027145	09/08/2016
42	Process and apparatus for protection of structural members from wear, corrosion and fatigue damage	1839/DEL/2015	22/06/2015
43	High temperature polymer electrolyte membrane fuel cells with exfoliated graphite based bipolar plates	494/DEL/2014	20/02/2014
44	An improved solar selective absorber coating with excellent optical absorptance, low thermal emissivity and excellent corrosion resistance property and a process of producing the same	1129/DEL/2013	16/04/2013
45	Novel ceramic materials having improved mechanical properties and process for their preparation	3396/DEL/2005	19/12/2005

International Patents Granted & Applications Awaiting Grant

S.N	Title of Patent	Country	Patent Number/ Application Number	Date of Grant	Date of Filing with the Patent Office	Indian Patent/Family details
01	Process for forming coatings on metallic bodies and an apparatus for carrying out the process	USA	US6893551B2	17/05/2005	02/08/2002	IN 209817
02	A device for controlling the on & off time of the metal oxide semiconductor field effect transistor (MOSFET), a device for spark coating the surfaces of metal workpiece incorporating the said control device and a method of coating metal surfaces using the said device	USA	US8143550B2	27/03/2012	20/03/2006	IN 262189
03	A process for the preparation of nano silver and nano silver-coated ceramic powders	South Africa Sri Lanka Indonesia	2006/8591 14258 IDP000044402	30/04/2008 02/11/2011 06/02/2017	13/10/2006 17/10/2006 18/10/2006	IN284812 IN284812 IN284812
04	A process for continuous coating deposition and an apparatus for carrying out the process	South Africa UK USA Japan France	2009/06786 2464378 US8486237B2 5442386 2937342	26/05/2010 15/05/2013 16/07/2013 27/12/2013 18/12/2015	30/09/2009 02/10/2009 14/10/2009 15/10/2009 12/10/2009	1829/DEL/2008 1829/DEL/2008 1829/DEL/2008 1829/DEL/2008 1829/DEL/2008
05	Method of depositing electrically conductive electrode material onto the surface of an electrically conductive work piece	USA	US8674262B2	18/03/2014	12/08/2011	IN 262189
06	Improved process for the preparation of stable suspension of nano silver particles having antibacterial activity	United Kingdom	GB2496089	18/06/2014	19/07/2011	IN 289543
07	A process for continuous coating deposition and an apparatus for carrying out the process	USA	US9365945B2	14/06/2016	17/08/2012	1829/DEL/2008
08	An improved hybrid methodology for producing composite, multilayered and graded coatings by plasma spraying utilizing powder and solution precursor feedstock	South Africa Canada	2012/02480 2784395	28/11/2012 16/09/2014	05/04/2012 31/07/2012	IN 323443 IN 323443
09	Multi-track laser surface hardening of low carbon cold rolled closely annealed (CRCA) grades of steels	USA Australia	US11186887B2 AU2014362928	30/11/2021 21/02/2019	10/12/2014 10/12/2014	IN375427 IN375427
10	A method of producing high performance lithium titanate anode material for lithium ion battery applications	Japan Germany USA China Korea	JP7121734 B2 112018000205.5 US11001506 CN110023245B KR20190121291	09/08/2022 - 11/05/2021 11/01/2022 15/03/2023	10/04/2019 28/06/2019 22/05/2019 22/05/2019 02/07/2019	IN365560 IN365560 IN365560 IN365560 IN365560
11	An improved gas dynamic cold spray device and method of coating a substrate	Russia	RU2744008	01/03/2021	24/09/2019	IN20171100674
12	Microwave assisted sol-gel process for preparing in-situ carbon coated electrode materials and the product	Japan Republic of Korea	JP2021520601A 10-2020-7025994	16/05/2022 03/02/2023	16/09/2020 09/09/2020	IN20191100800 IN20191100800
	thereof	Europe	20763813.1	-	11/09/2020	IN20191100800
13	Method of producing single layer omnidirectional broadband antireflective and super hydrophilic coatings for solar and other applications		PCT/IN2021/051099		25/11/2021	IN20201105183
14	Method of producing in-situ carbon coated lithium iron phosphate cathode material for lithium-ion batteries and the product thereof	-	PCT/IN2021/051138		06/12/2021	IN412586
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Projects at ARCI

ARCI engages with various Government and Private organizations through multiple modes including sponsored R&D, contract R&D programmes in its thrust areas of Powder metallurgy, Nanomaterials, Surface engineering, Sol-gel Coating, Laser processing of materials, Ceramic processing, Carbon materials, Fuel cell technology, Solar energy materials and Automotive energy materials. In addition, every year ARCI has also undertaken assignments in the form of job works and characterization to provide technical solutions to the industry.

List of Major Projects undertaken by ARCI during the year 2022-23 are as follows:

S.No	Project Title	Funding Body
01	Design and development surface engineered solution to enhance the corrosion resistance of solar energy storage container	Science and Engineering Research Board (SERB)
02	Development, characterization and performance evaluation of polymer coated and uncoated aluminum and titanium alloy powder for selective laser sintering, selective laser melting and electron beam melting	DST (Indo-Philippines)
03	Development of additive manufacturing process for high-speed tool steel using laser powder bed fusion by varying process strategy and inoculating additions	SERB
04	Development of self-powered wearable thermoelectric power generator to boost the energy storage capacity by bioelectronics	DST
05	Research exposure cum training programme in engineering sciences in domain area for students of North-Eastern states and J&K	DST
06	Performance of phase change material based heat sink embedded with open cell metal foam through PM route for thermal energy storage	DST-Teachers Associateship for Research Excellence
07	Development of biodegradable alloys and AM process for soft tissue anchors	Indo German Science And Technology Centre (IGSTC)-DST
08	Project Management Unit - Phase 2	DST
09	Development and validation of Indian standards for battery swap systems for 2 and 3 wheeled vehicles	DST
10	Development for atomization and characterization of BZL12Y super alloy for realization of hot end aero engine component using AM (Phase-I&II)	Gas Turbine Research Establishment (GTRE), Bangalore
11	Development of laser processed Iron ore sinters for Hydrogen reduced iron & steel making	University of Hyderabad
12	Training coin cell & pouch Li-ion liquid cell fabrication	Qpi Volta
13	Development of strontium hexaferrite powders suitable for anisotropic bonded magnet application	Ashvini Magnets
14	Development and supply of skutterdite thermoelectric module	Foundation for Innovation and Social Entrepreneurship
15	Development and supply of Fe-P alloy for alternator application	Lucas TVS
16	Development and demonstration of anti-reflective coatings on polycarbonate lenses	Dream Vu
17	Ceramic coatings on plastics	ABB Global Industries & Services Pvt Ltd

Research Highlights

Multi-Layer Graphene as Cathode Conductive Additive in Lithium-ion Pouch Cells

Contributors: M. B. Sahana, P. Mahender and R. Gopalan

Conductive additives play a crucial role in enhancing electron transport and improving the overall conductivity within lithium-ion batteries, enabling better battery performance and efficiency. Our research demonstrates the efficacy of incorporating multilayer graphene (MLG) into carbon black (CB) as a conductive additive to enhance cyclic stability. Pouch cells utilizing NMC-CB-MLG electrodes, featuring LiNi_{1-X-Y}Co_xMn_yO2 cathodes and graphite anodes, exhibit outstanding capacity retention of 80% after 730 cycles at 1C, outperforming NMC-CB electrodes (65% after 320 cycles). These findings underscore the tremendous potential of MLG mixed with CB as a valuable conductive additive for large-scale, high-energy lithium-ion cells, fostering advancements in various applications.



a1) and b1) cyclic stability at 1C and corresponding discharge curves at every 100cycles: a2) and b2) SEM images of NMC-CB, NMC-CB-MLG electrode surface morphology highlighting the cracks observed in cycled NMC-CB electrode, detaching NMC particles from carbon black, while MLG holds the NMC particles together

Reference: Mahender Peddi, M. B. Sahana, A. K. Budumuru, K. Muthusamy, G. Sundararajan, R. Gopalan, Multilayer Graphene as a Cathode Conductive Additive in Lithium-Ion Pouch Cells: A Correlation of changes in electrolyte uptake and composition of the electrode electrolyte interface with enhanced cycling stability ACS Appl. Energy Mater. 2023, 6, 3251–3263

Temperature derived Fe Dissolution of a LiFePO₄/Graphite Cell at Fast Charge/Discharge Condition

Contributors: V. R. Rikka, S. R. Sahu, G. Mrinalini, R. Gopalan, G. Sundararajan and R. Prakash

The technology for EV-LIBs has seen striking growth in the last few years. The goal of replacing fossil fuel vehicles can only be accomplished with the application of LFP-LIBs. However, at higher current rates, capacity fading caused due to Fe dissolution is a major issue associated with LFP-LIBs. We provide a comprehensive experimental evidence linking to the high cell temperature as the main origin of Fe dissolution in the LFP/graphite cell cycled at fast charge/discharge (4C rate). In this study, a mechanistic understanding of the Fe dissolution-deposition mechanism was pursued at 4C rate (Scheme). After 400 charge-discharge cycles at 4C, Fe dissolution is accelerated and is shortly followed by deposition of Fe on graphite anode, and subsequent formation of Fe-catalyzed solid electrolyte interface layer at the anode, which accounts nearly 17-20% of the capacity loss against the initial capacity.



Dissolution-migration-deposition of Fe in LFP-LIBs.

Reference: V. R. Rikka, S. R Sahu, A Chatterjee, C. Sudakar, G Sundararajan, R. Gopalan, R Prakash, Temperature derived Fe dissolution of a LiFePO₄/graphite cell at fast charging and high state-of-charge condition, Energy Technol. 2023, 2201388

Enhancing Cycle Life and Energy Density during Fast Charging of LiFePO₄-Graphite Cell by Regulating Lithium Level



Charge/discharge conditions and cyclic stability profile.

Contributors: V. R. Rikka, S. R. Sahu, R. Gopalan, G. Sundararajan and R. Prakash

Range anxiety is a primary concern among present-day electric vehicles (EVs), which could be curtailed by maximizing the driving range per charge or reducing the charging time of the lithium-ion battery (LIB) pack. Maximizing the driving range is a multifaceted task as charging-discharging the LIB up to 100% of its nominal capacity is limited by the cell chemistry (voltage based) and operating conditions. Our studies on commercial LiFePO₄/graphite cells show that a cycle life of 4320 is achieved at 4C rate with 80%

State of Charge (SOC)-100% Depth of Discharge (DOD) combination (12 min charging time), which is the highest among the works reported with this cell chemistry (Scheme). Complete utilization of lithium during cycling resulted in the lowest cycle life of 956. This study demonstrates a proper charging-discharging protocol enabling longer driving range with faster charging times. Besides, it might endow promising possibilities of future EV LIB packs with reduced size/weight and high safety.

Reference: V.R. Rikka, S.R. Sahu, A. Chatterjee, R. Prakash, G. Sundararajan, R. Gopalan, Enhancing cycle life and usable energy density of fast charging LiFePO4-graphite cell by regulating electrodes' lithium level, iScience, 2022, 104831 (1-18).

Investigation and Development of All-Phosphate Dual-Ion Solid-State Batteries

Contributors: Raman Vedarajan, Sahana MB, Prakash R, and Ramya K

The limited availability of Li and transition metals that are extensively used in Lithium ion battery in India, has led to research in possible ways of reducing these, without comprising the energy density and safety. Vanadium pyrophosphates are promising high voltage materials that can be used in Sodium ion batteries. However, use of sodium ion batteries reduces the energy density. The best bet would be to use sodium as anode and Lithium vanadate's as the cathode materials in dual ion battery.



Synergistic effect of Li and Na ion intercalation in dual ion batteries

In this context, a Nasicon structured lithium sodium vanadium phosphate $(Li_{3-x}Na_xV_2(PO_4)_3)$ over a wide range of composition was studied in sol-gel approach synthetic route. It was understood that achieving single-phase crystals in these structures was difficult. However, ion exchange was easier in the Nasicon framework with predominantly sodium rather than lithium, while in the anti-Nasicon framework Li was predominant. The electrochemical studies showed that migration of both sodium ions and lithium ions was possible in case of the Nasicon structure, while in the anti-Nasicon framework, the lithium ion migration was predominant. The Nasicon exhibited a capacity of 100 mAh/g for both Lithium as well as sodium ion intercalation at an average potential of 3.7 V (vs Li) and 3.4 V (vs Na) respectively. While the anti-Nasicon structure showed 115 mAh/g and 80 mAh/g with respect to lithium and sodium intercalation respectively, in multiple steps.

Reference: Dara O.Semykina, Olga A. Podgomova, Sahana B Moodakare, Raman Vedarjan and NinaV. Kosova Crystal Chemistry and Ionic Conductivity of the NASICON-related phases in the $Li_{3-x}Na_xV_2(PO_4)_3$ system, Inorganic Chemistry, 2023, 62, 15, 5939-5950

Peltier and Thermoelectric Devices for Refrigeration and Power Generation



TE device manufactured at ARCI from the patented p and n-type compounds.

Based on the well-known Seebeck and Peltier effects, products for the utilization of heat otherwise let out in the atmosphere and precise cooling gained significant importance in the recent decade. At ARCI, the technical know-how to make the Peltier and Thermoelectric (TE) devices usable up to 150°C has been developed and demonstrated up to the technology readiness level (TRL) of 5. The various p and n-type degenerate semiconducting materials required for these devices were developed to show that conversion efficiency close to 10% is possible. The manufacturing process established demands the import of 20% of the components and the remaining 80% indigenously available. The figure given below shows the TE device manufactured at ARCI from the patented p and n-type compounds.

Reference: B. Jayachandran, T. Dasgupta, D. Sivaprahasam, Highly Stable Metal–Na_{0.02}Pb_{0.98}Te Contacts for Medium Temperature Thermoelectric Devices, ACS Applied Materials & Interfaces, 2023, 15, 22231-22240.

Development and Optimization of Zintl based Thermoelectric Materials for Power Generation from Waste Heat

Contributors: Minati Tiadi, Vikrant Trivedi and Manjusha Battabyal

Due to natural abundance, low cost, and compatibility with sustainable green technology, Mg_3Sb_2 are potential thermoelectric materials for near-room temperature applications. The effective use of these materials in devices requires both p and n-type Mg_3Sb_2 having comparable thermoelectric efficiency. P-type Mg_3Sb_2 has inferior thermoelectric efficiency compared to its n-type counterpart due to low electrical conductivity. Co-doping of monovalent atoms (Li-Ag, and Na-Ag) at the Mg site of Mg3Sb2 boosts the thermoelectric properties of p-type Mg_3Sb_2 . The zT value ~0.8 at 675 K for Mg_3Sb_2 is the highest value among p-type Mg_3Sb_2 .



Mechanism of thermoelectric efficiency enhancement in Na-Ag co-doped Mg₃Sb₂

References: (1) Minati Tiadi, Vikrant Trivedi, Santosh Kumar, Pawan Jain, Satyesh Yadav, R. Gopalan, Dillip K Satapathy, Manjusha Battabyal, Enhanced Thermoelectric Efficiency in P-type Mg₃Sb₂: Role of Monovalent Atoms Codoping at Mg sites, ACS Applied Materials & Interfaces, 2023, 15, 20175–20190.

2) Vikrant Trivedi, Minati Tiadi, Budaraju Srinivasa Murty, Dillip Satapathy, Manjusha Battabyal, R. Gopalan, Giant Thermoelectric Efficiency of Single-filled Skutterudite Nanocomposites: Role of Interface Carrier Filtering, ACS Applied Materials & Interfaces, 2022, 14, 51084–51095.

Towards Dy Free High Temperature Nd-Fe-B Magnets for Automotive Applications.



Contributors: M. B. Siva Kumar, D. Prabhu, B. Manjusha, G. Sundararajan and R. Gopalan

Showing the presence of Nb precipitates pinning the grain boundary along with the M vs H curve showing the coercivity enhancement achieved along with 3-DAP data confirming the presence of Nb precipitates and the decoration of Nd-Cu at the grain boundary aiding the enhancement in coercivity

Nd-Fe-B magnets capable of operating at high temperature are essential for manufacture of traction motors for EV applications. Currently heavy rare earth Dysprosium (Dy) is added to achieve necessary performance. Grain boundary (GB) diffusion technique is employed wherein low melting Nd eutectics is used as diffusion agent to enrich the Nd content at the grain boundary and enhance the coercivity thereby negating the usage of Dy. In this work we have demonstrated the advantage of Niobium as a grain growth inhibitor during grain boundary diffusion process aiding the enhancement in coercivity. Unlike the earlier reports in literature, which reported grain growth during GB diffusion, in the present study the grain size was restricted to less than 30 nm. 3D atom probe technique and Transmission electron microscopy confirmed the formation of Nb precipitates at the grain boundaries restricting the grain growth.

Reference: M. B. Siva Kumar, D. Prabhu, M. Sadhasivam, B. Manjush, N.Chandrasekaran, K. G. Pradeep, G. Sundararajan, R. Gopalan Enhancing the Coercivity of Nd-Cu-Diffused Nd-Fe-B Permanent Magnets by Nb-assisted Grain Boundary Pinning, Materials Research Letters, 2022, 10, 780-787.

Magnetocaloric Effect in Te Doped Ni-Mn-Sn Heusler Alloys for Magnetic Refrigeration

Contributors: R. Archana, S Kavita, V. V. Ramakrishna and R Gopalan

 $Ni_{43}Mn_{46}Sn_{11-x}Te_x$ (x=0.1, 0.2, 0.3, 0.4, 0.5, 1) alloys have been prepared by arc melting. Structural studies show the presence of L21 cubic austenite phase. Magnetic studies show that all the alloys exhibit first order phase transition. The martensite temperature increases with the increase in Te concentration. Magnetocaloric effect has been observed over a broad ange of temperature span from 215 K to 289 K by varying the Te concentration. Successive transitions and overlapping magnetocaloric effect occur with Te doping and they can be harnessed as layered magnetocaloric materials to enhance the refrigeration capacity.



Magnetic entropy change of $Ni_{43}Mn_{46}Sn_{11-x}Te_x$ alloys at 1 T and 7 T

Reference: R Archana, S Kavita, VV Ramakrishna, VS Kumar, P Bhatt, SM Yusuf and R.Gopalan Successive, overlapping transitions and magnetocaloric effect in Te doped Ni-Mn-Sn Heusler alloys, Journal of Alloys and Compounds, 2023, 947, 169434.

Cold spraying of Al-Aerospace Alloys: Ease of Coating Deposition at High Stagnation Temperatures

Contributors: M. Tarun Babu, S. Kumar and K. Suresh

The cold spray technique is very suitable for depositing aluminium alloys for aerospace applications but often, there are issues with clogging of the nozzle, limiting the use of the technique to helium as process gas and a polymer nozzle. To overcome this, we have developed a process for three Al-alloys (Al2024, Al6061, and Al7075) with air as the process gas, the breakthrough made possible by finite element method (FEM) simulations. The highest deposition efficiency for these alloys was achieved at stagnation temperatures of 600°C and remarkably, millimeter-thick coatings were attained in a single pass. Furthermore, the bond strength of coatings is comparable to that of coatings deposited using helium. Consequently, this coating technology is highly suitable for the repair and refurbishment of aerospace components based on Al alloy materials.



Simulation, process and coating property evaluation for the aerospace grade AI alloys.

Reference: M. Tarun Babu, S Kumar, GP Kumar, K. Suresh Cold Spraying of Al-Aerospace Alloys: Ease of Coating Deposition at High Stagnation Temperatures; Surface and Coating Technology, 2023, 467, 129703

Photoluminescence Studies on $MgAl_2O_4$: Eu³+ /Eu²+ for Photonic Application.

Contributors: Shiv Prakash Singh, Papiya Biswas, and Roy Johnson

We have produced Eu₂O₃ doped MgAl₂O₄ spinel material by slip casting method under different thermal processing conditions and explored its photoluminescence (PL) properties. Three different Eu₂O₃ concentrations of 0.05, 0.1, and 0.5 mol % were mixed in the 65 wt% spinel aqueous slurry and were slip cast. The green samples were sintered at 1650°C/5h and further subjected to a hot isostatic press (HIP) under high temperature 1800 oC and high pressure 1950 bar for 1 h. All HIPed samples were heat-treated at 1300°C/1h to remove the carbon contamination. PL for the sintered sample displays the distinctive emissions for the Eu³⁺ at 613 and 590 nm. The HIPed samples show Eu²⁺ blue emissions in the 445 - 480 nm range, and it show Eu³⁺ (red) emissions on further heat treatment at 1300°C. TheCIE diagram shows the tuneable color coordinates from orange to blue to red, depending on the processing conditions.



CIE plot for the 0.1 mol. % Eu₂O₃ doped in MgAl₂O₄ sample processed in three different conditions such as sintered, HIPed and HIPed with further heat treatment

Reference: Shiv Prakash Singh, Papiya Biswas, Roy Johnson, Tunable Luminescence and Oxygen Defects of the Spinel MgAl₂O₄:Eu³⁺/Eu²⁺ for Photonic Application, Materialia, 2022, 26, 101624.

Effect of GDC-Buffer Layer on Electrochemical Performance of 0.7Gd_{0.1}Ce_{0.9}O₂₋₀/ SrFe_{0.1}Mo_{0.9}O₃₋₀ -based Composite Anode for Solid-Oxide Fuel Cell (SOFC) Application.

Contributors: Amit Das and M. Buchi Suresh

This study was carried out to understand the interfacial effect on the polarization resistance of composite anode material used in Solid Oxide Fuel Cell development. Figure-1 shows the effect of $Gd_{0.1}Ce_{0.9}O_{2.\delta}$ (GDC) on the electrochemical performance of 70 wt.% $Gd_{0.1}Ce_{0.9}O_{2.\delta}$ (GDC)- SrFe_{0.1}Mo_{0.9}O_{3.\delta} (SFMO)-based composite SOFC anode with 8 mol.% Y₂O₃-ZrO₂ (8YSZ) material as electrolyte.

The area-specific resistance (ASR) of the composite anode without (0.7GDC/SFMO-NBL) with and (0.7GDC/SFMO-BL) GDC-buffer layer was estimated to be ~0.68 $\Omega.cm^2$ and ~0.09 $\Omega.cm^2$ at 850°C in 100% H₂ (3% H₂O) respectively. The electrode ASR value in the cell without the GDC buffer layer is ~7.5 times greater than in the cell possessing the GDC interlayer. A substantially large ASR value in 0.7GDC/SFMO-NBL suggests the possibility of insulating phase formation at the interface of the 0.7GDC/SFMO composite electrode and the 8YSZ electrolyte.



Impedance spectra were taken on the symmetrical cells of (a) 0.7GDC/SFMO-NBL and (b) 0.7GDC/SFMO-BL before the redox testing at 850°C in 3% H_2O/H_2 gas environment. The impedance spectra of (c) 0.7GDC/SFMO-NBL and (d) 0.7GDC/SFMO-BL cells are also given after subjecting them to 10th redox cycle.

The XRD pattern and FE-SEM micrographs including the EDX results confirmed that the formation of dense and insulating SrZrO₃-phase between the electrode and electrolyte at the interfaces reduces the numbers of triple-phase boundary and retards the transportation of O_2 - from the electrolyte to the reaction sites of the electrodes. Significant CTE mismatch of SrZrO₃ [29.8×10⁻⁶ K₋₁ (30-700°C) and 26.1×10⁻⁶ K⁻¹ (700-1500°C)] with the other components [GDC: 12.1×10⁻⁶ K₋₁ (30-900°C), SFMO: 12.8×10⁻⁶ K⁻¹ (30-900°C), and 8YSZ: 10.3×10⁻⁶ K⁻¹ (30-900°C)] causes the spallation of the electrode layer from the 8YSZ electrolyte and increases the ASR drastically with the numbers of redox cycles increases.

Reference: Amit Das; Sunil Kumar; M. Buchi Suresh, Shobit Omar, Interfacial Effect on the Polarization Resistance of SrM_{0.1}Mo_{0.9}O_{3.5} (M=Mg²⁺, Fe³⁺) / GDC-Based Composite Electrodes, Journal of Solid State Ionics 394, 2023, 116193

Contributors: R. Vijay, and P. Vijaya Durga

Iron aluminide (Fe₂AI) based intermetallics are candidate materials for high temperature applications in power plants and aerospace industries due to lower density, high strength, good resistance to oxidation/corrosion, and low cost. However, these materials could not find use because of insufficient ductility at room temperature and are low creep-resistant at high temperatures. Efforts are made at ARCI to improve these drawbacks by the addition of Cr, grain refinement (690 nm), and dispersion of stable and nano-sized (6.6 nm) oxides. The oxide dispersion strengthened (ODS) Fe₂Al developed at ARCI has exhibited ductility of 16% with yield strength of 1093 MPa at room temperature. The high temperature strength of this material is higher up to 600°C and similar at 700°C when compared to IN617. Atom probe tomography cluster analysis (Fig. 1) indicated that average size of the dispersoids is 7 nm. The bigger dispersoids (>20 nm) are of Y-Al-Ti-O type and smaller dispersoids (<10 nm) are of Y-Ti-O type oxides. The comparison of strength of ODS-Fe₃Al with other materials used in gas turbines is shown in Fig.2. The creep rupture life ODS-Fe3Al is shown in Fig. 3. The creep data indicates that the material can be used up to 550°C for gas turbine applications



Figure 1: Atom probe tomography cluster analysis of ODs-Fe,Al







Figure 3: Creep rupture life of ODS-Fe, AI with other gas turbine materials at 550°C.

Reference: P. V. Durga, M. Nagini, A. V. Reddy, S. R. Bakshi, R. Vijay; Effect of Fine Grain Structure and Nano Oxide Dispersoids on Improved Strength and Ductility of Iron Aluminide Based Intermetallics, Metallurgical and Materials Transactions A, 2022, 53, 1597-1603.

Microstructure and Mechanical Properties of Austenitic ODS Steel Processed using Ni–20Cr

Contributors: S. B. Chandrasekhar, P. Sai Karthik, S. Ganesh, P.S. Ninawe, M. Battabyal and R. Vijay

Austenitic oxide dispersion strengthened (AODS) steel of composition e-22Ni-18Cr-1.5W-0.22Ti-0.35Y₂O₂ (wt. %) was fabricated using Ni-20Cr (instead of Ni) in second-stage milling. Mechanical alloying process for producing AODS powder was studied by measuring the yield and average size of milled powder. After 5 h of milling, yield of milled powder was found to be 75% with Ni-20Cr and 42% with Ni. AODS powder was consolidated using hot extrusion and solution annealed. Yield strength and elongation were measured as 830 MPa and 27%, respectively, which are comparable to reported values. Thus, this study describes an alternative route to produce AODS steel with improved milled powder yield using Ni-20Cr, while still retaining higher strength levels associated with AODS steel.

Table I: Variations in yield and average size of AODS milled powder with respect to milling time using

Ni-20Cr and Ni precursors

Milling time, h	М	lilled powder yi	eld, %	Average milled powder size, µm			
	Ni–20Cr	Ni		Ni–20Cr		Ni	
		Carbonyl	Atomized		Carbonyl	Atomized	
1	95	92	94	90	120	107	
3	88	75	78	120	180	185	
5	75	42	47	189	352	346	

Reference: P.Sai Karthik, S.Ganesh, P. S. Ninawe, M. Battabyal, S. B. Chandrasekhar, R. Vijay, Microstructure and Mechanical Properties of Austenitic ODS Steel Processed using Ni-20Cr, Journal of Materials Research, DOI:10.1557/s43578-023-00938-6.

Development of Ultra Low Degradation with Excellent Biocompatibility of Mg-based Biodegradable Alloys

Contributors: Kaliyan Hembram, Hitesh Kumar, S. Dutta, and R. Vijay

Traditional non-degradable bioimplants such as 316L, Co-Cr alloys, and Ti alloys, have problems and drawbacks associated with stress shielding effects, metal ion releases and secondary surgery. In recent years, biodegradable (BD) metals such as Mg, Fe and Zn have been developed to overcome conventional implants issues. Among all, Mg is preferred over the other BD materials due to its biocompatibility and its mechanical properties; the modulus of elasticity is close to the human bone. Although, Mg-based alloys have advantages over other BD alloys, there are many issues, such as lower strength, higher corrosion rate, and higher hydrogen evaluation. In present study, Vacuum induction melting (VIM) was used to develop Mg-based BD alloy followed by T4 treatment in air. Figure 1(a) and (b) show microstructure and phase confirmation of the Mg-based alloy. Tensile testing as per ASTM E21 and Electrochemical testing were carried out to find out the mechanical properties and degradation rate of the samples, as shown in Figure 1 (c) and (d). The best combination of mechanical and degradation properties YS: 132 MPa, UTS: 238, E: 30 GPa, EL: 12% and degradation rate of 0.040 mm/year was obtained.



Typical (a) microstructure, (b) phase confirmation, (c)Tensile properties and (d) Potentiodynamic polarization to determine degradation rate of the Mg-based alloy samples

The in-vitro cytotoxicity test was conducted on alloy sample by extract method on HOS mammal cell using ISO 10993-5 2009. The score of more than 2 is considered as cytotoxic effect, the sample achieved a grade of 0, it is considered to be non-cytotoxic. The developed Mg-based alloy exhibited, ultra-low degradation rate, improved mechanical properties with excellent biocompatibility which could be explored for emerging commercial BD implant applications.

Reference: Hitesh Kumar, S. Dutta, R. Vijay and K. Hembram. A Zirconium oxide layered based Mg-Zn-Zr alloys and its method of preparation there of, Indian Patent application 202341055508 dated 18/08/2023

Bilayered Metal-Ceramic Components for Dental Implants by SPS

Contributors: D. Chakravarty, R. Jayasree, K. Raghava, PVV Srinivas, R. Vijay, T.N. Rao



(a) tapered graphite die; (b) schematic of the bi-layered Ti6Al4V-YSZ dental implant

The most commonly used materials for dental implants are titanium alloys and zirconia as they are MRI-resistant, biocompatible, non-cytotoxic, possess good corrosion resistance and have high mechanical strength. However, both titanium alloys and zirconia have their advantages and limitations. To alleviate such issues with the individual implants, a single-piece bi-layered component of Ti6Al4V and YSZ was developed through Spark Plasma Sintering (SPS) in a single step using a specially designed tapered die. The mechanical and in-vitro biological properties of the bi-layered components are comparable with commercially available implants making them an alternate dental implant material where the Ti6Al4V part can act as the fixture with the jaw bone and the YSZ part as the crown.

Reference: R. Jayasree, K. Raghava, M. Sadhasivam, P. V. V. Srinivas, R. Vijay, K. G. Pradeep, T. N. Rao, D. Chakravarty, Bilayered Metal-Ceramic Components for Dental Implants by SPS," Mater. Lett., 2023, 344, 134403.

NiMnCo-Oxalate based Electrodes from Spent Li-Ion Batteries for Hyrid Supercapacitor Applications





Performance of supecapacitor fabricated using spent Li-ion battery material.

Rapid transformation to Li-ion battery-operated electric vehicles is leading to the piling up of dead batteries after use. Finding a green and efficient way to recycle these batteries containing essential metals is crucial. The present work involves a facile and benign process for the synthesis of NiMnCo-oxalate from spent lithium-ion batteries, which are used as electrodes for supercapacitors. NiMnCo-oxalate was extracted from dead batteries using citric acid as green leachate. Microwave irradiation was employed to expedite the process of leaching. Microwave-irradiated citric acid-assisted NiMnCo-oxalate when tested for supercapacitor showed a high specific capacity of 93 mAhg⁻¹ (560Fg⁻¹) at 1A^{g-1.} The designed asymmetric supercapacitor showed good capacitance retention with an energy and power density of 36 Wh kg⁻¹ and 118 W kg⁻¹, respectively. Further, a polyaniline (PANI)//tungsten oxide (WO₃) based electrochromic device was powered by the asymmetric supercapacitor prepared from the recycled material.

Reference: Samhita Pappu, Sadananda Muduli, Nanaji Katchala, Tata Narasinga Rao, Sarada B. V., and Surendra K. Martha, Easy and Scalable Synthesis of NiMnCo-Oxalate Electrode Material for Supercapacitors from Spent Li-Ion Batteries: Power Source for Electrochromic Devices, Energy & Fuels, 2022, 36 (21), 13398-13407

Electrochemically Exfoliated Layered Carbons as Sustainable Anode Materials for Lead Carbon Hybrid Ultracapacitor

Contributors: B. V. Sarada, P.Samhita, and Tata Narasinga Rao



Electrochemical Performance of Pb-C HUC cell.

Lead-carbon hybrid ultracapacitors (Pb–C HUC) have gained importance to avoid sulfation issue of lead-acid batteries, simultaneously enhancing the system's power density and cycle life. In this work, exfoliated graphene oxides (EGO) were synthesized by the electrochemical exfoliation method followed by chemical activation and carbonization at 600 °C (AEGO-600). The composite electrode delivered 800 F g⁻¹ capacitance at 1 A g⁻¹. The Pb –C HUC fabricated using AEGO-600 anode and PbO₂ cathode can achieve a capacitance of 325 F g⁻¹ at 10 A g ⁻¹ and retain 71 % capacitance after 15000 charge-discharge cycles in the voltage range of 2.3–0.8 V. The highly stable capacitance was due to the formation of layered carbons in AEGO-600 that enhanced the favorable electrolyte ion assessment to maximum active sites. Owing to the facile, cost-effective synthesis approach and better charge storage behavior, the activated-exfoliated graphene oxides thus produced could be suitable candidates for future hybrid ultracapacitor systems.

Reference: Sadananda Muduli, Samhita Pappu, Sarada B. V., Tata Narasinga Rao, Surendra K. Martha, Electrochemically Exfoliated Carbons as Sustainable Anode Materials for Lead Carbon Hybrid Ultracapacitor, ChemElectroChem, https://doi.org/10.1002/celc.202200230, 2022

Enhanced Stability and High-Yield LiFePO₄/C Derived from Low-Cost Iron Precursors for High-Energy Li-ion Batteries

Contributors: S. Anandan, Ch. Gowthami, Sudhakara Sarma , B. V. Sarada, R. Vijay, Tata Narasinga Rao

Carbon-coated lithium iron phosphate (LFP/C) cathode material developed from economical, high-dense Fe_3O_4 iron precursor resulted in good capacity, high atomic economy, and appreciable tap density for lithium-ion battery (LIB) fabrication. Less gas evolution during heating and high-density precursors resulted in 20-25% more atomic efficiency and 1.5 to 1.8 times higher tap density over conventional Fe- precursor derived C-LFP. Electrochemical studies showed that Fe_3O_4 -LFP/C delivers a high capacity of 137 mAh g⁻¹ at 1C and retained 83% capacity after 600 cycles at 1C.In addition, Fe3O4-LFP/C with the high atomic economy (73%) and tap density equivalent to the commercially available LFP/C paves the path for affordable LFP synthesis for high-energy density batteries.



Development of C-LFP Material Technology at lab scale, Large scale synthesis of LFP by high energy attrition milling, and Technology Transfer & its Demonstration

Reference: Ch. Gowthami; Shreya, J. Kashyap, Sudhakara Sarma; B.V. Sarada, A. Venu Vinod, R. Vijay, Tata Narasinga Rao, Enhanced stability and high yield LiFePO4/C derived from low-cost iron precursors for high-energy Li-ion batteries. Journal of Energy Storage 2023, 72, 108453

Development of Sodium Ion Batteries for Energy Storage Applications

Contributors: Bijoy Das, P Laxman Mani Kanta, M. Venkatesh, and R. Gopalan



a) TEM image of carbon coated Na₃V₂(PO₄)₃ cathode. (b) Schematic of asymmetric and symmetric cells during charge/discharge cycling. (c) Ragone plot showing the specific energy and specific power of developed asymmetric and symmetric cells with literature reports.

Sodium-ion batteries (SIBs) are considered as promising alternatives to widely used Lithium-ion batteries (LIBs) due to their low cost, elemental abundance, encouraging electrochemical performance and safety features. SIBs, though in its early stage of development, are potential storage devices for grid energy storage and electric vehicle (EV) applications. The main objective of ARCI is to develop the prototype SIB for stationary and EV applications, from the indigenously developed electrodes and electrolytes of high electrochemical performance. The in-situ carbon coated Na₃V₂(PO₄)₃ prepared by micro-wave assisted sol-gel route has shown promising electrochemical performance when used as electrode material for both asymmetric and symmetric full cell. Asymmetric and symmetric cells have demonstrated cell level energy densities of 59 and 46 Wh/kg at 1 A/g respectively, which are much higher than many reported values. At 2 A/g, both configurations delivered high power (3722 and 3750 W/kg) within 1.4 and 1.5 min at retentions of 63 and 51% after 14,000 cycles respectively (Fig.1). Large scale synthesis of this promising cathode has been accomplished by getting ~500 g/ batch with existing facility. In addition, hard carbon as anode and cobalt free layered type Na_xMO₂ (M= Mn, Fe and Ni) (0.6<x<1.0) as cathodes have been developed and tested.

References: (1) Microwave assisted sol-gel process for preparing in-situ carbon coated electrode materials and the product there of; Bijoy Das, P Laxman Mani Kanta, N Lakshmi Priya, R. Gopalan, G. Sundararajan, Korean Patent: 10-2497808 (Granted).

2) P Laxman Mani Kanta, M Venkatesh, Satyesh Kumar Yadav, Bijoy Das*, R Gopalan, Applied Energy, 2023, 334, 120665.

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Structural Stability of Two-Dimensional Tungsten Disulfides at High Temperature under Pressure Sintering Conditions

Contributors: Joydip Joardar, A. Harish Kumar, K. Murugan, P.V.V. Srinivas, D. Nazeer Basha, and A. Karati

Two-dimensional tungsten disulfide $(2D-WS_2)$ is a versatile material with wide range of properties. Technology for bulk synthesis of $2D-WS_2$ powder (Fig. 1) has been successfully established at ARCI in recent years. The stability of the $2D-WS_2$ structure at high temperature under positive strain is key to the performance of the material as lubricant, self-lubricating composites, and other applications. Recent efforts demonstrated the formation of 2D-particle-to-particle bonding under field-assisted elevated temperature and pressure conditions and transformation of hexagonal to rhombohedral structure at 800-1000°C. Such behavior is expected to influence its physical and tribo-mechanical properties in consolidated state such as strength and lubrication characteristics, electrical and thermal conductivity, dielectric constant, etc.



 (a) High purity 2D-WS₂ synthesized from microwave plasma produced nanostructured WO_{3.x} precursors.
(b) XRD patterns showing rhombohedral WS₂ formation under pressure and temperature (at 1000°C). Atomic configuration of 2D-WS₂ with (c) hexagonal 2H and (d) rhombohedral 3R structure.

Reference: A. Harish Kumar, K. Murugan, P.V.V. Srinivas, D. Nazeer Basha, A. Karati, A.K. Pandey, J. Joardar, Spark Plasma Sintering Behavior and Structural Stability of 2D-WS₂ Nanosheets, Ceramics International, 2022, 48, 25151-25158.

Development in Ultrafast Laser Processing for Fabricating Multifunctional Surfaces

Contributors: Ravi Bathe

Ultrafast laser processing enables the creation of multifunctional surfaces through the formation of laser-induced periodic surface structures (LIPSS). These 3D hierarchical nano- and microstructured surfaces offer advantageous properties such as friction control, enhanced adhesion, optical absorption, and hydrophobicity. By utilizing a 100 fs pulse duration laser, well-defined and uniform structures were successfully generated on steel surfaces. These structures included one-directional grooves, two-dimensional cross-hatched patterns, and nano-scale laser-induced periodic structures (Figure 1). The resulting surfaces exhibited robustness and controllable superhydrophobic functionality, with water rolling at tilted angles ranging from 0.5 to 3.5 degrees. Achieving hydrophobicity above 155 degrees, and up to 167 degrees, demonstrates the effectiveness of femtosecond laser processing in enhancing surface properties.



Representations of ultrafast laser processing: (a) squared/sinusoidal groove machining, (b) squared/sinusoidal pillared machining (c) hierarchical structuring on squared/sinusoidal groove (d) hierarchical structuring on squared/sinusoidal pillared.

Reference: K. S. Srin; J. Ramkumar; Ravi Bathe; The isotropic and anisotropic self-cleaning surfaces by using only femtosecond laser, Results in Materials, 2023,17,100362. https://doi.org/10.1016/j.rinma.2022.100362

An Economically Viable Single-Pass Autogenous Diode Laser Welding Technology for Thick-Section Welding

Contributors: S M Shariff, Aqeel Md, E Anusha, and P S Ganesh

A novel diode laser-based autogenous welding technology has been developed for thick-section welding of metallic materials, including superalloys and steels used in heavy engineering, thermal power plants, and the marine industry. This technology is suitable for welding symmetrical butt/lap joints in flat or round parts such as plates and tubes. The welding process involves two steps: initial spot welding of filler wire on the groove of the joint using a high-power advanced fiber-coupled diode laser, followed by seam welding over the joint using optimized processing parameters. The technology has demonstrated successful welds on 10-mm thick Inconel 617 superalloy and P91 boiler steel plates, achieving 100% joint efficiencies in a flat-butt configuration.Figure illustrates typical weld bead obtained in Inconel 617 butt joint with comparative stress-strain graphs with respective base metal. A simulation model has been developed to ensure defect-free joints with no porosity, segregation, undercut, or underfill commonly encountered in thick-section welding. The joining technology offers high production rates, single-pass seams, minimal distortion, and reduced heat-affected zones, while maintaining comparable properties to existing high-energy beam welding technologies. Further development is underway for tube-to-tube and tube-to-fin welds.



Diode laser-based autogenous welding



Stress vs Strain Graph of base metal and diode laser welded metal

References: (1)Aqeel Md., J P Gautham and S M Shariff, Comparative study on autogenous diode laser, CO₂ Laser – MIG hybrid and multi-pass TIG welding of 10-mm thick Inconel 617 Superalloy, 2022, Material Science and Engineering A, 856, 1439667

2) S M Shariff, Md. Aqeel, E Anusha, P S Ganesh, J P Gautham, Autogenous laser welding system and method for joining thick metallic parts without filler wire feeder, 2022, Indian Patent (Filed), 202211005404

Laser Assisted Machining for Hard to Machine Alloys used in Boiler Applications



Cutting forces, tool wear and surface roughness in laser assisted machining (LAM) and conventional turning (CT)

The machining of Ni-based superalloys poses challenges due to work hardening and retained strength at elevated temperatures. To address this, ARCI implemented Laser Assisted Machining (LAM), which involves locally heating the material to achieve thermal softening before machining. The LAM setup integrated a high-power diode laser with a 4-axis CNC turn-mill system, along with a piezo-electric dynamometer and high-speed pyrometer for monitoring cutting forces and surface temperature. LAM was successfully developed

for turning IN625 alloys, resulting in a 40% reduction in cutting forces and a 30% decrease in tool wear. The system was further upgraded for laser-assisted milling, leading to a significant 65-80% reduction in cutting forces through design of experiments.

References: (1) Ajit M. Hebbale, S. Rajesh K. Reddy, Mirza Abdul Hadi Baig, Manish Tak, Ravi. N. Bathe; An Experimental Investigation of Laser-Assisted Machining of EN24 Steel, Sustainable Machining Strategies for Better Performance pp 39–47, Springer, Singapore (2022)

2) B. Amarendhar Rao, Manish Tak, R. Narasimha Rao, Ravi Bathe, Developing Laser-Assisted Machining Process for Nickel based Superalloy IN625 Using Experimental and Statistical Analysis, https://doi.org/10.21203/rs.3.rs-2910910/v1 (2023)

Hybrid Approach for Copper – Stainless Steel Bi-metallic Structure by Powder Bed Fusion

Contributors: Gururaj Telasang, D. M. Santhosh Sarang and Ravi Bathe

The hybrid approach of achieving dissimilar material structures offers the advantage of combining the good properties of two different materials, which can be used to achieve unique functionally graded components. Additionally, it can be utilized for repair and refurbishment with added advantages. The challenging combination of a bi-metallic structure consisting of copper alloy and stainless steel has been successfully achieved using laser beam powder bed fusion (PBF/L) additive manufacturing (AM) technology, as shown in Figure 1a. The bi-metallic structure demonstrated the intermixing of the stainless steel (SS316L) alloy and the copper alloy at the narrow interface, as depicted in Figure 1b. Furthermore, the diffusion of selected alloying elements across the interface was observed, as illustrated in Figure 1c. The interfacial mechanical properties of the bi-metallic structure were evaluated by measuring the microhardness across the interface with a gradient drop in hardness across the interface, and the tensile fracture occurred away from the interface on the copper alloy side.



1. (a) Photographs of as-built Cu alloy-SS bimetallic structure, (b) Micrographs of the bi-metallic interface, (c) EDS maps of elemental distribution across interface, (d) Micro-hardness profile across the bi-metallic interface and (e) Micro-tensile behavior of the interface.

Reference: Gururaj Telasang, S. Narayan, D. M. Santhoshsarang, Ravi Bathe, Selective Laser Melting of Stainless Steel on the Copper: An Investigation on the Interfacial Microstructure and Mechanical Properties, Journal of Manufacturing Processes, 2022, Vol 80, Pages 920-929.

Room Temperature Sputtered Aluminium doped Zinc Oxide (AZO) Thin Film Transparent Electrode

Contributors: Sanjay R. Dhage

Aluminum-doped zinc oxide (AZO) is a popular, low-cost, nontoxic material that finds application as a transparent conducting electrode in photonic, sensing, and photovoltaic devices. The high opto electrical properties are attained by heating a substrate while sputtering. To develop a room temperature sputtering process for producing quality AZO thin films without compromising much with its opto electrical properties is challenging. We successfully develop AZO thin films with a high figure of merit on large-area glass substrates by optimizing oxygen content during the sputtering process and without any intentional substrate heating. AZO thin films with an electrical sheet resistance of 8.8 Ω/\Box and a visible light transmittance of 79% with high thickness uniformity was achieved on 300 mm × 300 mm glass substrate.

Property	Achieved
Thickness	Property
Uniformity (std. Dev.)	3.50%
Sheet resistance	8.8 ohm/sq
Transmittance (vis)	79.00%
Adhesion test	Passed

Surface Morphology and cross section



Reference: Badgujar, A.C., Yadav, B.S., Jha, G.K., Dhage, S.R. Room Temperature Sputtered Aluminum-Doped ZnO Thin Film Transparent Electrode for Application in Solar Cells and for Low-Band-Gap Optoelectronic Devices, ACS Omega, 2022, 7(16), pp. 14203–14210

Quantum-sized TiO₂ Particles based Super-Hydrophilic and Self-Cleaning Antisoiling Coating for Photovoltaic Application

Contributors: Narendra Chundi, R. Easwaramoorthi, K. Suresh, A. Kottantharayil and S. Sakthivel

Soiling influences power generation and reduces the power conversion efficiency of solar energy conversion devices. In this regard, ARCI has successfully synthesized highly photocatalytic active quantum-size TiO₂ particles (average particle size is around 6nm) and utilized the same to develop a highly transparent antisoiling coating. An automated spray coating technique was employed for the development of antisoiling coating on PV cover glass and minimodule. The coating exhibited exceptional weather stability (IEC 61646) for over 1500 hours; excellent photo induced super hydrophilicity, Omni transparency, excellent antisoiling performance and mechanical stability. This dual-functional antisoiling coating is more critical in areas where the hydrophobic-based antisoiling coating is not practical, especially in industrial and highly polluted areas. Promising antisoiling performance was observed from the antisoiling coated PV module as it resulted in 2.5% lower soiling loss compared to that of un-coated minimodules. The coatings exhibited excellent mechanical stability and Omni transparency.



a) Synthesis of Quantum Size TiO₂ particles by solvo thermal method & b) Development of Antisoiling coating sol and coating establishment

References: (1) N. Chundi, R. Easwaramoorthi, Suresh Koppoju, S. Mallick, A.Kottantharayil, S. Sakthivel, Quantum-sized TiO₂ particles as highly stable super-hydrophilic and self-cleaning antisoiling coating for photovoltaic application, Solar Energy, 2023, 258, 1, 194-202

2) S. Sakthivel, C. Narendra, R. Easwaramoorthi, S.R. Atchuta, and K. K. Phani Kumar "A Superhydrophilic, Omni-transparent Anti-soiling coating for photovoltaics, and a method for synthesising the same" Indian Patent Application No. 202241052009, filed on 12.09.2022.

Cobalt-rich Spinel Oxide-based Wide Angular Spectral Selective Absorber Coatings for Solar Thermal Conversion Applications

Contributors: K. K. Phani Kumar and S.Sakthivel

Solar energy conversion technologies attain enormous attention to create more efficient energy production sources to meet the current world's demand. The solar thermal conversion system converts solar energy to heat energy, and the receiver tube is crucial for achieving high photo-thermal conversion efficiency. The absorber coatings with high solar absorptance at normal and wide incidence angles of solar radiation improve the performance of concentrated and non-concentrated solar thermal systems. To achieve high photo-thermal conversion efficiency in the solar thermal conversion system, ARCI has developed a novel spinel structured cobalt-rich transition metal oxide-based absorber coating a cost-effective wet chemical route and investigated its performance in actual field conditions.



Development of cobalt-rich Spinel nanoparticles based absorber coating with spectral selectivity, wide angular solar absorptance and thermal stability for solar thermal conversion applications

Reference: K.K. Phani Kumar, S. Mallick, S. Sakthivel, Cobalt-rich spinel oxide-based wide angular spectral selective absorber coatings for solar thermal conversion applications, Renewable Energy, 2023, 203, 334–344

Fabrication of Omnidirectional Broadband Dual-Functional Coating with High Optical and Self-Cleaning Properties for Photovoltaic application

Contributors: Debarun Biswas, Narendra Chundi, S.R. Atchuta, K. K. Phani Kumar, M. Shiva Prasad and S. Sakthivel

Escalating the transmitted irradiation, which diminishes due to the undesirable reflection at the interfaces and the surface dirt, requires a simultaneous functioning of anti-reflection and self-cleaning coating for photovoltaic modules. In this regard, ARCI has developed an unprecedented, facile, economical, reproducible, and eco-friendly fabrication of dual-functional coatings (Anti-reflective and Self-cleaning) with high optical and photocatalytic properties using novel MgF_2 and TiO_2 nanoparticles synthesized by the solvothermal method. This bilayer dual-functional coating offers enormous potential benefits and is highly conceivable for many applications



Development from materials to the prototype of Omnidirectional Broadband Dual-Functional (AR coating & Photocatalytic Self-Clean) coated PV cover glass & validation

Reference: Debarun Biswas, Narendra Chundi, S.R. Atchuta, K.K.Phani Kumar, Madiwala Shiva Prasad, S. Sakthivel, Fabrication of omnidirectional broadband dual-functional coating with high optical and self-cleaning properties for photovoltaic application, Solar Energy, 2022, 246, 36-44

Indigenous, Cost Effective and High-Performance Spinel-PCM Nanocomposite Based Latent Heat Thermal Energy Storage (LHTES) System for Solar Heating and Cooling Applications

Contributors: Mani Karthik and S. Sakthivel

Thermal energy storage (TES) technology stores thermal energy by heating or cooling a storage medium, so that the stored energy can be utilized later, either for heating or cooling applications. TES system can also be potentially used in industrial process heat and waste heat recovery. In this regard, ARCI has successfully developed a cost-effective spinel-PCM nanocomposite with 45 % enhancement of specific heat capacity (Cp) and long durable PCM capsules for high performance latent heat thermal energy storage (LHTES) prototype system for solar heating and cooling applications. The developed novel nanocomposite phase change material with enhanced specific heat capacity can be utilized to reduce the volume of the TES storage tank and subsequently reduce the overall cost of the thermal energy storage system.



Reference: Mani Karthik, Shanmugasundaram Sakthivel, Method of producing spinel nanostructured materials and Spinel-PCM nanocomposites for thermal energy storage applications, Indian Patent Application Filed No. 202241064003, Dated. 09.11.2022.

Low-cost Perovskite Solar Cells with Superior Thermal and Moisture Stability by Perovskite Engineering

Contributors: V. Ganapathy, Reshma Dileep K, R. Easwaramoorthi, and T. N. Rao

Carbon-based perovskite solar cells (CPSCs) are one of the successful device architectures in PSC with promising efficiency and stability. Though the stability improved remarkably, the sensitivity of perovskite materials towards humidity and thermal stress is a major obstacle for practical implementations. The inherent stability of perovskite absorbers towards environmental factors and the cost in fabrication of perovskite solar cells (PSCs) are major limitation towards commercializing PSCs. In this work. MaPbl (methylammonium-lead-iodide) perovskite was engineered to attain thermal stability by incorporating Guanidinium iodide (GuI) and moisture stability by surface passivation using 5- amino valeric acid iodide (5-AVAI). The modified MAPI, exhibits a 2D/3D encapsulant layer at the perovskite surface, which facilitates perovskite to attain high moisture and temperature stability. The engineered MAPI films exhibit excellent temperature (>150°C) and ambient stability (>59 days) when compared with MAPI films. CPSCs with an efficiency of 13.2% and a T80 lifetime of 93.2% without encapsulation were attained with the engineered perovskite (Figure 1). And it was utilized to fabricate mini modules that can be used in real time applications.





· Six cells were interconnected in series connection

Figure 1: Schematic representation of the beneficial effect of passivation and compositional engineering for enhancing the stability and Current-voltage spectra of the fabricated CPSCs, inset showing the 1000 h stability test.

Figure 2: (a) Schematic diagram and the digital image of mini-module and module integrated road reflector prototype (b) CPSC mini-module with 6 cells connected in series was integrated in the road reflector to power the LEDs, which can be charged under diffused light as well.

This stable perovskite was used as absorbers in CPSC minimodules (50mm x 50mm) and was successfully integrated with road reflectors to power the LEDs (Figure 2), which was used for charging 1.2V batteries and supercapacitors. Notably, this module can be powered even in diffused light and full sun, which is key in niche applications.

Reference: Reshma Dileep K, Easwaramoorthi Ramasamy, Koppoju Suresh, Sudhanshu Mallick, Tata Narasinga Rao, Ganapathy Veerappan, Compositional engineering and surface passivation for carbon-based perovskite solar cells with superior thermal and moisture stability, Journal of Power Sources, https://doi.org/10.1016/j.jpowsour.2023.232645

Influence of Bi-phasic TiO₂ as a Low-temperature Curable Electron Transport Layer for Efficient Perovskite Solar Cells

Contributors: S. Supraja, Reshma Dileep K, S. Sakthivel, and V. Ganapathy

A facile synthesis method for developing bi-phasic TiO, nanoparticles was successfully carried out by solvothermal synthesis. The effect of the reaction duration of solvothermal synthesis on the concentration of brookite and rutile phase was studied in detail using crystallographic and morphological analysis. The concentration of the rutile phase was found to increase with a decrement in the concentration of brookite TiO₂ with an increment in reaction duration. Different concentrations of TiO2 mixture obtained by variation of reaction time were utilized as electron transport layer in perovskite solar cells. An optimum concentration of the rutile-brookite mixture was attained at a synthesis duration of 10 h, which yielded higher conductivity, preferred electrode surface properties for perovskite growth, and also better charge extraction properties. TiO, with 10 h synthesis duration exhibited the highest power conversion efficiency of 14.0 %, while TiO₂-20 h and TiO₂-5 h exhibited 10.5% and 12.0% respectively.



Schematic representation of the bifacial TiO₂ synthesis, TEM images of as-synthesized bifacial TiO₂ and Current-voltage spectra 5h, 10h and 20h synthesized bifacial TiO₂ fabricated PSCs.

Reference: S. Supraja, Reshma Dillep K, Narendra Chundi, Easwaramoorthi Ramasamy, Sakthivel Shanmugasundaram, Ganapathy Veerappan, Composition of bi-phasic TiO₂ as a low-temperature curable electron transport layer for efficient perovskite solar cells, Journal of Solar Energy, https://doi.org/10.1016/j.solener.2022.10.037.

A Promising Scalable Bar Coating Approach using Single Crystal Derived Precursor Ink for High Performance Large Area Perovskite Solar Cells (PSCs)

Contributors: Sreekanth Mandati, Ramya Krishna Battula, Ganapathy Veerappan and Easwaramoorthi Ramasamy

In an effort to fabricate PSCs on large area substrates, an economic and scalable bar coating method is used for the fabrication of PSCs. Methyl ammonium lead iodide (MAPbI3) perovskite absorber has been bar coated on the ETL coated FTO glass substrates using single-crystal derived perovskite precursor. The single-crystal derived precursor has resulted in large area uniform perovskite absorbers and thus characterized appositely to establish the uniform coverage of desired guality MAPbI3. The spatial distribution of photoluminescence and absorption spectra of the perovskite absorber, collected systematically, confirms the device guality MAPbI3 with identical characteristics ascertaining the homogeneity of perovskite coating. Solar cells, fabricated using bar coated large area perovskite absorbers, have exhibited a champion power conversion efficiency (PCE) of 15.6 % with the average PCE being 14.5 %, unveiling the excellent performance homogeneity. Bar coated PSCs have not only exhibited significantly higher performance but also showed comparable reproducibility and much lower hysteresis values than the control PSCs, demonstrating the efficacy of bar coating method towards fabricating large area perovskite solar cells.



Photograph (left) and I-V curve (right) of PSC module prepared by bar coating method.

Reference: Sreekanth Mandati, Ramya Krishna Battula, Ganapathy Veerappan, Easwaramoorthi Ramasamy, Materials Today Chemistry, 2023, 29, 101415, https://doi.org/10.1016/j.mtchem.2023.101415

Self-healing Coatings for Corrosion Protection of Mild Steel

Contributors: Aarti Gautam, K. R. C. Soma Raju , and R. Subasri

Mild steel is one of the major construction materials used in industries due to its good mechanical strength and cost effectiveness but it undergoes corrosion in harsh environments. Chromate conversion coatings are the most successful candidates for protection against corrosion but are restricted due to their toxicity. Organic and inorganic hybrid sol-gel coatings are the best alternative as they not only exhibit excellent adhesion to the substrate but also promote adhesion of the primers and paints that are applied as top coats. Sol-gel coatings loaded with self-healing agents/corrosion inhibitors are gaining importance due to selfrepair of the damage caused by external factors. Encapsulation of self-healing agents into different type of nano containers proves to be more beneficial due to controlled release and hence prolonged life.



Comparison of corrosion currents for the samples generated

Benzotriazole (BTA) was used as self-healing corrosion inhibitor and layer-by-layer polyelectrolyte and halloysite nanotubes were used as nano containers. Nano container ends were capped with urea-formaldehyde nano capsules and dispersed in hybrid organic and inorganic sol-gel matrix sol. Electrochemical studies showed that self-healing coatings derived using BTA in halloysite nanotubes exhibited greater corrosion resistance when compared to bare, matrix, and self-healing coatings based on layer-by-layer polyelectrolyte nano containers.

Reference: Gautam A, Siva T, Sathiyanarayanan S, Gobi KV, Subasri R, Capped Inhibitor Loaded Halloysite Nanoclay-Based Self-Healing Silica Coatings for Corrosion Protection of Mild Steel. Ceram Int, 2022, 48(20):30151–30163. https://doi.org/10.1016/j.ceramint.2022.06.288

Biofilm Inhibiting Coatings

Contributors: Dr. R Subasri, Ramay Patra, and K.R.C.Soma Raju

Biofilms are a critical health concern because of their ability to develop tolerance and resistance against antibiotics. The source of bacteria responsible for biofilm formation can also be transferred from the hospital environment through potential carrier like surgical equipment, sutures, and even bandage used for wound dressing. During the process of biofilm formation, bacterial first irreversibly attach to a surface and then produce extracellular matrix whose components are polysaccharide, proteins, extracellular DNA and water. Development of biofilm-inhibiting coatings on surgical devices could help to limit biofilm formation at surgical site. There are two key strategies to develop biofilm-inhibiting coatings. One approach is by incorporating biocide directly in the coating matrix, and the other is by developing a super hydrophobic surface for reducing the initial attachment of bacteria. A sol-gel based biofilm inhibiting coating (ATL coating) was developed using combinatorial approach by combining bacterial repellence property through improved hydrophobic coating and biocidal property by incorporating a natural biocide, chitosan in the same coating. Biofilm inhibiting sol-gel coatings resulted in a zone of inhibition and > 95% log reduction in bacterial strains such as E. coli, S.aureus and K.pneumoniae.

Biofilm and bacteria morphology on (a) uncoated and (b) ATL coated SS420 stainless steel coupons after 24 hours exposure to S. aureus clinical isolate showing biofilm inhibition and reduced number of adhered bacteria on the coated SS 420 substrate.



References: (1) R Subasri, Ramay Patra, Manisha Yadav, Deepak Kumar, Birru Bhaskar, K R C Soma Raju, Subhash Tanwar, Susmita Chaudhuri, Prashant Garg, Biofilm Inhibiting Nanocomposite Coatings on Surgical Sutures: Durability and Mechanistic Insights, J. Coatings Technology and Research, 2023, 20, 377-392

2) Ramay Patra, K R C Soma Raju, Birru Bhaskar, Debrupa Sarkar, Susmita Chaudhuri, Prashant Garg, R Subasri, Biofilm Inhibiting Nanocomposite Coatings - A promising alternative to combat surgical site infections, J. Coatings Technology and Research, 2022, 19, 1607-1711

3) Birru Bhaskar, Ramay Patra, K R C Soma Raju, V. Nagarjuna, Susmita Chaudhuri, R Subasri, Prashant Garg, Biofilm Inhibiting Nanocomposite Coatings on Stainless Steel Surgical Instruments: A Possible Strategy to Prevent TASS, J. Coatings Technology and Research, 2023, 20, 559-572

An Analysis of High Strain Rate Nanoindentation Impact Testing

Contributors: P. Sudharshan Phani

Recent advances in electronics have enabled nanomechanical measurements with very low noise, fast time constants and high data acquisition rates. These capabilities open the door for a wide range of ultra-fast nanomechanical testing. Given the inherent dynamic nature of high-speed testing, a thorough understanding of the testing system's dynamics and electronics is extremely important for accurate measurements. In this work, a mathematical framework that includes the mechanical and electronic contributions of the instrument and the material constitutive response is presented as shown in the figure to provide guidelines for performing high strain rate nanoindentation testing. Simple closed-form solutions that provide insights on the choice of test methodology, test parameters and instrument design are presented along with the strain rate range over which accurate measurements can be performed with the commercially available nanoindenters.



response for geometrically self-similar indenters.

Reference: P.Sudharshan Phani, B. L. Hackett, C. C. Walker, W. C. Oliver, G. M. Pharr, On the Measurement of Hardness at High Strain Rates by Nanoindentation Impact Testing, Journal of Mechanics and Physics of Solids, 2023, 170, 105105

Identification of Best Wear Resistant Coatings for Cutting Tools used in the Machining of Nickel based Super Alloys

Contributors: Krishna Valleti, and Nitin Tandekar

Conventional (TiN & TiAIN) and nanocomposite (n-TiAIN/a-Si3N4 & n-CrAIN/a-Si3N4) Cathodic Arc Physical Vapor Deposition coatings were identified and developed for increasing the tool life when machining nickel-based super alloys. Using a 5-axis CNC machine, all developed coatings were evaluated for drilling and face milling performance in real time. On IN 625 and 718, conventional TiAIN coatings outperformed advanced nanocomposite coatings. Contrarily, as anticipated, nanocomposite coatings (n-CrAIN/a-Si3N4) performed better with IN 617. In the majority of instances, the application of coatings results in a doubling of the tool life. Micro-chipping is the leading cause of tool failure in any case (Fig. 1). If future research can avoid chipping, greater life extension will be possible.



Cutting-edge chipping at the end of tool life in case of uncoated (left), TiN coated (middle), and TiAIN coated drill bits (chipped off region shown by arrow)

References: (1) Nitin Tandekar, Pooja Miryalkar, L. Rama Krishna, Krishna Valleti, Influence of substrate bias on machining performance of TiAIN-coated drill bits, Materials and Manufacturing Process, DOI: 10.1080/10426914.2023.2187824, 2023.

2) Nitin Tandekar, Ambati Sandeep, Praveen Kumar, Pooja Miryalkar, Krishna Valleti, An assessment of tool life in drilling of Inconel 718 using cathodic arc PVD coated carbide bits, The International Journal of Advanced Manufacturing Technology, 2022., 120, P. 4821



Post Treatment of Cold Sprayed Coatings using High Energy Infrared Radiation: First Comprehensive Study on Structure-Property Correlation

Contributors: Naveen Manhar Chavan, and P Suresh Babu

It is a well-known fact that cold sprayed coatings need post treatment to achieve properties close to their bulk counterparts even when the coatings are obtained using high pressure cold spray. Most often post treatments are conventional furnace heat treatments primarily to relieve stresses and improve splat bonding. However, this methodology cannot be used all the time given the dimensional constraints of a furnace. Use of in tandem heating or mobile heating tools can greatly enhance the commercial potential of cold spray, provided the heating tools are cheaper and easily available. In the present study, one such heating tool viz., high energy infrared emitters are used to post treat cold sprayed copper based coatings. A comprehensive study exploring the influence of heating power density and exposure duration on coating properties and microstructure has been taken up. Pure Cu coatings respond exceedingly well to the mobile post treatment in terms of amelioration in coating microstructure and properties comparable to and better than treatment in a furnace. An analysis of the contribution from different microstructural features to the coating properties especially electrical conductivity has been made. In contrast, Cu–Al alloy coatings respond less favorably to both infrared and furnace post treatments. A discussion towards this anomalous behavior is also provided with the help of the microstructural observations.



(a) Variation of electrical conductivity with IR exposure and (b, c) etched micrographs in as sprayed and IR treated conditions

Reference: Naveen Manhar Chavan, Prita Pant, G. Sundararajan, P. Suresh Babu, Post Treatment of Cold Sprayed Coatings using High-Energy Infrared Radiation: First Comprehensive Study on Structure Property Correlation, Surface & Coatings Technology, 2022, 448, 128902

The influence of grain size and triple junctions on corrosion behavior of nanocrystalline metals

Contributors: Nitin P. Wasekar

The applications of nanocrystalline metals/coatings demand excellent corrosion resistance. An attempt was made to rationalize the higher corrosion rates of nanocrystalline passivating metals in ~3.5 wt% NaCl environment when grain size approaches below 10 nm. A simple model was proposed correlating the grain size with corrosion current utilizing the contribution from triple junctions. The higher corrosion rate below critical grain size was attributed to the presence of a high volume fraction of triple junctions demonstrating inverse Hall-Petch type (corrosion) relation. For the first time, the relationship proposed revealed the application window of nanocrystalline metals demanding improved corrosion resistance.



Ni-W alloys

Reference: Nitin P. Wasekar, The influence of grain size and triple junctions on corrosion behavior of nanocrystalline Ni and Ni-W alloy; Scripta Materialia, 2022, 213, 114604

Development of Thinner Hard Carbide Coating by HVAF as an Alternative to Hard Chrome Plating

Contributors: D Vijaya Lakshmi, P Suresh Babu, Rahul Jude Alroy and G Sivakumar

Hard chrome plating alternatives are being highly sought as the process consists of chromates, fluorites, carcinogenic hexavalent chromium and health hazardous. An environmental friendly chemical free process is required which is comparable to hard chrome plating (HCP) in major aspects. A new technique that has emerged in recent times is high velocity air fuel (HVAF), which uses relatively finer sized powders (5-15 µm) unlike other processes where there is susceptibility to overspray. Further, the coating can be deposited on as-machined condition to achieve smooth surface and around 50 µm coating thickness. This significantly reduces the post coating finishing operations. A detailed study has been carried out to deposit WC-10Co-Cr coatings by HVAF. Coatings with 50 microns thickness and surface roughness's (Ra) close to 1 to 2 µm surface were achieved on stainless steel substrates (Fig. 1). WC-10Co-4Cr coating exhibited four times better ball-on-disc sliding wear than HCP.



Thin dense WC-Co-Cr carbide coating deposited by HVAF

Reference: D. Vijaya Lakshmi, P. Suresh Babu, Rahul Jude Alroy, G. Siva Kumar, M. J. N. V. Prasad, Performance Evaluation of Thin Cermet Coatings produced by HVAF Spray: A New Approach for HardChrome Replacement, J Therm Spray Tech, 2023, 32, 904–917. https://doi.org/10.1007/s11666-023-01563-9

HVAF Vs Oxygenated HVAF Spraying: Role of Fundamental Understanding to Optimize Cr₃C₂-NiCr Coatings for Elevated Temperature Erosion Resistant Applications

Contributors: G. Sivakumar, and Rahul Jude Alroy

Fly ash erosion degradation is addressed through high velocity air-fuel (HVAF) Cr_3C_2 -NiCr composite coating. HVAF necessitates a slightly narrow particle size and for standard grade of powders, additional oxygen along with air + fuel combustion is fed into the torch to increase the overall heat content (HVAF(O)). Uniform coating microstructure with a homogeneous carbide distribution possible under all conditions however, undergoes slight decarburization under certain processing combinations. While comparing T91 substrate, a decrement in erosion rate of 42% with HVAF(O) coarse Cr_3C_2 -NiCr and 40% with HVAF sprayed fine Cr_3C_2 -NiCr was obtained under simulated high temperature erosion tests shown in Fig. 1. In comparison, Oxygen augmented HVAF spraying (HVAF(O)) is very effective for erosion performance without any deterioration of carbides, better microhardness and fracture toughness while higher particle size range was employed



Graph comparing the erosion rate of T-91 substrate and coatings at room temperature and 650°C

Reference: RJ Alroy, M Kamaraj, G Sivakumar; HVAF Vs Oxygenated HVAF spraying: Role of Fundamental understanding to optimize Cr₃C₂-NiCr coatings for elevated temperature erosion resistant applications Journal of Materials Processing Technology 2022, 309, 117735

Major Facilities Created During 2022-23

Laser Assisted Machining Facility

A 4-axes CNC turn-mill system (Make: Jyoti CNC Automation Ltd; Model: AX300) was procured and converted into a unique laser assisted machining facility. The system was made fully integrated with an existing 6kW diode laser (Make: Laserline GmbH) and a unique 5-axes flexible adapter was developed for mounting the optical head. A piezo-electric dynamometer and a two-colour high-speed pyrometer were connected with the system to obtain in-situ cutting force measurement and surface temperature measurement. The facility is flexible and adaptive for different shape and size of components for both laser-assisted turning and laser assisted face milling.

Post Weld Heat Treatment (PWHT) Furnace

Post-weld heat treatment or PWHT is a controlled process that involves reheating the metal below its lower critical transformation temperature, following a welding process. The material is then held at the elevated temperature for a predetermined period of time followed by cooling.

Technical details of the furnace:

- 1. Maximum Operating Temperature: 1200 deg C in oxidizing atmosphere
- 2. Rectangular chamber dimensions (effective hot zone): Length 1200 mm
- x Width 550 mm x Height 450 mm with swing door opening in the front.
- 3. Rate of Heating: 0.5-20 deg C / min

Hydraulic Guided 3 Point Bend Testing Machine

The testing machine is intended to perform guided 3 point bend tests of welded specimens. Welded Test specimen placed across the supports of the die, which is housed in a jig. The jig, which is fastened to the guide plate, forced upwards hydraulically against the mandrel clampes to top plate leading to bending of the weld strip by 180 deg. Bent specimen is visually checked for cracks or defects.

Technical details of the machine:

- 1. Hydraulic Pressing Capacity (Upward): 25 Tonnes
- Press Type: Four Post Construction self-restraining load frame construction having a single acting hydraulic cylinder at its centre with interlocked safety guard doors
- 3. Operation: Motorized as well as manual hand operated.
- 4. Ram Movement (Stroke): Upstroke of atleast 250mm
- 5. Ram speed: 3 19 mm/min

Electrochemical Workstation: Autolab M2O4

Electrochemical workstation was installed for carrying out electrochemical characterization of coatings of a wide variety deposited in the centre as well as outside centre. Make: Autolab Metrohm and Model: AUTM204. S.

Technical Details:

- 1. Electrochemical Impedance Spectroscopy: 10-3 to 106 Hz
- 2. Mott Schottky test is possible
- 3. Potentio dynamic polarization is possible
- 4. Pulse electrodeposition is possible











50 kN Bond Strength Measurement System

This system is for measurement of adhesion strength or bond strength of coatings using the ASTM C633 standard involving an adhesive. This is specifically meant for thermal spray coatings where the coating is sprayed on a circular sample, which is in turn glued to an uncoated dummy using the adhesive. The sample set is cured in an oven and then subjected to a tensile test which gives the bond strength data. Make BANBROS, India.

Roller Coating Machine with UV Curing Facility

Roller coating machine is designed to apply sol-gel coatings on 24" wide substrates such as paper boards, wood, plastic, metal and ceramic tiles. It can accommodate a maximum substrate thickness of 10 mm and conveyor speed of 0.5 to 10 m/min with a variable coating thickness from 2.5g - 10g per sq. m. It has a UV curing station with 250-350 nm wavelength 120 w/cm wattage medium pressure mercury lamp.

High Speed Precision Cutting Machine

Automatic high speed precision cutting machine has user friendly HMI touch screen operating panel with movable table feed, variable cut-off wheel speed from 500 to 5000 rpm, 50 mm cutting capacity with adjustable feed speed, motorized positioning system on the horizontal x -axis with positioning accuracy of 2 micro meters and library of cutting programs.

Hot Mounting Press

Fully automatic electro-pneumatic hot mounting machine has user-friendly LCD touch screen operating panel with 15 nos of pre-loaded programs for operator selection. It has a provision to change heating time, cooling time, mount temperature, mounting pressure, ramp up and down time. It has automatic water cooling system, buzzer indication for heating and cooling cycles and provision to accommodate1" to 2" mould sizes.

Disk Polisher

Single-phase 0.5 HP high torque double disk polisher with corrosion resistant body and wash bowl free flowing drain facility. It has 8" diameter standard disk with 10" and 12" disk options, feather touch control panel with 50 to 1000 rpm variable speed and flexible water jet.

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Events, Data and Statistics

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Major Events

Jayanthi Celebrations

Dr. B.R. Ambedkar, Dr. Babu Jagjivan Ram and Mahatma Jyothirao Phule Jayanthi celebrations were held at ARCI on April 14, 2022. Dr. Kaliyan Hembram, President ARCI SC/ST Employees Welfare Association welcomed the gathering. Director and Associate Directors, ARCI and ARCI SC/ST Employees Welfare Association members paid rich floral tributes. They all spoke about the immense contributions made by Dr.Ambedkar, Dr.Babu Jagjivan Ram and Mahatma Jyothirao Phule towards the upliftment of downtrodden and women. As part of celebrations, on April 29, 2022 a special talk was delivered by Prof. Bhangya Bhukya, Head of Department of History, Hyderabad Central University, Hyderabad, which was well attended by all the ARCI staff, research students etc.,







Director ARCI addressing the gathering and with SC/ST Welfare Association members

National Technology Day

ARCI organized the National Technology Day on May 11, 2022. Dr. S. Karunanidhi, Outstanding Scientist and Associate Director, Research Centre Imarat (RCI), Defence Research and Development Organization (DRDO), Hyderabad, delivered a talk on 'Aerospace Product Development by Precision Engineering'.

International Day of Yoga

ARCI celebrated International Day of Yoga on June 21, 2022, at ARCI, Hyderabad with yoga training classes. A physical yoga training session was conducted at ARCI, Hyderabad from 7 am to 9 am under the guidance of Yoga trainer Smt. G. Prameela, Trainer & Founder, Prameela Yoga Studio, Secunderabad. Around 75 Employees, Research Scholars, Students, etc., participated in the yoga session with lot of enthusiasm. Dr. P. K Jain. Scientist-G & Chairman. Azadi Ka Amrit Mahotsav (AKAM) Committee welcomed the gathering and Dr. Tata Narasinga Rao, Director (Additional Charge) and Dr. Roy Johnson, Associate Director addressed the gathering. Dr. Sanjay R. Dhage, Scientist-E introduced the Yoga trainer to the gathering. The training session mainly focused towards basic asanas that can be practiced by the participants at home or at office sitting place also. The session concluded with vote of thanks by Dr. M. Buchi Suresh, Scientist 'E' and Member AKAM Committee. International Yoga Day was also celebrated at ARCI Chennai Centre, on this occasion. Mr. Duraipandi, Yoga Teacher and Lifestyle Coach demonstrated yoga Asanas and their benefits.



Mr. Duraipandi, Yoga Teacher and Lifestyle Coach showing the Asanas at ARCI-Chennai

75th Independence day celebrations at ARCI

Azadi Ka Amrit Mahotsav, 75 glorious years of India's Independence was celebrated grandly and with great fervor at ARCI. The National flag was hoisted by Dr. Tata Narasinga Rao, Director (Additional Charge), followed by singing of National Anthem and March-past performed by ARCI security staff. Dr P.K. Jain, Chairman, Azadi Ka Amrit Mahotsav (AKAM) organizing committee made the opening remarks on the glorious achievements of India in the last 75 years post-independence and highlighted the importance of this historic event. ARCI has been organizing a series of events since April 2021 under AKAM which will continue till August 2023. Dr. Tata Narasinga Rao addressed the gathering and spoke on various innovations in the field of Science and Technology over the last 75 years in India as a whole and briefed on the achievements of ARCI. He added that ARCI, a 25 years young Centre, is an autonomous Research & Development Centre of Department of Science & Technology (DST) that has recently completed 50 years of its establishment with the objective of promoting new areas, policies and programmes related to science, technology and innovation in the country. He also mentioned that ARCI has aligned its programmes towards National Missions like Make in India, Alternative Energy etc. Dr. Roy Johnson, Associate Director in his address stressed upon the importance of technology development especially for self-reliance in strategic sector. On this occasion, Dr. R. Gopalan, Regional Director, ARCI- Chennai hoisted the national flag and greeted the employees and their family.

National flag, Tiranga is our pride. It unites and inspires every Indian. On Prime Minister of India's clarion call of Har Ghar Tiranga, all employees hoisted Tiranga at their residence with family. Tributes were paid to our valorous heroes who sacrificed themselves to the motherland. National flags were hoisted on all buildings inside ARCI premises.

A cultural program coordinated by Dr. R. Subasri, Co-chairman of AKAM committee to invoke spirit of patriotism and national integrity among all participants was organized on the occasion. Inspiring patriotic songs in Hindi & Telugu along with poems, and speeches, were rendered. Colourful Rangolis of national flag and AKAM logo were made artistically. Several posters portraying the proud achievements of India during 75 years in fields of Atomic Energy, Space, Defence, Agriculture, Dairy, transport etc., were prominently displayed, which was well received by participants specially youngsters. ARCI staff along with their family actively participated in all the programs.

Mr D. Ramesh, Security, Fire & Safety Officer and member of AKAM committee proposed the vote of thanks. Dr. P.K. Jain, Dr. R. Subasri, Dr. M. Buchi Suresh, Dr. Sanjay Dhage, Dr. R. Easwaramoorthi, Dr. S. Kavitha, Mr. S. Ramakrushnan, Mrs. N. Aparna Rao (Convener), Mr. M. R. Renju (Co-Convener) & Mr. E. Konda have extended their support for successfully conducting the event.



Flag hoisting, march-past by Security personnel, cultural program and address by Director, ARCI on the occasion of Independence Day celebrations



Regional Director, Dr. R. Gopalan with Chennai Centres Staff







Official Language (Hindi) Implementation at ARCI

The Official Language Implementation Committee (OLIC) under the Chairmanship of Dr. Tata Narasinga Rao, Director has been successful in the implementation and progressive use of Hindi at ARCI. Quarterly OLIC meetings were conducted to review the progressive use of Hindi at ARCI. The minutes of the meeting were sent to DST and Quarterly reports on Hindi works were sent to DST, Department of Official Language (D.O.L), Regional Implementation Office (South), Bengaluru with a copy to Town Official Language Implementation Committee (TOLIC-3) and by online to D.O.L. Ministry of Home Affairs, Govt. of India for review. During the year, ARCI achieved the target set by the D.O.L, Ministry of Home Affairs, Govt. of India in terms of proper and progressive implementation of official language. Along with regular rajbhasha lecture in quarterly workshops, scientific & technical lectures in Hindi are also delivered by ARCI Scientists/research students. The motive of OLIC in introducing these scientific lectures in Hindi workshops is to motivate the scientists to present their original R&D works in Hindi. ARCI conducted Hindi workshops on a quarterly basis for its scientists, officers, employees and research students. ARCI has also been imparting regular training in Hindi to its employees under the Hindi Teaching Scheme. Employees who have successfully completed Prabodh, Praveen, Pragya and Parangath were given cash awards and incentives as per norms. To encourage the employees to carry out their day-to-day official works in Hindi, a cash incentive scheme is in place and nine employees received cash awards, during the year for carrying out official works in Hindi. Cash award scheme is in place for the articles submitted by the employees, research students, etc., in regional language/mother tongue and Hindi which are published in annual hindi magazine "SRUJAN".

As a part of Human Resource Development in Hindi, a "Post Graduate Training Scheme" was introduced during the year. Under this scheme, a student is trained with an attractive monthly stipend for a period of one year in implementation of official language.

Hindi Sapthah Celebrations: ARCI celebrated "Hindi Sapthah" during September 19-29, 2022 (5 days). Essay, poems, debate, typing etc., competitions were conducted employees and students in which participated enthusiastically. Shri Shriram Singh Shekhawat, Lecturer, Hindi Teaching Scheme, Hyderabad, Chief Guest in his address motivated and encouraged employees to carry out their works in Hindi and also was very much impressed with the achievements of the ARCI in the field of Hindi implementation. For his long association with ARCI, especially in providing hindi training to most of the ARCI employees he was felicitated by Director, ARCI Employees and research students actively participated in the Hindi Saptha celebrations which concluded on September 29, 2022. All the winners were given prizes.



Director, ARCI felicitating Shri Shriram Singh Shekhawat.





Participants during Hindi week celebrations



Quiz Competition conducted by Shri Naveen Nathani



Annual Medical Check-up

Annual Medical Check-up (AMC) programme for ARCI employees for the year 2022 was carried out during September 14-15, 2022. Employees were categorized under two age groups i.e. below 45 years and 45 years & above and prescribed medical tests were carried-out for them. Apart from prescribed medical tests, special tests such 2D Echo, "Prostate Specific Antigen test for male employees, and "FSH" and "LH" tests were carried out for female employees who were 45 years & above age. AMC was also carried out for Chennai and Gurugram employees. So as to keep all the employees abreast on latest health related issues, a health talk on "Being Heart Aware" was delivered by Dr. M. Amaresh Rao, Professor & Head, Department of Cardio Thoracic Surgery, Nizam's Institute of Medical Sciences (NIMS), Hyderabad. The talk was well attended by all at ARCI, Hyderabad and through live telecast by Chennai & Gurugram staff.



Employees undergoing Annual Medica Check up

Inspection by 2nd Sub- Committee of Parliament on Official Language

The 2nd Sub-Committee of Parliament on Official Language visited during June 17-18, 2022. The Committee under the Chairmanship of honorable Rajya Sabha member Shri Pradeep Tamta, inspected ARCI's Hindi works on 18th June, 2022. On this occasion, Dr. Tata Narasinga Rao welcomed the Parliamentary delegation and presented a Nano face mask developed by ARCI and Scientific/Technical Glossary published by ARCI. The Parliamentary Committee after thorough study of the detailed questionnaire duly submitted by ARCI, appreciated the efforts made by ARCI in progressive implementation of official Language Hindi at ARCI as well as advised a few improvements.





Release of SRUJAN Magazine: 4th & 5th edition of annual Hindi magazine "SRUJAN" was released by the Parliamentary Committee on 18th June, 2022. The contents of the magazine were well appreciated by the Parliamentary Committee.



Swatch Bharath Special Campaign 2.0

As part of Swatch Bharath, ARCI Hyderabad and its off campus R&D Centres at Chennai and Gurugram Office observed "Special Campaign 2.0" during October 2, 2022 to October 31, 2022. Shri D. Ramesh, Security, Fire & Safety Officer, who was nominated as Nodal Officer, carried out cleanliness campaign, creation of space, scrap disposal, categorization of official records/files and weeding out old records, monitoring management. Mass cleaning of the ARCI premises and all its Centres of Excellence was carried out and disposal of Chemical wastes as per State Pollution Control Board recommendations and through authorized agencies.



Categorization of office records & Weeding out of old files



Vigilance Awareness Week

Vigilance Awareness Week-2022 was observed at ARCI from October 31 to November 6, 2022. The theme for the week was "Corruption free India for developed Nation". The messages from the honourable President, honourable Vice President and Central Vigilance Commission (CVC) were shared among the employees, project staff and research students. The Director and Vigilance Officer, ARCI have administered Integrity Pledge at the central lawns of the premises. Employees were encouraged to take online Integrity Pledge/e-pledge by visiting CVC website. During the week, posters on vigilance awareness were displayed at inner security gate and were displayed on all the digital boards. A vigilance awareness talk by Shri L. Narasimha Reddy, former Chief Justice of Patna High Court was organized during vigilance awareness week. Employees and students have actively participated in this years' theme Essay writing competition.



Rashtriya Ekta Diwas

On October 31, 2022, as part of birth anniversary of Shri Sardar Vallabhbhai Patel, the architect of national integration of independent India "Rashtriya Ekta Diwas" (National Unity Day) was observed at ARCI, Hyderabad, Chennai Centres and Gurugram office. Director, ARCI administered Rashtriya Ekta Diwas pledge both in Hindi and English respectively at ARCI Central lawns.

Samvidhan Diwas/Constitution Day

On November 26, 2022 all the employees, project staff, research students, trainees have actively participated in online celebrations of Samvidhan Diwas / Constitution Day. On this occasion, they have read Preamble of the Constitution, both in Hindi and English respectively. Informative messages about constitution / rare photographs, were displayed on the digital boards.

Annual Day

ARCI celebrated the 26th Annual Day on December 30, 2022. The program started with Tug-of-War for the staff and their family members, students and other contract staff. The official program began with welcoming all the dignitaries on to the Dias by Mrs. Priya Mathews and lighting of lamp by the guests on the Dias. Dr. M Buchi Suresh, Chairman of the annual day committee has given his welcome address and briefed about the events planned during the Annual Day. He has also felicitated Dr. T N Rao, Director, ARCI for achieving the MRSI award and Dr. Roy Johnson, Associate Director, ARCI for achieving Prof. Sasadhar Roy award respectively, for their contribution in the respective fields. Director and all the Associate Directors on the dias addressed the gathering and briefed about the achievements of ARCI during the past year and spoke about future vision for ARCI. Mementoes were also presented to the employees who completed 25 years of their service in ARCI. All the meritorious children of employees who achieved excellent result in their 10th and 12th class during the year 2020-2022 were awarded with cash prize by ARCI-ECTCS. Official program ended with the vote of thanks by Dr. Papiya Biswas. After conclusion of formal inauguration programme, cultural activities were organized in which ARCI staff, students and their children enthusiastically participated and entertained with their performances. Celebration concluded with the prize distribution to the participants in the cultural activities.



Annual Day Celebrations at ARCI, Chennai

ARCI Chennai Centres celebrated Annual Day on February 3, 2023. Dr. T.N. Rao, Director ARCI attended the annual day celebrations and addressed the gathering. All the staff members have actively participated in the cultural programmes organized on this occasion.



Republic Day

ARCI celebrated 74th Republic Day on January 26, 2023. ARCI Security staff performed March-past followed by hoisting of National Flag by Dr. T. Narasinga Rao, Director ARCI. Director and Associate Directors have addressed the gathering. The programme concluded with vote of thanks by Shri D. Ramesh, Security, Fire & Safety Officer.



Guard of Honour by the Security Personnel



Dr Tata Narasinga Rao, Director hoisting National flag



Security Staff with Dr. Tata Narasinga Rao, Director ARCI

National Science Day

On the lines of Azadi Ka Amrit Mahotsav and the National Science Day (NSD) celebrations, a one-day 'Orientation Programme for Promoting Science as Career' was organized for science faculty on February 23, 2023 at ARCI.

The objective of the programme was to inspire the teachers and lecturers to become science ambassadors for inculcating scientific temper among students by pursuing scientific careers and to strengthen the nation's self-reliance through its strength in science and technology. The Orientation Programme covered talks by expert scientists on recent advances in areas of materials physics and chemistry, followed by a visit to the state-of-the-art facilities at ARCI. This helped the teachers to stay up-to-date with the latest advancements and incorporate the information in their lessons. The overall experience was highly beneficial for science faculty to help them inspire the next generation of scientists. 70 Science faculty from Physics and Chemistry discipline from Government Degree Colleges in and around Hyderabad actively participated in the event. Dr. R. Subasri, Scientist 'G' and Co-Chairman, AKAM made her opening remarks and spoke about the importance of National Science Day and NSD theme of this year 'Global Science for Global Wellbeing'. She also briefed on the outreach events being carried out by ARCI for school and college students. Dr P. K. Jain, Associate Director and Chairman, Azadi Ka Amrit Mahotsav (AKAM) organizing Committee welcomed the gathering and mentioned about series of events being conducted at ARCI under AKAM. In his address, Dr. Jain cited various examples from daily life and how they could be correlated with science. He emphasized on the point that this programme would help teachers to ignite scientific thought process in young minds. Dr. Tata Narasinga Rao, Director, ARCI highlighted major achievements of ARCI and how ARCI has been contributing towards Atma Nirbhar Bharat. In his address, he shared his teaching experiences at various academic institutes about how students could be motivated by following innovative approaches in teaching. He informed the faculty to make use of this orientation programme to motive, inspire and encourage students towards research and select science as a career path. Dr. Roy Johnson, Associate Director, ARCI addressed the gathering and wished that the faculty should become the ambassadors in building the scientific temperament among students who are future Scientists of India. He also emphasized that teachers must inspire students to improve their observational skills, which is very important when one takes up science as their career. Sri Navin Mittal, IAS, Commissioner, Collegiate Education & Technical Education and Principal Secretary of Revenue & Chief Commissioner for Land Administration, Government of Telangana, the Chief Guest of the Event acknowledged the proactive role of science teachers in inspiring the future of students. He insisted the faculty to spark the interest in student community to take Science as a career. In his message to the students, he encouraged them to make use of readily available knowledge resources, build high-tech industries in the 'Amrit Kal' and contribute to India's march towards 'trillion-dollar economy' thus making India a 'developed Nation'. A panel discussion of participants with Senior Scientists was the highlight of the event.

The faculty expressed enthusiasm in witnessing the state-of-the-art facilities at ARCI and listening to the talks on topics Nanomaterials, Ceramics, Energy Materials, Nanocomposite Coatings and advanced characterization tools. Participation certificates were distributed to the Faculty members at the end of the event. On the occasion of National Science Day, student visits from Nagarjuna Government College, Nalgonda and other Government Degree and PG Colleges were scheduled on February 24 and 28, 2023. The event ended with vote of thanks by Dr. Sanjay Dhage, Scientist E & Member, AKAM.



Participants at the National Science Day celebrations 2023



Sri Navin Mittal, IAS addressing the gathering on the occasion of National Science Day

Safety Day Celebrations

The 52nd National Safety week was celebrated during March 4-10, 2023 at International Advanced Research Centre for Powder Metallurgy and New Materials, Balapur, Hyderabad. During the occasion, safety pledge was administered, lectures and interactive sessions were organized focusing on relevance and importance of safety in work place. As a part of celebrations safety slogan competitions for employees and students were conducted. In his message, Dr. Tata Narasinga Rao, Director, ARCI emphasized that safety should evolve as a habit of every person which shall propagate as the culture of the centre. Dr. Roy Johnson, Associate Director and Chairman Safety Committee in his address urged everyone in the organization to remain committed to safety and follow procedures and protocols for a sustainable organization with conducive working environment. Lectures were also delivered by Prof. GD Yadav, Padmashri Awardee, National Science Chair, Institute of Chemical Technology, Mumbai and by Dr. V. Ganapathy, Scientist and Mr. Ramesh, Safety Officer presented the activities of ARCI Safety Committee. The employees and students participated very enthusiastically.



ARCI Internal Complaints Committee (AICC)

ARCI Internal Complaints Committees (AICCs) are functioning both at ARCI, Hyderabad and at ARCI Chennai, Campuses. AICCs are actively involved in promoting awareness regarding Sexual Harassment of Women at Workplace. Bilingual awareness posters were displayed at prominent locations in ARCI Hyderabad and Chennai campuses.

Internal Committee (IC), ARCI, Hyderabad organized the International Women's Day (IWD) at ARCI 08th March, 2023, in-line with the UN theme on "DigitALL: Innovation and Technology for Gender Equality". The day was celebrated with great enthusiasm at ARCI. Dr. Geeta K. Vemuganti, Prof.& Dean, School of Medical Sciences, University of Hyderabad graced the occasion as Chief Guest. The proceeding for the day began with welcome address by Dr. P. Suresh Babu, Scientist E & Member (IC), ARCI and Dr. Neha Hebalkar, Scientist F & Preceding Officer delivered the opening speech. Dr. Tata Narasinga Rao, Director, ARCI addressed the gathering and gave a message of taking wise decisions in the life choices which can lead to less risk and more benefits. Associate Directors - Dr. Roy Johnson and Shri. D. Srinivasa Rao also addressed the gathering and extended their best wishes on the Occasion of International Women's day, to all the women working at ARCI.

Dr. Geeta Vemuganti, Chief Guest, delivered a talk on "Tissue Engineering and Regenerative Medicine: Progress and Promise" and also shared very inspiring anecdotes from her personal experience as a women. The talk was open to both the genders and was well-received. To inspire a feeling of inclusiveness and one-ness among all Badges with the message "Let Us March Together, चलो, साथ चले", were distributed to all the participants by Dr. Rambha Singh, Member, IC, ARCI. The women achievers of ARCI for the year 2022-23 were also presented with a memento by the Chief Guest and Director, ARCI.

An interactive session for the women of ARCI was organized by the IC. Interesting videos and a short cultural programme "Splash" with a theme-based on celebrating different shades and colours of a women was conducted, in which all the women participated whole-heartedly.





Internal Committee (IC), ARCI., Chennai organized the International Women's Day (IWD) at Chennai Centres on 09th March, 2023. On this occasion, Ms. Radha Rangarajan, Co-founder, Informatics, and a Marathon runner delivered a talk in line with the theme of the IWD.



Ms. Radha Rangarajan Co-founder, Informatics, and a Marathon runner



Women's Safety Observance Fortnight Programme at ARCI, Hyderabad

Internal Committee (IC), ARCI organized and conducted various activities throughout the period between November 25 – December 10, 2022, to create awareness about the POSH Act, Women's safety, Human rights, Women empowerment etc and received enthusiastic participation from the employees and students.

Poster and Slogan competitions on the following themes were conducted:

- He for She
- My daughter My pride
- Narishakti Role of women in Nation Building
- Safety of women @ workplace

Participants were encouraged to make slogans and posters in trilingual formats - English, Hindi and Telugu. Men and women actively participated in the competitions and the best 3 Posters and Slogans were chosen and the winners were awarded for their creative ideas.



Posters and Slogans at display in ARCI

Breaking Stereotypes : A challenge was given to everyone at ARCI, to write a few lines on any stereotype that they have broken or wish to break and drop it in a box (kept at a central location in the office from November 25-December 01, 2022). These were then read out during the interactive session held on December 01, 2022. It was observed that most people broke or wished to break gender-related stereotypes.



Drop Box for a challenge on Breaking Stereotypical thinking; Dr. Neha Hebalkar, Presiding officer reading out the Stereotypes that ARClans have broken and/or wish to break

All through the fortnight, Important information related to themes such as women safety, cyber safety, human rights, Posh Act were shared online through official WhatsApp groups of ARCI in the form of power point presentations and videos. These were also put up on digital notice boards of ARCI

On December 1, 2022, the following programmes were organized to mark the fortnight:

• Awareness Workshop for sensitizing on SH Act 2013, By Dr. Neha Hebalkar, Presiding Officer, IC & Sc-F, ARCI for Students & Research Scholars.



• Awareness Workshop for sensitizing on SH Act 2013 was conducted in Telugu by Dr. Mamatha Raghuveer Achanta, Founder Director Tharuni & External Member IC- ARCI for all out-sourced contract staff of Area Cleaning/ Gardening Electrical-pump house, canteen, security, etc.



• Interactive session on the POSH Act was conducted by IC ARCI members and moderated by Dr. Mamtha Raghuveer External member IC, ARCI. This session was open for all ARCI employees and students. Dr. Tata Narasinga Rao, Director ARCI, in his address, gave a strong message that there is zero tolerance to sexual harassment at ARCI.

On this occasion ARCI felicitated Dr. Mamatha for her long and dedicated services to ARCI as an External Member of ICC and for her devoted social work for Women and Girl's welfare.



Interactive session on POSH Act held at ARCI on Dec 1, 2022

ARCI witnessed enthusiastic participation from men and women alike in all the programmes organized, with the aim to spread awareness and sensitize them about making our workplaces, home and nation a safe place for women where they are respected, valued and nurtured. ICC of ARCI made all efforts to keep the programmes as interactive as possible so that there is a chance for each one of the participants to express their feelings and thoughts. Also efforts were made to provoke a positive thought process among them and not just to play a role of a listener of the talks. This inclusiveness helped the organisers to generate empathy for the topic, a few levels higher. Apart from the above, an "Women's Safety at Work Place:

• Know the POSH Act" – an Interactive Session was conducted by Dr. Neha Y. Hebalkar, Scientist F & Presiding Officer IC, ARCI and Ms. Priya A. Mathews, Scientist E & Member Secretary IC, ARCI at DLRL, DRDO., Hyderabad on December 06, 2022



Dr. Neha Hebalkar, Presiding Officer IC, ARCI and with Ms. Priya Anish Mathews, Member Secretary IC, ARCI conducting an interactive session at DLRL, DRDO, Hyderabad



ARCI's IC members with the team at DLRL

As part of Women's Safety Observance Fortnight Programme, Internal Complaints Committee (ICC), ARCI Chennai organized an awareness programme. As a part of programme, Smt. Letika Saran, IPS (Retd.) delivered an awareness lecture. All the staff and research students at Chennai Centres attended the programme.





Sports Day Celebrations

A 15 members Sports Committee was constituted to conduct sports and games (S&G) for the year 2022-23. On March 6, 2023, Director ARCI inaugurated sports and games events. Speaking on the occassion, the Director and Associate directors have stressed on the role of sports and games in our hectic life to balance and control stress and anxiety. In all, 13 events were conducted and 139 participants, which includes employees, project staff, research fellows, and students actively participated in Volleyball, Football, Cricket, Badminton, Tennikoit, Carom, Chess, Table Tennis, Athletics, Walkathon and Quiz etc.



Visit to ARCI Chennai Centres

Dr. SriVari Chandrasekar, Secretary, Department of Science & Technology, Govt. of India visited ARCI Chennai Centres on October 6, 2022.





Business Opportunity Workshop on Advanced Detonation Spray (ADSC-Mark II) and Cold Spray Coating Technologies

A one-day business opportunity workshop on Advanced Detonation Spray (ADSC-Mark II) and Cold spray coating technologies was conducted by ARCI on October 19, 2022. The workshop was attended by close to 80 participants most of whom belonged to thermal spray industry or emerging entrepreneurs. The focus of the workshop was to demonstrate the advancements on the Detonation spray technology about which detailed presentation was made followed by live demonstration of the system. A techno-commercial presentation of cold spray technology was also made followed by demonstration. After the workshop, several letters of intent were received at different stages of time and interactions with them are underway.



HYDROGEN: SHADES & APPLICATIONS National Hydrogen and Fuel Cell Day Workshop @ ARCI Chennai



7th-8th October, 2022 IIT Madras Research Park, Chennai







Address by former Secretary, DST Dr. T. Ramasami

Human Resource Development

ARCI-IIT Fellowship Programme

ARCI continues to sponsor fellowship programmes at Indian Institute of Technology (IITH) – Hyderabad. As part of these ARCI-IIT Fellowships, ARCI supports the doctoral study of talented students, selected as ARCI Fellows, to work in areas of immediate interest to ARCI under the expert guidance of an identified IIT faculty member. ARCI's support includes stipend, procurement of consumables and essential equipment. After successful completion of the programme, the ARCI Fellow is awarded a Ph.D. degree by the IITH.

The status of projects being undertaken is follows:

Project	Collaborating Institute	Name of the Fellow	Date of admission	Status
Development of More Efficient Cathode Matrix from Hard Carbon as Sulfur Host for Lithium-Sulfur Battery	IIT-Hyderabad	Sony K. Cherian	18.12.2020	Ongoing
Development of New Co-Cr-Fe-Mo Alloy using Additive Manufacturing for Biomedical Applications	IIT-Hyderabad	Monica Singhal	18.12.2020	Ongoing

Recognition of ARCI as an External Centre for Carrying Out Ph.D. Research Indian Academic Institutions/Universities

Apart from the above, the following Indian academic institutes recognized ARCI as an External Centre for carrying out Ph.D. Research. Accordingly, interested ARCI employees, Project Scientists and Research Fellows are encouraged to register for Ph.D. (as per university norms) at the Institute/University.

01. Indian Institute of Technology – Bombay	02. Indian Institute of Technology – Kharagpur
03. Indian Institute of Technology – Kanpur	04. Indian Institute of Technology – Hyderabad
05. Indian Institute of Technology – Madras	06. National Institute of Technology – Warangal
07. National Institute of Technology – Tiruchirappalli	08. National Institute of Technology – Surathkal
09 National Institute of Technology – Calicut	

List of Project Scientists/Research Fellows who Completed Ph.D. during the year 2021-22

S.N	Name of the Project Scientist/Fellow	Торіс	Ph.D. Registered at	Degree Awarded on
01	Boosagulla Divya	Fabrication of Solar Cell Photovoltaic Energy System Using Pulse Electrodeposited CIGS Absorber Under n-Type CdS Semiconductor Film Window	National Institute of Technology, Warangal	20.02.2023
02	Pappu Samhita	Development of Nanostructured Metal Oxide and Metal Sulfide-based Electrode Materials for High-performance Asymmetric Supercapacitors	Indian Institute of Technology, Hyderabad	16.12.2022
03	Mohd. Aqeel	Investigation on Metallurgical and Mechanical Behavior of Thick-sectioned Inconel 617 Weldments Produced by Laser-Based Welding Processes	University of Hyderabad	11.11.2022
04	S. Mamatha	Near-net Shaping of Simple and Complex Ceramic Parts by 3D Printing and Investigations on Physico-chemical, Thermal, Mechanical and Microstructural Properties	University of Hyderabad	20.09.2022
05	Pakki Tejassvi	Investigation on Electrospun Nanofiber Based Electrodes for Li-S Battery Applications	National Institute of Technology, Warangal	20.09.2022

S.N	Name of the Project Scientist/Fellow	Торіс	Ph.D. Registered at	Degree Awarded on
06	Adigilli Harish Kumar	Development of 2D - WS2 Reinforced Al-4Cu Alloy Matrix Composites	National Institute of Technology, Warangal	04.09.2022
07	T. Ramesh	Development of Novel Porous Carbons using Agricultural Biomass for High Performance and Cost-Effective Electrodes for Supercapacitor Application	National Institute of Technology, Warangal	October 2021

Post-Doctoral Fellows, Research Scholars, Senior / Junior Research Fellows, Post Graduate/ Graduate Trainees and M.Tech. / B.Tech. / M.Sc. Project Students joined during the Year at ARCI.

DST Inspire Faculty	02
SERB-TARE Fellowship	02
Post Doctoral Fellows/Research Scholars	02
Junior Research Fellows	13
Senior Research Fellow	01
Post Graduate Trainees	16
Graduate and Diploma Trainees	12
M. Tech. Project Students	23
B. Tech. / M.Sc. / Diploma Projects Students	52
Summer Research Interns	26

Project Scientist/ Research Fellows whose Ph.D. is Ongoing List of Project Scientists (as per date of Ph.D. registration)

S.N	Name of the Student Mr./Ms.	Ph. D. Topic	Ph.D. Registered at
1	Kumari Konda	Electrochemical Performance of various Cathode Materials using Half and Full Cell	Indian Institute of Technology, Bombay
2	P. Mahender	Development of Composite Cathode Materials for High Energy Density Li-ion Battery	Indian Institute of Technology, Madras
3	Muni Bhaskar Siva Kumar	Coercivity Modification in Nd-Fe-B Magnetic Material by Grain Boundary Diffusion of R-X Low Melting Eutectics	Indian Institute of Technology, Madras
4	Pothula Vijaya Durga	Development of Oxide Dispersion Strengthened Iron Aluminides with High Strength and Ductility for High Temperature Applications	Indian Institute of Technology, Madras
5	Puppala Laxman ManiKanta	Scalable Synthesis of NASICON type Sodium Vanadium Phosphate and its Doped Systems for Commercial Sodium Ion Batteries	Indian Institute of Technology, Madras
6	G. Vijayaraghavan	Microstructure-Property Correlation of High Performance Sm-Fe-N Permanent Magnetic Materials	Indian Institute of Technology, Madras
7	S. Ramakrishnan	Metallic Flow Field Plates for Low – temperature Proton Exchange Membrane Fuel Cell	Indian Institute of Technology, Kanpur
8	Minati Tiadi	Nanoscale Thermoelectric Materials and Devices for Sustainable Applications	Indian Institute of Technology, Madras

Research Fellows whose Ph.D. is Ongoing (as per date of Ph.D. registration)

S.N	Name of the Student Mr./Ms.	Ph. D. Topic	Ph.D. Registered at
1	B. Priyadarshini	Synthesis and Characterization of Magnesium Silicide and Zinc Anti Monide based Thermoelectric Materials Applications	National Institute of Technology, Tiruchirappalli
2	Keerthi Sanghamitra Kollipara	Study of Thermo-physical Properties of Aerogel Products for Thermal Insulation Application	National Institute of Technology, Warangal
3	V.P. Madhurima	Synthesis of Carbon Nano Materials and their Composites	National Institute of Technology, Warangal
4	KK Phani Kumar`	Development of Nano Composite based Solar Thermal Absorber Coatings	Indian Institute of Technology, Bombay
5	P. Sreeraj	Recycling of Valuable Components from Fuel Cell	Indian Institute of Technology, Bombay
6	Narendra Chundi	Development of Anti Soiling Coating and their Evaluation for Applications of Photovoltaic Modules	Indian Institute of Technology, Bombay
7	Battula Ramya Krishna	Suitability of Laser HybridAEngineering Perovskite Absorber Layer for Stable and Efficient Perovskite Solar Cells Welding of Inconel 617 Alloy for Steam Boilers	Indian Institute of Technology Madras
8	V. Sai Harsha Swarna Kumar	Aspects of PEM based Electrolysers for Hydrogen Production	Indian Institute of Technology, Madras
9	A. B. Aravind	Development of Materials for Aluminium Air Batteries.	National Institute of Technology, Tiruchirappalli
10	M. Tarun Babu	Structure Property of Cold Sprayed Aluminium Alloy Coatings	Indian Institute of Technology, Madras
11	D. Nazeer Basha	Laser Surface Texturing of Automotive Engine Components using Ultrafast Laser	Indian Institute of Technology, Madras
12	Bathini Lava Kumar	Mechanical and Electrochemical Behavior of Pulse Electrodeposited Functional Gradient Ni and Ni-W Coatings	Indian Institute of Technology, Bombay
13	K. Sriram	Development of Non-Noble Electro catalyst for Alkaline Electrolyzer Application	Indian Institute of Technology, Madras
14	M. Venkatesh	Development of Low Cost and High specific Capacity Cathode Materials for Sodium – Ion Battery Applications	Indian Institute of Technology, Madras
15	Vikrant Trivedi	Nanostructured Co4Sb12 Skutterudite Thermoelectric Material for Waste Heat Recovery Applications	Indian Institute of Technology, Madras
16	P. Raju	Investigations on the Applicability of Pressure Slip Casting and 3D – Printing for Al_2O_3 and Al_2O_3 -TiO ₂ Systems.	National Institute of Technology, Warangal
17	D. M. Santoshsarang	Design and Modelling of Residual Stresses of additive Manufacturing	Indian Institute of Technology, Madras
18	Jyothi Gupta	Investigation of Efficient and Stable Nanostructured Mo based Chalcogenides Electrocatalyst for Hydrogen Evolution Reaction	University of Hyderabad, Hyderabad

	S.N	Name of the Student Mr./Ms.	Ph. D. Topic	Ph.D. Registered at
	19	B. Amarendhar Rao	Laser Assisted Machining of Nickel based Super Alloys	National Institute of Technology, Warangal
	20	Kanchi Anjali	Mechanical and Microstructural Behaviour of Refractory High Entropy Alloy	University of Hyderabad, Hyderabad
	21	Rahul Jude Alroy	A study on Structure-Property Correlation of High Velocity Air -Fuel Sprayed CrC - NiCr Coatings for Improved Corrosion and Erosion Resistant.	Indian Institute of Technology, Madras
	22	Aarti Gautam	Self Healing Corrosion Protection Coatings on Mild Steel	National Institute of Technology, Warangal
	23	K. Reshma Dileep	Carbon based Perovskite Solar Cell	Indian Institute of Technology, Bombay
	24	Guduru Neelima Devi	Cold Spray Deposition of Nickel based Alloys	Indian Institute of Technology, Warangal
	25	Harita Seekala	Measuring the Size and Rate Dependence of Strength at Small Scales	University of Hyderabad, Madras
	26	Nowduru Ravikiran	Synthesis of Carbon 2D Hybrid Materials for Friction and Wear Reduction	University of Hyderabad, Hyderabad
	27	Kumaar Swamy Reddy. B	Solution – Processed Photo Detector	National Institute of Technology, Hyderabad
	28	Rentala Jayasree	Development of Functionally Graded Materials for Bio ApplicationsHigh Entropy Alloy	University of Hyderabad, Kharagpur
	29	D. Vijaya Lakshmi	A Comprehensive Study on High Velocity Thermal Sprayed Thin Coatings for Wear and Corrosion Resistant Applications	Indian Institute of Technology, Bombay
	30	Baswanta Sainath Patil	Additive Manufacturing of 15-5 PH Stainless Steel	Indian Institute of Technology, Hyderabad
	31	P. Sankar Ganesh	Development of Laser Surface re-engineering Process on Automotive Structual Steels for Improved Forming and Manufacturability	Indian Institute of Technology, Hyderabad
	32	Chandra Gowthami	Synthesis, Characterization and Validation of Modified Electrode Materials for Battery Applications	National Institute of Technology, Warangal
	33	Ramay Patra	Corrosion Sensing and Self-Healing Smart Nanocomposite Coatings	National Institute of Technology, Warangal
-	34	Madugula Swarna	Process development with Analysis of Laser post Processing for improved Mechanical Properties in DED Manufactured Super Alloy Component.	National Institute of Technology, Warangal
	35	Ch. Phani Nookarajendra	Ongoing Course Work	Indian Institute of Technology, Madras
	36	Shivangi Tewatia	Cathode Materials for Lithium Sulphur Batteries	Indian Institute of Technology, Madras

Visits by Students and Faculty to ARCI:

- 1. 16 Teachers and Students from Golden Jubilee English High School, Hyderabad visited ARCI on 21st April, 2022.
- 24 Faculty and Students from Cadets Training Wing, Military College of Electronics & Mechanical Engineering, Hyderabad visited ARCI on 2nd May, 2022.
- 3. 60 Faculty and Students from Government Degree College, Hyderabad visited ARCI on 6th June, 2022.
- 4. **23** Faculty and Students from St. Josephs Degree and PG College, Hyderabad visited ARCI on 24th August, 2022.
- 40 participants from various Institutes who participated in DST National Level Training programme on "Material Characterization and Modelling & Finite Element Analysis" hosted by GRIET, Hyderabad and GITAM University, Vizag visited ARCI on 26th August, 2022.
- 6. **25** Senior Scientists and Engineers from various centres of ISRO who participated in Management Development Programme (MDP) being organized by ASCI visited ARCI on 15th September, 2022.
- 20 Faculty from various Engineering Colleges who participated in AICTE ATAL FDP programme on "Novel Materials and Characterization" being hosted by IAE, Hyderabad on 20th September, 2022.
- 8. **25** Senior Scientists and Engineers from various centres of ISRO who participated in Management Development Programme (MDP) being organized by ASCI visited ARCI on 14th October, 2022.
- 9. **40** Faculty from various Engineering's College who participated in AICTE ATAL FDP programme on "Digital Manufacturing and Industry 4.0" being hosted by MVSR, Hyderabad on 28th October, 2022.
- 10. 60 Faculty and Students from The Aga Khan Academy, Hyderabad visited ARCI on 29th November, 2022.
- 11. **55** Faculty and Students from Dr. B.V. Raju Institute of Technology, Hyderabad visited ARCI on 2nd December, 2022.
- 12. 13 Scientists from various Government Departments who participated ASCI's program on "General Management Programme for Women Scientist" visited ARCI on 21st December, 2022.
- 13. 113 Faculty and Students from Shri Vishnu Engineering College for Women, Bhimavaram visited ARCI on 23rd December, 2022.
- 14. **43** Faculty and Students from Sarojini Naidu Vanita Maha Vidyalaya, Hyderabad visited ARCI on 19th January, 2023.
- 15. **37** Faculty and Students from Centre for Nano Science and Technology (CNST), JNTUH University Post Graduate College of Science and Technology, Hyderabad visited ARCI on 10th February, 2023.
- 16. 50 Faculty and Students from RBVRR Women's College, Hyderabad visited ARCI on 17th February, 2023.

Summer Research Internship Programme 2022-23

Students from IIT's, NIT's, IIIT's, Central Universities and various other state and private universities from all over the country were short-listed for availing Summer Research Internship Programme (SRIP) at ARCI, Hyderabad and Chennai Centres for the year 2022. 26 students, who were selected, have attended the programme from 16th May, 2022 for a minimum period of 45 days to a maximum period of 60 days. The selected students initially underwent a week long orientation course at various Centres of Excellence so as to get familiar with the activities being carried out at ARCI. Each student was guided by a scientist to carry out a mini project. The students were issued certificates on successful completion of the programme.

Promotions

ARCI has been following its existing assessment and promotion policy since the year 2000-01. As per the policy, assessments were carried out for all eligible employees and the following were promoted during the year 2022-23:

Name of the Promotees	Effective Date	Promotion for the post:	
Nume of the Fromotees	Encenve Date	From	То
Dr. Y. Srinivasa Rao	April 1, 2022	Scientist "F"	Scientist "G"
D. Sreenivas Reddy	April 1, 2022	Technical Officer "C"	Technical Officer "D"
A. JayaKumaran Thampi	April 1, 2022	Technician "D"	Technician "E"
Dr. Sanjay Bhardwaj	October 1, 2022	Scientist "F"	Scientist "G"
Dr. Shanmugasundaram Sakthivel	October 1, 2022	Scientist "F"	Scientist "G"
Dr. Pramod Hiralal Borse	October 1, 2022	Scientist "F"	Scientist "G"
Dr. Kaliyan Hembram	October 1, 2022	Scientist "E"	Scientist "F"
Dr. Sanjay R. Dhage	October 1, 2022	Scientist "E"	Scientist "F"
Dr. K. Suresh	October 1, 2022	Scientist "E"	Scientist "F"
Dr. D. Prabhu	October 1, 2022	Scientist "D"	Scientist "E"
Boorgu Venkatesham	October 1, 2022	Assistant "A"	Assistant "B"
Pokalkar Sai Kishore	October 1, 2022	Assistant "A"	Assistant "B"
Turupati Satyanarayana	October 1, 2022	Driver "B" (MACP)	Driver "C"

Superannuation

Employee Name	Designation Held	Date of Superannuation
A. Janga Reddy	Technician "D"	31/05/2022
A. JayaKumaran Thampi	Technician "E"	31/07/2022
Dr. Y. Srinivasa Rao	Scientist "G"	31/08/2022
G. Venkata Ramana Reddy	Technical Officer "D"	31/08/2022
D. Sreenivas Reddy	Technical Officer "D"	30/09/2022
Dr. Raghavan Gopalan	Regional Director (Re-employment)	30/11/2022
V. C. Sajeev	Technical Officer "D"	31/12/2022
V. Mahender	Technical Officer "D"	28/02/2023

Resignations

Employee Name	Designation Held	Date of Relieving
Dr. K. Nanaji	Scientist (Contract)	21/12/2022
Dr. A. Srinivasa Rao	Scientist (Contract)	12/01/2023
Dr. Prashanth Mishra	Project Scientist	23/12/2022

Reservations and Concessions

The Reservations and Concessions for SCs/STs/OBCs and persons with disabilities are followed as per Government of India orders from time to time. At ARCI, the overall representation of employees under SC is 20.25%, S.T is 5.69%, OBC is 27.84% and that of persons with disabilities is 1.89% and 1 person belongs to EWS as on March 31, 2023.

Faculty Internship Programme

Under Faculty Internship Programme, teaching faculty from Engineering colleges who are interested to be associated with research work, to carry out part of their research work or wanted to become familiar with latest R&D activities and facilities are permitted to work for a period of 2 to 8 weeks during their vacation.

Outreach programme under Scientific Social Responsibility

Some of the Scientists on voluntary basis have delivered online motivational talks /science talks for the benefit of the school students. On invitation by reputed government/private engineering colleges, scientist delivered lectures in the area of their specializations and shared their research experiences with the faculty and students.

Indian and Foreign Visitors for Technical Discussion

- 1. Dr. Bhawana Singh, Head, Materials Engineering, Dr. Mrinmay Mandal, Senior Scientist (R&D) and Dr. Srinivasulu, Scientist, Humble Hydrogen, Kolkata, visited on June 10, 2022
- 2. Mr Andrew Penkethman, Managing Director & CEO, Ardea Resources, Mr Andrew Jenkin, Research Director, Mineral Processing, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Dr Keith Vining, Group Leader, CSIRO, Dr Goutam Das, Senior Scientist Process Engineering, CSIRO, Mr Carl Popal, Executive Chairman, Eclipse Metals Limited, Ms Stacy Osenbaugh, Commercialisation Manager, Future Battery Industries, Ms Allison Britt, Director (Mineral Resources Promotion), Geoscience Australia (GA), Mr Rakesh Gupta, Chief Executive Officer, Legacy Iron Ore Limited, Prof Mohan Yellishetty, Co-Founder, Monash University, Ms Denise Eaton, Trade and Investment Commissioner (Mineral Resources and Energy, South Asia), Australian Trade and Investment Commission (Austrade), Mr Ramakrishna Dastrala, Director (Trade and Investment), Austrade, Mr Venkataramana Nallam, Technical & Marketing Manager, Iluka Resources Limited, Mr Glen D'Costa, Regional Manager (Asia), Mineral Technologies (MT) and Ms Ratika Jain, Lead (Strategy & Corporate Relations), Rio Tinto visited on September 30, 2022
- 3. Dr. V Jayaraman, Associate Director, Dr. Rajesh Ganesan, Head-Materials Chemistry Division, Shri N.Murugesan Scientific Officer-E, MCD, IGCAR, Kalpakkam, visited on October 20, 2022
- 4. Dr. Rob McHenry, Asst. Professor, Deakin University, Victoria, Australia visited on October 27, 2022
- 5. Mr. Maxence Bourjol, Sales Manager, 3D Ceram, France visited, on October 31, 2022
- 6. Mr. Ajoy Masand, Assist. Vice President, Shree Rapid Technologies, Mumbai, visited on October 31, 2022
- Dr. Ajit K Roy, Computational Group Leader and Principal Materials Research Engineer, Materials and Manufacturing Directorate, US Airforce Research Laboratory (USAFRL), Mr. Merrick Garb Armaments Cooperation Specialist (USAFRL) and Mr. Harish Potukuchi, Research Director, US Embassy, New Delhi visited on November 11, 2022
- 8. Mr. Saju Samuel Oomen, Founder and Dr. Thiagarajan, Managing Director, Hypos Future Energy Pvt. Ltd, Pondichery, visited on November 18, 2022
- 9. Prof. Bohumil Horak, Associate Professor, VS&TU Ostrava, Department of Cybernetics & BHI, Ostrava, Czech Republic visited on December 6, 2022
- 10. Lars Skaarup Jensen, Head-R&D and Project Manager, FL Smith, Denmark, visited on December 8, 2022
- 11. Mr. Santosh Gurunath, Cofounder and CEO, Umagine Ltd, Ahmedabad visited on December 19, 2022
- 12. Dr. Shiv Chauhan, Senior Manager, Tata Motors, Pune, visited on January 18, 2023
- 13. Dr. Kartikeyan, Team Lead, Ashok Leyland Ltd., Chennai visited on March 8, 2023

Lectures by Indian and Foreign Experts

- 1 Dr. S. Karunanidhi Outstanding Scientist and Associate Director Research Centre Imarat (RCI), Hyderabad delivered a lecture on "Aerospace Product Development by Precision Engineering" on May 11, 2022
- 2 Prof. Hariharan Srikanth, Professor, Department of Physics, University of South Florida, USA delivered a talk on "Functional Materials Laboratory: Probing the Physics of Magnetic Nanoparticles, Novel Magnetic Textures and Spinterfaces" on June 30, 2022
- 3 Prof. Sai Gautam Gopalakrishnan, Professor, Department of Materials Engineering, Indian Institute of Science (IISc), Bengaluru delivered a talk on "Density functional theory and batteries: improving accuracy and discovering cathodes" on July 29, 2022
- 4 Dr. Rohit Batra, Assistant Professor, IIT Chennai delivered an invited talk on "Accelerating Materials Discovery using Computations and Machine Learning" on August 17, 2022
- 5 Prof. Ramesh Natarajan, Professor, Indian Institute of Science (IISc), Bengaluru delivered a lecture on "Mineral Structures for New Application" on November 4, 2022
- 6 Prof. Kothandaraman Ramanujam, Department of Chemistry, IIT Madras, Chennai delivered a lecture on "Two's Company or Crowd?: The Importance of Being Single for Energy Delivery" on January 11, 2023
- 7 Prof. Tanvir Hussain, Professor, Coatings and Surface Engineering Department, University of Nottingham, United Kingdom delivered a lecture on "Innovations in Suspension Thermal Spray and Cold Spray: Ceramic Coatings from Liquid Feedstock and Metallic Coatings without Melting" by on February 21, 2023
- 8 Prof. GD Yadav, National Science Chair, Institute of Chemical Technology (ICT), Mumbai delivered Safety Day Lecture on March 06, 2023
- 9 Dr. Geeta K Vemuganti Prof.& Dean, School of Medical Sciences, University of Hyderabad delivered a lectures on "Tissue Engineering and Regenerative Medicine: Progress and Promise" on March 08, 2023

Papers Presented at Indian Conference / Symposia:

- 1 Dr. Bijoy Kumar Das presented a paper on "Recent Development in Sodium-ion Batteries for Grid Energy Storage" at the 'Deakin-IIT CoE e-Symposium on Sustainable Energy and Circular Economy Materials', organized by Deakin and Indian Institute of Technology (IIT) Madras during March 31–April 02, 2022 (Virtual)
- 2 Ms. Minati Tiadi made a poster presentation on "Optimizing Thermoelectric Properties of p-Type Mg₃Sb₂ via Heavy Atom Co-doping" at the 'In-house Symposium', organized by Department of Physics, IIT Madras during April 22-23, 2022
- 3 Mr. Venkatesh Manchala (Dr. Bijoy Kumar Das) presented a paper on "Rational Design of P2 and P3-type Mg doped Na2/3Mn2/3Ni1/3O2 Cathodes via Microwave Assisted Sol-Gel Route for High Performance Sodium-Ion Battery" at the 'National Conference on Energy Technologies (NCET-2022)' organized by INAE Chennai chapter and ARCI during April 29-30, 2022 (Virtual)
- 4 Mr. Mahender Peddi presented a paper on "Fabrication of lithium-ion pouch cells (LiNi_{1/3}Mn_{1/3}Co_{1/3}O₂ Graphite) for Electric Vehicle Applications' at the 'National conference on Energy Technologies (NCET-2022)' organized by INAE Chennai Chapter and ARCI during April 29-30, 2022 (Virtual)
- 5 Ms. Kumari Konda presented a paper on "Effect of Electrode Thickness and Porosity on the Long Cyclic Stability of Lithium-ion Batteries' at the 'National conference on Energy Technologies (NCET-2022)' organized by INAE Chennai Chapter and ARCI during April 29-30, 2022 (Virtual)
- 6 Dr. V.V.N. Phani Kumar presented a paper on "Investigation of micron sized lithium Iron Phosphates cathode using aqueous binder for Li-ion batteries" at the 'National Conference on Energy Technologies ('NCET)' organized by INAE Chennai Chapter and ARCI during April 29-30, 2022 (Virtual)
- 7 Mr. Laxman Manikanta Puppala presented a paper on "Ultrafast and scalable microwave synthesis of in-situ carbon coated Na3V2(PO4)3 embedded in 3D-mesoporous carbon matrix as dual electrode for high performance sodium ion battery" at the 'National Conference on Energy Technologies (NCET)' organized by INAE Chennai Chapter and ARCI during April 29-30, 2022 (Virtual)
- 8 Mr. S Ramakrishnan presented a paper on "Investigations on conducting polymer coated metallic bipolar plate in simulated proton exchange membrane fuel cell conditions" at the 'National Conference on Energy Technologies' organized by IIT M, Chennai during April 29-30, 2022

- 9 Mr. Vegi Tarun Kumar (Dr. Raman Vedarajan) presented a paper on "Engineering of Gas diffusion layer for improved water management in PEMFC" at the 'National Conference on Energy Technologies' organized by Indian Institute of Technology Madras, Chennai during April 29-30, 2022
- 10 Mr. S Ramakrishnan presented a paper on "Investigations on conducting polymer coated metallic bipolar plate in simulated proton exchange membrane fuel cell conditions" at the 'National Conference on Energy Technologies' organized by IIT M, Chennai during April 29-30, 2022
- 11 Mr. V. SriHarsha Swarna Kumar (Dr. R. Balaji) presented a paper on "Patterning of platinum coating on flow field plates for PEM water electrolyzers for hydrogen production" at the 'National Conference on Energy Technologies' organized by IIT Chennai during April 29-30, 2022
- 12 Mr. P. Sreeraj (Dr. Raman Vedarajan) presented a paper on "Degradation mechanism of Polymer Electrolyte Membrane in PEMFC and PEM Electrolyzer" at the 'National Conference on Energy Technologies' conducted by IIT Chennai during April 29-30, 2022
- 13 Mr. K. Sriram (Dr. Raman Vedarajan) presented a paper on "Electrochemically nitrided stainless steel electrodes for oxygen evolution reaction in alkaline water electrolyzer" at the 'National Conference on Energy Technologies' organized by IIT Chennai during April 29-30, 2022
- 14 Dr. Bijoy Kumar Das, presented a paper on "Sodium ion Batteries: Towards a sustainable and low cost energy storage technology" at the 'National Conference on Energy Technologies (NCET-2022)', Organized by IIT Madras and ARCI, Chennai during April 29–30, 2022 (Virtual)
- 15 Mr. N Ravi Kiran (Dr. P K Jain) made a poster presentation on "Novel Few-layered Graphene as an Excellent Additive in 15W40 Engine Oil for Enhanced Lubrication" at the '32nd International Conference on Diamond and Carbon Materials', Lisbon, Portugal during September 4-8, 2022
- 16 Md. Aqeel (Dr. S M Shariff) presented a paper on "Study on Laser Welding of Thick Inconel 617 Superalloy using High-Power Fiber-Coupled Diode Laser" at the 'International Conference on Innovations in Engineering and Technology (ICIET-2022)' during September 15-17, 2022
- 17 Dr. P Samhita (Dr. BV Sarada) made a Poster presentation on "Electrochemically Exfoliated Graphene Oxide incorporated NiCo2O4 for Aqueous and Non-Aqueous Supercapacitors" at the 'Regional meeting of the International Society of Electrochemistry' organized by ISE, Prague, Czech Republic, during September 15-19, 2022
- 18 Dr. Ravi Kali made an oral presentation on "Multilayer Graphene Nanoplatelets (MGNP) as high-performance anode materials for Lithium-ion Batteries" at the 'Online Workshop on Graphene 2022' organized by Indian Carbon Society and CSIR-NPL, Delhi, during November 1-2, 2022
- 19 Dr. S Kavita made an oral presentation on "Enhanced coercivity in additively manufactured Nd-Fe- B rare-earth magnet" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 20 Ms. P Vijaya Durga (Dr. R Vijay) presented a paper on "Effect of Nano Oxide Dispersoids on Microstructure for improved Strength and Ductility of Fe3AI Intermetallics" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 21 Ms. Ch Gowthami (Dr. S Anandan) presented paper on "Synthesis of high tap density C-LFP for high energy density Li-ion batteries" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 22 Mr. A Harish Kumar (Dr. Joydip Joardar) made an oral presentation on "Microstructural Studies on Nanostructured 2-Dimensional Tungsten disulfide Reinforced Al-Cu Alloy Matrix Composites" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 23 Dr. Kaliyan Hembram presented a paper on Influence of Zr addition on Microstructure, Mechanical properties and Degradation of Biodegradable Mg-Zn alloys" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 24 Hitesh Kumar (Dr. S M Shariff) presented a paper on "Autogenous diode laser welding of iron-based superalloys A-286 and Incoloy-800" at the 'International symposium on Accelerated Materials Design and Additive Manufacturing: Scientific and Technological perspectives (AMDAM)' during November 13–16, 2022
- 25 Md. Aqeel (Dr. S M Shariff) Poster Presentation on "Challenges in laser-based welding of thick-sectioned superalloy materials" at the 'International symposium on "Accelerated Materials Design and Additive Manufacturing: Scientific and Technological perspectives (AMDAM)' during November 13-16, 2022
- 26 Dr. Gururaj Telasang made a paper on "Microstructure and Mechanical Properties Evaluation of Powder Bed Additive Manufactured SS321 Stainless Steel: New Material for L-PBAM" at the e '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 27 Mr. Muni Bhaskar Siva made an oral presentation on "Enhancing the coercivity of Nd-Cu diffused Nd-Fe-B permanent magnets by Nb assisted grain boundary pinning" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022

- 28 Dr.Mahender Peddi gave an oral presentation on "The application-driven slurry preparation process for lithium-ion battery electrode preparation and a parametric optimization for the fabrication of 500mAh lithium-ion pouch cell" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 29 Mr. Venkatesh Manchala gave an oral presentation on Temperature-controlled synthesis of P2 and P3 type Mg doped Na2/3Mn2/3Ni1/3O2 cathodes via microwave-assisted sol-gel route for highperformance sodium-ion battery" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 30 Dr. Dibyendu Chakravarty presented an Invited paper on "Bilayered YSZ-Ti6Al4V dental implants by spark plasma sintering" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad, Organized by DMRL, Hyderabad during November 14-16, 2022
- 31. Dr. Kaliyan Hembram presented a paper on "Influence of Zr addition on Microstructure, Mechanical properties and Degradation of Biodegradable Mg-Zn alloys" at the e '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16 2022
- 32. Ms. Aarti Gautam (Dr. R. Subasri) presented a paper on "Self-healing Behavior of Smart Nanocontainer-based Sol-gel Coatings On Mild Steel" at the 'STREE 2020 National Conference & Expo', Organized by Jawaharlal Nehru University, New Delhi during November 24-26, 2022
- 33 Dr. Papiya Biswas, presented a paper on "Development of 3D Printed Ceramic Honeycomb Substrates for the Phytorid based Sewage Treatment and Ecofriendly Incinerators for the Disposal of Used Sanitary Pads" at the 'STREE 2020 National Conference and EXPO' Organized by Jawaharlal Nehru University, New Delhi during November 24-26, 2022
- 34 Ms. Reshma Dileep K (Dr. V Ganapathy) made an oral presentation on "Large area perovskite modules with enhanced stability for niche applications" at 'Nano India 2022', organized by Innovate Karnataka, KSTePS and JNCASR, Bangalore during December 5-7, 2022
- 35 Ms. Aarti Gautam (Dr. R Subasri) presented a paper "Comparison of Corrosion Protection of Organic and Inorganic Corrosion Inhibitors Loaded Sol-gel Coatings on Mild Steel" at the 'International conference on Corrosion and Coatings (i3C)' Organized CSIR-NML Jamshedpur, during December 7-8, 2022
- ³⁶ Mr. Ramay Patra (Dr. R Subasri) presented a paper on "pH Responsive, Self-Reporting Sol-Gel Coatings for Autonomous Detection of Metal Corrosion" at the 'International conference on Corrosion and Coatings (i3C)', Organized by CSIR NML, Jamshedpur, during December 7-8, 2022
- 37 Dr. Buchi Sursh presented a paper on "Development of anode supported solid oxide fuel cell with honeycomb structure" at the 'International Conference on Global Trends in Traditional to Space Ceramics (GT-TSC'22) – 86th Annual session of Indian Ceramic Society', Organized by Indian Ceramic Society at IIT-BHU, Varanasi, during December 8-9, 2022
- 38 Dr. Prasenjit Barick, presented a paper on "On the sintering of SrO-CaO-B2O3-Al2O3-ZnO-SiO2-TiO2 glass system" at the 'International Conference on Global Trends in Traditional to Space Ceramics (GT-TSC'22) 86th Annual session of Indian Ceramic Society', Organized by Indian Ceramic Society at IIT-BHU, Varanasi, during December 8-9, 2022
- ³⁹ Mr. D. Nazeer Basha (Dr. Ravi Bathe) presented a paper on "Femtosecond Laser textured micro-groove and micro-crosshatch patterns to enhance the tribological performance of gray cast iron" at the '12th International Conference on Precision, Micro, Meso and Nano Engineering 2022 (COPEN 12)' organized by IIT Kanpur during December 8-10, 2022
- 40 Dr. Rambha Singh presented a paper on "Problems and Solutions Encountered While Filling the Parliamentary Official Language Inspection Questionnaire" at the 'All India Joint Official language Scientific and Technical Seminar' organized by "Defence Research and Development Laboratory (DRDL), Hyderabad during January 11-12, 2023
- 41 Dr. Sanjay R. Dhage presented a paper on "Thin Film for Energy Application" at the '2nd All India Joint Official language Scientific/Technical Seminar' organized by Defence Electronics Research Laboratories (DLRL), Hyderabad during February 2-3, 2023
- 42 Mr. Smrutiranjan Panda (Dr. V Ganapathy) presented a poster on "Compositional engineering and surface passivation for carbon-based perovskite solar cells with superior thermal and moisture stability" at the 'Perovskite Society of India Meet (PSIM-2023)' organized by IIT Roorkee, during March 1-3, 2023

Lectures by ARCI Personnel

- 1 Dr. Srinivasan Anandan delivered an invited lecture on "Design, Development and Demonstration of Advanced Nanostructured Materials for Energy Storage Application" at the 'Webinar on Modelling, Simulation and Control of Advanced Power Converters' organized by E&ICT Academy & Department of Electrical Engineering, National Institute of Technology (NIT) Warangal in Association with Gokaraju Rangaraju Institute of Engineering and Technology on April 5, 2022 (Virtual)
- 2 Dr. Gururaj Telasang delivered an expert talk on "Laser Surface Engineering & Additive Manufacturing" at the 'One-day workshop on Surface Engineering and NDT' organized by Department of Metallurgical Engineering, Jawaharlal Nehru Technological University (JNTU), Hyderabad on April 6, 2022
- 3 Dr. R Gopalan delivered an invited talk on "Magnetism & Magnetic Materials" at PSG College, Coimbatore on April 8, 2022
- 4 Dr. R Gopalan delivered an invited talk on "Lithium Ion Battery Technology for EV applications" at PSG College, Coimbatore on April 9, 2022
- 5 Dr. Naveen Manhar Chavan delivered an invited talk on "Surface Engineering and Beyond" at 'AYAS 2022 A National Level Technical Symposium' organized by Department.of Metallurgy, (JNTU) Hyderabad on April 12-13, 2022
- 6 Mr. K V Phani Prabhakar delivered a lecture on "Overview of Advanced Material Joining Activities at CLPM" as part of 'ARCI Colloquium Series' organized by ARCI on April 13, 2022
- 7 Dr. R. Vijay delivered an invited lecture on "Development of New Generation Iron Aluminides by Powder Metallurgy Process" at the 'International Conference on Powder Metallurgy 2022 (PM22)' held at Pune during April 18-20, 2022
- 8 Dr. Joydip Joardar has delivered an invited lecture on "Development of Next Generation Self-lubricating MMCs with 2D reinforcements" at 'International Conference on Powder Metallurgy 2022 (PM22)' held at Pune during April 18-20, 2022
- 9 Dr. Gururaj Telasang delivered a lecture on "Additive Manufacturing of SS316L IN718 Bi-Metallic Structure" at the 'International Conference on Powder Metallurgy (PM – 22)', organized by Powder Metallurgy Associating of India (PMAI), during April 18-20, 2022 (Virtual)
- 10 Dr. Gururaj Telasang delivered an expert talk on "Metal Additive Manufacturing: Engineering Applications" at 'Continuing Professional Development Programme on 3D Printing in Manufacturing' organized by Design Prototyping Centre & Mechanical Division, Engineering Staff College of India, Hyderabad during April 25-29, 2022
- 11 Dr. S B Chandrasekhar delivered a lecture on "Development of ODS Austenitic Steel Challenges and Opportunities" as part of 'ARCI Colloquium Series" organized by ARCI on April 27, 2022
- 12 Dr. Ravi Bathe delivered an invited talk on "Development of Metal Additive Manufacturing Technology for Repairing of Aero-engine Components" at the 'National Seminar on Certification Challenges during Life Revision and Refurbishing of Aero Engine Components' organized by Regional Centre for Military Airworthiness, Koraput on April 28, 2022
- 13 Dr. V Ganapathy delivered a lecture on "Challenges in Large-scale Fabrication of Perovskite Solar Cells" at the Webinar on Sustainable Energy Technologies', Organized by IIT Guwahati on April 28, 2022
- 14 Dr. Srinivasan Anandan delivered an invited lecture on "Development of Indigenous Advanced Energy Storage (Li-ion Battery and Supercapacitor) Materials for Electric Vehicles Application: Requirements and Challenges" organized by Military College of Electronics and Mechanical Engineering (MCEME) on April 29, 2022
- 15 Dr. Tata Narasinga Rao delivered a lecture on "Translational materials research in energy storage technologies" during National Conference on Recent Innovations in Smart / Nano Materials-2022, Dept. of Physics, Univ. College of Science, O.U., Hyd.) on April 29, 2022
- 16 Dr. R. Prakash delivered an invited lecture on "Lithium-ion Batteries for Emerging Demands: Progress and Challenges" at the 'National Conference on Energy Technologies (NCET-2022)', organized by INEA Chennai Chapter along with IIT Madras and ARCI during April 29-30, 2022 (Virtual)
- 17 Dr. Bijoy Kumar Das gave an invited talk on "Sodium-ion Batteries: Towards a Sustainable, Low-Cost Energy Storage Technology" at the 'National Conference on Energy Technologies (NCET-2022)", organized by INEA Chennai Chapter along with IIT Madras and ARCI, during April 29-30, 2022 (Virtual)
- 18 Dr. Sanjay Bhardwaj delivered a lecture on "ARCI Technologies and Services for Potential Strategic Use" for faculty and students from cadets training wings, of Military College of Electronics and Mechanical Engineering (MCEME), Secunderabad on May 2, 2022
- 19 Dr. R. Balaji delivered an invited lecture on "The Significant Role of Functional Materials in Realizing a Hydrogen Economy" at the 'International Conference on Functional Materials for Energy, Environment and Bio-Medical Applications', organized by Bishop Heber College, Tiruchirapalli on May 4, 2022
- 20 Dr. R Gopalan delivered an invited talk on "Energy Materials" at Vellore Institute of Technology (VIT), Chennai on May 5, 2022
- 21 Dr. Tata Narasinga Rao delivered a lecture on "Translational materials research in energy storage technologies" during Webinar on Battery Technology, Centre for High Technology on May 6, 2022
- 22 Dr. Bijoy Kumar Das delivered an invited lecture on "Introduction to Electrochemical Sensors" organized by VIT, at Chennai on May 25, 2022 (Virtual)
- 23 Dr. S Kavita delivered a guest lecture on "Nanomaterials and Applications" at VIT, Vellore on May 25, 2022 (Virtual)
- 24 Dr. Neha Y Hebalkar delivered a lecture on "Aerogel Technology Development: Lab to Product Journey" as part of 'ARCI Colloquium Series' organized by ARCI on May 25, 2022
- 25 Dr. Manjusha Battabayal delivered an invited talk on "Maximizing the Thermoelectric Performance in Antimonides through Carrier Filtering forMid-temperature Power Generation" at 'National Seminar on Advanced Energy Materials and Research (NSAEMR-2022)' organized by Periyar University, Salem, Tamilnadu during May 26-27, 2022
- 26 Dr. Gururaj Telasang delivered expert talks on "Laser Surface Engineering" and "Metal Additive Manufacturing" at the 'Three-week Industrial Training Program for the Faculty of Physics of Government Polytechnic Colleges in Telangana State' organized by the UGC–HRDC, Osmania University, Hyderabad on June 3, 2022
- 27 Dr. Tata Narasinga Rao delivered a lecture on "Translational materials research in energy storage technologies" during International Conference on Battery Science and Technology 2022 (ICBST) by S&T Digital, Pune on June 3, 2022
- 28 Dr. Neha Hebalkar delivered an invited talk on "Nanotechnology and its Applications in Everyday Life" at the 'Three Week Industrial Training Program for the faculty of Chemistry of Government Colleges in Telangana state' organized by the UGC–HRDC, Osmania University, Hyderabad on June 08, 2022
- 29 Dr. P Suresh Babu delivered a lecture on "Nanoindentation: Principles, Applications and Case Studies" as part of 'ARCI Colloquium Series' organized by ARCI on June 08, 2022
- 30 Dr. R. Balaji delivered an invited lecture on "Supercapacitor- Fundamentals & Application" at the 'Guest Lecture Series' conducted by the Department of Communication Engineering, VIT, Vellore on June 10, 2022
- 31 Dr. K Suresh delivered an invited talk on "Probing the Nanostructures using X-rays" at the 'National Workshop on Scattering Methods (Electron, X-ray and Ion) for Materials Characterization' organized by IIT Bhubaneswar, during June 13 20, 2022
- 32 Dr. R Subasri delivered an invited talk on "Modifying Surfaces using Chemical Nanotechnology" at the 'Industrial Training Program for the Faculty of Chemistry of Government Colleges in Telangana State' organized by UGC– HRDC, Osmania University, Hyderabad on June 15, 2022
- 33 Dr. Sanjay Bhardwaj delivered an invited talk on "Intellectual Property Rights : Creation to Monetization" for faculty members of Chemistry from Government Polytechnic Colleges in Telangana state in Three Week Industrial Training Programme organized by UGC–HRDC, Osmania University, Hyderabad on June 17, 2022
- 34 Dr. Gururaj Telasang delivered an invited talk on "Nanostructured Surfaces for Functional Materials and Systems" at the '16th National Symposium on Frontiers in Engineering (NatFoE)', organized by Jadavpur University, Kolkata during June 18-19, 2022
- 35 Dr. V Ganapathy delivered a lecture on "Fabrication of Perovskite Solar Cells and its Materials Perspectives" at the 'Three Week Industrial Training Program for Faculty of Chemistry of Government Colleges in Telangana', Organized by UGC– HRDC, Osmania University, Hyderabad on June 21, 2022
- 36 Dr. P Sudharshan Phani delivered a lecture on "Structure-property Correlations at the Micrometer Length Scale in Dual Phase Steels" as part of 'ARCI Colloquium Series' organized by ARCI on June 22, 2022



- 37 Dr. R. Balaji delivered an invited lecture on "PEM Fuel Cell System Development Challenges and Opportunities" at the 'Prof. G.C. Carg Endowment Lecture' conducted by the Department of Automobile Engineering, MIT, Anna University Chennai on June 29, 2022
- 38 Dr. Nitin P Wasekar delivered a lecture on "Pulsed Electrodeposition of Nanostructured Coatings: From Synthesis to Application Development in Automotive Industry" as part of 'ARCI Colloquium Series' organized by ARCI on July 07, 2022
- 39 Dr. Gururaj Telasang delivered an expert talk on "Additive Manufacturing: Process and Applications" at 'Monthly Lecture Series' organized by the SAEINDIA, Hyderabad division at MVSR engineering college, Hyderabad on July 8, 2022
- 40 Dr. G Sivakumar delivered an invited lecture on "Recent Thermal Spray Advancements at ARCI" at the 'Discussion Meeting on Thermal Spray' organized by United Technologies Limited, Bangalore on July 15, 2022
- 41 Dr. Dibyendu Chakravarty delivered a lecture on "Spark Plasma Sintering: An Advanced Processing Tool for Niche Applications" as part of 'ARCI Colloquium Series' organized by ARCI on July 20, 2022
- 42 Dr. Sanjay Bhardwaj delivered an invited talk on "R & D Commercialization and Start-up Opportunities" organized by Advanced Materials Research Centre, Faculty of Science and Institution's Innovation Council, Rabindranath Tagore University, Bhopal on July 21, 2022
- 43 Dr. Sanjay Bhardwaj delivered an invited talk on "Research Collaborations and Technology Transfer" at 'General Management Programme for Directors and Division Heads of Government – funded R & D Organizations' organized by Department of Science and Technology, Govt. of India at Administrative Staff College of India (ASCI), Hyderabad on July 29, 2022
- 44 Dr. K Suresh delivered a lecture on "Probing the Microstructure with X-rays" as part of 'ARCI Colloquium Series' organized by ARCI on August 03, 2022
- 45 Dr. Manjusha Battabayal delivered an invited lecture on "Green Thermoelectrics for Future Sustainable Energy" at the 'International Conference on Sustainability: Integrated and Scientific Approach (ICS- 2022)' organized by University of Mumbai during August 4-6, 2022
- 46 Dr. B. V. Sarada delivered an invited Lecture on "Technologies for Energy Conversion and Storage" during a workshop on 'Recent Trends in Science and Technology' organized by Mahatma Gandhi University, Nalgonda and RBVRR Women's College, Hyderabad on August 8, 2022
- 47 Dr. Sanjay R Dhage delivered a lecture on "Thin Film Deposition and Application in Solar Cells" as part of 'ARCI Colloquium Series' organized by ARCI on August 17, 2022
- 48 Dr. Sanjay Bhardwaj delivered an invited talk on "Challenges in Technology Transfer and Solutions towards Commercialization" at 'TIFAC-DSIR-IICT Joint Workshop on Techno-commercial Assessment of TRL6 and above Technologies in the domains of Chemical, Pharmaceutical, Healthcare and Medical Sciences' organized by CSIR-IICT on August 22, 2022
- 49 Dr. R Gopalan delivered an invited talk on "Li-ion Battery for Science and Technology"at the Homi Bhabha National Institute, Mumbai on August 22, 2022
- 50 Dr. Krishna Valleti delivered a keynote lecture on "Material Characterization, Modelling and Finite Element Analysis" at 'STUTI Programme', organized by GITAM university, Visakhapatnam during August 22 28, 2022
- 51 Dr. Balaji Padya delivered an invited talk on "Layered 2-dimensional Graphene Sheets for Controlling Friction and Wear at Metal-metal Interfaces" at the 'National level seminar on Advancement in tribology for sustainability', organized by National Institute of Technology (NIT), Warangal during August 26-27, 2022

- 52 Dr. Gururaj Telasang delivered an invited talk on "Interfacial Microstructure and Mechanical Properties of Bimetallic Structures by Selective Laser Melting" at the 'International Conference on Laser-Assisted Material Processing (LAMP 2022)', organized by IIT Kharagpur, Birla Institute of Technology (BIT) Mesra, and Indian National Academy of Engineering (INAE), New Delhi during August 29-31, 2022
- 53 Dr. Ravi Bathe delivered an invited talk on "Ultrafast Laser Micro-textured Engineered Surfaces for Friction Control" at the 'International Conference on Laser Assisted Material Processing (LAMP 2022) organized by Indian Institute of Technology, Kharagpur during August 29- 31, 2022
- 54 Mr. N Ravi Kiran (Dr. PK Jain) delivered an invited lecture on "Modification and Utilization of Tyre Pyrolysis Waste Carbon as Friction/wear reducing Additive in Lubricant Oil" at 'International Conference on Reuse, Recycling, Upcycling, Sustainable Waste Management and Circular Economy (ICRSC – 2022)' organized by International Unit on Macromolecular Science and Engineering (IUMSE), Mahatma Gandhi University, Kerala, during September 9-11, 2022 (Virtual)
- 55 Dr. P Sudharshan Phani delivered an invited lecture on "High speed nanoindentation mapping A new paradigm in small scale mechanical testing" at 'ICFAST 2022, organized by University of Hyderabad, Hyderabad on September 10,2022
- 56 Dr. R. Vijay has delivered an invited lecture on "New Materials and Advanced Processes for High Temperature Applications" during 'AICTE ATAL Faculty Development Program on Novel Materials and Applications' organized by Institute of Aeronautical Engineering, Hyderabad during September 12-23, 2022
- 57 Dr. R Gopalan delivered an invited talk on "Magnetic Materials & Applications" at Bharathiar University, Coimbatore on September 13, 2022
- 58 Dr. Kaliyan Hembram delivered a lecture on "Next Generation Biodegradable Metal Implants: Challenges and Opportunities" as part of 'ARCI Colloquium Series' organized by ARCI on September 14, 2022
- 59 Dr. Sanjay Bhardwaj delivered an invited talk on "Leveraging Intellectual Capital of R&D Labs" at 'Management Development Programme (MDP) for Scientists/Engineers of Indian Space Research Organization (ISRO)' organized by ASCI, Hyderabad on September 15, 2022
- 60 Dr. Sanjay Bhardwaj delivered an invited talk on "Research Collaborations" at 'Science Administration and Research Management Programme for Scientists of Government – funded R&D Organizations' organized by Department of Science and Technology, Govt. of India at Administrative Staff College of India (ASCI) Hyderabad on September 16, 2022
- 61 Dr. Sanjay Bhardwaj delivered a lecture on "Utilizing R & D Results" at 'AICTE ATAL Faculty Development Programme on Novel Materials and Characterization' for faculty & students of Institute of Aeronautical Engineering, Hyderabad on September 20, 2022
- 62 Dr. G Sivakumar delivered an invited lecture on "Advanced Coating Technologies for Thermal Power Plant Applications: An ARCI Perspective" at 'Power Plant Summit' organized by CII, New Delhi on September 20, 2022
- 63 Dr. Malobika Karanjai delivered an invited lecture on "Composites & Friction Composites" at 'Powder Metallurgy Short Course (PMSC22)' organized at College of Engineering, Pune on September 22, 2022 (Virtual)
- 64 Dr. Sanjay R. Dhage delivered an invited talk on "Advances in Sputtering Techniques in Solar Cells" at the 'Refresher Course in Advance Instrumentation' organized by UGC-Human Resource Development Center, Dr. Babasaheb Ambedkar Marathwada University (BAMU) on September 22, 2022
- 65 Dr. V. Ganapathy delivered a lecture on "Introduction of Perovskite solar cells: Fundamentals; Do's and Don'ts" at the 'Indo-UK Joint Hands of Training on Solar Energy Conversion Devices', organized by VIT, Vellore during September 22-23, 2022
- 66 Dr. G Sivakumar delivered an invited lecture on "Solution Precursor and Suspension Plasma Spray: Recent developments on Functional Coatings for diverse Industrial Applications" at 'National Conference on Recent Developments and Evolving Trends in Plasma Science and Technology' organized by Bharatiyar University, Coimbatore on September 23, 2022

- 67 Dr. Malobika Karanjai delivered an invited lecture on "Biomaterials and Engineering" at 'Powder Metallurgy Short Course (PMSC22)' organized at College of Engineering, Pune on September 23, 2022 (Virtual)
- 68 Mr. K V Phani Prabhakar delivered an expert talk on "Challenges in Dissimilar Materials Joining by Weld Brazing Techniques" at VIT, Vellore on September 23, 2022
- 69 Dr. R. Prakash, delivered an invited talk on "The Development of Lithium Ion Batteries Ecosystem for Electric Mobility" at Satyabhama Institute of Science and Technology on September 23, 2022
- 70 Dr. Papiya Biswas delivered a Technical Hindi lecture on "Ceramic Honeycomb based Antimine Boots organized by OLIC, ARCI on September 23, 2022
- 71 Dr. Tata Narasinga Rao delivered a lecture on "Application of Nanomaterials for Energy and Environment" during The AICTE ATAL Faculty Development Program (FDP), Institute of Aeronautical Engineering, Dundigal, Hyderabad on September 23, 2022
- 72 Dr. S Sakthivel delivered a plenary lecture on "Functional nanocoatings for PV & Solar thermal applications" at the 'National Conference of SCHEMCON 2022', organized by NIT Warangal,, during September 23-24, 2022
- 73 Dr. Sanjay Bhardwaj delivered an invited talk on "Developing Technologies in the Advanced Materials Domain" at '18th Annual Session of Chemical Engineering Students' Congress (SCHEMCON 2022)' organized by Department of Chemical Engineering, NIT Warangal and Indian Institute of Chemical Engineers Hyderabad Regional Centre (IIChE HRC) on September 24, 2022
- 74 Dr. K Murugan delivered a lecture on "Ellipsometry: Few Case Studies from Various Technology Development Programs" as part of 'ARCI Colloquium Series' organized by ARCI on September 28, 2022
- 75 Dr. R. Subasri delivered a lecture on "Some Exciting Applications of Nanocomposite Coatings!!!" at St Francis College for Women, Hyderabad, on September 29, 2022
- 76 Ms. Priya Anish Mathews delivered a lecture on "Importance of Protecting Intellectual Property Rights" at the St. Francis College for Women, Hyderabad on September 29, 2022
- 77 R Subasri delivered an lecture on "Multifunctional Nanocomposite Coatings" for at Central University Tamil Nadu, Thiruvarur, on September 29, 2022 (Virtual)
- 78 Dr. Bijoy Kumar Das delivered an invited lecture on "Sodium over Lithium: The Low-cost Alternative to Li-ion Batteries for Indian Subcontinent" organized by Department of Chemistry, Vasavi College of Engineering (A), Hyderabad on October 10, 2022 (Virtual)
- 79 Ms. S Nirmala delivered a lecture on "Role of Electronics & Instrumentation in Industrial R&D with Multidisciplinary Equipment" as part of 'ARCI Colloquium Series' organized by ARCI on October 12, 2022
- 80 Dr. Sanjay Bhardwaj delivered an invited talk on "Leveraging Intellectual Capital of R & D Labs" at 'Management Development Programme (MDP) for Scientists/Engineers of Indian Space Research Organization (ISRO)' organized by ASCI, Hyderabad on October 14, 2022
- 81 Dr. Ravi Bathe delivered an invited talk on "Laser Processing of Materials: From Lab to Industry" at 'Fourth International Webinar Series under the pCOE Advanced Laser Material Processing' organized by Indian Institute of Technology(IIT), Madras on October 14, 2022
- 82 Ms. Priya Anish Mathews delivered a lecture on "Idea to IPR: Think, Create, Innovate and Protect" at the Maturi Venkata Subba Rao (MVSR) Engineering College, Hyderabad on October 14, 2022
- 83 Dr. Gururaj Telasang delivered invited an talk on "Additive Manufacturing Materials and Applications Development" at the '11th International Conference and Exhibition on 3D Printing and Additive Manufacturing Technology' organized by the Additive Manufacturing Society of India (AMSI), Bangalore, during October 14-15, 2022

- 84 Dr. G Sivakumar delivered a lecture on "Solution Precursor / Suspension Plasma & High Velocity Air-Fuel Spray Technologies" at 'DSC and CGDS Business Workshop' organized by ARCI, Hyderabad on October 22, 2022
- 85 Dr. Srinivasan Anandan delivered a lecture on "Development of Indigenous Energy Storage Materials: Requirement and Challenges" as part of 'ARCI Colloquium Series' organized by ARCI on October 26, 2022
- 86 Dr. Raman Vedarajan delivered invited lectures on the "Fundamentals of Electrochemistry in Energy Devices and its Research", "PEM Fuel Cell and its fundamental electrochemistry", "Electrochemistry in Solid State Li Battery" at the 'Annual Chemistry Forum Meet' organized by Manonmaniam Sundaranar University, Tirunelveli during October 27-28, 2022
- 87 Dr. K Suresh delivered an invited talk on "Probing Nano-heterogenity in Advanced functional and structural materials" at the 'National Workshop on Atom Probe Tomography' organized by IIT Kanpur, during October 27-29, 2022
- 88 Dr. Sanjay Bhardwaj delivered a lecture on "Commercializing Research" at the 'AICTE ATAL Faculty Development Programme on Digital Manufacturing and Industry 4.0' for faculty & students of MVSR Engineering College, Hyderabad on October 28, 2022
- 89 Mr. N. Ravi Kiran (Dr. P.K. Jain) made an oral presentation on "Carbon Nanospheres with Graphene like Layers Derived from Industrial Waste and their Application as Lubricant Additive" at the 'Workshop on Graphene 2022' organized by Indian Carbon Society and CSIR-NPL, Delhi during November 1-2, 2022
- 90 Dr Nitin Wasekar delivered an invited talk on 'The Influence of Grain Size on Corrosion Resistance of Metals' at the 'International Conference and Exhibition on Emerging Materials and Technologies along with the Heat Treat Show (MET + HTS)' at Mumbai during November 02-04, 2022
- 91 Dr. Tata Narasinga Rao delivered a Plenary talk on "Translational Materials Research in Energy Storage Technologies" during International Conference and Exhibition on Emerging Materials and Technologies, ASM International India Chapter, Mumbai on November 3, 2022
- 92 Dr. Tata Narasinga Rao delivered a lecture on "Nanomaterials-Based Technologies (From Laboratory to Market)" during EST Industry lecture, IIT Hyderabad on November 7, 2022
- 93 Dr. Dulal Chandra Jana delivered a lecture on "Aqueous Processing of Silicon Carbide Ceramics and Studies of Solid-state Sintering Kinetics" as part of 'ARCI Colloquium Series' organized by ARCI on November 09, 2022
- 94 Dr. K Suresh delivered an invited talk on "Microstructure of gas atomized powders and cold sprayed coatings of aluminum alloys" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 95. Dr. D. Prabhu gave an invited talk on "Coercivity enhancement through grain boundary engineering" at the '76th Annual Technical Meeting (ATM-2022) of IIM', organized by DMRL, Hyderabad during November 13-16, 2022
- 96 Dr. Tata Narasinga Rao delivered keynote lecture on "Indigenizing the Technologies for Advanced Materials (Powder to Product)" during 76th IIM ATM 2022 Keynote lecture on November 15, 2022
- 97 Dr. B. V. Sarada delivered an Invited Lecture on "Materials and Processes for Energy and Healthcare" at '12th National Conference on Emerging Materials & Nanotechnology (NCEMN-2022)' Organized by Indian Association of Solid-State Chemists and Allied Scientists (ISCAS) and Govt. V.Y.T. PG Autonomous College, Durg (CG) during November 18-19 2022
- 98 Dr. Srinivasan Anandan delivered an invited lecture on "Development, and Demonstration of Indigenous Energy Storage (Li-ion Battery & Supercapacitor) Materials for Electric Vehicles Application" at the 'FDP on Smart Materials in Chemistry' organized by Adhiyamaan College of Engineering, Hosur on November 19, 2022
- 99 Dr. Tata Narasinga Rao delivered a Plenary lecture on "Indigenizing the Technologies for Advanced Materials (Powder to Product)" during 12th National Conference on Emerging Materials & Nanotechnology (NCEMN-2022) organized by Dept. of Chemistry, Govt. V.Y.T. PG Autonomous College, Durg, Raipur on November 19, 2022

- 100 Dr. Gururaj Telasang delivered an expert talk on 'Additive Manufacturing: Selective Laser Melting' organized by Methodist College of Engineering, Hyderabad on November 19, 2022
- 101 Dr. K. Ramya delivered an invited lecture on "Fuel Cells: Applications and Challenges" at the 'Faculty Development Program on Recent Advances in Renewable Energy Technologies for Sustainable Development' organized by SRM Institute of Science and Technology, Chennai during November 21-26, 2022
- 102 Dr. Krishna Valleti delivered a lecture on "Physical Vapor Deposition (PVD) and Related Activities at CEC" as part of 'ARCI Colloquium Series' organized by ARCI on November 23, 2022
- 103 Dr. B. V. Sarada delivered an invited Lecture on 'Materials and Processes for Biomedical Applications' at the Central University of Tamilnadu on November 29, 2022
- 104 Dr. G Sivakumar delivered an invited lecture on "High Velocity Thermal Spraying for Diverse Wear Resistant Applications", at the "Future Perspectives in Cold Spray Process and its Applications' organized by Government College of Engineering, Bargur on December 5, 2022
- 105 Dr. Neha Hebalkar and Ms. Priya Mathews, conducted an interactive talk on "Women's Safety at Work Place -Know the POSH Act" at DLRL, Hyderabad on December 6, 2022
- 106 Dr. Gururaj Telasang delivered an expert talk on "Basics of Additive Manufacturing: Powder Bed Fusion" at the 'Pre-conference workshop' organized by ASME in collaboration EFx, Bengaluru on December 7, 2022
- 107 Dr. R Eawaramoorthi delivered a lecture on "Lab-to-Fab translation of Perovskite Solar Cell Technology" as part of 'ARCI Colloquium Series' organized by ARCI on December 07, 2022
- 108 Dr. R. Subasri delivered the keynote lecture on "Autonomous Self-Healing Corrosion Protection Coatings" at the 'International Conference on Corrosion and Coatings (i3C)', Jamshedpur organized by IIM Jamshedpur and Tata Steel Limited, on December 08, 2022
- 109 Dr. Gururaj Telasang delivered an invited talk on "Powder Bed Additive Manufacturing: Materials and Applications" at the 'ASME India AM 3D Aero 2022' organized by ASME India at MSRIT, Bengaluru during December 8-9, 2022
- 110 Dr Naveen Manhar Chavan delivered an invited talk on "Significance of Sieving and Sizing in Thermal Spray" at NMDC Hyderabad on December 9, 2022
- 111 Dr. Tata Narasinga Rao delivered a lecture on "Role of Project & Productivity Management in R&D" during the workshop of, CHESS Laser Complex, Kanchanbagh, Hyderabadon December 9, 2022
- 112 Ms. Ch Gowthami (Dr. S Anandan) delivered a talk on "Advances in Battery Technologies for Electric and Hybrid Vehicles" organized by Indian Institute of Metals, Hyderabad during December 09-10, 2022
- 113 Dr. R. Balaji delivered an invited lecture on "A Glimpse of PEM Fuel Cell Activities at Advanced Research Centre International (ARCI)" at the 'International Conference on Electrochemical Power Sources-11', organized by the National University of Singapore (NUS), Singapore during December 11-15, 2022
- 114 Dr. S. Kumar delivered an invited talk on "Cold spray coating technique" at the 'SERB sponsored work shop on thermal spraying' organized by Government college of Engineering, Bargur, Tamilnadu on December 12, 2022
- 115 Dr. Gururaj Telasang delivered a lecture on "Additive Manufacturing Technology and Applications" at the 'Faculty Development Programme on Advanced Remanufacturing Technology' organized by National Institute of Advanced Manufacturing Technology (NIAMT), Ranchi, Jharkhand during December 12-23, 2022
- 116 Dr. Sanjay R. Dhage delivered an invited talk on "Solar Energy: The Ultimate Renewable Resource" at the 'National Energy Conservation Day celebration' organized by St Anne's College for Women Hyderabad on December 13, 2022
- 117 Dr. K Suresh delivered an invited talk on "Probing Nano-heterogenity" at the 'Workshop on Condenced Matter Research' organized by CVR College of Engineering, Hyderabad on December 15, 2022

- 118 Dr. Sanjay Bhardwaj delivered an invited talk on "Accelerating Translational Research by using Technology Readiness Levels (TRLs) and Related Methodologies at the 'Workshop on Industry 4.0 Implementation and Practices (TRL in Indian Context)' organized by IIT, Chennai on December 15, 2022
- 119 Dr. G Sivakumar delivered an invited lecture on "Self-Reliance through Thermal Spray processes for Refurbishment, Life Extension and Augmented Performance of Aerospace Components" at the 'National Seminar on Self Reliance in Aero Engine' organized by HAL Koraput on December 15, 2022
- 120 Dr Naveen Manhar Chavan delivered an invited talk on "High Pressure Cold Spray Deposition" at the 'Advanced Remanufacturing Tech' organized by NIFFT, Ranchi and AICTE on December 17, 2022 (Virtual)
- 121 Dr. Sanjay Bhardwaj delivered an invited talk on "Research Collaborations and Translational Research" at the 'General Management Programme for Women Scientists' sponsored by DST and organized by Administrative Staff College of India (ASCI), Hyderabad on December 21, 2022
- 122 Dr. V. Ganapathy delivered a lecture on "Fabrication of Perovskite Solar Cells and its Materials Perspectives" at the 'Brainstorming Workshop on the Innovative Solar PV Technology and Possibilities of their Commercialization for Large Area PV Modules in Collaboration with Industries' Organized by Jamia Millia Islamia University, New Delhi on December 21, 2022
- 123 Ms. Priya Anish Mathews delivered a lecture on "Intellectual Property Rights: Awareness and Protection" as part of 'ARCI Colloquium Series' organized by ARCI on December 21, 2022
- 124 Dr. D Sivaprahasam delivered an invited talk on "Thermoelectric Power from Waste Heat: Challenges in Converting Materials into Generator" at the "Conference on Perspectives in Materials Research' organized by Indian Institute of Science, Bangalore, during December 21-23, 2022
- 125 Dr. Sanjay Bhardwaj delivered a lecture on "Innovation Ecosystem" for faculty & students of Shri Vishnu Engineering College for Women, Bhimavaram, Andhra Pradesh on December 23, 2022
- 126 Dr. Balaji Padya delivered an invited talk on "Frontiers in Carbon Technology: Basics and Advanced Applications" at the 'Faculty Induction Programme (FIP) organized by UGC-Human Resource Development Centre, Osmania University, Hyderabad on December 23, 2022
- 127 Dr. Tata Narasinga Rao delivered lecture on "Indigenizing the Technologies for Energy Storage Materials (Powder to Product)" during Materials Research Society of India (MRSI), Jodhpur on December 23, 2022
- 128 Dr. R. Balaji delivered an invited lecture on "The Role of Functional Materials in Realizing Hydrogen Energy Technology" at the Faculty Development Programme on 'Clean and Sustainable Energy' conducted by SRM Institute of Science and Technology, Chennai on December 27, 2022
- 129 Mr. Manish Tak delivered a lecture on "Electron Beam Melting Additive Manufacturing" as part of 'ARCI Colloquium Series' organized by ARCI on January 04, 2023
- 130 Dr. R. Subasri delivered an invited talk on "Smart Nanocontainer-based Coatings for Prolonged Corrosion Protection" at the 'National Symposium on Convergence of Chemistry & Materials (CCM-2023)' organized by BITS-Pilani, Hyderabad on January 6, 2023
- 131 Dr. Neha Hebalkar delivered an invited lecture on "Developing Applications of Nanoporous Aerogels for Energy Conservation" at the '108th Indian Science Congress' held at Nagpur University, Nagpur on January 06, 2023
- 132 Dr. R Easwaramoorthi delivered a lecture on "Lab-to-Fab Translation of Perovskite Solar Cell Technology" at the 'International Conference on Advances in Renewable Energy-2023' organized by SRTM University, Nanded during January 11-13, 2023
- 133 Dr. Gururaj Telasang delivered lecture on "Basic of Additive Manufacturing: Powder Bed Fusion" at the 'Workshop on Advances in Materials Processes and Characterization (AMPC) 2023' organized by BIT Sindri, Dhanbad during January 17-21, 2023

- 134 Dr. Papiya Biswas delivered a lecture on "IR Transparent Spinel: Processing and Applications" as part of 'ARCI Colloquium Series' organized by ARCI on January 18, 2023
- 135 Dr. Sanjay Bhardwaj delivered a lecture on "Science and Technology Ecosystem" for faculty & students of Sarojini Naidu Vanita Maha Vidyalaya, Hyderabad on January 19, 2023
- 136 Dr. R. Balaji delivered an invited lecture on "The Role of Functional Materials Development in Realizing Hydrogen Energy Technology" at the 'Faculty Expert Lecture in the ATAL FDP Course on Recent Advances in Functional Materials for Energy Storage and Generation' conducted by NIT Warangal on January 23, 2023
- 137 Dr. M Buchi Suresh delivered an invited lecture on "Solid Oxide Cells (SOFC/SOEC) for Energy Generation ARCI Perspective" at the 'National Theme Meeting on Hydrogen Energy & Technology (HET-2023)' held at BARC, Mumbai during January 23-24, 2023
- 138 Dr. Gururaj Telasang delivered an expert lecture on "Powder Bed Fusion: Materials and Engineering Applications" at the '3-day CEP course on Additive Manufacturing of Metal Components', organized by DMRL, Hyderabad during January 23-25, 2023
- 139 Dr. R Vijay delivered an invited talk on "Development of Powders for Additive Manufacturing of Metallic Parts" at the 'Continuing Education Program (CEP) course on Additive Manufacturing of Metal Components' organized by DMRL, Hyderabad during January 23-25, 2023
- 140 Dr. Tata Narasinga Rao delivered a Plenary lecture on "Indigenizing the Technologies for Advanced Materials (Powder to Product)" during The Annual Technical Symposium of the Department of Metallurgical and Materials Engineering, the National Institute of Technology, Tiruchirapalli (NIT Trichy) on January 29, 2023
- 141 Dr. Gururaj Telasang delivered lecture on "Metal Additive Manufacturing: Selective Laser Melting and Engineering Applications" at the 'Colloquium series' organized by ARCI, Hyderabad on February 1, 2023
- 142 Dr. S M Shariff delivered a lecture on "The physics and engineering aspects of a laser" at the 'Telangana Science Fair Academy Teacher-Student Interactive WebTalk Series – 2023' on February 7, 2023
- 143 Dr. T. N. Rao, Dr. Sanjay Bhardwaj and Ms. Priya A. Mathews delivered a lecture on "Introduction of IP, Translational Research and Technology-driven Entrepreneurship " as a part of MS 5700 course on Intellectual Property (IP), Translational Research and Technology-Driven-Entrepreneurship at Indian Institute of Technology Hyderabad on February 8, 2023.
- 144 Dr. Neha Hebalkar delivered an invited talk on "Aerogels for Energy Conservation and Saving" at the 'Faculty Development Program on Innovations in Materials and Processing for Energy, Environment and Electronics' organized by Marathwada Mitramandal's College of Engineering, The Maharashtra Academy of Sciences and C-MET Pune on February 09, 2023
- 145 Dr. Neha Hebalkar delivered a plenary talk on "Nanomaterials to Nanotechnology Journey from Lab to Market" at the 'National Conference on Innovative Approaches in Chemical Sciences' organized by D Y Patil Education Society and Sadguru Gadage Maharaj College, Karad on February 10, 2023
- 146 Dr. Sanjay Bhardwaj delivered an invited talk on "Enhancing the Impact of Research Capability" organized by University College of Engineering, Science & Technology, JNTU Hyderabad on February 10, 2023
- 147 Dr. Balaji Padya delivered an invited talk on "Nano Technology-A New Dimensions in Material Science" at the 'Faculty Induction Programme (FIP) organized by UGC-Human Resource Development Centre, Osmania University on February 15, 2023
- 148 Dr. Sanjay Bhardwaj delivered a lecture on "Technology Readiness Levels (TRLs) and Other Adapted Tools for Managing Translational Research" as a part of MS 5700 course on Intellectual Property (IP), Translational Research and Technology-Driven-Entrepreneurship at IIT Hyderabad on February 15, 2023.
- 149 Dr. M Buchi Suresh delivered a lecture on "Solid Oxide Fuel Cells: An Emerging Energy Efficient Technology" as part of 'ARCI Colloquium Series' organized by ARCI on February 15, 2023
- 150 Dr. S Sakthivel delivered an invited lecture on 'Nanocomposite based Absorber Coatings for Concentrated Solar Thermal Application" at the "Workshop on Advanced Composite Materials for Energy Conversion and Storage Applications', organized by University College of Engineering, BIT Campus, Anna University, Trichy during February 16-22, 2023

- 151 Dr. S Sakthivel Delivered an invited lecture on "Functional Coatings for Self-clean and Easy to Cleaning of PV Panels" at the 'Workshop on Advanced Composite Materials for Energy Conversion and Storage Applications' organized by University College of Engineering, BIT Campus, Anna University, Trichy, during February 16-22, 2023
- 152 Dr. Raman Vedarajan delivered an invited lecture on "Priorities, Discrimination and Success in Science" at San Academy, Chennai on February 17, 2023
- 153 Dr. Raman Vedarajan delivered an invited lecture on "Hydrogen for Global Well Being", at the 'Lavoise Science interaction' organized by Annai Hajira Women's College (AHWC), Tirunelveli, on February 21, 2023
- 154 Dr. Sanjay Bhardwaj delivered a lecture on " Identification of Value Addition Requirements in Translational Research Value Chain and Technoloical Collaborations " as a part of MS 5700 course on Intellectual Property (IP), Translational Research and Technology-Driven-Entrepreneurship at IIT Hyderabad on February 22, 2023.
- 155 Dr. Naveen Manhar Chavan delivered an invited talk on "Fundamentals and Applications of Cold Spray" organized by Skyroot Pvt Ltd, Hyderabad on February 22, 2022 (Virtual)
- 156 Dr. R Subasri delivered an invited talk on "Using Nanotechnology to Generate Surfaces that Mimic Nature" at the 'Orientation Program for Promoting Science as Career for Faculty members of Degree Colleges in Telangana during National Science Day Celebrations' organized by ARCI, Hyderabad on February 23, 2023
- 157 Dr. Raman Vedarajan delivered an invited Lecture on "Science and Economy of Hydrogen", at the 'National Science Day conference' organized by Savitha Dental College on February 23, 2023
- 158 Dr. M Buchi Suresh delivered an invited lecture on "Role of Advanced Ceramics for Future Technologies" at the 'Orientation Programme for Promoting Science as Career' as a part of Science Day Celebrations at ARCI, Hyderabad on February 23, 2023
- 159 Dr. K Suresh delivered an invited talk on "Microstructure of gas atomized powders and cold sprayed coatings of aerospace grade aluminum alloys" at the 'National Conference on Advanced Materials and Manufacturing Technologies (AMMT-2023)' organized by NIIST, Trivandrum during February 23-24, 2023
- 160 Dr. Neha Hebalkar delivered an Invited online talk on 'Silica Aerogel based Industrial Thermal Insulation' at the '2nd Management Development Program on Innovations in Nanoscience and Nanotechnology for Industrial Applications' organized by School of Nanoscience and Technology, Shivaji University, Kolhapur on February 24, 2023
- 161 Dr. Srinivasan Anandan delivered an invited lecture on "Design, Development and Demonstration of Indigenous Energy Storage Materials for Electric Vehicles Applications" at the 'Faculty Development Programme' on Power Electronics, Energy Storage and Renewable Technologies (PEESRT) for e-transportation in India' organized by Gokaraju Rangaraju Institute of Engineering and Technology, Hyderabad and NIT Warangal on February 24, 2023 (Virtual)
- 162 Dr. Sanjay Bhardwaj delivered a lecture talk on "Science for Society" for faculty & students of Nagarjuna Government College, Nalgonda, Telangana on February 24, 2023
- 163 Dr. B. V. Sarada delivered an invited lecture on "Nanostructured Materials for Supercapacitor Applications" at the 'Faculty Development Program on Energy Harvesting Technologies' organized by Geetanjali College of Engineering and Technology and IEEE Hyderabad Chapter during February 27 - March 04, 2023
- 164 Dr. R Subasri delivered a talk on "Global Science for Global Well Being" at the 'National Science Day Celebrations' organized by ARCI, Hyderabad on February 28, 2023
- 165 Dr. B. V. Sarada delivered an invited lecture on "Materials and Technologies for Energy and Biomedical Applications", organized by Vigyan University on February 28, 2023delivered a talk on "Global Science for Global Well Being" at the 'National Science Day Celebrations' organized by ARCI, Hyderabad on February 28, 2023
- 166 Dr. Sanjay Bhardwaj delivered a lecture on "TRL based Partnership Strategies " as a part of MS 5700 course on Intellectual Property (IP), Translational Research and Technology-Driven-Entrepreneurship at IIT Hyderabad on March 1, 2023
- 167 Dr. S Kumar delivered a lecture on "Bonding Mechanism in Cold Sprayed Coatings" as part of 'ARCI Colloquium Series' organized by ARCI on March 01, 2023
- 168 Dr. R. Vijay delivered an invited lecture on "Development of Oxide Dispersion Strengthened Iron based Alloys for High Temperature Applications" at the 'Continuing Education Program (CEP) course on Principles Processing and Application of Powder Metallurgy Materials for Defence Applications' organized by DMRL, Hyderabad during March 1-3, 2023
- 169 Dr. R. Vijay delivered an invited lecture on "Development of Oxide Dispersion Strengthened Iron based Alloys for High Temperature Applications" at the 'Continuing Education Program (CEP) course on Principles Processing and Application of Powder Metallurgy Materials for Defence Applications' organized by DMRL, Hyderabad during March 1-3, 2023

- 170 Dr. R Easwaramoorthi delivered a lecture on "Efficient and Durable Large-area Perovskite Solar Cell Module" at the 'Perosvkite Society of India Annual Meeting (PSIM-2023)', Organized by IIT Roorkee, Roorkee during March 1-3, 2023
- 171 Dr. R Easwaramoorthi delivered a lecture on "Efficient and Durable Large-area Perovskite Solar Cell Module" at the 'Perosvkite Society of India Annual Meeting (PSIM-2023)', Organized by IIT Roorkee, Roorkee during March 1-3, 2023
- 172 Dr. V Ganapathy delivered a lecture on "Carbon based Perovskite solar cells for Scalability and Stability" at the 'Perosvkite Society of India Annual Meeting (PSIM-2023)', Organized by IIT Roorkee, Roorkee during March 1-3, 2023
- 173 Dr. Sanjay Bhardwaj delivered an invited talk on "Research Collaborations" at the 'Management Development Programme for JAG Level Officers of Geological Survey of India' organized by ASCI, Hyderabad on March 3, 2023
- 174 Dr. Sanjay Bhardwaj delivered an invited talk on "Science and Technology for National Prosperity" organized by Babu Jagjivan Ram Government Degree College, Narayanaguda, Hyderabad on March 3, 2023
- 175 Dr. Dibyendu Chakravarty delivered an invited lecture on "Nanomaterials: Applications in Powder Metallurgy" at the 'CEP course' organized by DMRL, Hyderabad on March 3, 2023
- 176 Dr. Ravi Bathe delivered an invited talk on "Additive Manufacturing of Complex Parts with Powder Bed Fusion Technology" at the '2nd International Conference on Advanced Materials and Manufacturing Processes (ICAMMP-2023)' organized by Jawaharlal Nehru Technological University, Gurajada, Vizianagaram (JNTUGV) during March 3-4, 2023
- 177 Dr. D Sivaprahasam delivered invited talk on "Strategies to Fabricate devices from particulate thermoelectric Materials" at the '5th international workshop on advanced functional nanomaterials (IWAN-5, 2023)' organized by Anna University, Chennai, during March 3-4, 2023
- 178 Dr. R. Vijay delivered an invited lecture on "Materials for Energy Storage and Powders for Advanced Processing" at the 'UK-India Industry-Academia Scoping Workshop: Critical Metals and Materials Research and Innovation opportunities' organized by British High Commission, New Delhi and Indian Institute of Technology Bombay during March 6-7, 2023
- 179 Dr. D Prabhu delivered an invited talk on "Nano Engineered Magnets" at the 'National Symposium –INPHYNITT-2023' organized by NIT, Trichy on March 7, 2023
- 180 Dr. R Easwaramoorthi delivered a lecture on "Single-crystal derived Perovskite Precursor for Efficient and Stable Perovskite Solar Cells" at the '2nd Indo-Japan joint workshop on Photovoltaics' Organized by SSN Institutions on Mach 9, 2023
- 181 Dr. Gururaj Telasang delivered a lecture on "Additive Manufacturing: Selective Laser Melting" at the 'Workshop on Additive Manufacturing of Biomedical Implants - Academia and Industry Perspectives' organized by IIT Chennai during March 10-11, 2023
- 182 Dr. Raman Vedarajan delivered an invited talk on "Electronically Conductive Coatings for Corrosion Protection" at the 'Electrochemical Corrosion Techniques: Theory and Hands-on Training' organized by NACE India at B.S Abdur Rahman Crescent Institute of Science and Technology, Chennai on March 11, 2023
- 183 Dr. R. Vijay delivered a plenary lecture on "Advances in Powder Materials and Technologies" at the 'International conference on Powder Metallurgy (PM23)', organized by Powder Metallurgy Association of India, Mumbai during March 13-15, 2023
- 184 Dr. Joydip Joardar delivered an invited lecture on "Development of 2-Dimenional Tungsten-disulfide Reinforced Al-Cu Alloy based Self-lubricating Composites" at the 'International Conference on Powder Metallurgy and Particulate Materials (PMAI-PM23)' organized by Powder Metallurgy Association of India, Mumba during March 13-15, 2023
- 185 Dr. Gururaj Telasang delivered an invited talk on "Powder Bed Fusion Additive Manufacturing: Materials and Applications" at the 'International Conference on Powder Metallurgy & Particulate Materials (PM23)' organized by Powder Metallurgy Association of India, Mumbai during March 13-15, 2023.
- 186 Dr. R Easwaramoorthi delivered a lecture on "Scalable Fabrication of Perovskite Solar Cells" at the 'Indo-German Workshop on Developments in Established and Emerging Photovoltaic Technologies' organized by SRM Institute of Science and Technology, Chennai during March 13-15, 2023
- 187 Dr. R Prakash delivered an invited talk on "Aqueous Process Based Micron -sized Lithium Iron Phosphate as Cathode for Lithium Ion Batteries" at the 'PMAI 2023 International Conference' organized by Powder Metallurgy Association of India, Mumbai during March 13-15, 2023
- 188 Dr. D Sivaprahasam delivered an invited talk on "Powder Metallurgy Processed Thermoelectric Devices" at the 'PMAI 2023 International Conference', organized by Powder Metallurgy Association of India, Mumbai during March 13-15, 2023
- 189 Dr. Malobika Karanjai delivered a key note invited lecture on "New Generation PM based Soft Magnetic Composites for Axial Flux Motors & PM Synchronous Reluctance Motors" at the '23rd International Conference on Particulate Materials & Technology PM23' organized by Powder Metallurgy Association of India (PMAI) Bombay on March 14, 2023

- 190 Dr. R Senthil Kumar delivered a lecture on "Powder to Product Transformation of Transparent Ceramic Materials at ARCI" as part of 'ARCI Colloquium Series' organized by ARCI on March 15, 2023
- 191 Ms. Priya Anish Mathews delivered a lecture on the topic Turn Ideas into Valuable Assets through Intellectual Property Rights (IPR) Protection as a part of MS 5700 Course on 'IP, Translational Research, Technology Driven Entrepreneurship' at IIT Hyderabad on March 15, 2023.
- 192 Dr. K Ramya delivered an invited lecture on "Development of Anion Exchange Membrane-based Fuel Cell and Electrolyzer" at the '14th International Conference on Advancements in Polymeric Materials', organized by CIPET: SARP-APDDRL, Bengaluru on March 17-19, 2023
- 193 Dr. R Balaji delivered an invited lecture on "An Overview of Hydrogen Energy Technology and its Recent Development" at the 'Expert lecture program' organized by the Department of Chemical Engineering, NIT Tiruchirappalli on March 20, 2023
- 194 Dr. Sanjay Bhardwaj delivered a lecture on "Research Collaborations" for faculty & students of Military College of Electronics & Mechanical Engineering, Secunderabad on March 20, 2023
- 195 Dr. R Balaji delivered an invited lecture on "The Challenges and Opportunities in Realising Green Hydrogen Mission" at the 'National Conference on Novel Materials for Harnessing Green Hydrogen for Energy and Environment Applications: A Step Forward towards the National Hydrogen Mission', Conducted by the Nallamuthu Gounder Mahalingam College, Pollachi, TamilNadu on March 23, 2023
- 196 Dr. S Sakthivel delivered an invited lecture on "Functional Coatings for PV & Solar Thermal Applications" at the 'International Conference of ICONN2023" organized by SRM Institute of Science and Technology, Chennai, during March 27-29, 2023
- 197 Dr. B V Sarada delivered an invited lecture on "Biocompatible Coatings on AM Built Medical Implants" at the 'National Workshop on Composite Materials for Biomedical Applications', organized by Department of Mechanical Engineering, Acharya Nagarjuna University, Guntur on March 27, 2023
- 198 Dr. Prasenjit Barick delivered a lecture on "Glass and Glass-Ceramics An overview" as part of 'ARCI Colloquium Series' organized by ARCI on March 29, 2023
- 199 Ms. Priya Anish Mathews delivered lectures on the topics 'Obtaining a Patent: The Steps Involved in Securing Patent Rights' and 'Hands-On Experience: Understanding What, When, Where, Why, and How of Prior-Art Searches' as a part of MS 5700 Course on 'IP, Translational Research, Technology Driven Entrepreneurship' at IIT Hyderabad on March 29, 2023
- 200 Dr. M B Sahana Delivered an invited talk on "Influence of Conductive Additives on Lithium Ion Battery Performance" at the 'International Workshop Electrochemical Techniques for Next Generation Batteries' organized by SRM Institute of Science and Technology and IIT Madras, Chennai during March 29-30, 2023
- 201 Dr. Srinivasan Anandan, delivered an invited lecture on "Lab to Fab Translation of Energy Storage Materials for Electric Vehicles Application" at the 'Research day' organized by School of Electrical & Electronics Engineering, SASTRA Deemed University, Thanjavur on March 31, 2023

Participation in Training Programmes in India

- 1 Dr. D. Prabhu attended "Industrial Meet on Rare Earth Permanent Magnet Technology" organized by DMRL, Hyderabad on May 13, 2022
- 2 Dr. Pawan Kumar Jain attended online training programme on "Policy for Science and Science for Policies" organized by NIAS-DST during August 22-26, 2022
- 3 Dr. Krishna Valleti attended training programme on "Material Characterization, Modelling and Finite Element Analysis" organized by Gokaraju Rangaraju Institute of Engineering and Technology (GREIT), Hyderabad during August 22-28, 2022
- 4 Dr. B. V. Sarada attended training programme on "Leadership and Organization Development for Women Scientists/Technologists" conducted by Centre for Organization Development (CoD) at Hyderabad during September 12-16, 2022
- 5 Dr. Sanjay R. Dhage attended training programme on "Administrative Vigilance" conducted by Department of Science & Technology (DST) during October 19-21, 2022
- 6 Ms. Priya Anish Mathews and Ms. K. Swati attended Awareness program on "IPR-patents, designs, Trademarks, GI and Copyright" organized by Commissionerate of Collegiate & Technical Education, Govt. of Telangana, Hyderabad during December 15-16, 2022
- 7 Dr. Malobika Karanjai attended 11th training programme on "Science and Technology for Rural Societies for Women Scientists and Technologists" conducted by Indian Institute of Public Administration (IIPA), New Delhi during December 19-23, 2022
- 8 Ms. Priya Anish Mathews attended training programme on "Integrated Scientific Project Management for Women Scientists and Technologists" conducted by Centre for Organization Development (COD), Hyderabad during February 6-10, 2023

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Participation in Indian Conferences/Symposia/Seminars/Workshops/Exhibitions

- 1 Dr. R Prakash, Dr. T. Mohan Dr. Vallabha Rao Rikka attended "Demonstration of 60V, 1MWh LIB pack for EV application with Leep e-drive" organized at Chennai Expo on EV and ESS on April 30, 2022
- 2 Mr. Manish Tak and Dr. Kaliyan Hembram participated in "National Conference on 3D Printing in Medical Devices and Implants" organized by National Center for Additive Manufacturing (NCAM), Hyderabad on May 13, 2022
- 3 Dr. R. Vijay and Dr. D Prabhu attended "DMRL DRDO- Industry Meet on Rare Earth Permanent Magnet (REPM) Technologies" organized by DMRL, Hyderabad on May 13, 2022
- 4 Dr. Kaliyan Hembram attended the "National Conference on 3-D Printing in Medical Devices and Implants 2022" organized by National Center for Additive Manufacturing, Hyderabad on May 13,2022
- 5 Dr. Shariff SM, Dr. Koppoju Suresh, Dr. Gururaj Telasang and Mr. S. Ganesh attended one day technical workshop on "Accelerated Materials Discovery through Computational Approaches" organized by DMRL, Hyderabad on June 16, 2022
- 6 Dr. B. V. Sarada attended a workshop on "Women Scientists Conclave: Self Reliance" organized by The Academy for Science, Technology, and Communication (ASTC) along with National Academy of Sciences (NASI) Hyderabad chapter, Hyderabad on October 10, 2022
- 7 Dr. V. V. Phani Kumar participated in the "International Exhibition & Conferences on 4th Materials, Engineering & Technology (MET) exhibition and 14th Heat Treatment show" organized at the Bombay Exhibition center during November 2-4, 2022
- 8 Shri. S. Ramakrishnan and Mr. P. Sreeraj (Dr. Raman Vedarajan) participated in "enVision, India's First Energy Festival", organized by IIT Madras Research Park and India Energy Storage Alliance (IESA) during November 3-5, 2022
- 9 Dr. B. V. Sarada attended "Prof. Y. Nayudamma Memorial Lecture" organized by Telangana Academy of Sciences, Hyderabad on November 26, 2022
- 10 Dr. Gururaj Telasang attended a trade show on "Additive Manufacturing and 3D Printing", organized by AMTech India and NCAM, Hyderabad, during December 2-3, 2022
- 11 Ms. Ch. Gowthami (Dr.S.Anandan) attended a talk on "Advances in Battery Technologies for Electric and Hybrid Vehicles" at Hyderabad during December 9-10, 2022
- 12 Ms. Priya Anish Mathews and Ms. K. Swati attended Awareness program on "IPR-patents, designs, Trademarks, GI and Copyright" organized by Commissionerate of Collegiate & Technical Education, Hyderabad during December 15-16, 2022
- 13 Ms. Ch. Gowthami (Dr. S Anandan) attended "108th Indian Science Congress Expo" organized by Indian Science Congress at Nagpur during Jan 03-07,2023
- 14 Dr. B. V. Sarada and Dr. Kaliyan Hembram attended a workshop on "Metallic Bio-Implants: Role of Additive Manufacturing" organized by DMRL, Hyderabad on January 06, 2023
- 15 Mr. D. Nazeer Basha (Dr. Ravi Bathe) attended the Micro-credit course on "Laser Assisted Additive Manufacturing of Steel (LAMS)" organized by IIT Kharagpur, during January 9-16, 2023 (Online)
- 16 Dr. Sanjay R. Dhage participated in the "All India Joint Official language Scientific and Technical Seminar" organized by Defence Research and Development Laboratory (DRDL), Hyderabad during January 11-12, 2023
- 17 Dr. Rambha Singh participated in the "2nd All India Joint Official language Scientific/Technical Seminar" organized by Defence Electronics Research Laboratories (DLRL), Hyderabad during February 2-3, 2023
- 18 Mr. K.V.Phani Prabhakar, and Mr. E. Anbu Rasu participated in two days National Workshop on 'Challenges in Welding and Additive Manufacturing" organized by BITS Pilani, Hyderabad during February 9-10, 2023
- 19 Dr. B. V. Sarada participated in "BioAsia 2023" organized by Govt. of Telangana, Hyderabad during February 24 26, 2023
- 20 Mr. D. Nazeer Basha (Dr. Ravi Bathe) attended the Short-term course on "Characterization and Testing of Components Following Laser Materials Processing including Surface Engineering and Additive Manufacturing", organized by IIT Kharagpur, during March 18-26, 2023 (online)

Panel Discussion

Name	Technical Session Topic	Event Name	Date
Dr. Joydip Joardar		International Conference on Powder Metallurgy, held at PuneSectional Committee,TED-27	April 18-20, 2022
Dr. B V Sarada	Medical Additive: Opportunity in R&D and Its Roll Out Strategy Medical Additive: Opportunity in R&D and Its Roll Out Strategy	National Centre for Additive Manufacturing (NCAM) Hyderabad	May 13, 2022
Dr. Tata Narasinga Rao	Roadmap for implementation of 3D printing in Healthcare	National Centre for Additive Manufacturing (NCAM) Hyderabad	May 13, 2022
Dr. R Vijay	Advanced Materials	Joint UK-INDIA Advanced Manufacturing Pathfinder Program organized by Innovate UK and the Department of Science and Technology, Government of India (Virtual)	June 28, 2022
Dr. R Vijay	Resource Efficient & Sustainable Manufacturing	Joint UK-INDIA Advanced Manufacturing Pathfinder Program organized by Innovate UK and the Department of Science and Technology, Government of India (Virtual)	June 30, 2022
Dr. R. Prakash	Battery Session II	Annual Technical Meeting of Indian Institute of Metals (IIM-ATM), held at HyderabadBattery Swapping Standards Development	November 13-16, 2022
Dr. Sanjay Bhardwaj	Contract Research – Expanding scope of industry- institution engagement & modelling contracts for mutually beneficial outcomes	STEM SUMMIT 2022 held at New Delhi	November 16-17, 2022
Dr. Sanjay Bhardwaj		Workshop on 'Industry 4.0 Implementation and Practices (TRL in Indian Context)' held at IIT Madras, Chennai	December 15, 2022
Dr. B V Sarada	DigitALL: Innovation & Technology for Gender Equality	Women's Conclave organized by CSIR-Central Electrochemical Research Institute (CECRI). (Virtual)	March 8, 2023
Dr. Joydip Joardar	Alternative Metals and Materials (Earth abundant) – Substitution of Critical Metals and Materials	UK-India Industry-Academia scoping workshop: Critical Metals Research and Innovation opportunities (British-High Cmmission-IIT-Bombay)	March 6-7, 2023
Dr. Malobika Karanjai		International Conference on Powder Metallurgy & Particulate Materials + Exhibition 2023 organized by PMAI, held at Pune	March 13, 2023
Dr. Joydip Joardar	Press and Sinter	International Conference on Powder Metallurgy and Particulate Materials (PMAI-PM 23), held at Pune	March 13-15, 2023

SCI Publications (2022)

- 1 N.P Wasekar, "The influence of grain size and triple junctions on corrosion behavior of nanocrystalline Ni and Ni-W alloy", Scripta Materialia, Vol. 213, Art 114604, 2022
- 2 Shiv Prakash Singh, Papiya Biswas, Roy Johnson, "Colloidal Shaping of Transparent Spinel through Slip Casting Using Contamination Free Spinel Moulds" Transactions of the Indian Ceramic Society, Vol. 81(1), p30-36, 2022
- 3 Amol C Badgujar, RO Dusane, Sanjay R Dhage, "Solution-processed CIGS thin film solar cell by controlled selenization process", Materials Today Proceedings, Vol 52, p 529-833, 2022
- 4 KRC Somaraju, A Jyothirmayi, L Rama Krishna, R Subasri, "Corrosion Behavior of Anodized and Sol-Gel Duplex Coatings on AA3004", Transactions of Indian Insitute of Metals, Vol. 75(8), p 2159-2168, 2022
- 5 SV Pavana Mocherla, V Ramya, Debendranath Kar, D Prabhu, R Gopalan, "Correlation between milling-induced strain, microstructure, and magnetic properties in anisotropic SrFe12O19 powders", Ceramics International, Vol. 84(18), p2669-26677, 2022
- 6 S Kumar, AS Dhavale, N M Chavan, S Acharya, "Superconducting niobium coating deposited using cold spray", Materials Letters, Vol. 312, Art 131715, 2022
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Non-SCI Papers:

- 1 Anup Sharma, Deepak Marla, Suhas Joshi, Ravi Bathe, "A Study of Femtosecond Laser Processed Microtextures on Silicon Wafers to Enhance Optical Absorption", Lasers in Manufacturing and Materials Processing, Vol. 9(3), p 277-291, 2022
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Conference Proceedings

1 Priya Anish Mathews, Swati Koonisetty, Sanjay Bhardwaj, S.Sakthivel, and G.Padmanabham, 'Protective Materials and Coatings for Solar Energy Devices: A Patent Roundup' Proceedings of International Conference on Recent Technologies and Advanced Materials for Green Energy and Sustainable Environment (RTAMGESE 2021), ISBN:978-93-5457-143-5, p 57-61, 2021 (published in 2022-2023)

Books and Book Chapters

- 1 A chapter on "Oxide free Material for Perovskite Solar Cells" authored by Ramya Krishna, P Bhyrappa, C Sudakar, R Easwaramoorthi, Ganapathy. V, in the book on 'Oxide free Nanomaterials for Energy Storage and Conversion Applications', (Eds) Prabhakarn Arunachalam, Jayaraman Theerthagiri, Abdullah Al-Mayouf, Myong Yong Choi, Madhavan Jagannathan, ISBN: 9780128239360, Elsevier Science, p 287-306, 2022
- 2 A chapter on "MXenes and their Composites for Supercapacitors and Hybrid Capacitors" authored by N Aamani, Elsa George, M Vijayakumar, A Bharathi Sankar and Mani Karthik, in the book on 'Mxenes and their Composites: Synthesis, Properties and Potential Applications ', (Eds) Kishor Kumar Sadasivuni, Kalim Deshmukh, S. K. Khadheer Pasha, Tomas Kovarik, ISBN: 978-0-12-823361-0, Elsevier Science, p 371-396, 2022
- 3 A chapter on "Recent Progress in the Development of Smart Coatings for Corrosion Protection of Magnesium Alloys" authored by Swapnil H. Adsul, Shirish H. Sonawane, R Subasri, in the book on 'Magnesium Alloys: Advances in Research and Applications', (Eds) Catalin Julian Pruncu and Kavian Omar Cooke, ISBN: 978-1-68507-975-8, Nova Publishers, 2022
- 4 A chapter on "Multifunctional Duplex Coatings on Mg Alloys Generated through Anodization and the Sol-Gel Process" authored by K Pradeep Premkumar and R Subasri, in the book on 'Magnesium Alloys: Advances in Research and Applications', (Eds) Catalin Julian Pruncu and Kavian Omar Cooke, ISBN: 978-1-68507-975-8, Nova Publishers, 2022
- 5 A chapter on "Corrosion Protection of Metals/Alloys through Multifunctional Sol-gel Nanocomposite Coatings" authored by Swapnil H. Adsul, K Pradeep Prem Kumar, S Manasa, Aarti Gautam, KV Gobi, Shirish H. Sonawane and R Subasri, in the book on 'A Treatise on Corrosion Science, Engineering and Technology', (Eds) U Kamachi Mudali, T Subba Rao, S Ningshen, Radhakrishna G. Pillai, Rani P. George and TM Sridhar, ISBN: 9789811693014, Indian Institute of Metals Series, Springer Nature, p 641-662, 2022
- 6 A chapter on "Benzotriazole Encapsulated Nanocontainer-based Self-healing Coatings for Corrosion Protection of Mild Steel" authored by Aarti Gautam, K R C Soma Raju, KV Gobi, R Subasri, in the book on 'Recent Trends in Electrochemical Science and Technology: Proceedings of Papers Presented at NSEST-2020 and ECSIRM-2020', (Eds) U. Kamachi Mudali, S.T. Aruna, H.P. Nagaswarupa, Dinesh Rangappa, ISBN: 978-981-16-7553-9, Springer Nature, p 1-15, 2022
- 7 A chapter on "Proton Exchange Membrane Testing and Diagnostics" authored by Abha Bharti and Rajalakshmi Natarajan in the book on 'PEM Fuel Cells Fundamentals, Advanced Technologies, and Practical Application', (Ed) Gurbinder Kaur, ISBN: 978-0-12-823708-3, Elsevier Science, p 137-172, 2022
- 8 A chapter on "High-Temperature Proton Exchange Membrane—An Insight" authored by Sundararajan Ramakrishnan, Krishnan Ramya and Natarajan Rajalakshmi in the book on 'PEM Fuel Cells Fundamentals, Advanced Technologies, and Practical Application', (Ed) Gurbinder Kaur, ISBN: 978-0-12-823708-3, Elsevier Science, p 223-242, 2022
- 9 A chapter on "Synthesis and Structure of 2-D materials", authored by Bijoy Kumar Das and R. Gopalan, in the book on 'Emerging Two Dimensional Materials and Applications', ISBN: 9781032162874, CRC Press, p 7-16, 2022
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Other Articles Published Via Print, Digital or Electronic Media

- 1 Sanjay R. Dhage, "Indigenous Technology Development of Thin Film Solar Cell and Module", Srujan-ARCI's Hindi Magazine, Vol. 6, p.4-5, 2022-23
- 2 K. Swati, Priya A. Mathews, and Sanjay Bhardwaj, "Patentability: Scope and Limitations" SRUJAN ARCI Hindi Magazine, Vol. 6, p.15-18, 2022-23
- 3. Gururaj Telasang, "New Manufacturing Process for Steel Alloy Powder for Developing Efficient Cooling Channels can Make Pressure Die Casting More Efficient" DST website, June 2022
- 4 Sanjay Bhardwaj, "Managing Technologies for Societal Impact, Souvenir "Shaping India's Techade Challenges and Opportunities", 10th National Congress of Jesuit Alumni Associations of India (JAAI), p 55, February 10-12, 2023
- 5 Gururaj Telasang, "Novel Bi-metallic Joining Process can Create a Composite from Copper and Steel for Engineering Applications which Need High Thermal & Electrical Conductivity" DST website, March 2023
- 6 R. Easwaramoorthi and Dr. V. Ganapathy, "Perovskite Solar Cells with Enhanced Stability Fabricated using Inorganic Material", Ministry of Science and Technology website, March 31, 2023
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Contribution to Professional Societies/Bodies as Office Bearers

Dr. Sanjay Bhardwaj • Chairman of Indian Institute of Chemical Engineers – Hyderabad Regional Centre (IIChE – HRC) during 2022-23 • Vice-chairman, 18th Annual Session of Chemical Engineering Student Congress (SCHEMCON 2022) on theme "Sustainable Technological Advancements in Chemical Industries – 2022" Dr. Malobika Karanjai • Nominated as Co-opted Member of Consultative Group on e-mobility for draft the 'Technical Road Map on Deployment of Zero Emission Truck in India', Office of the Principal Scientific Adviser to Govt. of India.	ts'
Dr. Malobika Karanjai • Nominated as Co-opted Member of Consultative Group on e-mobility in draft the 'Technical Road Map on Deployment of Zero Emission Truck in India', Office of the Principal Scientific Adviser to Govt. of India.	
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	to king
 Mentor & Advisor for Atal Incubation Centre ALEAP Women Entrepreneurs Hub (AIC ALEAP WE-HUB), a multisector incubator ce of Association of Lady Entrepreneurs of India (ALEAP), Atal Innovation Mission (AIM) of NITI Aayog, Gol 	ntre n
Co-Convener of International Conference on Powder Metallurgy & Particulate Materials + Exhibition 2023 (PMAI-PM 23)-13th to 15th Ma 2023	ırch
Guest Editor of PM23 papers for publication in (i) Materials Today Proceedings, Elsevier (ii) J. Powder Technology, Taylor & Francis	
Dr. Joydip Joardar • Member, Governing Council, Powder Metallurgy Association of India (PMAI) 2022-2024.	
Dr. M. Buchi Suresh • Executive Member of Indian Ceramic Society	
 Dr. Gururaj Telasang As convenor organised on a One day Workshop on Simulation-driven design for E mobility" at BVRIT Narasapur, Supported by Altair India, SAEINDIA Hyderabad division activity on February 24, 2023 	as
 Extended Additive Manufacturing expert service to teaching as an Adjunct Professor (2023) at the School of Engineering Sciences and Technology (SEST), University of Hyderabad 	
 Nominated as a Member – BOS for Department of Metallurgical Engineering, JNTU College of Engineering, Hyderabad and RGUKT - Basar from the academic year 2022 – 23 onwards 	-
Dr. Shiv Prakash Singh • Associate Editor (Journal of American Ceramic Society) • Associate Editor (Frontiers in Materials)	

Awards and Honours

- Mr. V. Sri Harsha Swarna Kumar (Dr R Balaji) received the 'Best Oral Presentation award' for the paper on "Patterning of platinum coating on flow field plates for PEM water electrolyzers for hydrogen production" at the 'National conference on Energy Technologies' conducted by Indian Institute of Technology, Chennai during April 29-30, 2022
- Dr. V.V.N. Phani Kumar won the 'Best Presentation Award' for the paper "Investigation of micron-sized lithium Iron Phosphates cathode using an aqueous binder for Li-ion batteries" at the National Conference on Energy Technologies (NCET) organized by IIT Chennai, during April 29-30, 2022
- Mr. Lava Kumar Bathini (Dr Nitin Wasekar) won the 'Best Poster Runner-up Award' at International Conference on Strength of Materials (ICSMA-2022) held at Metz, France on June 28, 2022
- Dr. Malobika Karanjai was awarded the 'Distinguished Materials Researcher' by Venus International Foundation at Chennai on July 2, 2022
- Ms. Ramya Krishna Battula (Dr. R Easwaramoorthi) received the 'Best Paper Award' for the paper on "Precursor tuning for post-treatment free MAPbI3 films for efficient and stable perovskite solar cells" at the '8th International conference on Advances in Energy Research (ICAER 2022)' held at IIT Bombay duirng July 7-9, 2022
- Vikrant Trivedi (Dr. Manjusha Battabyal) won '3rd Prize in International Metallography Contest' by Metallurgical Engineering (Sponsored by Struers) on September 15, 2022
- Ms. K Reshma Dileep (Dr. V Ganapathy) received the '2022-IGSTC Industrial Fellowship (PIEF)' by Indo-German Science and Technology Centre, and Dept. of Science & Technology, Govt. of India during October, 2022 – March, 2023
- Mr. Lava Kumar Bathini (Dr Nitin Wasekar) won '2nd Prize for the Best Oral Presentation' for the paper "Compositional gradient nanocrystalline Ni-W coatings for superior wear resistance" at the Annual Technical Meeting of Indian Institute of Metals (IIM-ATM), Hyderabad during November 13-16, 2022
- Mr. Muni Bhaskar Siva secured the 'First prize in an oral presentation' at the Annual Technical Meeting of Indian Institute of Metals (IIM-ATM), Hyderabad during November 13-16, 2022
- Ms. Aarti Gautam (Dr. R Subasri) was awarded the 'First Prize in Oral Presentation' at the 'STREE 2020 National Conference & Expo' held at Jawaharlal Nehru University, New Delhi during November 24-26, 2022
- Dr. Neha Hebalkar was inducted as a 'Fellow of Maharashtra Science Academy' on December 2, 2022
- Ms. Aarti Gautam (Dr. R Subasri) was awarded the 'Best Paper Award' at the 'International Conference on Corrosion and Coatings (i3C)' organized by IIM, Jamshedpur in association with Tata Steel, CSIR-NML & NIT, Jamshedpur during December 7-8, 2022
- Mr. D. Nazeer Basha (Dr. Ravi Bathe) received the 'Best poster Presentation Award' for the paper on "Femtosecond Laser textured micro-groove and micro-crosshatch patterns to enhance the tribological performance of gray cast iron" at 12th International Conference on Precision, Micro, Meso and Nano Engineering 2022 (COPEN 12) held at IIT Kanpur during December 8-10, 2022
- Dr. Tata Narasinga Rao received the 'MRSI Materials Science Annual Prize-2022' from Materials Research Society of India (MRSI) at the Annual General Meeting of MRSI held at Jodhpur during December 19-23, 2022
- Dr. Sanjay Bhardwaj received the 'Annual Trophy of Best Regional Centre Award 2022' as Chairman of Indian Institute of Chemical Engineers – Hyderabad Regional Centre (IIChE – HRC), at the 'CHEMCON 2022 Conference and 75th Annual Session of IIChE' held at Harcourt Butler Technical University (HBTU), Kanpur during December 27-30, 2022
- Dr. P Barick was honored as the 'Reviewer of the Quarter' by Indian Ceramic Society, India for the period January to March, 2023
- Mr. Amir Ahemad (Dr. R Easwaramoorthi) received the 'Best Poster Presentation Award' for the paper "Single crystal derived perovskite precursor for efficient perovskite solar cells" at the '2nd Indo-Japan joint workshop on Photovoltaics', organized by SSN Institutions, Chennai on March 9, 2023

Personnel (as on March 31, 2023)

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Dr. Tata Narasinga Rao Director (Additional Charge) from 04.06.2021 to 24.11.2022 Director from 25.11.2022

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> > * On Contract Basis

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E. Anbu Rasu, Technical Officer 'C'

S. Sankar Ganesh, Technical Officer 'C'

K. Naresh Kumar, Technical Officer 'B'

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- E. Konda, Technician 'E'
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- B. Venkanna, Technician 'E'
- G. Venkat Reddy, Technician 'E'
- P. Anjaiah, Technician 'E'
- A. J. Thampi, Technician 'E' (upto 31/07/2022)
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Finance & Accounts Officer (Projects) Anirban Bhattacharjee

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Security, Fire & Safety Officer D. Ramesh

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Assistants

Ms. K. Madhura Vani, Assistant 'B' Narendra Kumar Bhakta, Assistant 'B" J. Bansilal, Junior Assistant (MACP) Ramavathu Ranga Naik, Assistant 'B' Boorgu Venkatesham, Assistant 'B' Pokalkar Sai Kishore, Assistant 'B' Sudheendra, Assistant 'A' Pagadala Siva Prasad Reddy, Assistant 'A' Ch. Venugopal, Assistant 'A' Edunuri Ramesh, Assistant 'A' A.Balraj, Assistant 'A' K. Prashanth, Assistant 'A' P. Prasad Babu, Assistant 'A' Thati Thoti T Koteswar Rao, Assistant 'A' Pakanati Ashoka Reddy, Assistant 'A' Nalamasa Sampathkumar, Assistant 'A' Ramavath Sunil Naik, Assistant 'A'

Junior Translation Officer Dr. Rambha Singh

Drivers

T. Satyanarayana, Driver 'C'M. A. Fazal Hussain, Driver 'B' (MACP)P. Ashok, Driver 'B' (MACP)

Lab Assistants Ms. Sakina Hussain, Lab Assistant 'A'

Consultants

Dr. V. Chandrasekharan

P. Sampath Kumar

D. Thirunaryanan

G Venkata Narayana

Project Scientists In Projects

Dr. Mani Karthik, Project Scientist 'E'
Dr. Manjusha Battabyal, Project Scientist 'D'
G. Vijaya Ragavan, Project Scientist 'B'
P. Sai Karthik, Project Scientist 'B'
P. Vijaya Durga, Project Scientist 'B'
Minati Tiadi, Project Scientist 'B'

Project Technical Assistant In Project

- R. Vasudevan
- N. Kannadasan

Debendra Nath Kar

- K. Velmurgan
- K. Shanmugam
- T. P. Sarangan
- A. Sivaraj
- D. Vigneshwaran
- N. Ramesh
- K. Sudalaiyandi
- M. Nandhagopal

Financial Report

Independent Auditors' Report

То

Governing Council Members of International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad.

Report on the Financial Statements

We have audited the accompanying financial statements of **International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI)** ("the Society"), which comprise the consolidated Balance Sheet as at March 31, 2023, the Consolidated Income and Expenditure Account and Consolidated Receipts and Payments Account for the year then ended and a summary of Consolidated significant accounting policies and other explanatory notes and Standalone Balance Sheet, Standalone Income and Expenditure Account, Standalone Receipts and Payments Account and Standalone significant accounting policies and other explanatory notes of the following funds:

i) Operational Fund ii) Technology Demonstration and Transfer Fund iii) Sponsored Projects Fund

Management's Responsibility for the Financial Statements

Governing Body of the Society is responsible for preparation of these financial statements of the Society in accordance with the Generally Accepted Accounting Principles in India (GAAP) and the significant accounting policies stated in financial statements. This responsibility also includes maintenance of adequate accounting records for safeguarding the assets of the society and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statements, that are free from the material misstatement, whether due to fraud or error.

Auditors' Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our examination in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the examination to obtain reasonable assurance about whether financial statements are free from material misstatements.

Examination of financial statements involves performing procedures to obtain audit evidence about the amount of disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the society's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of the accounting policies used and the reasonableness of the accounting estimates made by the Management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements of the Society for the year ended March 31, 2023 are prepared in all material aspects, in accordance with Generally Accepted Accounting Principles in India (GAAP) and the significant accounting policies stated in Note 24 to the Financial Statements. Other Matters:

- a) In our opinion, proper books of accounts as required by the law have been by kept the society so far as it appears from our examination of those books.
- b) The Balance Sheet, the Income and Expenditure Account, and Receipts and Payments account dealt with by this report are in agreement with the books of accounts.

For ANANT RAO & MALLIK Chartered Accountants FRN: 006266S Sd/-V. ANANT RAO Partner M No. 022644 Date: 11-09-2023 UDIN: 23022644BGUPMU5965

Name of Entity: International Advanced Research Centre for Powder I ARC INTERNATIONAL FUND (OPERATIONAL) BALANCE SHEET AS	Metallurgy and New Materials (ARC-INTI AT 31-3-2023	(RNATIONAL)	(Amount in Rs)
GRANTS - IN - AID: FUND AND LIABILITIES	Schedule	Current Year	Previous Year
GRANTS - IN - AID	~	1,20,63,42,317.35	1,38,64,19,850.75
RESERVES AND SURPLUS	0	0.00	0.00
EARMARKED/ENDOWMENT FUNDS	Э	0.00	0.00
SECURED LOANS AND BORROWINGS	4	0.00	0.00
UNSECURED LOANS AND BORROWINGS	5	0.00	0.00
DEFERRED CREDIT LIABILITIES	9	0.00	0.00
CURRENT LIABILITIES AND PROVISIONS	2	36,49,75,635.97	39,78,52,308.75
TOTAL		1,57,13,17,953.32	1,78,42,72,159.50
ASSETS	Schedule	Current Year	Previous Year
FIXED ASSETS	ω	96,66,58,277.36	1,09,61,75,006.98
INVESTMENTS - FROM EARMARKED /ENDOWMENT FUND	σ	0.00	0.00
INVESTMENTS - OTHERS	10	0.00	0.00
CURRENT ASSETS, LOANS, ADVANCES ETC.		60,46,59,675.96	68,80,97,152.52
MISCELLANEOUS EXPENDITURE (to the extent not written off or adjusted)			
TOTAL		1,57,13,17,953.32	1,78,42,72,159.50
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		
As per our report of even date for M/s Anant Rao & Mallik Chartered Accountants Firm Registration No. 006266St			
Sd/- Sd/- V.Anant Rao Partner Membership No. 022644 Date: 11-09-2023 Place:Hyderabad	Sd/- D.Srinivasa I Accounts Officer Associate Di	kao ector(Admin, Finance & Stores)	Sd/- Dr. Tata Narasinga Rao Director

Name of Entity: International Advanced Re- INCOME AND EXPENDITURE ACCOUNT O	search Centre for Powder Metallurgy and Ne F ARC INTERNATIONAL FUND (OPERATIO	w Materials (ARC-INTE NAL) FOR THE YEAR E	RNATIONAL) NDED 31-3-2023	(Amount in Rs)
INCOME		Schedule	Current Year	Previous Year
Income from Sales/Services		12	0.00	0.00
Grants/Subsidies		13	57,93,03,551.00	56,34,00,000.00
Fees/Subscriptions		14	0.00	0.00
Income From Investments (Income on Inve	sstment from earmarked/endowment Funds).	15	0.00	0.00
Income from Royalty, publications etc		16	0.00	0.00
Interest Earned		17	61,59,888.42	3,66,99,940.00
Other Income		18	3,50,44,868.49	4,10,70,439.37
Increase/(decrease) in-stock of finished goo	ods and work-in-progress	19	0.00	0.00
TOTAL (A)			62,05,08,307.91	64,11,70,379.37
EXPENDITURE		Schedule	Current Year	Previous Year
Establishment Expenses		20	41,37,74,366.38	38,53,83,047.47
Other Expenses		21	24,02,24,045.84	23,71,09,887.59
Expenditure on Grants/Subsidies		22	0.00	8,44,860.00
Interest		23	1,12,43,397.00	3,11,05,954.00
Depreciation (Net Total at the year-end-Cor	rresponding to Schedule 8)		15,94,60,931.09	18,57,34,376.13
TOTAL (B)			82,47,02,740.31	84,01,78,125.19
Balance being excess of Expenditure over I	Income (B-A)		20,41,94,432.40	19,90,07,745.82
Transfer to Special Reserve [Specify each]				
Transfer to /From General Reserve				
BALANCE being Excess of Expenditure ov	er Income T/F to- GRANTS IN AID		20,41,94,432.40	19,90,07,745.82
SIGNIFICANT ACCOUNTING POLICIES		24		
CONTINGENT LIABILITIES AND NOTES	ON ACCOUNTS	25		
As per our report of even date for M/s Anant Rao & Mallik Chartered Accountants Firm Registration No. 006266S				
Sd/- V.Anant Rao Partner Membership No. 022644 Date: 11-09-2023 Place:Hvderabad	Sd/- G.M.Raj Kumar Senior Finance & Accounts Officer	Sd/- D.Srinivasa Rac Associated Dire	o ctor (Admin, Finance & Stores)	Sd/- Dr. Tata Narasinga Rao Director

Schedule - 24 Background Information & Significant Accounting Policies

1 Operation Fund of ARC – International (OP Fund of ARCI) is the main fund of International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI/ Society).

Grants received from Department of Science and Technology (DST), Ministry of Science and Technology, Government of India (GOI) are recognized in the financial statements of OP Fund of ARCI as Income of the Society if these grants are for meeting operational expenses of the Society and as part of Corpus, if utilized for the purposes of capital expenses. These Grants are allocated by GOI in the form of annual budgets under Plan Funds to DST. DST draws the funds from GOI and forwards the same to ARCI. The funds released by DST are in the form of Grants in Aid.

Other Funds of the Society are Technology Development & Transfer Fund (TDT) and Sponsored Project Fund (SP Funds).

2 Basis of preparation of financial statements:

Financial statements of Op Fund of ARCI, Hyderabad, have been prepared on historical cost convention and on accrual basis unless otherwise stated.

Significant Accounting Polices:

(A) Grants:

Grants are recognized on receipt basis.

Grants received from DST and earmarked for special / specific projects are grouped under Sponsored Project Fund.

(B) Reserves & Surpluses:

Fifty percent of Net Surplus / Deficit in Technology Demonstration & Transfer Fund (TDT Fund) is transferred to OP Fund of ARCI and is recognized under Reserves ad Surplus. Balance Fifty percent is retained in TDT Fund

3 Fixed Assets:

Fixed assets are stated at cost. Cost includes duties, taxes, freight, insurance etc attributable to acquisition and installation of asset.

Depreciation and Amortization :

Depreciation on fixed assets (except Lease Hold building) is provided on written down value method as per rates stated in Income Tax Rules, 1962.

Non -Refundable advance towards Lease Hold Building is amortized over lease period.

4 Interest Income:

Interest income from bank balances/deposit is recognized on time proportionate basis.

5 Research and Development (R&D) Expenditure:

R&D expenditure including cost of raw materials, consumables, other inputs and services etc. is charged off as revenue expenditure. Raw materials, consumables, stores spares and other inputs are procured on need basis and issued to indenting departments soon after they are received. Hence values of closing stock of these materials is not recognized in the accounts.

6 Foreign Exchange Transactions:

Foreign exchange transactions during the year are recorded at the exchange rate prevailing on the date of transactions.

7 Retirement Benefits:

Contributions of Society's share of Provident Fund and New Pension Scheme (Defined Contribution Plans) are charged to Income and Expenditure Account as per applicable rules/statutes.

Provision towards gratuity and leave encashment (Defined benefit Plan) is made on actuarial valuation carried out by Life Insurance Corporation of India. The Society has covered its gratuity and leave encashment liability with Life Insurance Corporation of India (LIC) and contributions are made to LIC on yearly basis as per the actuarial reports shared to the Society by LIC.

8 Margin Money Deposits:

Society places one hundred percent of its funds as Margin Money Deposits with Banks towards Letters of Credit issued to the vendors of the Society. These are grouped under Loans and Advances- Advances Recoverable in Cash/Kind.

For M/s. Anant Rao & Mallik Chartered Accountants Firm Registration No 006266S Sd/-V. Anant Rao Partner Membership No. 022644 Hyderabad

Sd/-G.M. Raj Kumar Senior Finance & Accounts Officer Sd/-D. Srinivasa Rao Associate Director (Admin, Finance & Stores) Sd/-Dr. Tata Narasinga Rao Director

INTERNATIONAL ADVANCED RESEARCH CENTRE FOR POWDER METALLURGY AND NEW MATERIALS (ARC-International) BALAPUR POST. HYDERABAD ARCI (OPERATIONAL) FUND

Schedule – 25 Notes to the Accounts

1 Department of Science and Technology (DST) sanctioned and released during the year Rs.62,59,00,000/ towards revenue and Rs:17,61,00,000/- as capital grant-in-aid under Plan (Previous year Rs.56,34,00,000 and Rs.17,60,00,000/- towards revenue and capital respectively under Plan grant-in-aid). Grants were refunded /returned during the year Rs. 4,65,96,449 towards revenue and Rs.17,93,01,857/- as Capital grant-in-aid under plan (previous year Rs: Nil and Nil.Under Non-Plan, Grant-in-aid sanctioned was nil.

2 Capital Work in Progress

Rs. 1,07,55,538/- as at March 31,2023 as stated in Schedule 8 to the financial statements – pending capitalization for more than three years. Management identified certain deficiencies while installing these equipments. The process of resolving the deficiencies is going on. In the opinion of the management of the Society, all these capital works are capable of being used for the purpose for which these assets once these deficiencies. The management, at present, is of the opinion that these capital works do neither require any impairment nor provisioning.

For M/s. Anant Rao & Mallik Chartered Accountants Firm Registration No 006266S Sd/-V. Anant Rao Partner Membership No. 022644 Hyderabad

Sd/-G.M. Raj Kumar Senior Finance & Accounts Officer Sd/-D. Srinivasa Rao Associate Director (Admin, Finance & Stores) Sd/-Dr. Tata Narasinga Rao Director



³ The figures of previous year have been regrouped/reclassified wherever necessary.

Name of Entity: International Advanced Res RECEIPTS AND PAYMENTS OF ARC INTERN	earch Centre for Power ATIONAL FUND (OPI	der Metallurgy and Ne ERATIONAL) FOR THI	w Materials (ARC-INTERNATIONAL) HYD E YEAR ENDED 31-3-2023	ERABAD	(Amount in Rs)
RECEIPTS	Current Year	Previous Year	PAYMENTS	Current Year	Previous Year
I. Opening Balances a) Cash in hand b) Bank Balances i) In Current accounts	13,896.00	32,692.00	I. Revenue Expenses a) Establishment Expenses b) Other Expenses	41,76,49,520.00 26,53,34,690.46	36,48,71,558.00 23,10,96,533.49
i) In Deposit accounts iii) Savings accounts	150,000,000.00 104,919,712.27	57,000,000.00 34,253,657.01			
Total Opening Balances	254,933,608.27	91,286,349.01	Total Expens	es 68,29,84,210.46	59,59,68,091.49
 II. Grants Received a) From Government of India b) From State Government c) From other sources [details] 1) Fund received on closed Projects 	576,101,694.00	739,400,000.00	II) Payments made against various Payments made against various proje	projects ts 0.00	0.00
Total Grants Received	576,101,694.00	739,400,000.00	Total of payments Against Project	is 0.00	0.00
III. Income on Investments From a) Earmarked /Endowment funds b) Own Funds (oth investments)	0.00	0.00	III. Investments and deposits made a) Out of Earmarked/Endowment fund b) Out of Own Funds (investments-oth	s 0.00 ers) 0.00	0.00
Total Income on Investment	0.00	0.00	Total : Investments and Depos	ts 0.00	0.00
IV. Interest Received a) On Bank Deposits b) Interest from Sponsored Projects c) Loans, Advances to staff etc.	9,335,359.00 0.00 0.00	32,998,169.00 0.00 0.00	IV. Expenditure on Fixed Assets & Capital Work - in- Progress Total of Fixed Assets	19,21,19,863.25 19,21,19,863.25	4,68,34,647.25 4,68,34,647.25
Total Interest Received	9,335,359.00	32,998,169.00			
V. Other Income	53,132,356.39	71,129,288.00	 V. Refund of surplus money/ loans a) To Government of India b) To State Governments c) To other providers of funds 	00.0	00.0 00.0
				0.00	0.00

					(Amount -Rs)
RECEIPTS	Current Year	Previous Year	PAYMENTS	Current Year	Previous Year
VI. Amount Borrowed	0.00	0.00	VI. Finance charges (Interest)	0.00	0.00
VII. Any other receipts [Give details] 1) Sales of Fixed Assets 2) Tax Deduction at Source & GST Deductions	17,63,790.25 0.00	0.00 79,961.00	VII) Other Payments (Specify) 1) Interest - DST 2) Security Deposit - Supplier 3) GST - IGST	1,12,43,397.00 0.00 0.00	3,58,00,595.00 12,58,420.00 98,405.00
Total Any other receipts	17,63,790.25	79,961.00	Total Other Payments	1,12,43,397.00	3,71,57,420.00
			VIII) Closing Balances a) Cash in hand	0.00	13,896.00
			u) baint balances i) In Current accounts ii) In Deposit accounts iii) In Savings accounts	0.00 0.00 89,19,337.20	0.00 15,00,00,000.00 10,49,19,712.27
			Total Closing Balances	89,19,337.20	25,49,33,698.27
Grand Total 8	9,52,66,807.91	93,48,93,767.01	Grand Total	89,52,66,807.91	93,48,93,767.01
As per our report of even date					

for M/s Anant Rao & Mallik Chartered Accountants Firm Registration No. 006266S Sd/-V. Anant Rao

Sd/-V. Anant Rao Partner Membership No. 022644 Date: 11-09-2023 Place:Hyderabad

Sd/-G.M.Raj Kumar Senior Finance & Accounts Officer

Sd/-D.Srinivasa Rao Associate Director(Admin,Fin & Stores)

Sd/-Dr. Tata Narasinga Rao Director

Our Collaborators

- Altmin Private Limited
- **Applied Materials**
- Andhra Pradesh MedTech Zone Limited
- Allox Advanced Materials Pvt. Ltd.
- Andhra University
- Andhra Pradesh Mineral Development Corporation Ltd.
- Ashok Leyland Limited
- ABB Global Industries and Services Private Limited
- **Bharat Electronics Limited**
- Bharat Heavy Electricals Limited
- Bhabha Atomic Research Centre
- Belarusian State University of Informatics and Radio Electronics
- Council of Scientific and Industrial Research (CSIR)
- Central Glass & Ceramic Research Institute
- Centre for High Technology
- Defense Research and Development Organization
- DesignTech Systems Limited
- Deakin University, Australia
- Fraunhofer Institutions, Germany
- GE India Industrial Pvt. Ltd.
- GFCL EV Products Ltd.
- Hindustan Aeronautics Limited
- **HBL** Power Systems
- Hindustan Petroleum Corporation Limited
- **High Energy Batteries**
- Indian Institute of Chemical Technology
- Indian Airforce
- Indian Space Research Organization
- Indira Gandhi Centre for Atomic Research
- Indian Institute of Technology-Bombay
- Indian Institute of Technology-Madras
- Indian Institute of Technology-Kanpur
- Indian Institute of Technology-Kharagpur
- Indian Institute of Technology-Hyderabad
- Indian Oil Corporation Limited
- Industrial Materials Institute of National Research Council of Canada (NRC-IMI), Canada
- Institute for Problems of Materials Science (IPMS), Ukraine

- International Centre for Electron Beam Technologies, Ukraine
- Indigenous Energy Storage Technologies Private Limited
- Indify Fuel Cell Private Limited
- Jindal Specialty Chemicals India Pvt. Ltd.
- KPIT Technologies Ltd.
- Las Engineers and Consultants Pvt. Ltd.
- Log 9 Materials Scientific Pvt. Ltd.
- Larsen and Toubro Limited
- Mahindra and Mahindra
- Magic Myna Pvt. Ltd.
- Mishra Dhathu Private Limited
- MPA Industrie, France
- Nanomechanics, USA
- National Institute of Technology-Warangal
- National Institute of Technology-Tiruchirappalli
- National Institute of Technology- Nagpur
- National Engineering Industries Ltd.
- Nsure Reliable Power Solutions Pvt. Ltd.
- Osmania University
- Phasetron Engineers India (P) Limited
- Prayogik Technologies Pvt. Ltd.
- Prayogik Energy Pvt. Ltd.
- Prototech Power Pvt. Ltd.
- Resil Chemicals Pvt. Ltd.
- Sri Chitra Tirunal Institute for Medical Sciences and Technology
- Sai Surface Coating Technologies
- SLM Solutions Singapore Pvt. Ltd.
- Shimita Systems
- SAP Parts Pvt. Ltd.
- Toyota Kirloskar Motor Pvt. Ltd.
- Tenaco Labs Pvt. Ltd.
- Tata Steel Limited
- TVS Lucas
- Tata Motors Ltd.
- University of Hyderabad
- United Technologies Corporation India Pvt. Ltd. (UTCIPL)
- Wahl India Grooming Product Pvt. Ltd.
- Zoz GmbH, Germany

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ARCI Hyderabad

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Dr. Pawan Kumar Jain

Dr. Sanjay Bhardwaj



International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI)

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