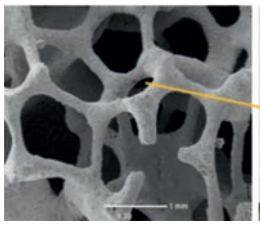
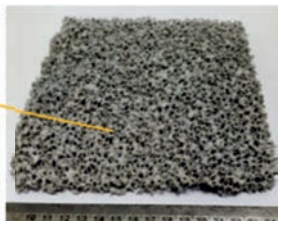
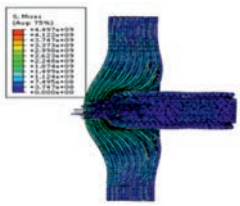
ANNUAL REPORT

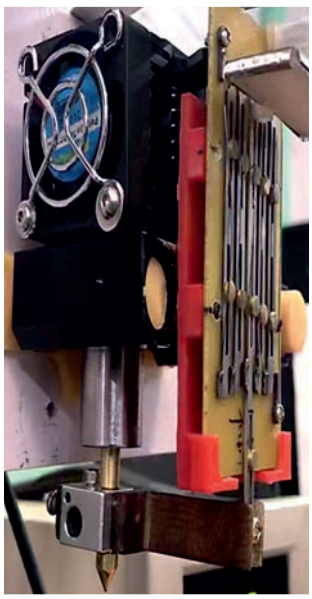
CSIR-AMPRI







2019-2020



CSIR-Advanced Materials and Processes Research Institute, Bhopal

Annual Report

2019-2020

CSIR-Advanced Materials and Processes Research Institute, Bhopal

CSIR-AMPRI

From Director's Desk

CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal is a constituent laboratory of Council of Scientific & Industrial Research, carries out advance research in frontier and multi-disciplinary research areas of lightweight metallic and polymeric materials, smart and functional materials, advanced radiation shielding materials, cement free concrete, materials of biomedical interest and hybrid green composites towards industrial benefit for the masses.

During the last few years, this institute has special focus on the institute –industry amalgamation and commercialization of technologies through NDAs, MOUs and technology transfer. The sustained efforts in this direction have resulted in transfer of significant technologies for commercialization which include Lead Free X-Ray Shielding Tiles to M/s Prism Johnson Ltd Mumbai, Surface Plasmon Resonance (SPR) Raman substrates to M/s Techno's instruments Jaipur, Multifunctional Bamboo Composite Material for Modern Housing and Structures to M/s Permali Wallace Pvt Ltd Bhopal, cement free concrete to M/s JSPL Raigadh, Hammer tips for Sugar Mills to M/s Asugar Pvt. Ltd Pune, High performance Hybrid Composite Materials to M/s Chauhan Fly Ash Products Ballarpur, Silicon Carbide Reinforced Composite to M/s Exclusive Magnesium Hyderabad, Hybrid Wood Substitute Composite Materials (CM-Wood) to M/s VSM Industries Pvt Ltd Surat, Advanced Hybrid Composite Wood and Wood Substitute Materials (AC Wood) to M/s Eco Bright Sheet Company Pvt. Ltd. Bhilai, Nano Alumina adsorbent based water filter for Arsenic and Fluoride removal, Marcus Projects Private Limited Lucknow, Defluoridation of drinking water using nano adsorbent based domestic filter to M/s MSW Social Enterprises Pvt. Ltd. Indore, A novel process for making advanced radiation shielding materials for board application spectrum to M/s ASSURAYS Noida ,U.P. Also, the institute is progressing well in terms of quantity and quality of publications and patents.

Besides these, the Scientists of this Institute are very actively involved in mission mode activities for improvement of the livelihood of the society through various interactive programs, adoption of particular villages under CSIR-800 program, waste to wealth programme, skill development programms and strategy for social development.

The dedicated team of Scientific, Technical and Administrative staff strives for achieving excellence and contribute to the needs of the industry, social sector and the Nation at large. We expect to keep this spirit high in the coming year also and make every effort to take CSIR-AMPRI, Bhopal to newer heights and to position it globally as a leading materials research laboratory.

Dr. Avanish Kumar Srivastava

Director

CSIR-AMPRI: An Overview

Advanced Materials and Processes Research Institute (AMPRI), Bhopal was instituted in May 1981 as "Regional Research Laboratory" (RRL) and officially started functioning from CSIR, New Delhi. The institute was then shifted to Bhopal and was located in Bhopal (now Barkatullah University campus). It subsequently found a place in the present premises in December 1983. The laboratory initially had about 15 scientists, with 10 of them specialized in metallurgy/materials science. This was the core strength of the institute at that time.

The institute was initially started R&D on the synthesis and characterization of aluminium-graphite metal matrix composites and natural fiber. Gradually the scope of R&D broadened to include waste to wealth (building materials and wood substitute), mineral processing, environmental impact assessment, water resource modeling and problems related to agricultural, mining, sugar mill and thermal power plant machinery components. Health assessment, improvement and failure analysis of engineering components/systems and development of lightweight materials/components/products and processes for the automobile sector constituted other activities of significance. The work was extended with FEM simulation and modelling which became an integral part of the studies in many cases. Through its activities on water resource modelling, surface treated agricultural implements, bell metal artifacts, handicrafts using sisal fibre, use of fly ash for building materials and agricultural soil reclamation, etc., CSIR-AMPRI became visible as a promising institute for rural technologies related to the specific problems of Madhya Pradesh.

The Governing Body of the Council of Scientific & Industrial Research renamed all its five Regional Research Laboratories (RRLs) to enable them to reflect a futuristic outlook. The changed profiles of the laboratories with respect to their direction of growth, orientation of expertise and accumulated excellence have all been weighed in while rechristening them. The name changed from Regional Research Laboratory, Bhopal to Advanced Materials and Processes Research Institute (AMPRI) with effective from March 6, 2007. In consonance with the new identity, R&D programmes in lightweight materials such as Al and Mg alloys, metallic and polymer based composites, foams, and functional materials, microfluidics for point of care diagnostics, nanomaterials, new materials based on industrial wastes such as fly ash and red mud, and CSIR-800 projects of societal relevance have been undertaken. These programmes have an industry/user link from inception stage. A state of the art processing and characterization facility and simulation modelling capabilities are being set up to trigger new materials development, innovations and improvements.

Current Programmes Future Perspectives

The present manpower includes 43 scientists (against the sanctioned strength of 100) that are well trained in different disciplines of material science and other related areas along with 86 supporting staffs. The number of scientists is planned to increase to ~80 in the near future in view of the widened range of R&D activities. AMPRI is equipped with modern facilities for material synthesis, processing and property characterization such as SEM, HR-TEM, pressure die casting machine, semisolid processing unit, rolling mill, Mg melting unit, FESEM, Electromagnetic forming/joining unit, cryomilling unit, DTA, XRF, FT-IR, Raman Spectrophotometer, X-ray attenuation testing machine, electrochemical analyzer, UV-Visible spectrophotometer, AAS and those related to nanoscale R&D have been added in past few years.

The current activities of AMPRI are broadly categorised under:

- Lightweight Materials
- Nanostructured Materials
- Smart and Functional Materials
- Integrated Approach for Design and Product Development
- Waste to Value added Materials
- Jigyasa and Skill Development Activities

In the category of lightweight materials, important activities are related to Al metal matrix composites, polymer matrix composites, Al foam and Mg-based alloys. CSIR-AMPRI has laid a major emphasis on lightweight materials development like Al foam, Mg-based alloys, in-situ MMCs and nanostructured materials. Also, activities on electromagnetic forming, smart and functional materials, steel and Ti foams, and materials modelling and design are being carried out since the last 12th Five-year Plan.

Under the research theme of nanostructured materials, lab is constantly working for the development of nanostructured material for different applications like nano-adsorbent, capacitor application, energy related areas, for sensors etc. Under this theme the lab has already established a process for the bulk scale synthesis of nanoalumina by a cost-effective process. The developed nano adsorbents possess significantly high fluoride and arsenic adsorption capacity. The sediment domestic water filter device has also been developed using this nanoalumina and the know-how is transferred to the industries.

Institute is employing an integrated approach for design and product development in the area of shape memory polymer composites, natural fibre polymer composites, hierarchical carbon fibre reinforced composites, graphene-metal composites, coating materials, metallic foam, sandwich panel and metal matrix composite, brake drum component, bamboo composites etc. Advanced techniques like 3D surface scanning, 3D printing and selective laser melting processes, CVD techniques, micro compounding of nano-materials with smart polymers, universal bamboo shaping machine, design & analysis software, advanced characterization equipments are being used to develop products and processes. A dedicated team of scientists and technical staff along with students and project staff are working coherently to contribute significantly in S & T advancement.

In the area of Waste to Wealth, the institute is mainly engaged on the utilization of fly ash and red mud. The institute has developed wood substitute technology using red mud, fly ash and natural fibres and has potential applications for making doors, panels, partitions and furniture. CSIR-AMPRI has developed radiation shielding materials from red mud and holds a US Patent on the work. The potential applications of this technology are for the shielding of gamma and neutron in nuclear power plants and for diagnostic X-ray shielding in X-ray and CT scan rooms. This material has been started to use by the hospitals to shield diagnostic X-rays.

CSIR-AMPRI has worked on various rural development and dissemination activities which will have large implications for CSIR-800. During 11th Five Year Plan, the institute has taken up a project under Rural Sector Projects – Sisal Fibre Technologies for Rural Employment Generation. Sisal plant produces the hardest vegetable fibre which will have applications in cordage and handicrafts. The yarn and textile made out of this fibre is used for making composites for applications in sectors like housing, automobile, geotextiles, etc.

CSIR-AMPRI is actively engaged in microfluidic electrochemical & fluorescence based biosensors which have recently been advanced for portable point-of-care diagnostics by integrating lab-on-a-chip technology and electrochemical analysis. Institute has developed several automated procedures for electrochemical detection of biomarkers, pharmaceutical and environmental samples using micro liquid, capillary gas chromatographic and capillary electrophoretic separation techniques and micro-chip based separation under the concept of lab-on-a-chip. The microfluidic electrochemical &fluorescence-based biosensors approach offers a new platform for a rapid, miniaturized, and sensitive diagnostic sensor in a single device for various human diseases.

The overall objective of AMPRI is to achieve world-class status in the area of engineering materials, components and process development. Accordingly, the HR Profile and S&T infrastructure would aim to address the needs of both fundamental and applied research, technology development and business development in the area of materials of the future. The present resource base being created would not only provide commercial tractability for the present but also provide a root for more lucrative, elite and innovative areas for the future. It is envisaged to make the institute a place of pilgrimage for top material scientists and the stakeholders

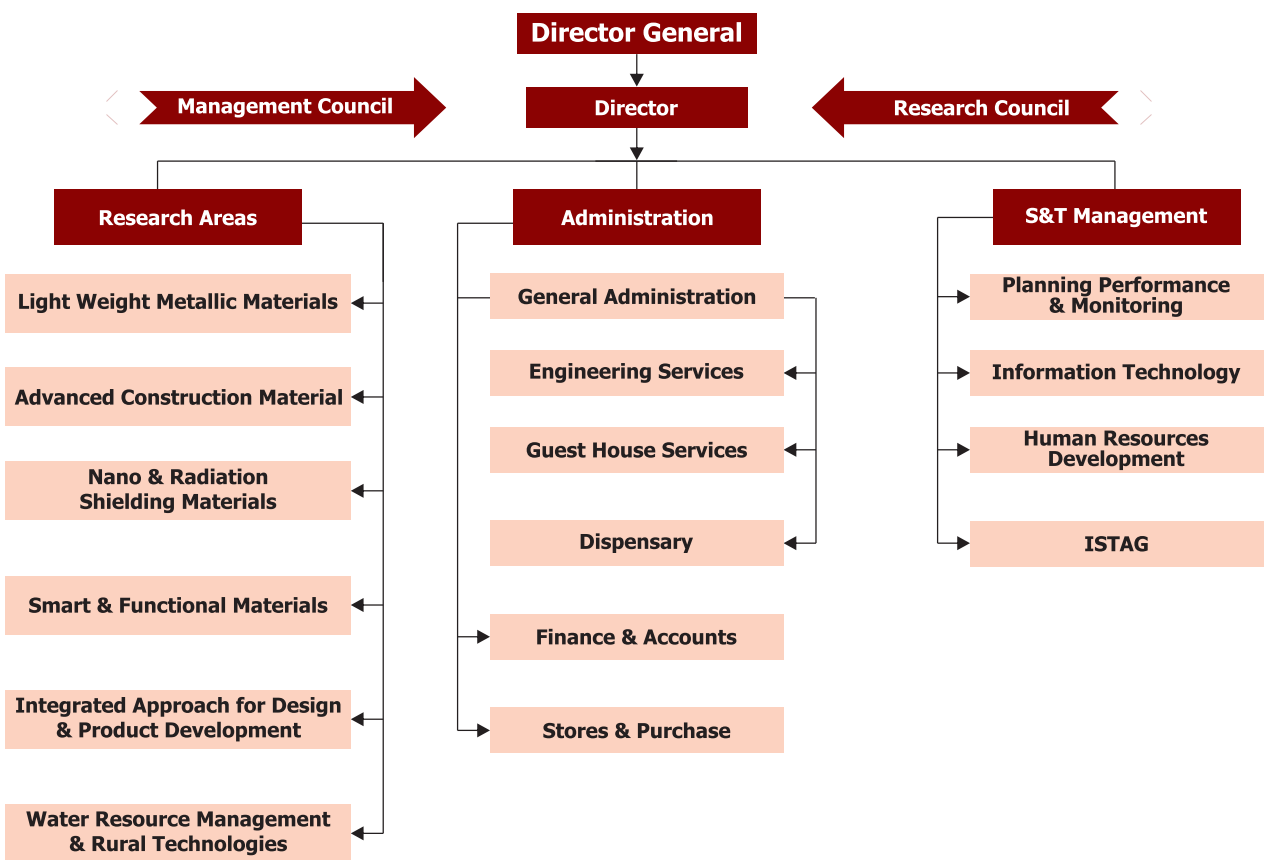
Vision

CSIR-AMPRI, Bhopal is committed to develop innovative, cutting edge, intenationally competitive, energy efficient and environmental friendly technologies /products in the area of advanced materials for societal benefits and to contribute to the Nation's Economy.

Mandate

- Research & Development on Engineering Materials for Strategic, High Performance and Societal Applications
- Materials, Processes and Technology development for Component/Products for a variety of engineering materials, including Metals & Alloys, Composites, Polymers, Building Materials and materials from Waste to Wealth
- To undertake consultancy, sponsored, grant-in-aid, network & other national, international projects for both public and private sectors in above areas.

Organization Chart



Research Council

Dr. S. K. Salwan Vice Chancellor, Apeejay Stya University Palwal, Gurgaon, Haryana	Chairman
Dr. Navin Chandra Director General, M.P. Council of Science & Technology, Bhopal	Member
Shri Shripadraj Ponkshe General Manager, Tata Motors Limited Pimpri, Pune.	Member
Prof. Vikram Jayaram Department of Materials Engineering Indian Institute of Science, Bengaluru	Member
Prof. John Philip Professor, Homi -Bhabha National Institute Indira Gandhi Centre for Atomic Research Kalpakkam	Member
Dr. Samir V. Kamat Director General, DRDO (NS&M) Visakhapatnam	Member
Dr. Satish Kumar Director, National Institute of Technology (NIT), Kurukshetra	Member
Prof. B.B. Dhar (Former Director, CIMFR) D-20, Pamposh Enclave New Delhi .	Member
Dr. I. Chattoraj Director, CSIR -National Metallurgical Laboratory Jamshedpur.	DG-CSIR Nominee
Dr. S. Basu Director, CSIR -Institute of Minerals & Materials Technology, Bhubaneswar	Member
Dr. Avanish Kumar Srivastava Director CSIR-Advanced Materials and Processes Research Institute, Hoshangabad Road, Bhopal – 462 026.	Director
Dr. S K S Rathore Head, PPD CSIR-Advanced Materials and Processes Research Institute, Hoshangabad Road, Bhopal – 462 026.	Secretary, RC

Management Council

Director	Chairman
Dr. Rakesh Kumar, Director, CSIR-NEERI, Nagpur	Member
Shri A.K. Goel, Head, ESD, CSIR Complex, New Delhi	DG's nominee
Dr. S.A.R. Hashmi, Chief Scientist	Member
Dr. P. Asokan, Senior Principal Scientist	Member
Dr. Deepti Mishra, Senior Principal Scientist	Member
Dr. Meraj Ahmad, Senior Scientist	Member
Dr. Edward Peter, Principal Technical Officer	Member
Head, RPBD/PME	Member
CoFA/FAO	Member
COA/AO	Member-Secretary

Ongoing/Completed Projects

No.	Title of the Project	Project Code	Sponsoring Agency	Start Date & Duration	Cost Rs. Lakhs
1.	Bulk Utilization of Red Mud for Making advanced Ligno-Silico-Aluminous (LSA) Geoplymeric materials	GAP0078	MOEF	17/08/2016 36 months	63.91
2.	Manufacturing light weight high strength and glossy finish polymeric composites from marble and granite waste stream	GAP0079	DST	15/12/2016 36 months	315.26
3.	Development and dissemination of technologies for sustainable Rural Development of primitive Bharia Tribal in Patalkot Valley.	GAP0080	DST	05/07/2016 36 months	20.12
4.	Up Scaling of technology for making advanced non- toxic radiation Shielding materials of strategic importance, utilizing Industrial wastes	GAP0081	DST & CSIR	05/07/2016 36 months	279.88
5.	Lightweight carbon foam as an electrode for Lead acid batteries	GAP0082	DST	27/09/2016 60 months	100.00
6.	Development of multi-elementally and nano morphologically modified advanced lightweight carbon nanotubes based radiation shielding bandage useful for broad application spectrum	GAP0085	DST	23/02/2017 36 months	24.95
7.	Fabrication of high performance piezoelectric nano-generators	GAP0086	DST	21/12/2017 24 months	22.57
8.	Durable water repellent and stain resistant super hydrophobic textile finishes based on polymer nano-composite	GAP0087	DST	18/04/2018 24 months	26.51
9.	Fabrication of high dense sintered Red Mud X ray and Gamma ray shielding applications	GAP0088	MPCST	02/08/2018 24 months	8.40
10.	Development of metal pyrophosphate electrolytes for proton conducting ceramic electrolytes fuel cell operating in 100-400 C	GAP0089	SERB	10/10/2018 24 months	23.24

11.	Tetravalent metal pyrophosphate-alkali carbonate composite electrolytes for fuel cells operating in intermediate temperature range	GAP0090	SERB	26/11/2018 24 months	58.53
12.	Development of open cell aluminium foams for heat sink and EMI Shielding applications	GAP0091	Min. of Mines	04/12/2018 24 months	30.00
13.	Morphology controlled copper sulphide decorated with graphene sheets as an electrode material for Na-ion capacitor in aqueous and non-aqueous electrolytes	GAP0092	SERB, New Delhi	13/03/2019 36 months	39.94
14.	Development of joining process for industrial components through electromagnetic forming	GAP0093	DST	24/05/2019 36 months	49.40
15.	Conversion of CO2 into useful fuel gases via novel nanoparticles dispersed N-doped graphitic nanofiber electrodes based bio-electrochemical fuel cell	GAP0094	DST	08/05/2019 24 months	13.55
16	Hydrogen Powered desalination system using recycled aluminium: A novel process to extract potable fresh water from sea water (joint project with CIIRC Jyothy Institute of Technology)	GAP0095	DST	20/03/2020 36 months	95.56517
17	Developement and fabrication of high power energy and density supercapicitor based on conjugated microporous polymer.	GAP0096	SERB, New Delhi	20/03/2020 24 months	19.2
18	Graphene-based composites for high performance thermally conducting interface and electromagnetic interference shielding applications	GAP0099	DST	21/11/2019 18 months	13.15
19.	Up Scaling of technology for making advanced non- toxic radiation Shielding materials of strategic importance, utilizing Industrial wastes	MLP0104	CSIR	05/07/2016 36 months	279.89
20.	Development of Solid state electromagnetic joining technique for materials of interest in aerospace/space	MLP0105	CSIR	22/07/2018 24 months	96.90

21.	Electromyogram (EMG) Controlled below Elbow prosthesis-"Light weight Shape Memory Alloy (SMA) wire actuated prosthetic hand	MLP 106	CSIR	02/08/2018 24 months	55.00
22.	Development of multilayer sandwich panel for defence applications	MLP 107	CSIR	18/08/2018 24 months	155.00
23.	Red mud based lead free material for X-Ray and CT Scanner rooms	MLP0108	CSIR	24/08/2018 12 months	53.20
24.	Design and development of bamboo structures (Bamboo/Composite sections & joints) (Joint project of CSIR-AMPRI, CSIR-IHBT, CSIR-CSIO and CSIR-CBRI)	MLP0109	CSIR	24/08/2018 24 months	429.60
25.	Centre for Morphological, Compositional and Structural analysis employing Electron Microscopy and Electron Electroscopy (FCP)	MLP0110	CSIR	28/08/2018 12 months	850.00
26.	Additive manufacturing of Graphene reinforced metal and polymer composites	MLP0111	CSIR	28/08/2018 24 months	62.88
27.	Hierarchical Reinforcement approach for improved ILSS of CFRP	MLP0112	CSIR	28/08/2018 24 months	96.00
28.	Advanced Geopolymeric coating material for structures of mild steel (AGCM)	MLP0113	CSIR	03/09/2018 24 months	49.00
29.	Up scaling of Advanced Solid form Geopolymeric Concrete for road applications	MLP0114	CSIR	03/09/2018 24 months	287.00
30.	Development and Manufacturing of hybrid green composites using industrial and agro wastes in pilot scale and facilitating entrepreneurship	MLP0115	CSIR	03/09/2018 24 months	203.54
31.	Electrical Insulating Hybrid Composite sheet using industrial inorganic wastes	MLP0116	CSIR	06/09/2018 24 months	64.40
32.	Development of metallic foam for biological, thermal and engineering application	MLP0117	CSIR	12/09/2018 24 months	251.40

33.	Prospects in development of Magnesium alloys for engineering and biological applications	MLP0118	CSIR	18/09/2018 24 months	141.00
34.	High performance metal matrix composites for transportation, defense, aerospace and engineering sectors	MLP0119	CSIR	20/09/2018 24 months	245.72
35.	Development of fly ash based geo-polymeric materials for broad application spectrum	MLP0120	CSIR	01/12/2018 24 months	110.60
36.	Pilot scale production and demonstration of closed cell aluminium composite and hybrid composite foam for automobiles, rail, ship, buildings, defense and construction sectors	MLP0121	CSIR	17/12/2018 24 months	16.0.0
37.	Utilization of waste through appropriate technologies for developing value added products	MLP0122	CSIR	19/02/2019 13 months	48.75
38.	Manufacturing light weight high strength and glossy finish polymeric composites from marble and granite waste stream	OLP0115	CSIR	15/12/2016 36 months	135.00
39.	Development of Artificial Intelligence (AI) controlled Linear Displacement Actuator (LDA) based on thermo-responsive smart materials (SMAs/SMPs) 'SMAILDAS'	HCP0013	CSIR	20/03/2018 24 months	79.12
40.	Development of open cell aluminum foam for sink and EMI shielding applications	OLP 0116	CSIR	04/12/2018 24 months	9.00
41.	CSIR Integrated Skill Initiative	NWP 100	CSIR	12/03/2019 12 months	168.50
42.	Jigyasa-to inculcate scientific temper amongst school children	NWP 101	CSIR	12/03/2019 12 months	49.10
43.	Leachability study of Fly Ash Dumping Site and its Impact on water and Soil Quality of the Surrounding Region of M/s Bharat Oman Refineries Limited, Bina, District Sagar (M.P.)	SSP0048	Bharat Oman Refineries Limited, Bina,	29/01/2018 15 months	27.24

44.	Development of solid-state magnetic pulse welding techniquefor materials of interest in accelerator program	SSP0050	RRCAT, Indore	05/06/2018 18 months	20.00
45.	Carrying out feasibility study for value added products and technology transfer using fly ash	SSP0052	Tata Power Company Mumbai	10/01/2019 06 month	15.00
46.	Design, development and supply of Aluminium foam	SSP0053	Ordnance Factory, Medak	13/03/2019 18 months	30.00 +18% GST
47.	Water Source Sustainability study for Ganga water source for proposed 2X660MW thermal power project at Mirzapur	CNP0113	Adani Infra Limited, Ahmadabad	22/07/2018 12 months	17.50
48	Assessment of secured landfill site and its impact on surrounding region of Birla Cable Limited, Udyog Vihar, Rewa, M.P.	CNP0114	Birla Cable Limited, Udyog Vihar,PO Chorhata, Rewa	19/11/2019 6 months	5.0+GST

Patents

Filed in India

S No	NFNO	Title	Inventors	Application No.
1	0115NF2019/IN	Lead free red mud based X-ray shielding tiles	Shabi Thankaraj Salammal, Sunil K Sanghi, Deepti Mishra and Avanish Kumar Srivastava	201911033448
2	0113NF2019/IN	Bamboo based composite material and process for preparation thereof	Hashmi Syed Azhar Rasheed, Naik Ajay, Gowri V Sorna, Saxena Sajeev, Shiramdas Murali, Rathore Sanjai Kumar Singh, Srivastava Avanish Kumar	201911034398
3	0120NF2019/IN	Multi-functional hybrid composite material from bamboo and the process for preparation of the same	Hashmi Syed Azhar Rasheed, Verma Sarika, Mili Medha, Gorhe Nikhil Rajendra, Naik Ajay, Rathore Sanjai Kumar Singh, Srivastava Avanish Kumar	201911040180
4	0106NF2019/IN	Advanced multi-functional asbestos free thermal insulating material and the process for preparation thereof	Verma Sarika, Sanghi Kumar Sunil, Khan Mohammed Akram, Rathore Sanjai Kumar Singh, Srivastava Avanish Kumar	201911033450
5	0065NF2019/IN	Radiation shielding material capable of attenuating x-ray by dual mechanism and process for preparation thereof	Verma Sarika, Rathore Sanjai Kumar Singh, Srivastava Avanish Kumar	201911033451
6	0052NF2019/IN	Radiation shielding red mud based	Gupta Manoj Kumar, Asokan Pappu, Rathore Sanjai	202011007069

		hybrid composite panels and process for preparing the same	Kumar Singh, Srivastava Avanish Kumar, Verma Teerthraj, Parihar Anit	
7	0214NF2019/IN	High Dense Red Mud Shields for X- and γ-ray Attenuation	Shabi Thankaraj Salammal, Deepti Mishra, Sunil K Sanghi, Varsha Agrawal, Rini Paulose, Rahul Arya, Sathaiah Sriram, S K S Rathore and Avanish Kumar Srivastava	
8	0003NF2020.	Advanced Inorganic - Organic Geopolymeric Corrosion Protective Coating Material for Mild Steel.	Deepti Mishra, Rainy Gupta, Akshay Singh Tomar, Sunil Kumar Sanghi, Thankaraj Salammal Shabi, Mohd.Akram Khan, Archana Singh, V.Sorna Gowri, S.K.S Rathore, Avanish Kumar Srivastava,	

Filed in Foreign Countries

S No	NFNO	Country	Title	Inventors	Application No.
1	0121NF2016/US	USA	Development of gravity operated low cost household defluoridation device using gamma nanoalumina incorporated filter	Indra Bhushan Singh, Archana Singh, Swati Dubey, Akshay Singh Tomar, Priyanka Arya, Avanish Kumar Srivastava	16/421220
2	0128NF2018/WO	WIPO	A glossy finish sandwich composite and process for preparing the same	Asokan Pappu, Gupta Manoj Kumar, Mishra Alka, Peters Edward, Kulshreshth Ajay, Rathore Sanjai Kumar Singh, Srivastava Avanish Kumar	PCT/IN2019/050599
3	0214NF2019	Australia, China, Brazil, Guinea, Europe and USA	High Dense Red Mud Shields for X- and γ-ray Attenuation	Shabi Thankaraj Salammal, Deepti Mishra, Sunil K Sanghi, Varsha Agrawal, Rini Paulose, Rahul Arya, Sathaiah Sriram,. S K S Rathore and Avanish Kumar Srivastava	0214NF2019

Granted in India

S No	NFNO	Title	Inventors	Application No.
1	0189NF2012/IN	A composition of metal bearing industrial waste vitrified ceramic aggregates useful in concrete constructions	Indra Bhushan Singh, Satyabrata Das, Amol Kumar Jha, Rajesh Kumar Morchhale	0191DEL2013
2	0296NF2002/IN	A novel composition useful for making fibre reinforced composite material using fibers separated from machining waste generated from printed circuit board manufacturing plant and making the tiles therefrom.	Hashmi S A R, Chand N, Naik A, Nema V K	0282DEL2003

Granted in Foreign Countries

S No	NFNO	Country	Title	Inventors	Grant Date	Patent No.
1	0214NF2016/US	USA	Advanced non-toxic Red Mud based Nano gel type functional radiation shielding materials and the process thereof	Amritphale Sudhir Sitaram, Verma Sarika, Das Satyabrata	16-Apr-19	10262764

Knowhow Transfer

01	Process for making fly ash based geopolymer concrete using solid form ingredients for construction purposes	M/S JMR Enterprises, Yojna Bhawan ward 36 Puranpura Lal Dhau Vidisha (M.P.)	11/05/2019
02	Lead Free X-Ray Shielding Tiles	M/S Prism Johnson Ltd., Mumbai	10/06/2019
03	Surface Plasmon Resonance (SPR) Raman substrates	M/S Techno's instruments, Jaipur	03/01/2020
04	Multifunctional Bamboo Composite Material for Modern Housing and Structures	M/S Permali Wallace Pvt. Ltd., Bhopal	20/02/2020

MoU and NDA with Academic/R&D Institutions

S. No.	Name of Organization	Date
1	Dr. Ram Manohar Lohia Awadh University, Ayodhya	02/04/2019
2	Nirma University, Sarkhej-Gandhinagar Highway, Post Chandlodia, Via: Gota, Ahmedabad-382481, GUJARAT	30/04/2019
3	Indian Institute of Technology Delhi (IITD)	16/07/2019
4	EEPC India, Vanijiya Bhavan (1st Floor), International Trade Facilitation Centre, 1/1, Wood Street, Kolkata-700016	17/07/2019
5	Lovely Professional University, Jalandhar-Delhi GT Road, Phagwara – 144411 Punjab	24/07/2019
6	M/S Garnet tools, Dewas (M.P.) (NDA)	28/06/2019
7	CSIR-Central Electronics Engineering Research Institute (CSIR-CEERI), Pilani -333031 Rajasthan and M/s Additive Manufacturing India Pvt. Ltd.. Plot No. 23&24, 2nd Floor, Shaktipuram Industrial Estate, Prashanthi Nagar, IDA Kukutpally, Hyderabad -500072 . (NDA)	06/08/2019
8	Trivisen- St John's Innovation Centre, Cowley Road, Milton, Cambridge. CB 4, OWS, United Kingdom (Trivisen incorporated) (NDA) for Two years i.e 20/02/2020-19/02/2022	20/02/2020

Research Publications

1. Mussel-Inspired Durable Antimicrobial Contact Lenses: The Role of Covalent and Noncovalent Attachment of Antimicrobials, Chetna Dhand, Chun Yan Ong, Neeraj Dwivedi, Jayasudha Varadarajan, Mercy Halleluyah Periayah, Edward Jianyang Lim, Venkatesh Mayandi, Eunice Tze Leng Goh, Raymond P. Najjar, Lai Wah Chan, Roger W. Beuerman, Li Lian Foo, Xian Jun Loh, Rajamani Lakshminarayanan, ACS Biomaterials Science and Engineering 2020, 6 (5), 3162-3173. (JIF: 4.511)
2. Slippery and Wear Resistant Surfaces Enabled by Interface Engineered Graphene, Neeraj Dwivedi, Tarak K Patra, Jae-Bok Lee, Reuben J Yeo, Srilok Srinivasan, Tanmay Dutta, Kiran Sasikumar, Chetna Dhand, Sudhiranjan Tripathy, Mohammad SM Saifullah, Aaron J Danner, SAR Hashmi, AK Srivastava, Jong-Hyun Ahn, Subramanian KRS Sankaranarayanan, Hyunsoo Yang, Charanjit Singh Bhatia, Nano Letters 2020, 20 (2), 905-917. (JIF: 12.279)
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R & D Activities

Integrated Approach for Design & Product Development

1. Hierarchical Reinforcement Approach for Improved ILSS of CFRP

The carbon-fibre reinforced polymer (CFRP) composites are widely used in aerospace, automotive, defence/strategic, and sports sectors due to their high specific strength and modulus. These CFRP composites exhibit extraordinary mechanical properties in in-plane directions, however these laminate composite have only a fractional strength in the out-of-plane direction and fail through delamination of plies as shown in Figure 1a.

In this project, avenues were explored to strengthen the laminates in out-of-plane direction through hierarchical approach. Through addition of various hierarchical secondary reinforcements, including CNT, milled fibres, and in-lab processed short fibres, mechanical properties of carbon fibre reinforced polymer composites have been improved. The addition of the secondary reinforcements, like CNT and commercial milled fibres, have been observed to influence the typical flexural load-deflection behaviour and flexural strength values as shown in Figure 1b. The secondary reinforcement addition imparts an increasing-decreasing nature to the flexural strength values as a function of secondary-reinforcement content, with inflection observed at around 1 wt.% of secondary reinforcement. The addition of high-strength secondary reinforcements provides additional stress-bearing components in the composite, which through stress-transfer lead to increment in the flexural strength of the composite relative to conventional CFRP laminates. With increased loadings, after a given threshold value, the secondary-reinforcement tends to agglomerate in the resin, thus leading to deterioration in flexural strength. The added reinforcements, however, have been observed to enhance flexural modulus with increasing amounts of secondary reinforcements. It was observed that secondary reinforcements improved the ILSS of CFRP laminates to varying extents, as shown in Figure 1c. Unlike conventional CFRP laminates, the hierarchically reinforced CFRPs have multiple scattering centres to deflect the propagating cracks and therefore delay delamination of plies. Among the secondary reinforcements used, carbon short fibres were found to be superior compared to CNTs in improving the ILSS, however CNTs performed better in terms of flexural modulus. The ILSS of conventional CFRP was observed to be 46.6 MPa which was improved up to 54.3 MPa using commercially available milled carbon fibres at loading of 1 wt.%. Comparatively, the ILSS value for CNT reinforced hierarchical CFRP at loading of 1 wt.% was observed to be 52.1 MPa. In this project, to improve the ILSS, further short carbon fibres were prepared in the institute using chopped carbon fibres as precursor, and were appropriately

processed further to improve their surface characteristics and dispersion. The hierarchical CFRP laminates made using in-lab processed short carbon fibres showed an ILSS of 65.4 MPa, an impressive rise of ~40% (Figure 1d), with an addition of just 0.5 wt.% of secondary reinforcements. This improved ILSS will translate into improved longevity and service life of components made using H-CFRP over conventional CFRP.

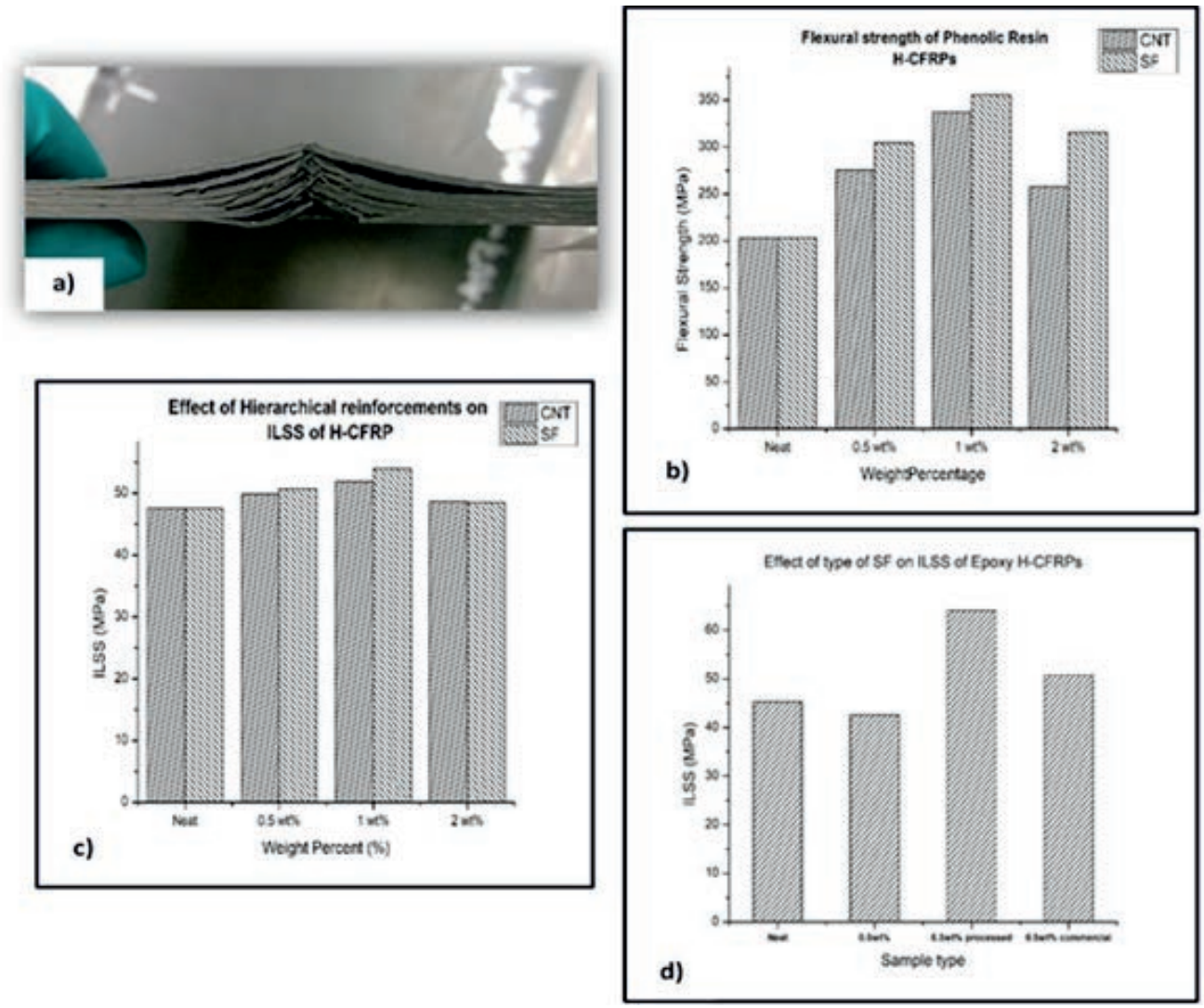


Figure 1 (a) Typical delamination failure of CPRF laminates (b) Effect of hierarchical reinforcement on flexural strength of phenolic H-CFRP laminates (c) Effect of hierarchical reinforcement on ILSS of H-CFRP laminates (d) Comparison of in-lab processed short carbon fibres as hierarchical reinforcement on ILSS of H-CFRP w.r.t other secondary reinforcements.

2. Development of Bamboo Composite Structural Elements

CSIR-AMPRI, Bhopal has been utilizing the naturally available renewable resource bamboo for

design and development of high-end value-added products as structural elements (Figure 2). CSIR-AMPRI has developed the know how of making "Bamboo Composites for Modern Housing and Structures" as a part of its patent application 0113/NF/2019 Application No. 201911034398.The properties of the developed bamboo composites are found to be superior to natural products such as teak wood in terms of strength, moisture contents and dimensional stability under different environments, uniformity and consistency. A finished product of bamboo composite has economical advantages over the finished teak wood as well as bamboo-wood-composites of similar specifications available in the market. The bamboo composites obtained by the method described here can be converted to panels of different thicknesses with different widths and lengths.

These panels have applications as wall-panels, partitions, coverings, decoration laminates, floorings, thermal/ electrical insulations, doors, windows, table tops, false ceilings, roofs etc. The thicker sections can be used as structural elements such as beams, columns, trusses, benches, floor support, decks, frames for doors, windows etc.

Figure 2 A panel of size 1200 mm x 900 mm of bamboo composite, using industrial process machinery is shown.

The R&D output from this project will be beneficial for the society in the establishment of various bamboo-based industries / MSMEs, as well as support to bamboo harvesters, farmers,

entrepreneurs etc. Eventually it will also result in employment generation and economic development in different states in various sectors at different levels in India.

Significant Output of the project

- Indian Patent has been filed on Bamboo Composite with Application No. 201911034398.
- Knowhow on "Bamboo Composites for Modern Housing and Structures" has been transferred to M/s Permali Wallace Pvt. Limited, Bhopal.
- Design & development of Prototype Demonstrative Structure at CSIR-AMPRI premise using Bamboo Composites is being planned.
- Foundation stone for the construction of a Conference hall utilizing CSIR-AMPRI's recently transferred technology on Bamboo Composites for Structural Applications has been already laid on March 6th, 2020 at CSIR-HRDC, Ghaziabad.

Technology Transfer to M/s Permali Wallace Pvt. Ltd. on 20-02-2020 in presence of Dr Shekhar C. Mande, Director General, CSIR India at Anusandhan Bhawan, New Delhi

3. Graphene based Composites for High Performance Thermally Conducting Interface and Electromagnetic Interface Shielding Applications

The study explored the hydrogen adsorption capacity of self-assembled aligned graphene oxide at room temperature. The characteristics of as-prepared graphene oxide were determined by scanning electron microscopy, Raman spectroscopy, and X-ray diffractometry techniques. Three different temperatures were taken for preheating, i.e., 25, 250, and 400°C. The maximum

adsorption pressure was given to 20 bar, and we evaluated the hydrogen adsorption competency at room temperature (25°C). The maximum hydrogen storage capacity was achieved as ~ 2.5 wt%, which was found for the graphene oxide sample preheated at 400 °C (Figure 3). This hydrogen storage capacity was found to be 67% and 40% which is more than the graphene oxide samples preheated at 25 and 250°C, respectively. Such enhancement of hydrogen storage capacity in the self-aligned graphene oxide samples at room temperature is attributed to reduced interlayer spacing and increased topological defects in preheated graphene oxide samples at 400°C.

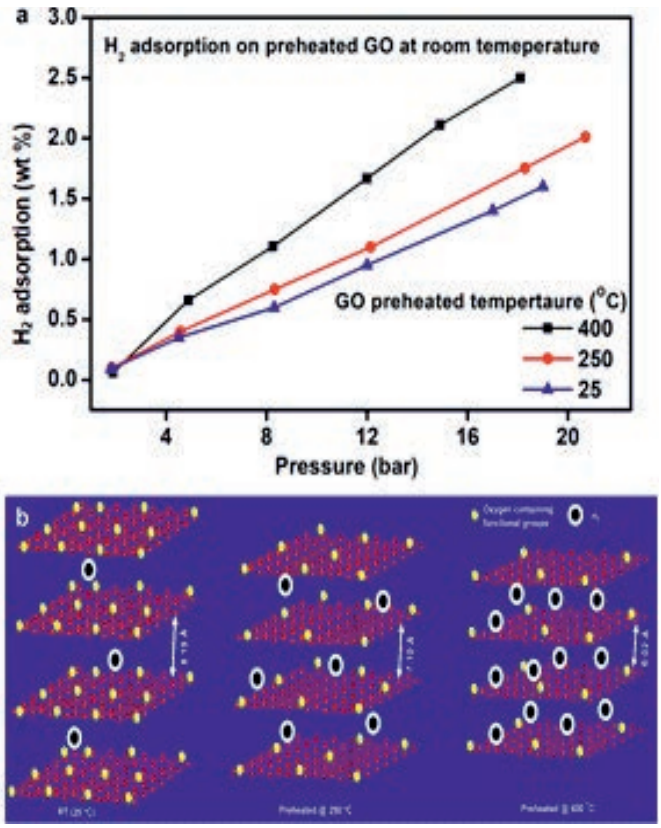


Figure 3 (a) Room temperature hydrogen storage isotherm recorded for preheated GO samples (b) Schematic illustration for temperature-dependent interlayer distance along with hydrogen adsorption

4. Computer Simulation and Modelling of Bamboo Composite and Metal Foam Material

Design, modelling and FEM analysis of various materials and its deformation behaviour

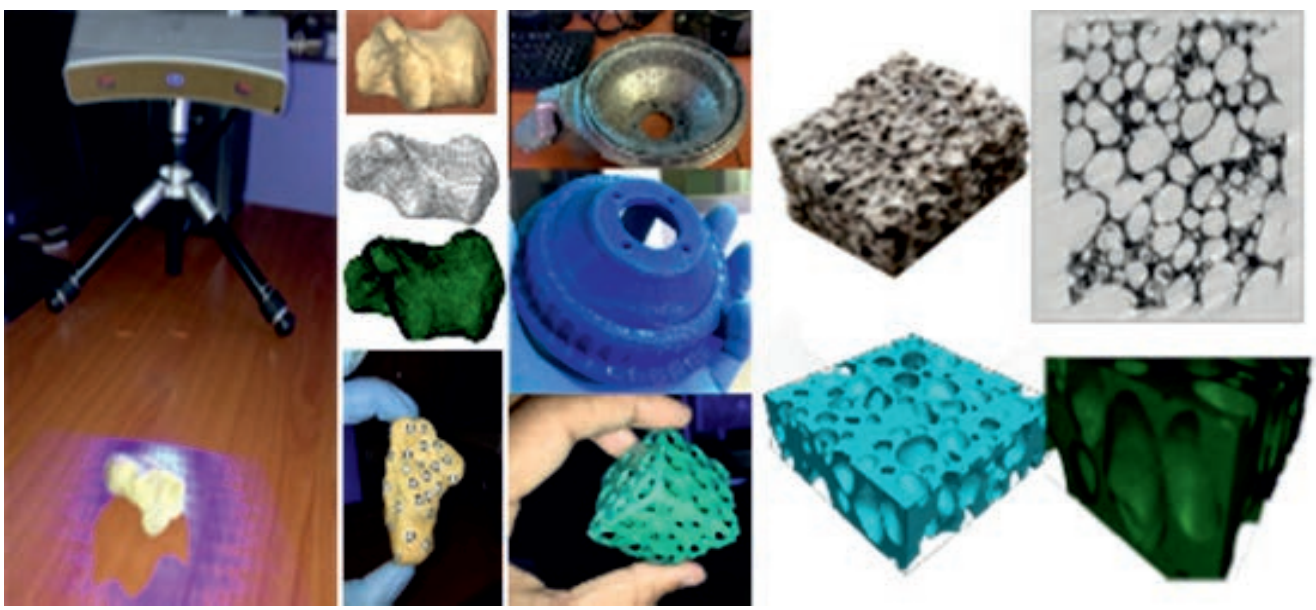


Figure 4 Scanning, 3D printing, and Foam scanning and FEM mesh of foam structure

performance were predicted using FEM software (Figure 4). The failure behaviour of bamboo composite material and metallic foam materials are understood using FEM analysis. The de-lamination behaviour of different layers of bamboo was modelled using cohesive zone modelling. A new solution has been developed to model accurately compressive deformation behaviour of metallic foam unto densification region using crushable foam FEM model. This will help in the design and development of component made-up of bamboo composite material and also where metallic foam material will be used. The modelling and simulation facilities were also established to scan the solid surfaces, 3D printing of prototype models, FEM mesh of metallic foam through CT scan images.

4. 1 Evaluation of flexural behaviour of bamboo composite material

Bamboo is among the fastest growing natural fibre and continuous efforts are going on to use it as a structural material in different forms. In the present efforts, bamboo composite material boards were prepared by splitting the bamboo into bundles following the patented process developed by CSIR-AMPRI, Bhopal. To understand the long and short beam effect on the developed bamboo composite material, two different spans to depth ratios were considered in the present study. The length of flexural specimens with span to depth ratios of sixteen and eight were cut along the direction of bamboo fibres. The two spans of 250 mm and 125 mm center to center support distance were used in the long and short beam flexural tests, respectively. Samples were tested at strain rate of 1 mm/min using three-point bend test setup having roller supports of diameter 25 mm of Instron 8801 UTM testing machine. FEM based methodology has been established to predict accurately the maximum load carrying capacity and also the mode of failure behaviour of bamboo composite material under flexural loading condition. In short span, flexural test the initial failure of specimen was due to de-lamination between different layers of bamboo fibre bundles followed by final failure in the bamboo fibre. In case of long span, the de-lamination phenomenon between the layers of bamboo fibre bundles was not significant, as also observed during the experimental flexural test. The failure in the bamboo fibre was initiated near the mid span which finally leads to the failure of the specimen. Two-dimensional (2D) FEM model of bamboo composite material flexural test specimens were created keeping the same dimension as that used in the experiments. Eight layers of bamboo fibres were created each of 2 mm thickness size. To model the de-lamination behaviour between bamboo fibre bundles a layer of cohesive zone elements of 1micron thickness size was in-between two layers of bamboo fibre bundles. In the present work, deformation behaviour of bamboo composite material was tried to understand using finite element analysis and it can be seen in the figures that the established FEM methodology could able to predict reasonably well the deformation behaviour as well as mode of failure pattern of bamboo composite material under flexural loading condition (Figure 5).

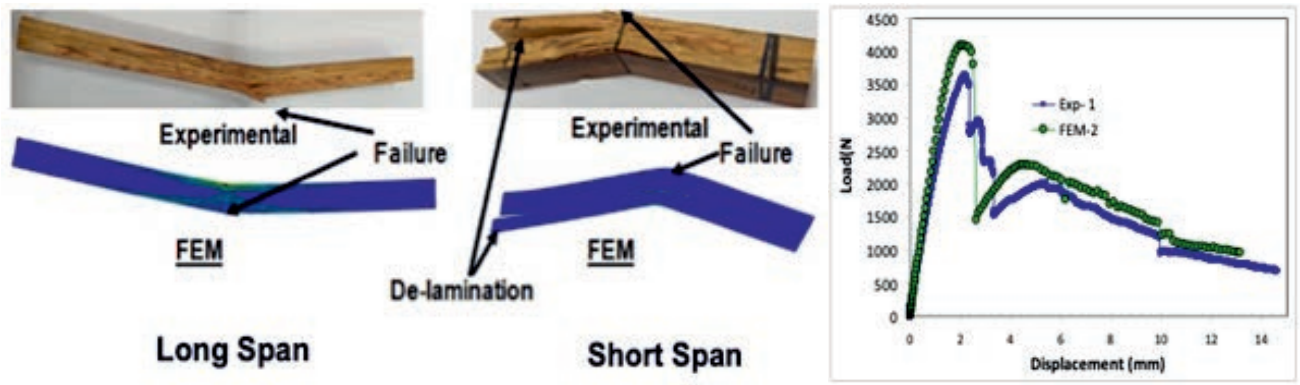


Figure 5 Flexural tests of bamboo composite material and its FEM prediction

4.2 Developing solution for accurate prediction of compressive deformation behaviour of metallic foam upto densification region

Closed Cell Metal foam exhibits excellent properties such as lightweight, higher specific strength, and excellent energy absorption characteristic under the compressive load condition and thus it has immense potential to be used as core material in composite structures. The closed-cell metallic foam may be used in energy absorption applications where it deforms under a compressive loading condition. This unique property of metallic foam may lead to many potential engineering applications such as sandwich panel, packing materials, energy absorption devices, the structural members in automobiles, spacecraft and railways, etc. In the design of composite structures used in above mentioned application and to understand numerically its deformation behaviour there is a difficulty of choosing the correct constitutive behaviour of metallic foam due to its porous structure. A solution has been proposed to

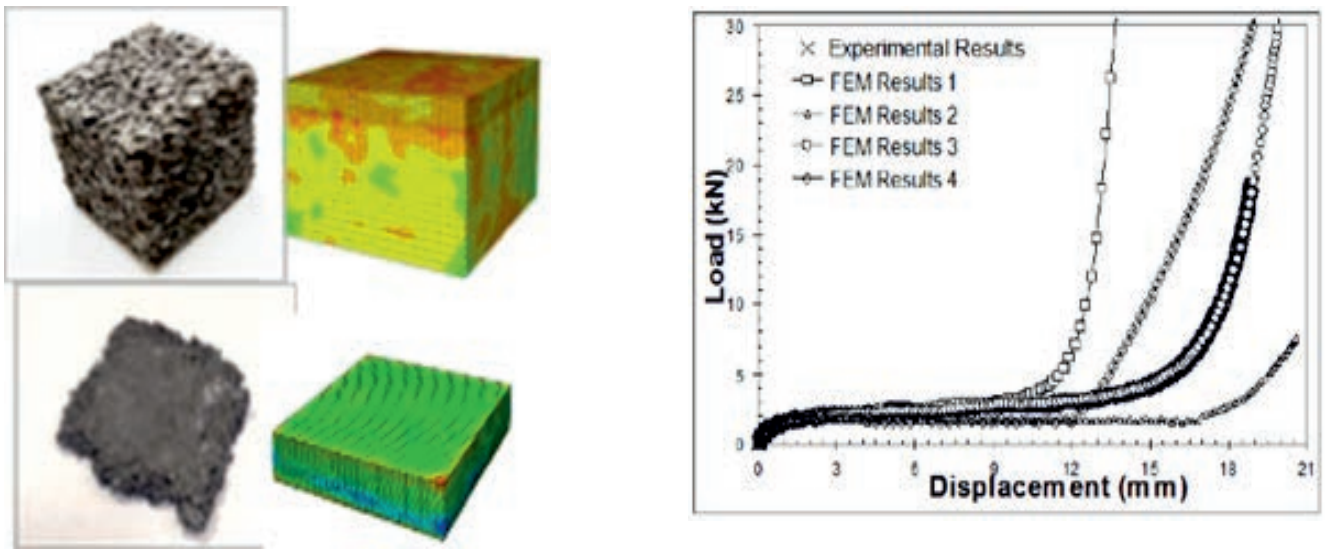


Figure 6 Prediction of metallic foam behaviour: (a) FEM crushable foam model; (b) Experimental and FEM results comparison

accurately predict the experimental behavior of a closed-cell metallic foam up-to densification region by the use of a crushable foam model under compressive loading condition (Figure 6). The effect of using different stress-strain material curves and other input parameters of the crushable foam model is quantified in terms of predicting experimentally determined compressive load-displacement behavior of the metallic foam.

5. Evaluating Different Binders Strength and Flexural Behaviour of Sandwich Panel Component

In some other work on metal foam, the bonding between metal sheet and metallic foam is also tried to evaluate and improve. Bare metallic foam used as a structural member possesses weak mechanical properties under bending conditions. Therefore, to utilize the excellent properties of metallic foam and to increase its application domain, there is a requirement of increasing its flexural strength. Bare foam covered with two thin face metal sheets can be a good solution but it faces delamination problem, specially towards face sheet side, which requires development of good bond between face sheet and metallic foam. In the work carried out using elcometerpull off adhesion tester, an attempt has been made to evaluate the bonding strength between the metal sheet and the binder, effect of binding agents and effect of surface property of face sheet for developing the metallic foam in-filled sandwich panel (Figure 7).

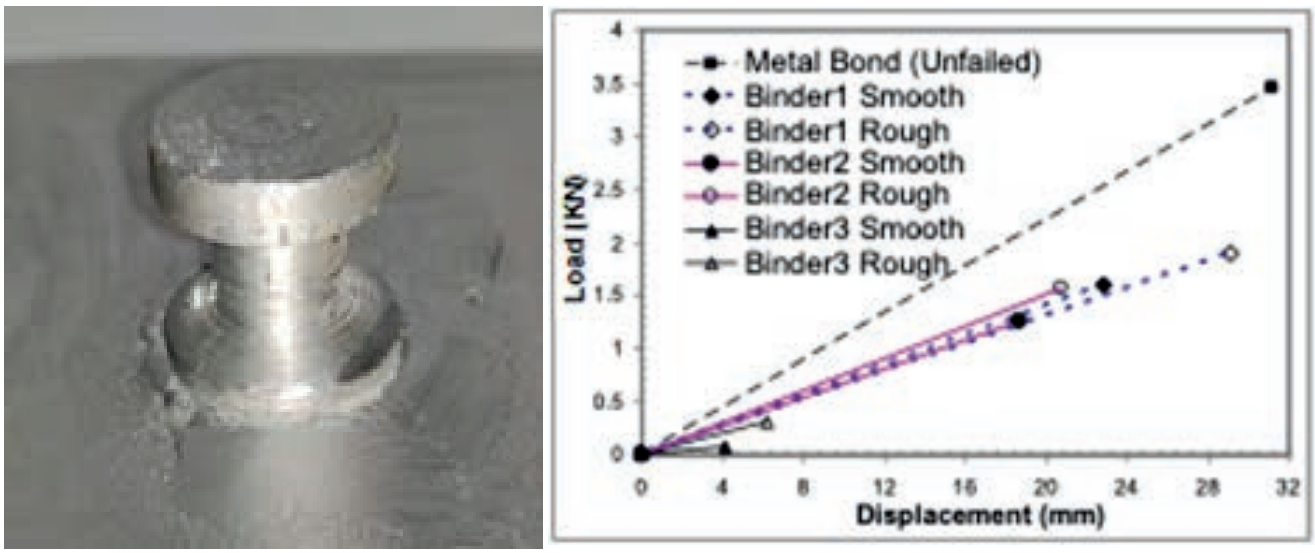


Figure 7 Evaluating bond strength of binder used in sandwich panel: (a) metallic bond; (b) pulloff adhesion tests performance of different binders used.

The attempts were also made to establish metallic bond between face sheet and metallic foam to improve the performance of sandwich panel (Figure 8). FEM models of foam-filled sandwich panel were also made and analysis has been done to study the effect of individual thickness of sheet and metallic foam core on the performance of sandwich panel. The work will be useful in the design and development of sandwich panel component.

Figure 8 Flexural samples of metallic foam in-filled sandwich component.

6. SS316L+ Graphene & Al10SiMg + Graphene Composites through Additive Manufacturing:

Additive Manufacturing (3D Printing) and Light weight structures: It is very powerful and futuristic manufacturing processes where there are limited materials are available. By making graphene and 2D materials composites, one can vary the materials properties to match the conventional metal and alloy properties. We can make light weight components and parts using

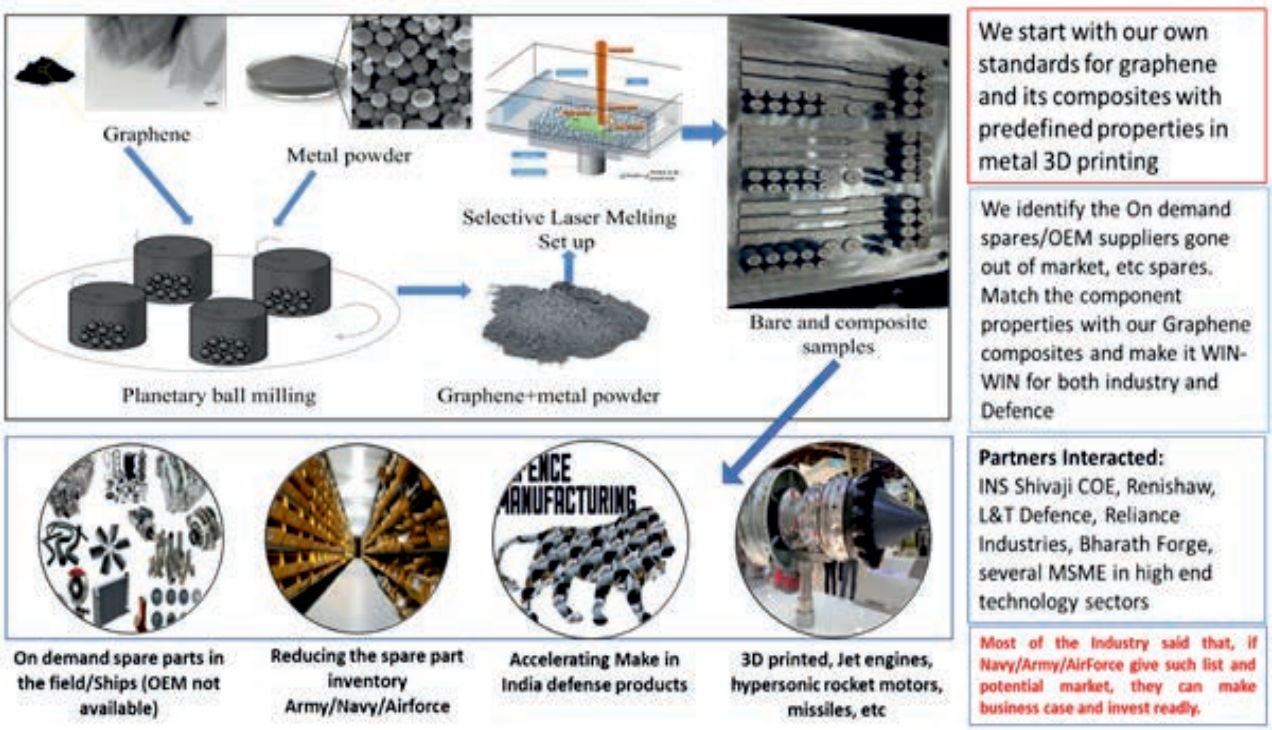


Figure 9 Graphene/metal composite through Additive manufacturing for INDIAN DEFENCE

very less materials as the graphene is 100 time stronger than steel. Hence, one can develop various application using graphene composites like aerospace structures, engines, electrical vehicles, heat exchanger, transformer core, etc. These will result in high efficient engines, vehicles and less fuel conception and less carbon emission. Cutting edge area of R&D will enable India to leap frog jump in to manufacturing technologies plays key role in Industry 4.0. The developed technology will play key role in immediate reduction spare parts inventory of Indian Navy, Air Force, Ordinance Factory Board, Indian Aviation industries, etc., and our dependence on imports in these sectors. Several billions of dollars could be saved in foreign exchange. At CSIR-AMPRI, we have developed Additive Manufacturing processes for graphene reinforced metal/alloy matrix composites with exceptional properties has been demonstrated for first time in India. Where we have demonstrated steel, which is 4 time stronger compared to same steel made by heat casting. These materials also have very less wear and tear compared to the regular steel.

7. Graphene Foam and High-Quality Graphene through RTP-CVD

Graphene has incurred intense interest since its first isolation in 2004, and with the vast array of unique properties like high mechanical flexibility, large surface area, chemical stability, superior

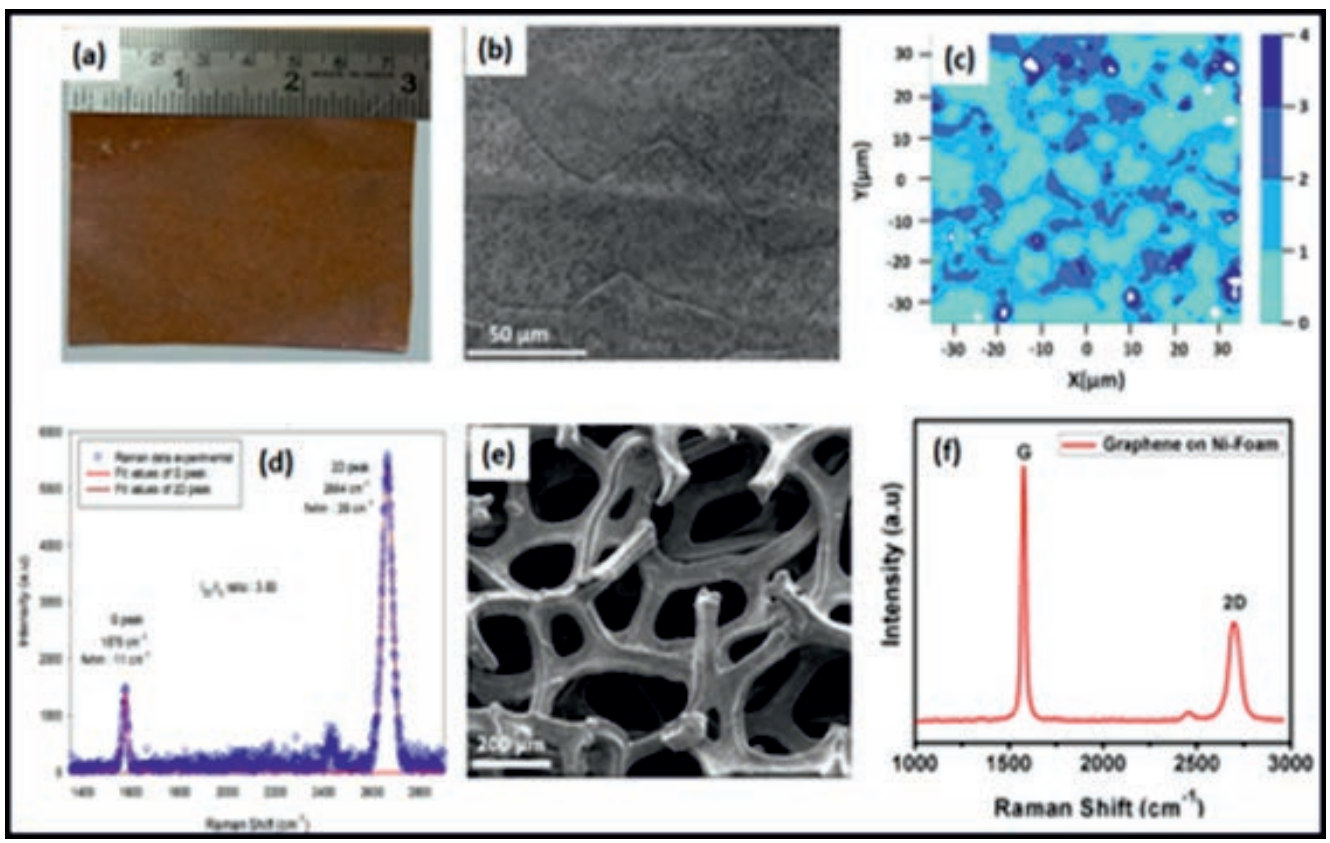


Figure 10 (a) Photographic image (b) FESEM image (c) I2D/IGmapping and (d) Raman Spectra of high-quality single layer graphene (e) FESEM image and (f) Raman Spectra of graphene grown on Ni-foam.

electric and thermal conductivities that render them great choices as alternative electrode materials for electrochemical energy storage systems and materials for nanogenerators. Here, we report highly scalable process for producing high-quality single layer graphene on Cu foils by Rapid Thermal Process (RTP) Chemical Vapor Deposition (CVD) technique. In this work, we discuss the reaction parameter for the production of high-quality single layer graphene using defect engineered seed growth of graphene on Cu foil. Additionally, we have successfully demonstrated transfer of this graphene into desired substrate. The developed single layer graphene has been characterized w.r.t various characterization techniques such as Raman, optical and Field Emission Scanning Electron Microscopy (FESEM) (Figure 10). The Raman spectrum shows typical features of monolayer graphene, e.g., ~ 3.83 I2D/IGratio and a symmetric 2D band cantered at ~2664 cm-1with a FWHM of ~26 cm-1. From the optical and FESEM images we can clearly observe that single layer high quality graphene is uniformly grown on copper foil. We have also prepared porous graphene on Ni foam in ambient condition. This graphene foam will be used as electrode for electrochemical energy storage materials.

8. Al + Graphene Composites through Accumulative Roll Bonding

Incorporation of graphene in commercially pure aluminium by hot accumulative roll bonding (ARB) is studied. Annealed Al sheets were hot ARB processed up to 6 passes by repetitive graphene coating, stacking, rolling and cutting process, respectively. Another set of monolithic Al was also processed with similar processing parameters for comparative study. A good interface between graphene and aluminium was observed under transmission electron microscopy. Interlayer bonding and grain boundary structure was examined by scanning electron microscopy and electron backscattered diffraction mapping, respectively. Fraction of high angle grain boundaries not only increases with respect to ARB passes but also with graphene incorporation. Raman mapping was also performed to understand the quality as well as the distribution of graphene. Tensile strength and hardness of processed composite were increased up to 25 % and 20 %, respectively, in comparison to monolithic Al which is attributed to graphene reinforcement effect. Thermal conductivity (TC) of annealed Al, 6pass monolithic Al, and 6pass graphene/Al composite was also measured. Due to ARB processing, TC of annealed Al was reduced by ~17 % but the addition of 0.1 wt. % graphene was able to recover the reduced TC.

9. Slippery and Wear Resistant Surfaces Enabled by Interface Engineered Graphene

Recently, our group discovered a way to improve the tribological behaviour of a number of commercially used materials such as silicon, glass and ceramic Al_2O_3+TiC composite. Using graphene and newly discovered graphene/silicon nitride (SiNx) bilayer overcoats, we have been

able to largely reduce the friction and wear of silicon, glass and ceramic surfaces. The results for friction and wear control of silicon (Si) surface, using single layer graphene (1LG), bilayer graphene (2LG), 1LG/SiNx bilayer, and 2LG/SiNx bilayer overcoats, is shown in Figure 11. It is to be noted that monolithic SiNx overcoat also displays high friction and wear, similar to Si surface. This work got published in prestigious journal Nano Letters with details as "Slippery and Wear Resistant Surfaces Enabled by Interface Engineered Graphene" by Neeraj Dwivedi, Tarak Patra, Jae-Bok Lee, Reuben J. Yeo, Srilok Srinivasan, Tanmay Dutta, K. Sasikumar, Chetna Dhand, Sudhiranjan Tripathy, M. S. M. Saifullah, Aaron Danner, S. A. R. Hashmi, A. K. Srivastava, Jong-Hyun Ahn, Subramanian K. R. S. Sankaranarayanan, Hyunsoo Yang, Charanjit S. Bhatia, Nano Letters 2020, 20, 905-917 having Impact Factor of 12.27.

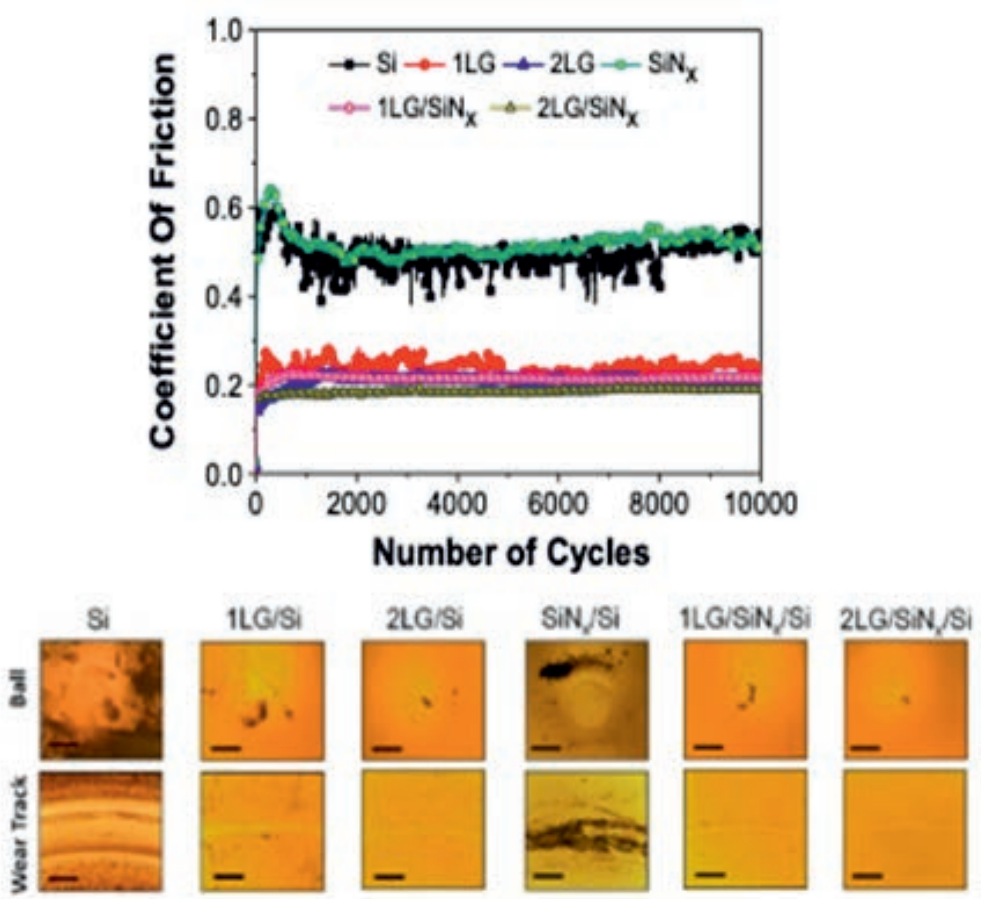


Figure 11. Application of 1-layer graphene (1LG), 2-layer graphene (2LG) and 1LG, 2LG/SiNx hybrid coatings largely reduce the friction and wear of silicon.

10.Facile Synthesis of Copper-Graphene Composites

Graphene reinforced copper composites have recently drawn interest of many researchers world-wide due to their wide spectrum of applications ranging from thermal dissipation to sensors to biocidal applications. Graphene incorporation in copper matrix is challenging due to

large density difference and agglomeration tendency of graphene. Therefore, in this work a facile method of depositing copper on pristine graphene nano-platelets was developed to make graphene platelets less prone to agglomeration during further powder metallurgical operations. Graphene nanoplatelets were used as substrate in the reduction reaction resulting in copper graphene nanoplatelets. Unlike reported techniques, this is a single stage deposition process resulting in formation of nano-islands of copper on graphene nanoplatelets.

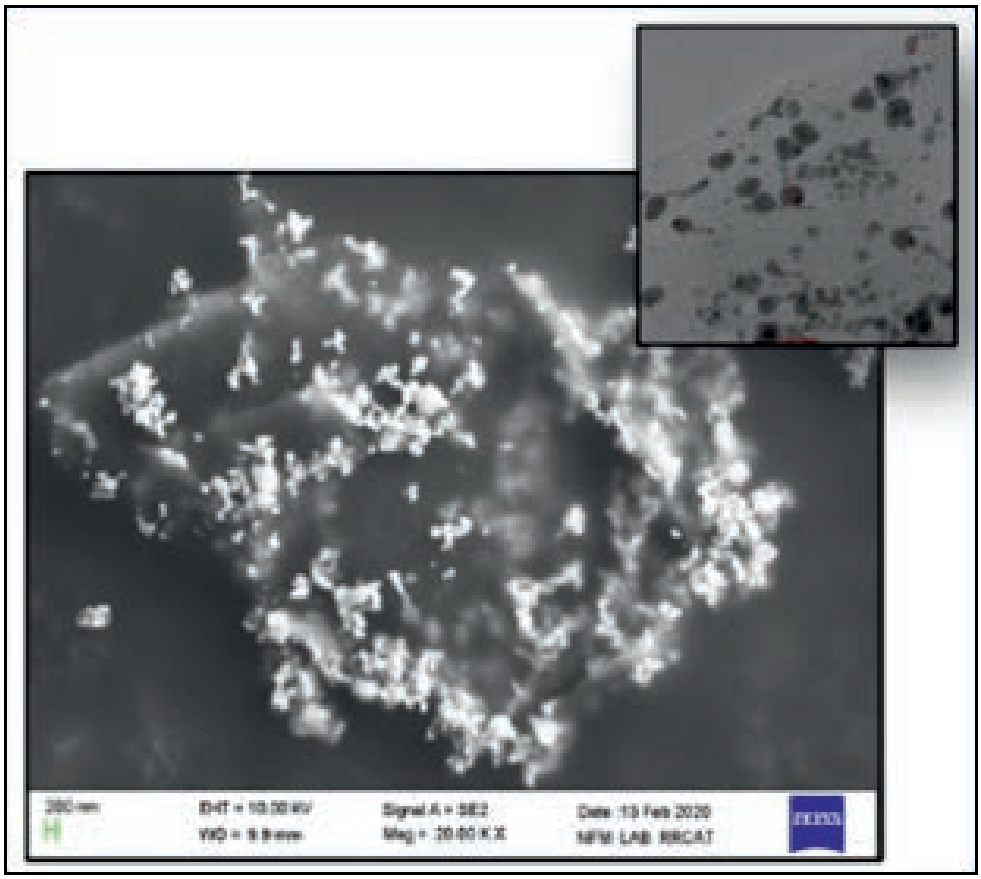


Figure 12. Copper-deposited graphene nanoplatelets

11. Polypyrrole Coated Paddy-Straw Reinforced Polyurethane Composites for Dielectric Applications

Paddy-straw burning is a national problem leading to pollution in most of the Northern India. Through appropriate processing and valorisation of these paddy straw they can be used in other useful applications like dielectric materials. The paddy straws are coated with polypyrrole, a conducting polymer, through a simple procedure which causes its enhanced interaction with polymeric matrix. This enhanced interaction led to significant improvements in dielectric constant, tensile properties, and water absorption of the made composites. This work has resulted in lightweight composites with improved performance that pave the way for low cost,

sustainable and eco-friendly materials for high end applications including electronics and sensors. The schematic representation of the concerned work shown below (Figure 13).

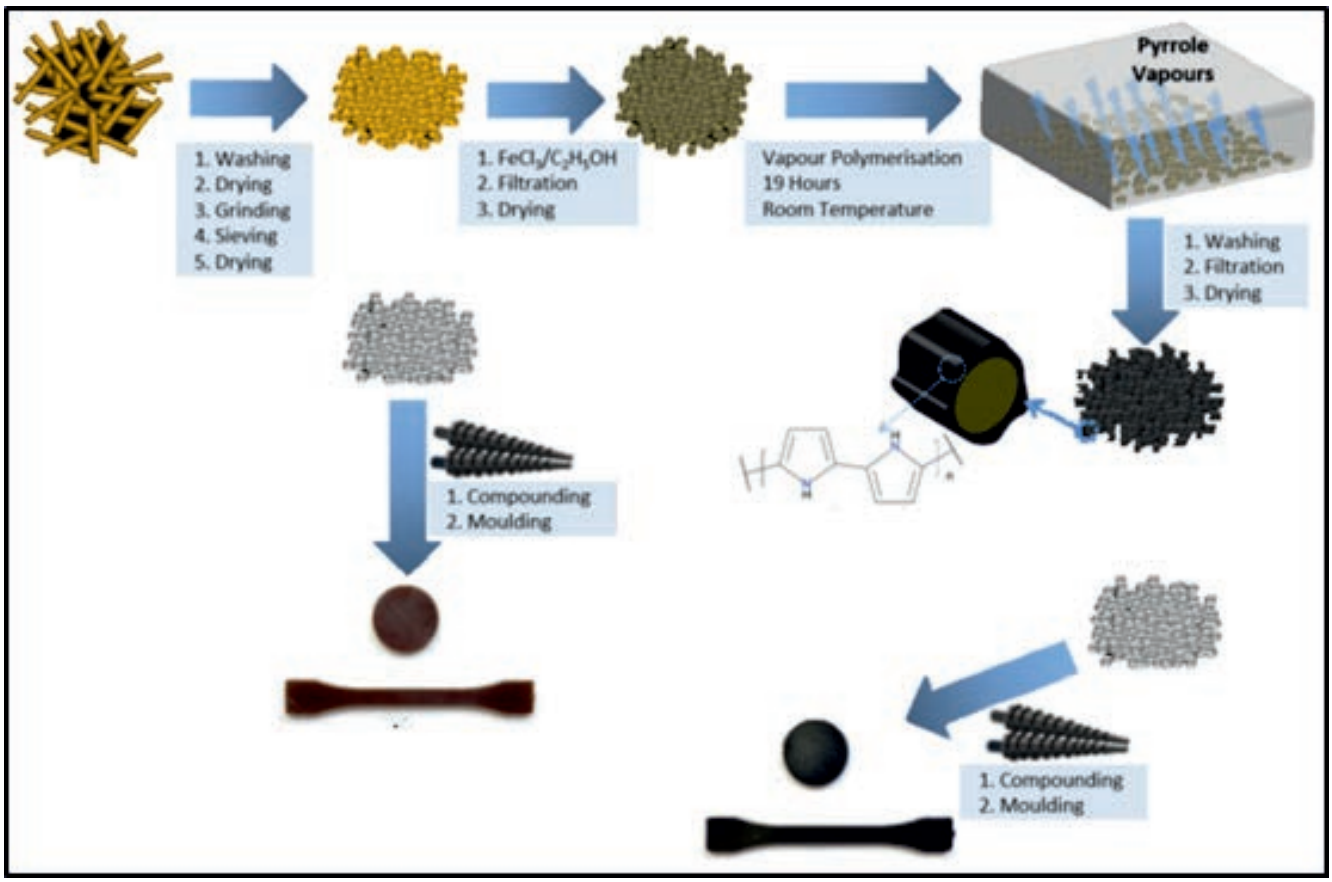


Figure 13 Schematic representation of making polypyrrole coated paddy straw reinforced polyurethane composites

1. High performance metal matrix composites for transportation, defense, aerospace and engineering sectors

1.1. Nanocomposites by casting route and Up-scaling the process

(i) The process for making Al-composite and hybrid composite foams have been developed at a scale of 35 kg in single heat.

(ii) Process for making in-situ foam filled tubes (Figure 14) have been developed and characterized in detail.

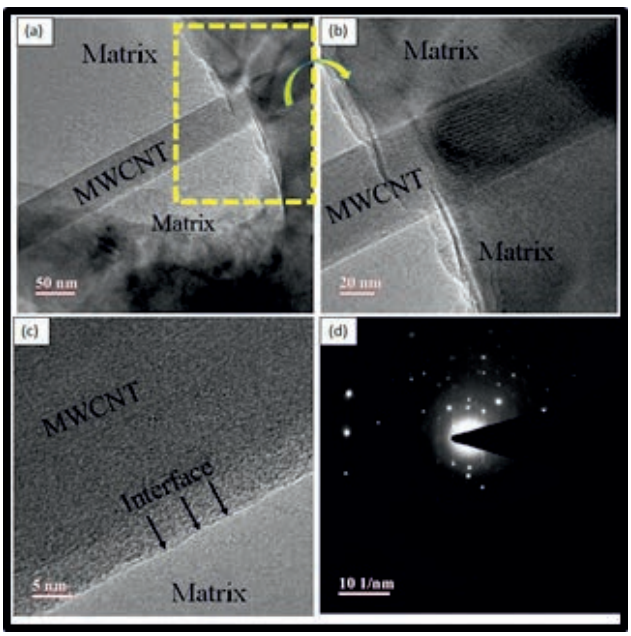


Figure 14 Microstructure of hybrid composite showing strong interface bonding between CNT and Matrix.

1.2. Processing of the Metallic hollow spheres

Metal hollow spheres were made using lost core technique. Volatile substrate balls were used as a base/core in this method and these balls were coated by metal powders with the help of

binder. Binder was dissolved in solution and mixed in metal powders for making a slurry for coating. Volatile substrate balls were sprayed with this slurry and the slurry was coated into volatile substrate balls and then dried. Now these coated balls were heated for removing the substrate. At this stage, green metal spheres were achieved which were further sintered in a vacuum furnace to get metallurgical bonding. Wall thickness of these hollow spheres were measured using SEM.

Figure 15 Prepared hollow sphere with different wall thicknesses.

1.3. High strength-high conductive Cu composites:

(i) Fabrication of copper-graphene composite by roll bonding (Figure 16)

(ii) Optimizing the operating parameters; Roll bonding speed, temperature.

(iii) Results- Improvement in terms of Vicker micro hardness of up to 103HV at suitable rolling-speed with taking theoretical Vicker hardness of annealed copper as 40HV with little improvement in electrical conductivity.

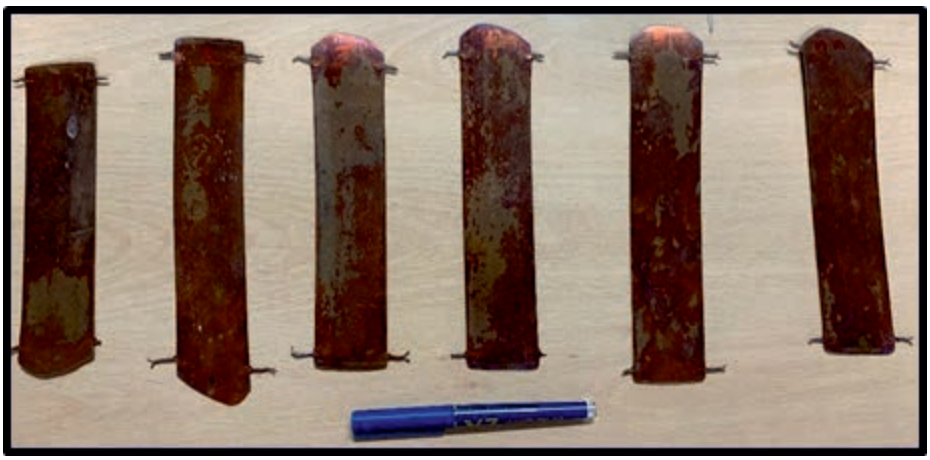


Figure 16 Samples of copper graphene composite after ARB

2. Bio-CO_2-electroreduction to formic acid:

Bio-electroreduction of CO_2 to formate is carried out in a double-chambered microbial electrolysis system (MES) using the iron phthalocyanine (FePc) dispersed carbide-derived carbon (CDC) cathode (Figure 17). Formate dehydrogenase (FDH) released by prokaryotic E. coli catalyzes the CO_2 reduction and acts as a promotor for selective formate generation. The prepared FePc-CDC composite catalyst is characterized by several physico- and electro-chemical characterization techniques including scanning electron microscopy, surface area analysis, X-ray diffraction, and infrared spectroscopy to corroborate the sustainability of as-synthesized catalyst material in MES. The FePc-CDC-based MES shows a maximum format production rate of ~ 30 mg/L.h from CO_2 (120 mg/L.h) at a poised potential of -1.0 V (Ag/AgCl) using E.coli and neutral red mediator. The study clearly demonstrates that the electrofermentation of CO_2 to formate in a FePc-CDC cathode-based MES can be a selective and viable green process for the utilization of CO_2 as a sole carbon feed-stock.

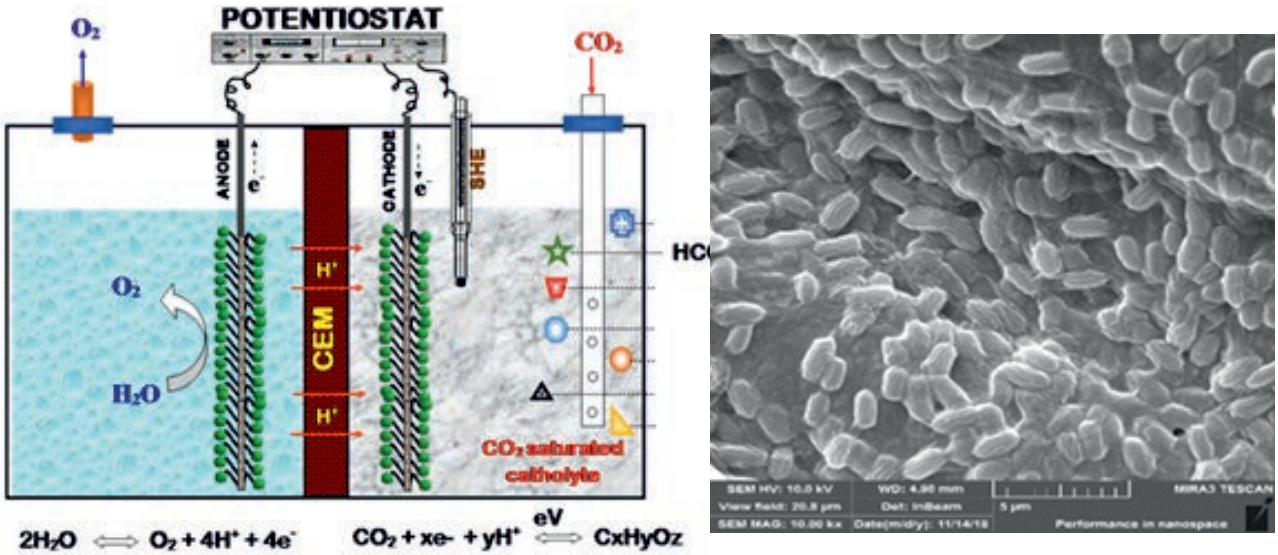


Figure 17 Schematic of bio-electroreduction of CO_2 (left) and E. coli immobilized SEM micrograph of electrode

3. Lightweight carbon foam as an electrode for lead-acid batteries

The lead-acid batteries are still one of the most reliable, economical, and environmentally friendly options for energy storage. However, electrodes in the lead-acid batteries suffer from the problem of heavyweight, corrosion, poor thermal stability, and diffusion of electrolytes in one dimension which ultimately affects the output power. In this concern, carbon foam has great attention due to remarkable properties such as lightweight, highly porous, highly resistive to corrode, good electrical and thermal conducting, and high surface area. Present work demonstrates the effect of MWCNTs on the electrochemical performance in terms of cyclic

voltammetry, charge-discharge capacity, and impedance of carbon foam (Figure 18). The value of current density and capacity has been enhanced to 180 mA/cm2 and 200 mAh respectively on the loading of 1 % MWCNTs. All the results indicated that this effort provided a novel concept for replacing the lead grid with carbon foam for high energy density and lightweight lead-acid batteries. The multifunctional carbon foams demonstrate that they are outstanding materials with potential applications in EMI shielding and thermal management for defence and aerospace sectors.

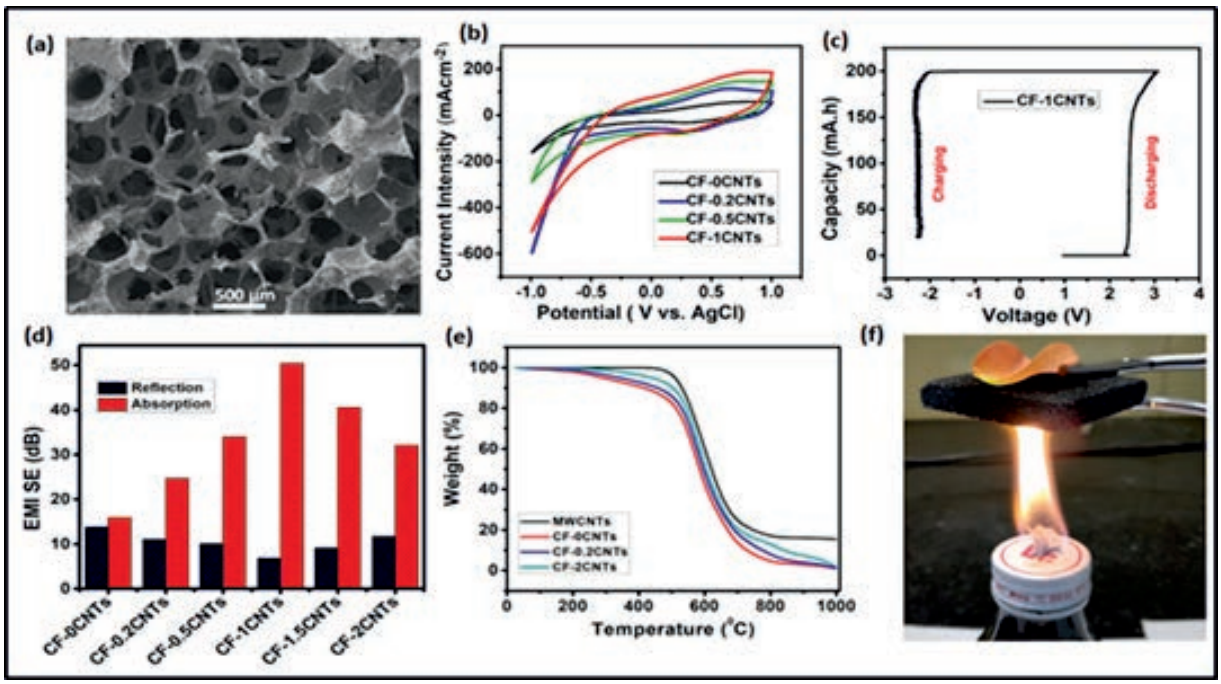


Figure 18 (a) SEM image, (b) Cyclic voltammetry, (c) Charge-discharge curve, (d) EMI shielding in terms of reflection and absorption (e) Thermal stability and (f) Flame retardant performance of carbon-CNTs composite foam.

4. Prospects in Development of Magnesium Alloys for Engineering and Health Sectors

Under this project a new green process for melting and casting of Magnesium alloys with repeatable and reproducible manner without using any flux and toxic gasses like SF_6 and CO_2. The process developed indigenously in India. This could be upscaled and explored for commercialization. The alloy prepared in repeatable and reproducible manner. 19 alloy compositions are made and characterized mechanically. The chemistry and mechanical properties are repeatable and reproducible. The process is scaled up to 30 kg/heat. The RE added AZ91 alloy showed considerable higher strength (Ys 250 MPa, UTS-400 MPa) at a density of only 1.79 gm/cc. Further, the same alloy exhibit yield strength of ~180 MPa at a temperature of 200°C. Wrought alloys AS series were also made and these alloy after casting exhibited UTS

around 325 MPa and after rolling and heat treatment these alloys exhibited strength of UTS 500 MPa. Rolled sheet of 1.5 mm thickness are successfully made at CSIR-AMPRI.

Room temperature and high temperature strength of synthesized alloys and its comparison with results in ASM international (*).

Magnesium alloy series	Achieved UTS (MPa) and (YS (MPa))	YS* (MPa)	UTS *(MPa)	UTS at 250 (MPa)
AZ91	240 ± 10 (165 ± 10)	160	250	165
AZ91+0.5Si	290 ± 10 (195 ± 15)	175	240	165
AZ91 (Y+ Nd, Nb)	325-340 ± 13 (212± 15)	172	250	190
AZ91+(Y+Sc, Zr)	370-389± 16 (235±20)	145	230	199

5. Pilot scale production and demonstration of closed cell aluminium composite and hybrid composite foam for automobiles, rail, ship building, defence and construction sectors.

The project was conducted with the objectives of pilot scale production (150 kg/day) of closed cell aluminium Composite (Al-SiC) and hybrid composite (Al-SiC-CNT) foams and to deploy the materials for crash worthiness (automobile), Rail sandwich panel), blast resistance (sandwich panels with Al-foam and steel plates) and Al-foam core sandwich panels for door and other light weight structural applications. The facilities for making Aluminium closed cell foam of controlled densities at a scale of 150kg /day has been established. The system for foam making is automated. After making these foams, the sandwich structures for door panels are made. The foam filled crash box plus bumper assembly is made and tested at ARAI pune. Ordinance factory Medak has come forward for the design and development for development of Steel-Al foam sandwich plates for light combat vehicles for blast resistance applications. Designing the structure has been done and the designed structure for evaluation are being made. The developed foams are partially open when its density reduces less than 0.6gm/cc. These foams are used successfully for making rural climatizer in which the wall of the climatizer ware made with Al-foam and water at controlled rate is pored over the aluminium foam structure which is in subsequent time get wetted with water. This water when evaporated naturally, takes the latent heat from the surrounding causing the inside chamber cooler. (Figure 19). The temperature inside the chamber at extreme summer (when ambient temperature is 5°C, the inside chamber temperature comes to be around 25 to 30°C. The system is use full for storage for food (24 to 36 Hrs), vegetables (48 to 72 Hrs).

Figure 19 Rural Climatizer made at CSIR-AMPRI using aluminium foam

6. Design, development and supply of closed cell foams- (SSP-053)Ordinance Factory Medak, Telangana

Ordinance factory Medak (ODF-Medak) is developing next generation Infantry Combat Vehicles (ICVs) for improved mine blast resistance. Closed cell foams exhibit excellent damping capacity and impact energy absorption. CSIR-AMPRI has developed aluminium hybrid closed cell foam reinforced with nano materials such as CNT/Graphene, which are observed with tremendous improvement in strength (~25-30 MPa), and energy absorption (15Mj/m3).AA5083+10% SiC+0.2 % CNT hybrid foam has been made with 30 kg weight for each casting. This foam has been characterized for compressive properties at quasi static and high strain rates. The average plateau strength is ~10 and 15 MPa for quasi static and high strain rate (~800/s) respectively. Figure 20 (a) shows the high strain rate deformation of hybrid foam at about 800/s strain rate. Optical microscopy has been carried to study the morphology of the foam. The observed average cell size is 1.9 mm. Raman spectroscopy has been carried out to study the distribution of the CNT and observed well dispersion of CNT within the matrix.

Hybrid foam core sandwich panel simulation has been carried out using LS_Dyna software with different configurations such as only foam, with and without metallic faces sheets etc. One blast test rig, on which actual experiment will be carried out, was also simulated. Blast simulation was carried out using 100g TNT as source, as per the blast test scale down laws. Vertical displacement, acceleration, stress on both sides of the foam panel have been measured. It was observed that two configurations of sandwich foam panels are capable of withstand the blast of TNT without imparting much stress as well as acceleration as shown in Figure 20b. This combination will be taken up for further experimentation. Figure 20b shows the simulation

results with 20 mm thick steel face sheets and 60 mm thick foam core, which is capable of attenuating blast of 100g TNT.

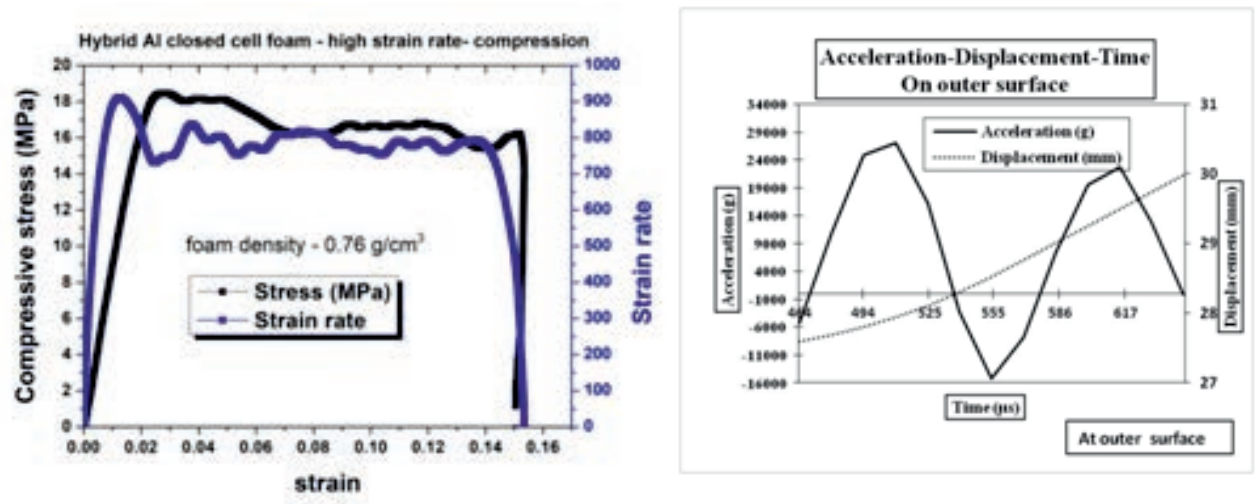


Figure 20 (a) compression stress-strain curve at ~800/s strain rate (b) Acceleration- displacement – time of impact for a foam 20-60-20 mm foam core sandwich panel.

7. Development of Metallic foam for biological, thermal and engineering applications

The project was to develop the metallic foam Ti and Ti-Mg foam for biological, open cell SS foam and Metal foam filled with wax for thermal and Foam sandwich panel for engineering applications. Open-cell Stainless Steel (SS) foams: These are useful in various applications because of its remarkable properties such as low density, high surface area, high mechanical strength and good catalytic performance. The open-cell SS foams by using cost effective polymer template technique. Figure 21(a) shows the as prepared open-cell SS foam, Scanning Electron Microscope (SEM) image, compressive stress-strain curves and catalytic study of SS foam. The compressive results show that the yield stress, elastic modulus and energy absorption are in the range of 5.2 to 10.5 MPa, 2.01 to 7.31 GPa and 1.2 to 3.5MJ/m3 respectively. From Figure 21(d), SS foam gave more activity for water oxidation catalyst in comparison to SS plate. It is due to more surface area for water oxidation.

Metal foam filled with Wax: This activity aims to increase the thermal conductivity of phase change materials using metal foam structures for storing latent heat. For this, copper foam and copper/aluminium wire woven foam structures have been used to increase the thermal conductivity for faster heat storage and extraction. A thermal energy storage tanks with capacity of storing 180 KJ energy have been designed using PCM. After storing and extracting heat from all kind of the PCM, PCM-copper foam, PCM-copper wire woven foam, and PCM-aluminium wire woven structure showed fastest heat storage of all. The heat extraction of PCM-

aluminium wire woven foam was also comparable to the PCM-copper foam. The lower cost of aluminium wire showed a way to design and fabricate solar thermal energy storage tanks of higher capacity. Thermal efficiency of thermal energy storage tank ranged from 70-85% in case of using water as heat extraction media. The efficiency ranged from 80-96% on using air as heat extraction media. The setup is shown in Figure 21(b).

Foam sandwich panel: The work has been carried out to evaluate the flexural behaviour of metallic foam filled sandwich panel. A numerical solution has been developing for predicting experimental compression behaviour of metallic foam. A facility is also established to create exact structure of metallic foam by simple-ware software using micro CT scan images. The flexural behaviour of sandwich panel was evaluated experimentally using different types of polymeric binders and metallic bond between metallic foam and metallic face sheet. It is found through experiments that the metallic bonding between face sheet and metallic foam is much stronger than that of polymeric bonding. The work has also been extended to numerically understand the combined initial stiffness and the maximum load carrying capacity of sandwich panel using different thickness of metallic foam as core and different thicknesses of two face sheets used in sandwich panel, keeping the thickness of sandwich panel as constant. The foam model is shown in Fig 21C and flexural behaviour of sandwich panel is also shown in Fig 21C.

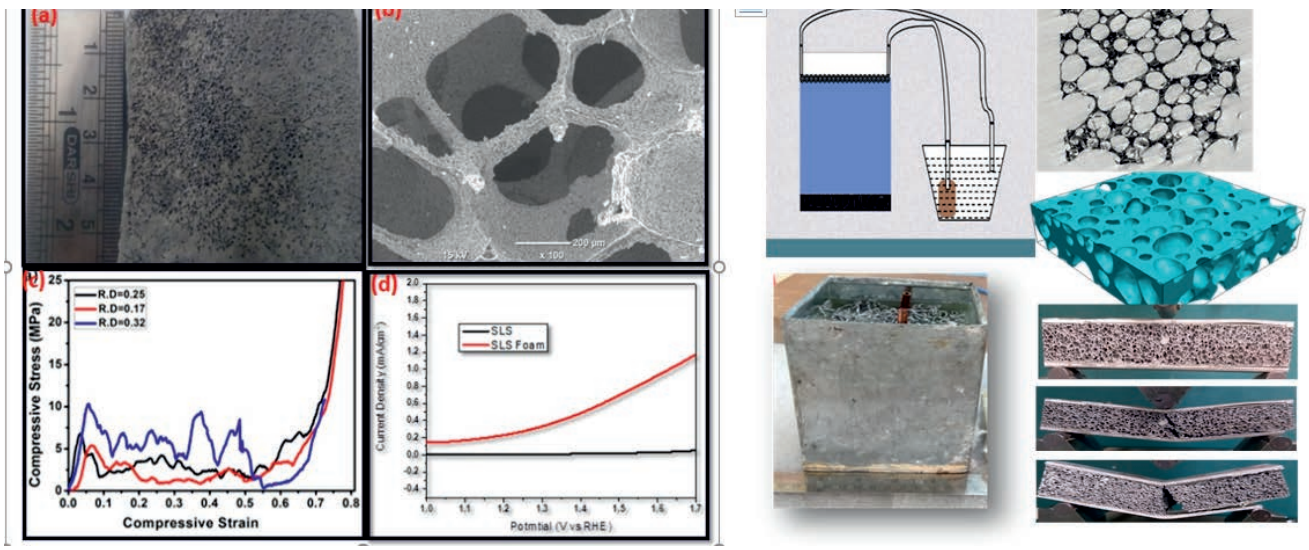


Figure 21 SS foam, SEM image and Stress- strain curves of different porosity SS foam, Pictorial view of Heat extraction and thermal storage tank

8. Development of multilayer sandwich panel for defense applications

The objective of the project is to develop low cost multi-layered metal-intermetallic hybrid laminates for armour application for self as well as vehicle protection. These laminates would have higher protection as compared to conventional ceramic-metal laminates composites and fiber-reinforced polymer composites laminate. The Lightweight amours-laminated composites

with ceramic front layers and metallic/Polymer-Fiber composites backing layers. It has same ballistic performance with lower areal densities as compared to steel. In the conventional laminated armours, the ceramic plate breaks and erodes the projectile and metallic/polymer backup absorbs the kinetic energy of impactor and supports ceramic particles. But intermetallics have higher toughness and more ductility than ceramic and thus can replace ceramic layer with intermetallics. Metal-intermetallics laminate (MIL) composites based on Al/Ti system has Young's modulus up to 200 GPa, fracture toughness up to 20–50MPa.m1/2. The multilayer system the failure initiated in intermetallic region- Crack deflection, blunting and higher stress distribution in intermetallic layer, the metallic layer toughen the multilayer Ti–Al3Ti composites. Our approach is by placing Al and Ti mixture in between Ti sheets. The Al3Ti formed due to reactive sintering and further hot pressing the complete assembly. Earlier we have synthesized 50*50 mm panel and optimized the hot pressing cycle. Now we are synthesizing of 200mm*200 mm panel is procured. We have carried out high strain rate testing of Ti sheets and Al3Ti plates and simulation of multilayer armour is going on with NIJ III+ using AK 47 bullets. The simulation of Ti alloy/TiAl3 multilayer against AK47 bullet separately at different thickness was tested and found that 8mm plate is completely absorbing the energy of AK47 bullet at 800m/sec. The NIJ III+ bullets is comprised of 7.62 x 39mm mild steel core as well as High strength steel core which has bullet weight ~9.5-10g and its speed is in the range of 700-900 m/sec. The 8 mm multi-layer can absorb both kinds of bullets.

Figure 22 Schematic of Multilayer laminates and 8 mm armour plates (200mm* 200mm), Simulation of 8 mm Ti-TiAl3 multi-layer plates with MSC NIJ III+ 7.62*39 mm Bullet

Materials for Radiation Shielding & Cement Free Concrete Division

1. Fabrication of High Dense Sintered Red Mud Tiles for X and Gamma Ray Shielding Application

Radiation shielding materials are the inevitable part of civil construction in X-ray diagnosis, radiation therapy, food sterilization plants, nuclear power plants, particle accelerators, etc., to protect operating personals, common public and environment from the hazardous radiations. Currently toxic lead and heavy weight concrete are used to make radiation shielding structures. The heavy weight concretes are used to fabricate by incorporating 60-80% of iron ores or barite. As an alternative, CSIR-AMPRI has converted the iron rich red mud into radiation shielding materials through ceramic route by adding some high Z metal compounds with it. The green tiles were fabricated by applying 60 kg/cm2 and then sintered between 900 - 1200°C. The optimum sintering temperature was determined through differential scanning calorimetric (DSC) analyses. The developed tile possesses the flexural strength of 30 N/mm2, which is suitable for using both in the wall and floor to shield radiations. The 15 mm thick tile possesses the attenuation characteristics of 2mm lead at 140 kVp. No heavy elements were found to leach out of the tiles in acidic or base. At higher temperature, phases such as gehlenite, andradite, nepheline, ilmenite and SFCA (silico-ferrite of calcium and aluminum) phases were found to form. The barite was found to be non-reactive. The porosity of the tiles was 33%, which is detrimental for the radiation attenuation. The porosity of the tiles was further reduced by varying the binder and processing conditions.

The developed tiles are suitable to make radiation shielding structures in diagnostic X-ray, computerized tomography (CT) scanner, Cath Lab, etc., to protect the common public, operators, and environment from toxic X-rays. The developed material is nearly three times cheaper than the historically used lead based radiation shielding materials. Since the use of lead has been discouraged by many countries, this CSIR-AMPRI's technology can emerge as an alternative material for attenuating high energy X- rays. Moreover, it will promote the large-scale utilization of hazardous red mud, which is left unutilized in the disposal plants and thereby to solve the associated environmental problems.

The tiles were installed in M/S Saideep Healthcare and Research Pvt Ltd, Ahmednagar of Maharashtra to cover the wall of 3 X-ray diagnostic rooms, one CT scan room and one Cath Lab (Figure 23). Totally 2500 square feet tiles were utilized and it has been tested and approved by

AERB. The same tiles are used to build radiation shielding structures at CSIR-AMPRI to install 150 kVp X-ray attenuation testing facilities.

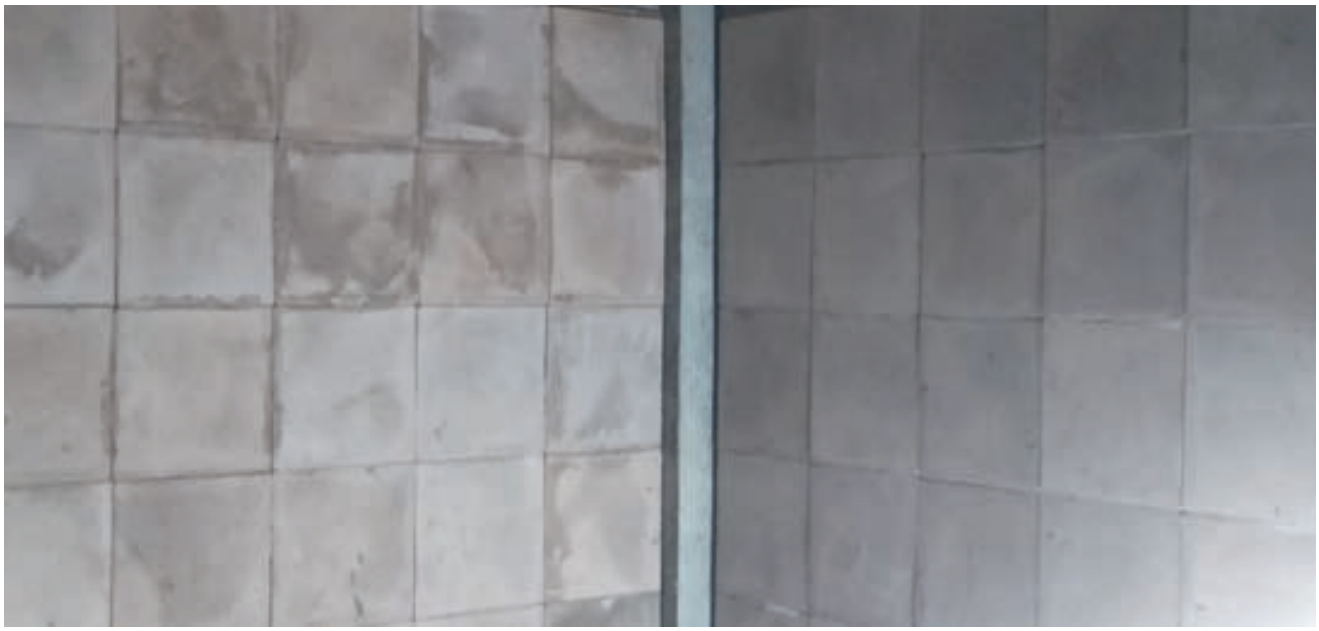


Figure 23 Joint free X-ray shielding tiles that are paved on the wall of X-ray attenuation facility developed at CSIR-AMPRI, Bhopal.

2. Advanced Geopolymeric Coating Material for Structures of Mild Steel

- Mild steel is used in different applications like pipes, ship building and for construction and structural purposes. It is subjected to adverse environmental conditions resulting in decrease in life of mild steel based structures.
- CSIR-AMPRI, Bhopal has developed geopolymeric coating material utilizing class F fly ash, alkali activators, water and inorganic/organic additives by novel environment friendly process. (Patent No. 9,938,414 B2 granted)
- The developed coating material can be coated on organic free, clean and treated mild steel surface by spray and paint brush coating techniques.
- Coating was evaluated for adhesion strength (ASTM D 4541), porosity (ASTM G62), scratch resistance (IS 101-1988), water resistance (IS 101-1989), accelerated corrosion test (ASTM B117) and accelerated weathering test (ASTM G 154). Adhesion strength found in the range of 8-12 MPa. Accelerated weathering test (ASTM G 154) for 168 hours indicated that no blistering, cracking, delamination, discoloration was observed.
- Coating was evaluated in coastal area at NTPC Simhadri. Successful results have been achieved.

- Interaction with different parties are under progress for commercialization of technology.
- Application: Deck, walls and basementareas of ship where temperature reaches upto 50-60 °C, mild steel pipelines of NTPC near coastal areas, Underground pipeline for water supply.

Figure 24 Coated mild steel plates

3. Durable Water Repellent and Stain Resistant Super Hydrophobic Textile Finishes Based on Polymer Nanocomposites

Polymer nanocomposites offer possibility of developing a new class of nanofinishing materials for textiles with their own manifold of structure property relationship. Approaches to modify the polymer nanocomposites by various inorganic substances can lead to huge number of additional functionalities which are increasingly demanded by the textile industries. In this research work ZnO nanoflower were prepared by hydrothermal method and ZnO-PDMS nanocomposites were prepared by dispersing the ZnO nanoflower in the solution of PDMS and applied on fabric to achieve superhydrophobic textiles.

Objective: To develop and optimize the process for the production of nano finished textiles using polymer nano composites in combination with specifically tailored nanoparticles to improve textile functionalities to achieve superhydrophobic surface.

Major research directions are the following:

- Synthesis of ZnO nanoflower by hydrothermal method
- Synthesis and functionalisation of nano particles to improve various functionalities and their dispersion in polymer matrices.

- Evaluation and optimization of various pretreatments of textile materials
- Development and evaluation of polymer nano composites as surface finishing of textiles

Development of polymer nanocomposites:

a) Fig.1 shows the FESEM micrograph of ZnO nanoflowers..The average grain size of ZnO nanoflower was calculated to be 21 nm according to the Debye-scherrer formula

b) Fig.2 The spectrum show well defined peaks located at different 2θ values :31.5,34.2,36.0,47.3,56.4,62.7,66.1,67.7,68.9,72.4 and 89.4 match well with the standard JCPDS power diffraction and this typical peak shows that ZnO nanoflower is in the crystal structure of Zincite.

c) Fig.3 shows the FT-IR spectrum of the synthesized ZnO nano flower. The peaks at 457cm -1 and 545 cm-1 clearly show ZnO absorption.

d) Fig.4 shows the contact angles on textile at different % concentration of ZnO nanoflower. which were found to be in the range from 140° to 151°

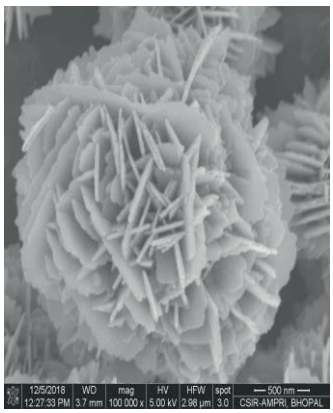


Fig. 1 FESEM of ZnO nano flower

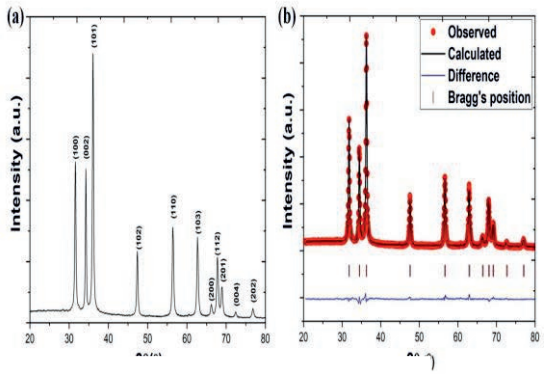


Fig.2 XRD of ZnO nano lower

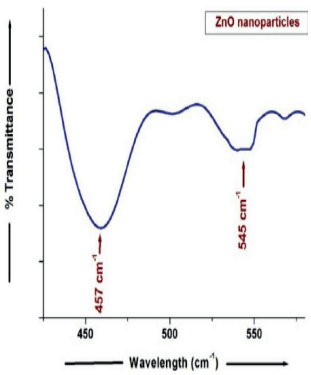


Fig.3 FTIR of ZnO nano lower

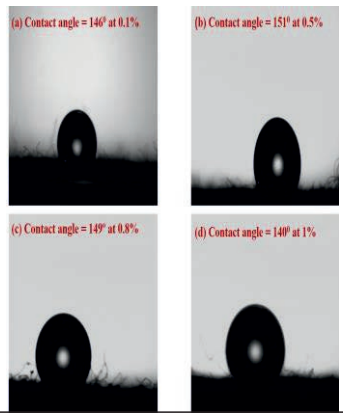


Fig.4 Contact angle on coated textile with different concentration of ZnO nanoflower

This work gives novel and simple method of development of ZnO-PDMS nanocomposites and its application on textiles to impart superhydrophobobicity.

4. Development of Radiation Shielding Fabrics Based on Carbon Nanotube Finishing

Radiation shielding is one of the most challenging topic in today's world since it is concerned with health related issues, defence, aerospace and many labs and industries. Historically 'Pb' is being used in most of these field but since it is highly toxic, costly, heavy and non-recyclable, researchers are moving towards some other materials like some of the heavy metals, mixtures of metals or polymer composites incorporated with metals which should be cost effective and having high attenuation factor with high strength and high thermal stability.

Carbon nanotubes as Shielding materials: Unique cylindrical morphology of Carbon nanotubes imparts shielding property. When radiation falls on cylindrical surface of CNT they lose energy after incidence with CNT wall. By coatings based on CNT on fabric high attenuation property of CNT transferred to fabric C=C equivalent to UV photons.. Thus it opens a vast area or research in the field of radiation shielding fabrics

Advantages of using CNT : Light weight shielding fabrics in place of heavy lead and other heavy metal based protections. Shielding Fabrics can be used on safety equipment, fabrics used in nuclear power plants, medical equipment handling , astronaut suits etc

Research strategy

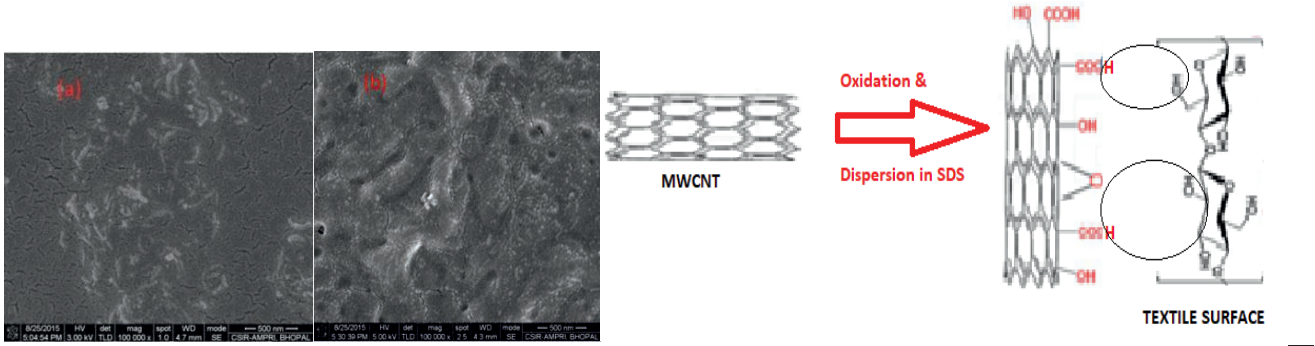
Incorporation of carbon nanotube in textile coating

- Combination of CNT with binders for textile coating
- Preparing coating formulation for application on textiles
- Measuring the shielding capacity

SEM image of MWCNT

Fig. (a) raw MWCNTs are in the form of agglomerated bundleshave fiber-like structure

Fig. (b) MWCNT treated with surfactant Length of MWCNTs get shortened



Pre-treatment of textile surface for functionalization of textile surface under Plasma discharge at 10kv,5kHz frequency, 30Watt power in the atmosphere of N2 and air.

SEM Image of MWCNT Coated cotton fibre:

- Fig. 1 shows the pores of cotton fabric without coating. The uncoated fabric features an interstices structure
- Fig.2 MWCNT coating effectively fills the pores and enwrap the walls of the pores in the fabric

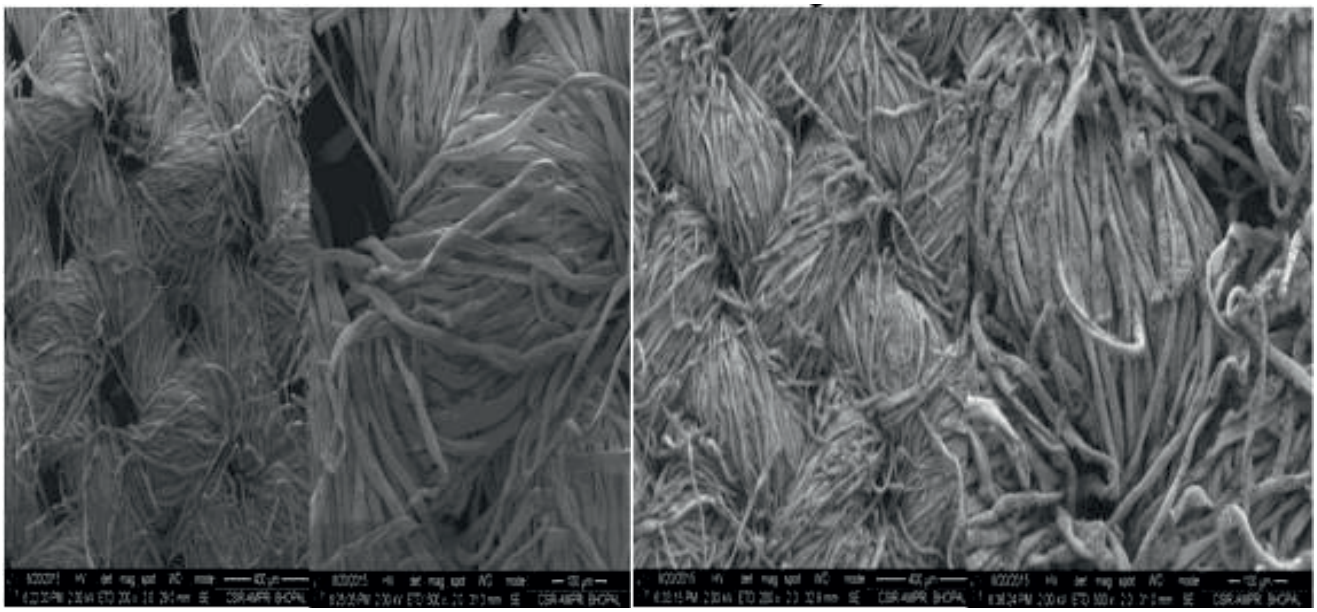


Fig 1 uncoated fabric **Fig 2 MWCNT coated fabric.**

Evidence in favour of shielding property of coated fabrics By X-Ray analysis :

5. Leachability Study of Fly Ash Dumping Site and Its Impact on Water and Soil Quality of the Surrounding Region of M/s Bharat Oman Refineries Limited, Bina, District Sagar (M.P).

Summary: The project has been awarded to CSIR-AMPRI Bhopal by M/s Bharat Oman Refineries Limited, Bina, District Sagar (M.P) to assess the impact of leachate from fly ash dumping site by

conducting detailed study on impact of leachate potential on water and soil quality of the surrounding region and possible impacts, if any, arising out of the leachate from existing fly ash dumping site. The objective of the study is to analyse different physico-chemical properties at 04 locations of surface water and 16 locations of ground water in nearby villages of BORL, Bina during pre-monsoon and post–monsoon season respectively. In all, 20 water samples were collected during the study period. Apart from this, 13 soil samples, 04 fly ash samples were also collected for mineralogy, heavy metal characterisation and Toxicity Characteristics Leaching Procedure (TCLP) test. In addition, water samples were collected and analysed for dissolved oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The assessment in both the seasons has been completed.

Based on the study, it was found that almost all the surface water samples were within the acceptable limits of standards as per IS:2296-1982 (Drinking water source without conventional treatment but after disinfection) whereas all ground water samples were within the acceptable limits as per Indian Standards for drinking water (BIS: 10500, 2012) and is suitable for drinking and domestic use. It can be concluded for pre-monsoon and post-monsoon seasons that the water quality of the region is overall healthy and no adverse impact is observed on the water quality and soil quality of the region due to fly ash dumping site and industrial process operations of BORL, Bina.A project review meeting under the Chairmanship of Managing Director, BORL Bina has also been conducted. Final project report has been submitted to the sponsoring agency.

Collection of Water and Soil Samples

DO Fixation at Sampling Location

Installation of AAQM Equipment

Project Review meeting at BORL Bina M.P.

Submission of Final Project Report to Managing Director, BORL Bina, 23.05.2019

6. Development of Fly Ash based Geopolymeric Materials for Broad Application Spectrum.

Summary: The Fast Track Translational (FTT) project has been awarded by CSIR, New Delhi under the Mining, Minerals, Metals & Materials (4M) theme. The project envisages bulk utilization of NTPC silo fly ash for the development of advanced geopolymeric tetrapod and synthetic aggregates. Synthetic aggregates shall be made from silo fly ash using sea water as additive and based on the properties of aggregates they shall be used in making geopolymeric tetrapod for comparative study. The product shall be very useful for industries like NTPC Ltd.,

Sanjay Gandhi Thermal Power Station (SGTPS), Birsinghpur (M.P.), Panchayats & Rural Development Department, Govt. of West Bengal etc. for prevention of canal bed scouring and river bank protection. It can also be used as breakwater to protect anchorage from the effect of weather and long shore drift and as filling material. The tetrapod shall be used for employment generation in rural areas and for city beautification & aesthetics.

Sample collection and its physico-chemical characterization along with the mineralogical studies have been completed. Based on the characterization, sample preparation has been done. The six- monthly progress report has been submitted to CSIR, New Delhi. First Monitoring Committee Meeting for 4M theme has been held on 10th July, 2019 at New Delhi. The project is on track and progressing as per stated objectives and timeline. One project proposal has been submitted to M/s Sanjay Gandhi Thermal Power Station, Birsinghpur, District Umaria (M.P.). Efforts for 'Know-how' transfer is in progress.

Field visit and meeting held with Chief Engineer (Gen.) at SGTPS Birsinghpur on 25.01.2019

7. Assessment of secured landfill site and its impact on surrounding region of Birla cable Limited, Udyog Vihar, Rewa (M.P.)

In order to assess the existing scenario of Secured Landfill Site (SLF), scientists of CSIR-AMPRI, Bhopal visited Birla Cable Limited, Rewa (M.P.) on 26th July 2019 and examined the existing secured landfill, piezometric points, drainage system and leachate collection pit. Detailed discussions were held with senior officials of Birla Cable Limited, Rewa (M.P.) regarding scope of work to be taken up by CSIR-AMPRI, Bhopal after lifting of waste from the SLF site. Based on the

visit and subsequent discussion, the project has been undertaken.




Site visit at M/s Birla Cable Limited, Rewa (M.P.)

8. Process for conversion of coal ash into aggregates

Fine /Coarse aggregates from Fly/Pond ash

Fly ash based synthetic aggregates were prepared using silo ash from NTPC Simhadari, Visakhapatnam which is located in the coastal area of Andhra Pradesh. Fine and coarse aggregates were synthesized by geopolymeric method using alkaline activator. For comparative studies chemical solutions in the process were prepared using normal water as well as sea water. The synthetic Fly ash aggregates were tested for physical, chemical and engineering properties and the results were compared with that of conventional aggregates. Mortar and Concrete samples were casted and tested according to Indian standards. Optimisation studies were conducted to get the desired results. The process will be helpful in manufacturing synthetic aggregates in coastal areas using Fly ash and Sea water.

Novelty

- Aggregates can be tailored as per requirement
- Full/part replacement of river sand with synthetic sand
- Testing for fine aggregate properties as per IS Standards
- Mortar and Concrete Characteristics tested
- Detailed mix design for M20/M30 concrete using fly ash sand
- Durability properties of Mixes evaluated

Benefits

Solution to both environment and fast depleting natural sand.

Bulk Utilisation of Silo ash

Abandoned Pond ash which is otherwise not suitable for construction industry can be utilised

Coal ash Fine Aggregates for replacement of River Sand

9. Centre for "Morphological, Compositional and Structural Analysis Employing Electron Microscopy and Electron Spectroscopy

The CSIR Hq. has given above titled facility creation project (FCP) to CSIR-AMPRI, Bhopal. It has FE-TEM equipment (JEOL JEM-F200) along with TEM sample preparation facilities. The transmission electron microscope is attached with STEM, EDS, HAADF detector along with FEG

electron source & accessories. Whereas, the TEM sample preparation facility includes the following equipments:

1. Ion Beam Milling System (Make: Gatan, PIPS II Cool, Model 695)
2. Dimple Grinder (Make: Gatan, Dimple Grinder II, Model 657)
3. Ultrasonic Disc Cutter (Make: Gatan, Model 601)
4. Disc Punch (Make: Gatan, Model 659)
5. Disc Grinder & Specimen Lapping Kit (Make: Gatan, Model 623)
6. Hot Plate for Sample Mounting (Make: Bio Technics India, Model BIT-22)

FE-TEM (JEOL JEM-F200)

Ion Beam Milling System

Dimple Grinder

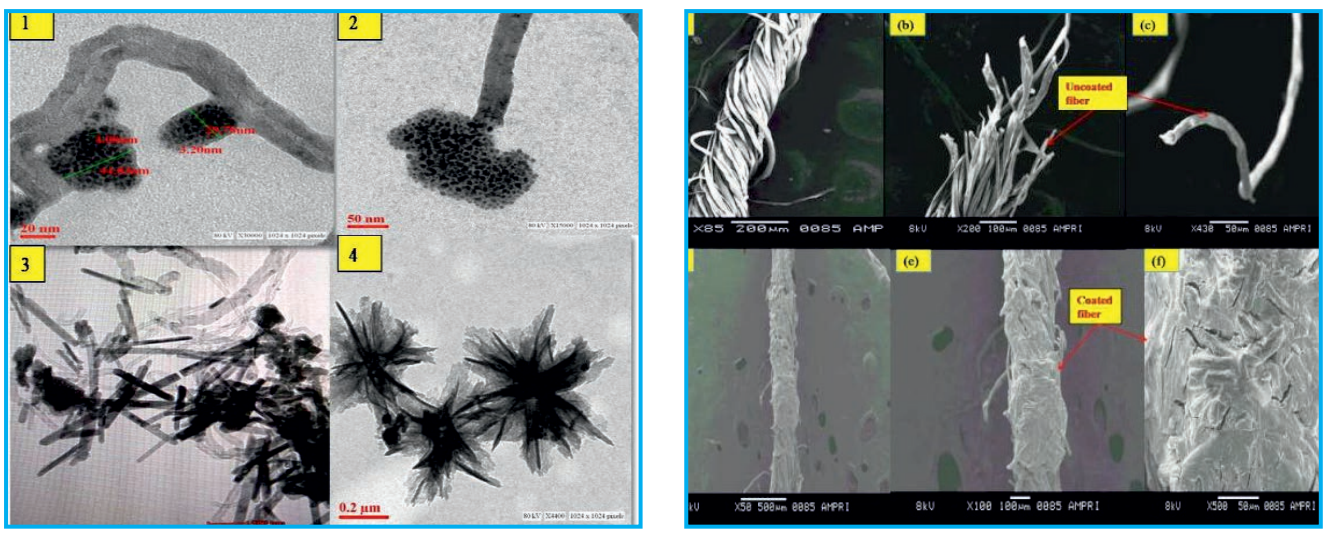
Ultrasonic Disc Cutter

7. Minitom Low Speed Diamond Saw (Make: Struers, Model Minitom)

The above facility can be used to the study the morphology of nano and bulk materials and also to solve the different structural problems of these materials. The electron diffraction, HRTEM / STEM imaging and energy dispersive spectroscopy can be utilized to develop the advanced materials and to understand their behavior at nano and atomic level.

10. Development of Multi-Elementally and Nano Morphologically Modified Advanced Light Weight Carbon Nano Tube Based Radiation Shielding Bandage Useful for Broad Application Spectrum

Carbon nanotubes (CNTs) has extraordinary mechanical, thermal and electrical properties due to which they have high potential applications in various sectors for developing composite materials, smart structures, chemical sensors, energy storage, nano-electronic devices, and radiation shielding materials too. This shielding characteristic of carbon nanotubes is based upon its unique cylindrical nanoscale morphology. Further, the application of diagnostics X-ray involves complete exposures of the human body, which leads to harmful radiation effects and the high density of conventional shielding materials prohibits their applications in the form of shielding bandage etc.



a) b)

Figure 25 a) TEM micrograph Nano particles of metal compounds impregnated in advanced MWCNT based radiation shielding material b) SEM of Uncoated and coated textile fibrils.

In the reported work, the shielding efficiency of MWCNTs is increased by modifying them via in-situ synthesis of high Z to low Z values metallic compounds on the wall of cylindrical space of carbon nanotubes in different nano morphologies like Nano flower, nanorods, polygonal etc. Further, this research has enabled obtaining radiation shielding characteristics even using

relatively lower density elements by developing multilayer, multi-elemental and multi phase's structures.

The experimental work for the in-situ synthesis of multi-elementally and nano morphologically designed advanced carbon nano tubes involves the synthesis of materials by simultaneous and synergistically interaction of the microwave, ultra-sonic techniques optionally based on solvothermal and the hydrothermal approach using precursors of organic compounds like multiple walled carbon nanotubes (MWCNT), Hexamethylene tetramine, cytosine, etc. and salts of inorganic compounds like bismuth, barium, titanium, gadolinium, etc. ranging from nano to micron form in desired stoichiometric ratio for obtaining jelly-like material such that it can be easily diffused with textile fibrils to provide shielding characteristics that can be converted into an x-ray radiation shielding bandage.

The Exhaustive Characterization and Chemical monitoring of developed materials for obtaining desired different physico- mechano, chemical, and homogeneous radiation shielding characteristics using various sophisticated complementary techniques like a) X-ray diffraction b) FTIR c)ESEM d) EDS e) DSC f) TGA g) PL h) TEM i)XPS etc. have been studied (Figure 25). The radiation shielding characteristic is evaluated using standard X-ray attenuation test for ascertaining homogeneous radiation attenuation properties in the developed material.

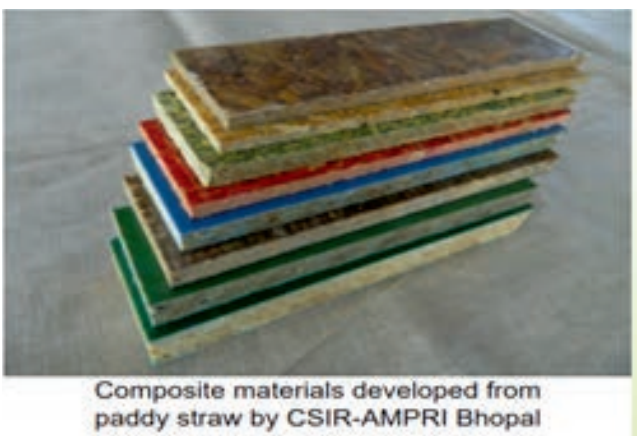
The use of developed smart multifunctional radiation shielding bandage possess a broad application spectrum ranging from attenuating emergency radiation leakages, transport of casks and sealing of complex shielding installations of a public domain such as X-ray radiation, CT scanner rooms, and medical equipment and bunkers for army personnel, nuclear power plants, hospitals, medical etc. of strategic natures.

Two patent applications related to the R & D work has been filed in India (Patent Application Ref. No. 0065NF2019 &. 0181NF2019 respectively).

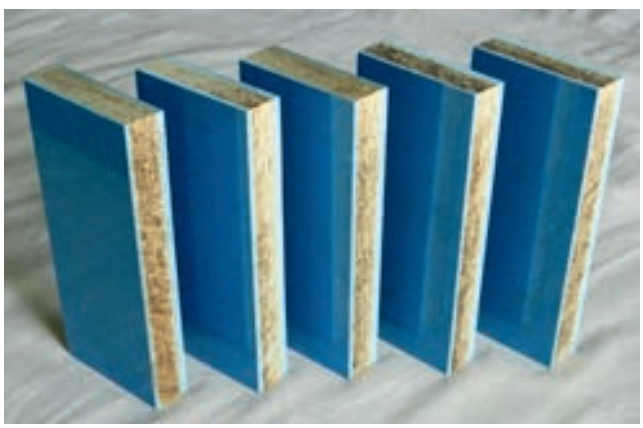
1. Development and Manufacturing of hybrid green composites using industrial and agro wastes in pilot scale and facilitating entrepreneurship

Significant Achievement:

- Different agro waste such as wheat straw, paddy straw and sugarcane baggage were collected from Madhya Pradesh, Haryana and Punjab and characterized their properties in terms of structural, mineralogical, elemental, physical, chemical, macromolecules (lignin, cellulose, hemicellulose) pH, conductivity and thermal characterization.
- Interacted with the farmers and discussed their existing issue related with burning of agro residue and their disposal exploring for potential utilization in composite manufacturing.
- The developed termite and fungus resistance composite materials/ products using industrial (inorganic) and agro (organic) waste arising from different industrial and agricultural sectors.
- A process of know-how and technology package has been developed for manufacturing hybrid composite materials related to providing a holistic solution for industrial and agro waste arising from industrial and agricultural operations.
- A process knowhow for making high-performance lightweight glossy finish hybrid green sandwich composites using agro-fibres and industrial waste particulates have been fabricated using compression moulding systems at various conditions in pilot sale and



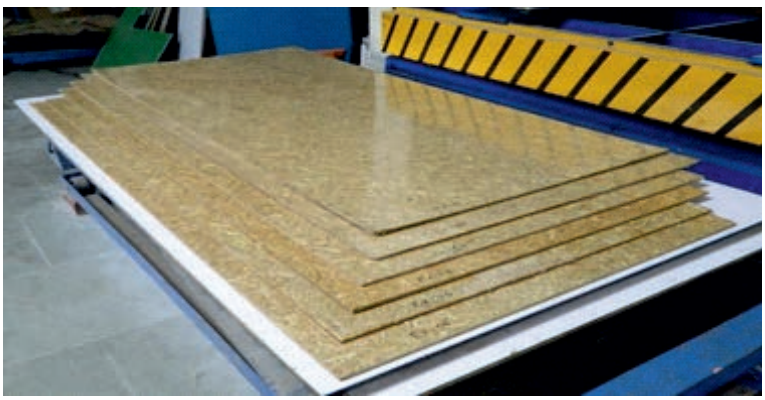
Paddy straw-industrial waste composites



Wheat straw- industrial waste composites

exploring for commercialization.

- patent titled "A glossy finish sandwich composite and process for preparing the same" has been filed (Patent Application Number: 201811047389 on 14/12/2018).



Hybrid green composite boards made of agro wastes (paddy) straw fibres in pilot scale (2m x 1 m with 12 mm thick) at CSIR-AMPRI Bhopal

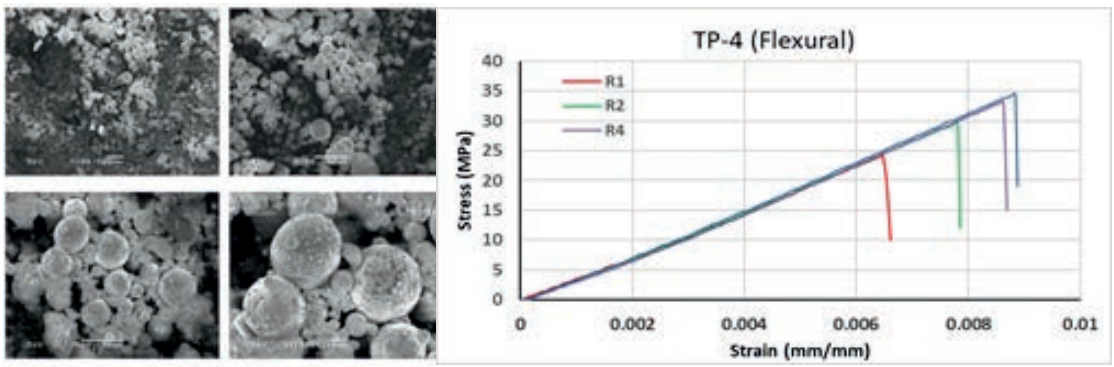
Visit to Haryana and interaction with Honorable Chief Minister of Haryana Shri Manohar Lal Khattar with Dr. Avanish K Srivatava & AMPRI Team exploring for commercialization during which one of our RC member Dr. Sathish Kumar Director NIT Kurukshetra and local industries authorities were participated in the meeting

2. Feasibility studies of Tata Power fly ash to explore their use of making modular kitchen materials/artificial granite

Significant Achievement:

- Fly ash generated from Indonesian coal by TATA Power plant at Mumbai has been received and characterized in terms of physico-chemical, mineralogical, morphological, elemental, thermal analysis.
- A new class of artificial kitchen platform / artificial granite with different thickness and size have been developed
- Mechanical properties, water absorption, thermal retardant, acid resistant properties of the product were studied.

- The findings of the study showed that glossy finish artificial granite can be manufactured using tata power fly ash for modular kitchen application and now exploring for commercial production.



SEM Properties of Tata fly ash Flexural Properties of Tata fly ash composite product

Visit of Mr. Uttam Pawaskar Group Head and Mr. Prag Railkar, Chief Corporate, Tata Power, inspecting artificial granite made of Tata fly ash at CSIR-AMPRI Bhopal

A memento made of Tata Power fly ash was presented to Shri Asok Sethi, CEO, Tata Power by Dr. Avanish K. Srivastava Director CSIR-AMPRI Bhopal during the visit of Tata Power team to AMPRI Bhopal

3. Fabrication of high performance piezoelectric nanogenerator

Significant Achievement:

- We achieved the growth of pristine vertically aligned flexible two dimensional (2D) pure ZnO nanodiscs via a simple seed assisted solution route and their use in the fabrication of a piezoelectric nanogenerator (Figure 26).
- A flexible piezoelectric nanogenerator was fabricated using the vertically aligned ZnO nanodiscs as the active piezoelectric material and a carbon nanotube–polydimethylsiloxane (CNT: PDMS) film as the top electrode.
- This unique 2D-type ZnO nanodisc-based nanogenerator generated a direct current (DC) type output voltage and current density of about 2.5 V and 30 nA cm−2 under compressive vertical strain, respectively.
- Significant enhancement of the piezoelectric output voltage from the flexible nanogenerator based on the vertically aligned two-dimensional (2D) zinc oxide (ZnO) nanodiscs was achieved via thermal annealing. An output voltage and current density of 17 V and 150 nA cm−2 were detected from the thermally annealed 2D ZnO nanodisc based nanogenerator which is approximately 8 times higher (voltage) than that from the pristine nanogenerator.
- We have successfully fabricated transparent and flexible piezoelectric lead-free zinc silicate (Zn_2SiO_4) nanorods-graphene based nanogenerators for harvesting mechanical energies for the first time.
- Piezoelectric properties of grown Zn_2SiO_4 nanorods was confirmed and a piezoelectric charge coefficient (d33) of about 117 pm/V was obtained through piezoelectric force microscopy study. A high-performance piezoelectric hybrid composite nanogenerator was successfully fabricated using polydimethylsiloxane (PDMS) polymer, Zn_2SiO_4 nanorods and CVD grown monolayer graphene sheet.

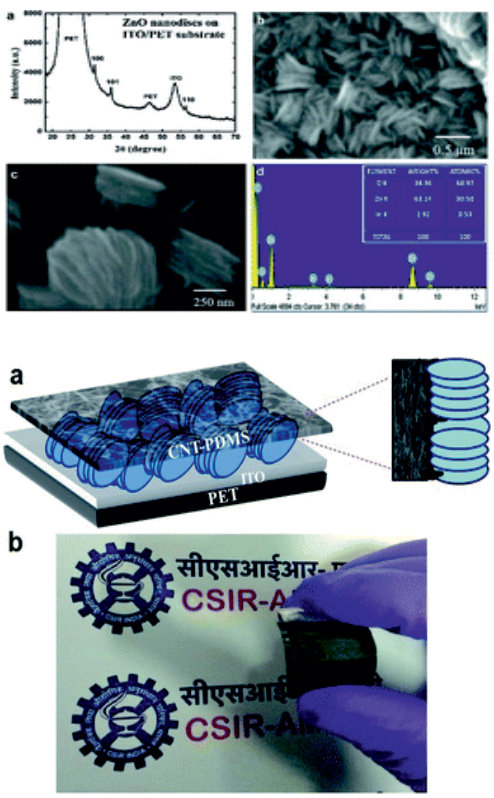


Figure 26 Vertical aligned 2D ZnO nanodisc based flexible nanogenerator.

- The average piezoelectric output voltage and current density of 5.5 V and 0.50 μA/cm^2 were obtained under very small pressure of 0.15 kgf applied through computer controlled dynamic shaker without applying any external electric poling (Fig. 27). The average energy conversion efficiency of the flexible piezoelectric Zn_2SiO_4: PDMS-based device was found to be ≈29.48 %. The mechanism of high piezoelectric output performance from Zn_2SiO_4 nanorods device was

discussed and co-related with dielectric, piezoelectric and proper adhesion of graphene sheet with polymer composites.

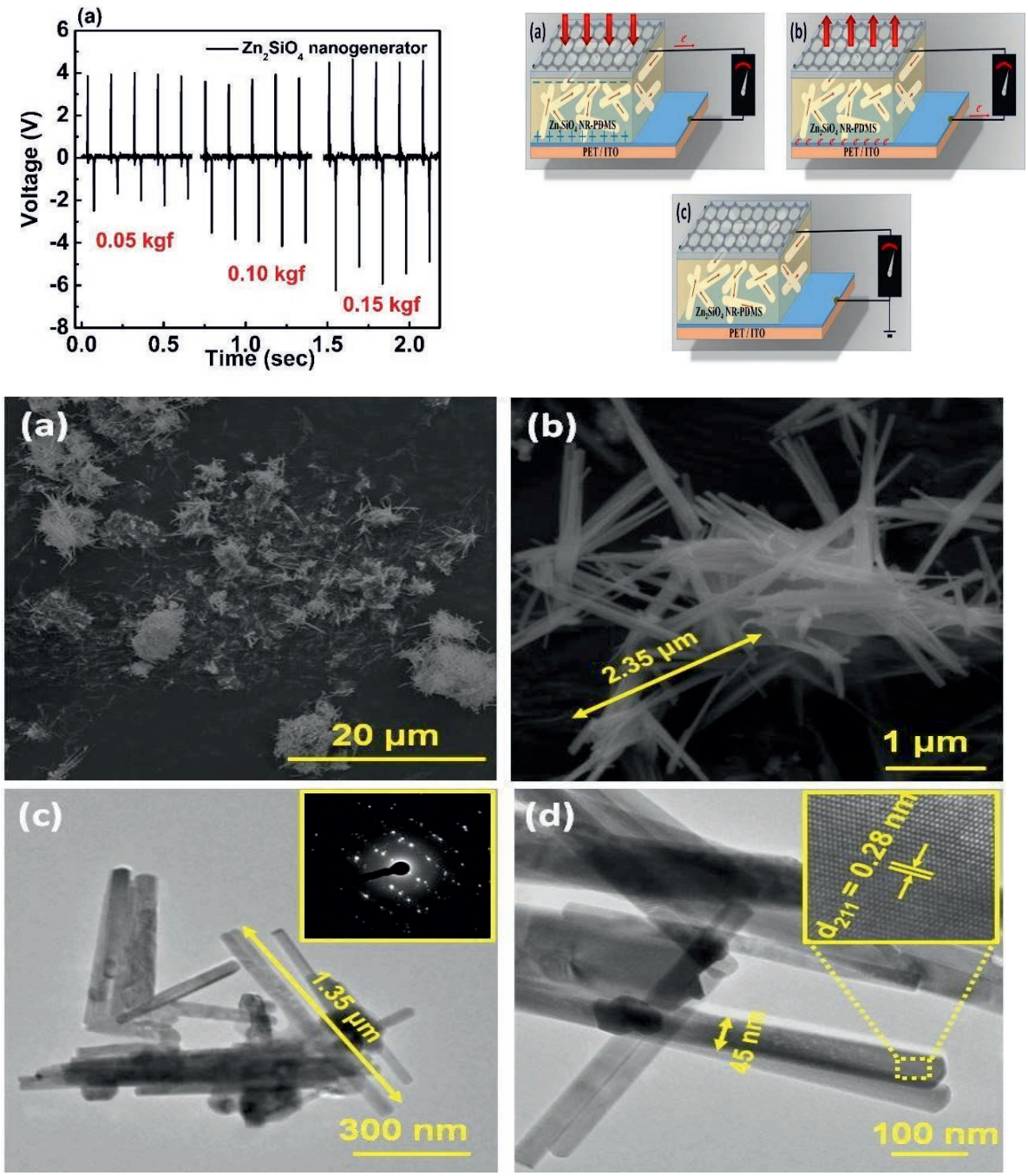
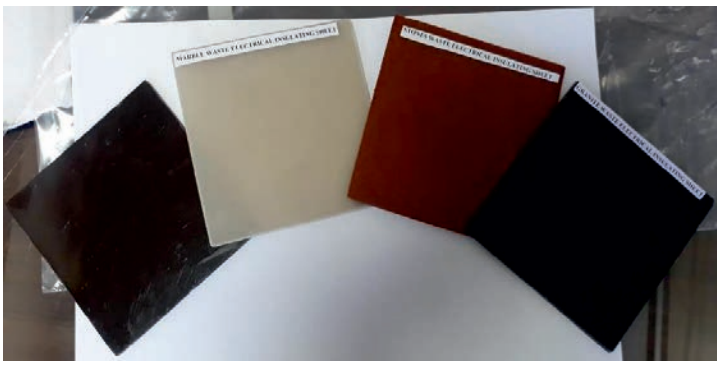


Figure 27 Graphene-Zinc Silicate flexible composite nanogenerator and their output performance and morphology.

4. Electrical Insulating Hybrid Composite Sheet Using Industrial Inorganic Wastes

Significant Achievement:

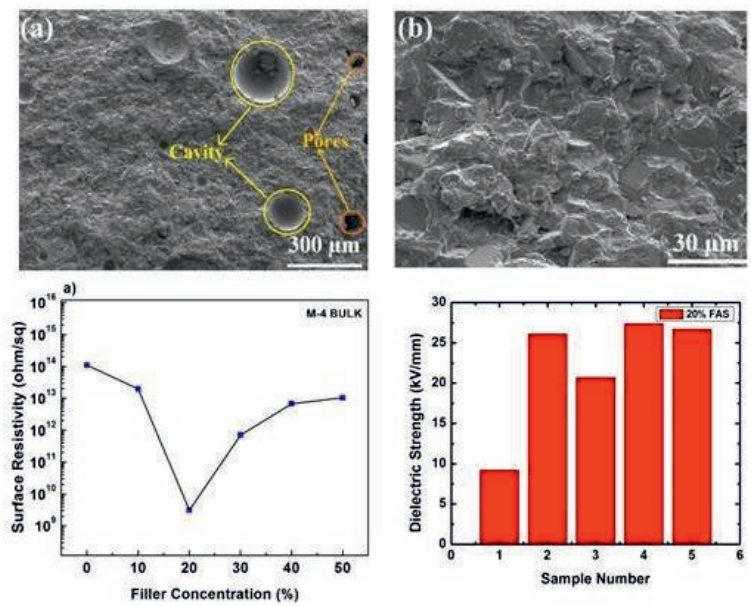
- Industrial marble, stones and fly ash inorganic particulates waste collected from sample are collected from the various industrial site are used to develop the new class of moisture resistant and acid resistant electrical insulating products.
- Water resistant with high strength Electrical insulating composite sheet of chemically treated stones waste powder in epoxy polymer with various filler concentration (10, 20, 40, 50 %) have been prepared using compressive moulding machine at various pressure and temperature.
- Surface modification and nanoscale of industrial waste particulate such as stones waste, marble waste have been done using organic solvent to improve the interfacial bonding with epoxy polymer.



- Moisture resistant Electrical insulating hybrid composite based on industrial waste are developed. Electrical insulating hybrid composite based on nanoscale marble wastes are prepared using compressive molding machines and their various properties such as interfacial bonding, mechanical strength is measured.
- Dielectric Breakdown of developed bulk and nano marble, stone and fly ash waste with various filler concentrations (10, 20, 30 and 50 %) are measured as per ASTM standard

(ASTM-D-149). Very high values of dielectric breakdown of 15-36 kV/mm are achieved from the developed electrical insulating sheet.

- Very high surface and volume resistivity in order of 1014-1016 ohm.cm are successfully achieved from the developed product. Temperature dependent dielectric properties, dissipation factor and ac conductivity of stones, marble and fly ash based electrical insulating products are carried out.



5. Techno-Commercial Study for production of value-added products from ash produced of 2G Ethanol Bio-Refinery at Bargarh, Odisha

Significant Achievement:

- Bharat Petroleum Corporation Limited proposes to set up Second Generation (2G) Ethanol Bio-refinery in Odisha (Bargarh) for the production of Ethanol from Rice Straw.
- In the proposed Bio-refinery, the biomass (Rice Straw) would be converted to 2G Ethanol and some by-products like CO_2, Ash, Lignin, Technical Alcohol and Fusel Oil would be generated in the process. About 140 T of the ash will be generated every day from the BPCL 2G plant. To utilize the ash as a value-added product, CSIR-AMPRI has developed Hybrid panels as doors substitute and as wood alternatives.
- A market survey was carried out by the CSIR team to identify the feasible routes to use the rice straw ash of 140 MT/D from the proposed Bio-Refinery plant by BPCL at Bargarh. Market survey identified the Brick manufacturing, hybrid composite panel manufacturing, cement manufacturing, silica extraction, landfill and use of rice straw ash in fertilizer as potential areas. All application areas were studied in terms of supply and demand scenario, their feasibility, cost- benefit analysis and recommendation to BPCL.

Hybrid Composite Panels from BPCL ash:

- Global demand of polymer composite/wood panels has been carried out and feasibility study of BPCL rice straw ash powder to make hybrid composite panels was carried out at CSIR-AMPRI, Bhopal. The synthesis of ash polymer composites was carried out using compressive moulding/casting machines. Using the provided samples, composite panels of size 10x10 cm with thickness of 3 mm was successfully developed. The developed product had a smooth and glossy finished surface. The developed product showed almost no water absorption and ultra-low thickness swelling and was termite proof.
- A detailed technology package to use the BPCL ash for manufacturing hybrid panels of 140 T/day was developed and techno-economy analysis, cost benefit, revenue generation and potential with clients was prepared.

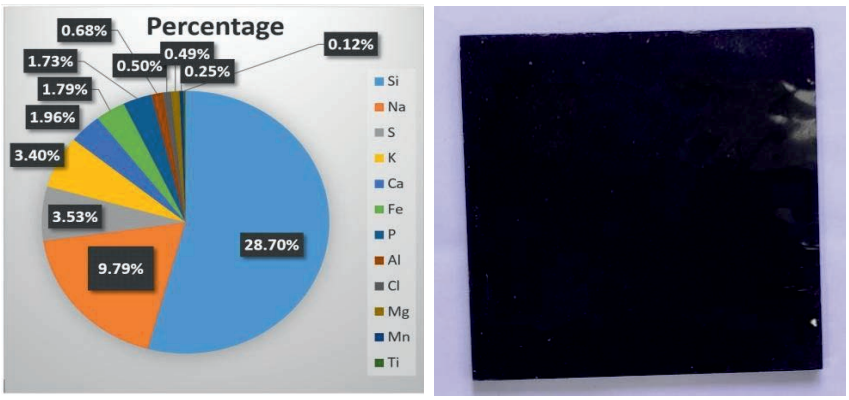


Figure 28 Elemental analysis of BPCL ash and product developed from the ash

Visit of BPCL officers, CSIR-IIP and CSIR-NISTADS, Delhi team to CSIR-AMPRI, Bhopal

- To use the BPCL ash in cement industry, bricks industry, various network with more than 50 industries including ACC Cement are contacted and provided to the BPCL to turn Ash into value added product and details techno-commercial study has been done
- Details study and technological solution with interaction/consultation of Odisha Pollution Control Board officers for BPCL ash as land reclamation and land filling option are also provided.

6. Manufacturing hybrid, high strength and glossy finish polymeric composites from Marble and Granite stream

Project Objectives

- Development advanced hybrid green composites as an alternative to timber, GRP and plastic products for use in building and construction industry and transportation system
- Converting waste into high performance green materials and saving mother earth and solving challenges associated with marble, granite and stone waste streams disposal.

Highlights of Field Work completed

Granite waste slurry samples were collected from six different locations in the state of Rajasthan. These locations included granite cutting industry, waste dumping sites, processing units. Detailed surveys and meetings with industry persons were held and collected data on the current state of mining, processing of granite and the amount of waste generated from these respective local regions.

Facility Created for Characterization of Marble, Granite and Stone Wastes

Created a state of the art facility for the characterization of above collected waste samples, preparation and fabrication (lab scale and pilot-scale) of composite samples and their characterization using sophisticated analytical and processing equipment. This includes: Compression moulding machine (Garnet Tools® Pvt. Ltd., India), injection moulding machine (Milacron®, USA), Resin mixing system (Garnet Tools® Pvt. Ltd., India), X-Ray Fluorescence Spectrometer (Bruker®, Germany), Weatherometer (Q-Lab®, USA), Grinding machine, High Energy Planetary Ball Milling machine (Retsch®, Germany), Ion Analyzer (Thermofisher®, USA), ultrapure Water System (Millipore®, USA).

Composite Development

Processed granite particulates were characterized for their physical, chemical, mineralogical and morphological properties. Composites were prepared under compression moulding techniques with filler percentages of 30, 50, 60 % and jute textile fibre reinforcement. Influence of granite waste particulates and fibres on physical, mechanical and electrical properties were tested. This includes water absorption, thickness swelling and density, tensile, flexural and impact properties, electrical resistivity and thermal conductivity. The fabrication of granite

waste particulates fortified hybrid composites is shown below:

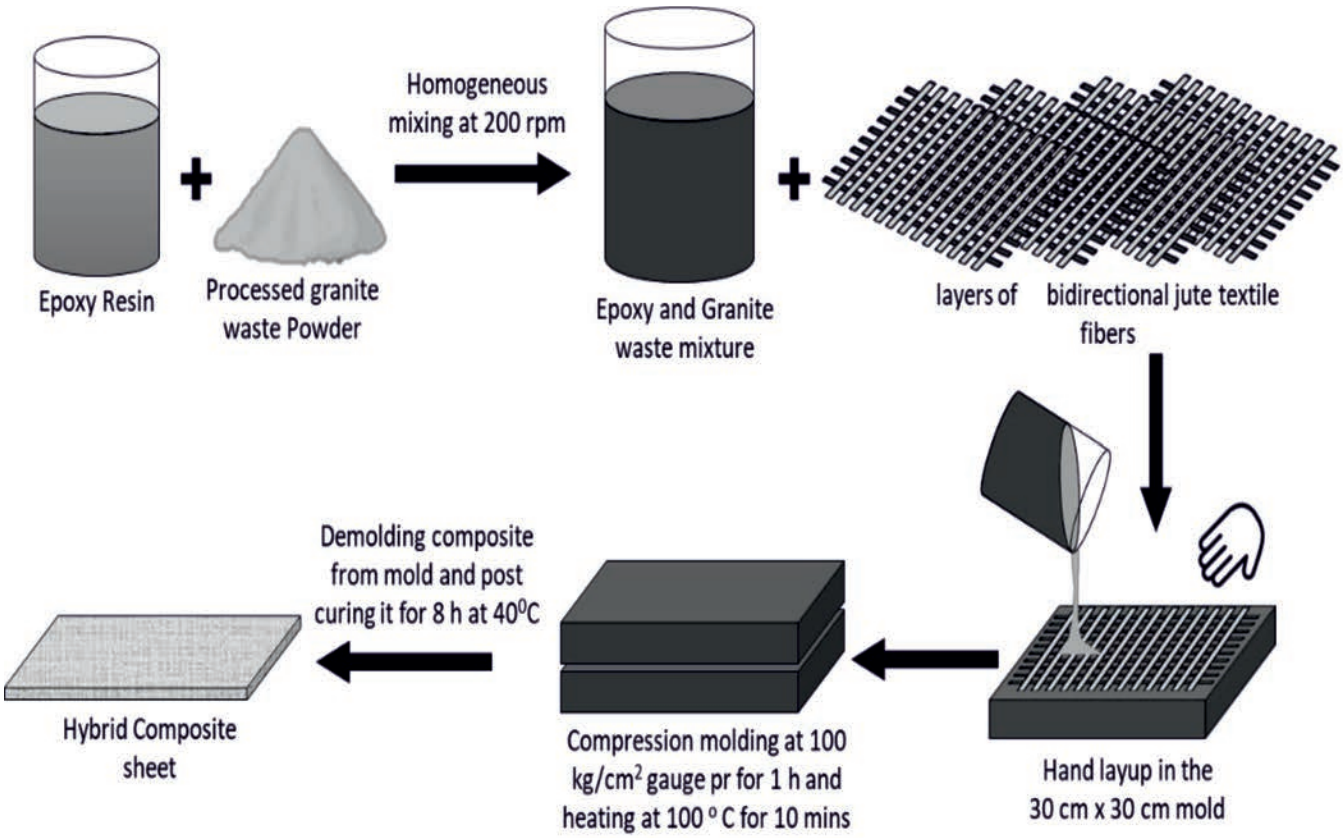
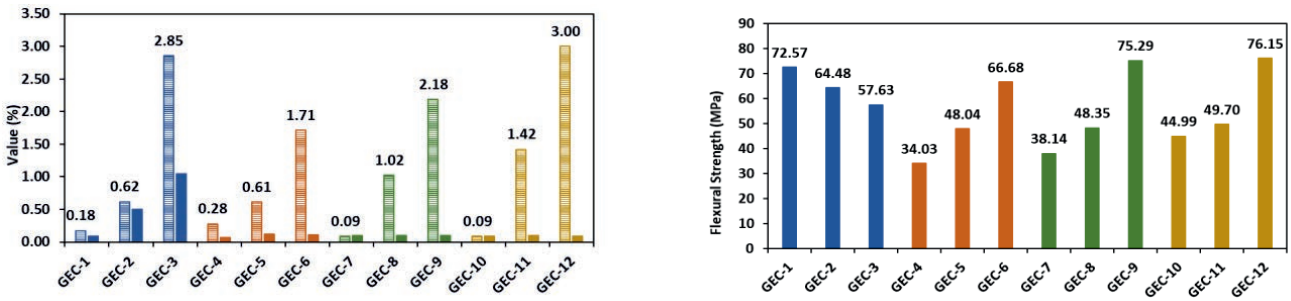


Figure 29 Schematic view of fabrication of granite waste particulates and jute textile fibre reinforced hybrid composites

Findings

The results revealed that incorporation of 60 % of granite waste particulates with jute textile fibre reinforcement has resulted in higher flexural strength and tensile strength of composites. The significant enhancement in impact strength (148%) and thermal conductivity (150%) of composites were more pronounced with the influence of granite waste particulates in jute textile fibres reinforcement. Moreover, the composites exhibited very low water absorption (0.1%) confirming the scope of hybrid granite composites for possible applications in electrical insulation followed by civil infrastructure materials. Application of high amounts of granite waste particulates has contributed to having very low embodied energy content with high performance inI terms of physical, mechanical and electrical properties.

The findings of the research have shown a new approach for manufacturing cost effective, sustainable and environment friendly composite material leading to contributions to Make in India, Clean India and Skill India Program. Realization of the research outcome in commercial operation will certainly create employment and income to rural and urban people and reduce the environmental problem associated with granite and marble wastes management.



Water absorption (WA) and Flexural strength of GEC composite samples

Granite waste particulates fortified composites materials having different color texture

7. Development and Dissemination of the technologies for Sustainable Rural Development of Primitive Bhariya tribal of Patalkot Valley, Chhindwara district

We have provided safe drinking water to the villagers in terms of quality and quantity and disseminated Sisal based technology for rural employment and income generation for upliftment of the villagers who are living at the grass root level. We have adopted four villages

namely Rated, Karеam, Chimtipur and Charadhana and started implementing the development activities for the Primitive Bharia Tribal in Patalkot Valley, Chhindwara District, Madhya Pradesh. Water harvesting measures for drinking and domestic users has been done by AMPRI to enhance the water, sanitation and hygiene activities among the Bharia tribal in Patalkot valley. Detail GPS based hydrogeological study has been done in the valley and the springs and the other sources of drinking water have been studied. Two small water harvesting cemented tanks are constructed at hilly area and tapped the springs water and shifted by the pipe line connection from the source to the villages through gravity. Four community based terafil filters of 1000 lt capacity are installed in all four villages. Four gravity based nanoalumina water purification filters are also installed. Two in primary school, Rated village and two in Primary and middle school of Chhimtipur village of Patalkot valley. To recharge the ground water and springs, various rain water harvesting structures have been constructed in the suitable places. 14 boulder checks and 4 gabion structures and 2 recharge pits were constructed in the valley to recharge the ground water and the springs.

In sisal based technology the raw material is the sisal leaves so sustainable sisal plantation is needed for getting sisal leaves for sustainability of sisal based technology for rural employment and income generation. Thirty thousand sisal plantation has already been done in Patalkot valley so that the villagers will be having sisal leaves for extracting sisal fiber for making different items. Three Raspador machines and rope making machines are ready to supply to the villagers. Four days trainings has been given to 26 master trainers from Charadhana and Karеam villages and 34 villagers from Rated and Chimtipur villages at AMPRI, Bhopal on Sisal fiber extraction, processing of sisal fiber, yarn making, ropes making, handicrafts and other useful products making for employment and income generation in the valley.

CSIR-AMPRI R & D intervention to Primitive Bharia Tribal in Patalkot Valley, Tamia block, Chhindwara District, Madhya Pradesh through water recharging, rain water harvesting and sisal cultivation harvesting.

Training provided to Primitive Bharia Tribal of Patalkot Valley, MP through sisal fibre extraction, processing and making fancy articles and handicraft items at CSIR-AMPRI Bhopal

1. Electromyogram (EMG) controlled Below Elbow prosthesis: Light weight Shape Memory Alloy (SMA) wire actuated prosthetic hand.

CSIR-AMPRI has been developed SMA actuator based prosthetic hand (Figure 30). The main objectives of the development are to achieve at least two degree of movement, actuation and sensing using compact, lightweight SMA actuators. The Shape Memory Alloy actuator is one of the light weights and high power to weight ratio that can actuate the motion/displacement and generate required forces. This is a novel application for the actuation of prosthetic hand for replacing the heavy actuators based on DC motors and pneumatics etc. CSIR- AMPRI, Bhopal is involved in this national project under health mission of CSIR which aims to improve the quality of life to below elbow amputee patients with indigenously developed light weight electromyogram (EMG) controlled shape memory alloy actuator for individual finger movement prosthesis with variable speed and proportional grip force control.

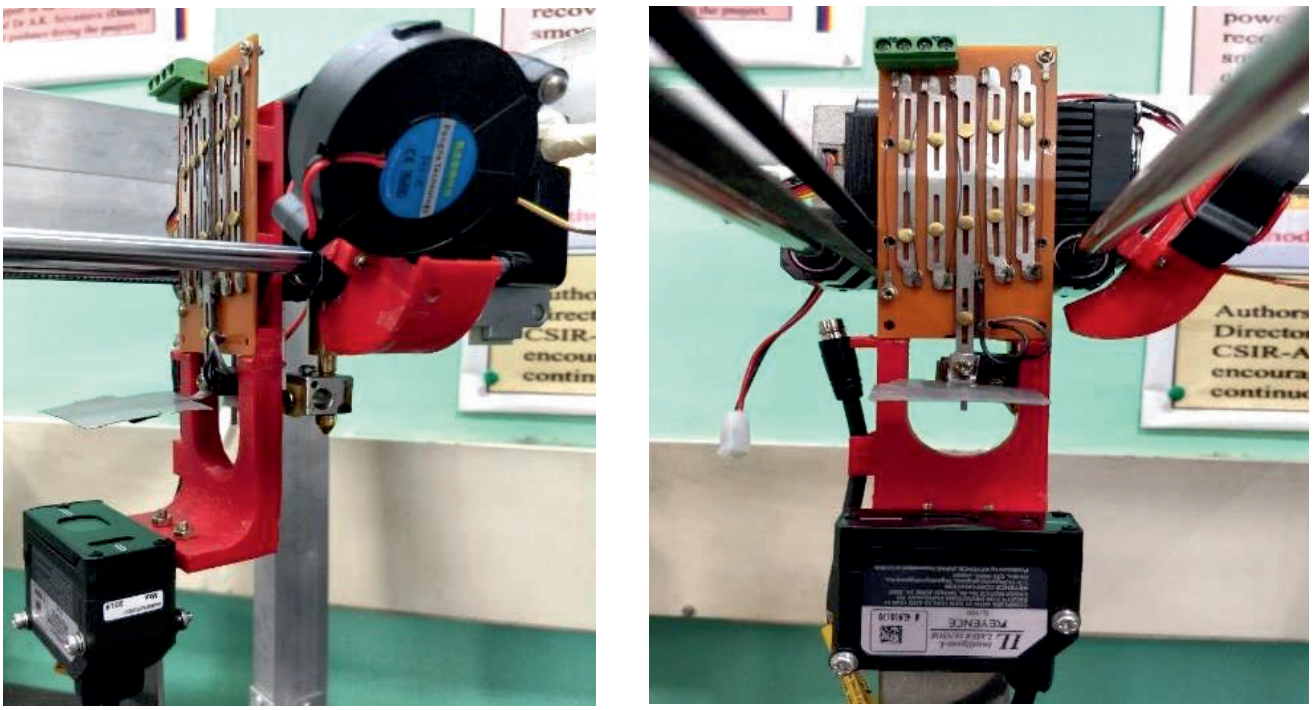
Figure 30 Prototype of SMA Actualted Prosthetic hand.

The outcome of the project would help to restoring their day to day routine activity work. The outcome of the project will fill the gap of the need of indigenous high end functional prosthetic devices at affordable price which is to be activated by light weight SMA (Shape Memory Alloy) based actuators. These actuators have been activated to all the fingers of the hand. This research work was conducted in industry association which has direct impact to the society in terms of light weight and compact actuator which replace the heavy & bulky DC motors, power requirement and cost effective. The project was concluded under the sponsor of CSIR theme health care project: Light weight Shape Memory Alloy (SMA) Wire Actuated Prosthetic Hand for amputee persons with collaboration of CSIR-CSIO and leading prosthesis developing industry, M/s Alimco Kanpur.

2) Development of Artificial Intelligence (AI) controlled Linear Displacement Actuator (LDA) based on thermo-responsive smart materials (SMAs/SMPs) 'SMAILDAS'

The engineering application of SMA based actuator systems are growing very rapidly because of their compact & very simple in operation, light in weight, reliable and high energy to weight ratio. These devices are future devices and will be used to replace the existing actuators in modern car/vehicles, 3D printers' head/bed, micro-displacement actuation, space applications, robotic application, medical and prosthetic applications and so on.Therefore, AMPRI is known among the CSIR laboratory who is working in the area of Smart material-based actuator development for engineering application. Smart Material has unique shape dependent properties. These are controlled by the external temperature stimuli. SMA actuator in wires are arranged in antagonistically for bidirectional movement. The length of wire is 165 mm divided in 55 mm segments and connected in series, 0.381 mm in diameter with 70-90^{0}C transformation temperature. The transformation temperatures were achieved by electrically heated using PWM (Pulse Width Modulation) signal. The actuator was designed in mechanical designing software and initially fabricated. This Smart actuator system incorporate functions of sensing, actuation, and control to describe and analyze a situation, and make decisions based on the available data in a predictive or adaptive manner. Due to highly nonlinear behaviour of the SMA, a neural network would be suitable tool to predict the position estimation of the actuator using ER. In this SMA actuator, SMA wires are arranged in antagonistically for bidirectional movement. The actuator was designed in mechanical designing software and initially fabricated and tested on 3D printed prototype. The focused application area of the deliverables are the 3D Printing industries, where the 3D Printer Bed/ Nozzle could be controlled with the developed actuator for Positional displacement in the range of 5 mm @ 3% strain recovery & Positional resolution up to 200 microns along with the capability to hold the load up to 500grams. However, it can be extended in other possibilities in robotics, space applications and instrumentation.Sensor-less (without external bulky and heavy sensors feedback) linear position control of the SMA actuator system will be the major benefit to the targeted industry and other positional control

applications. The project is collaboratively taken by CSIR-AMPRI, Bhopal and CSIR-CEERI, Pilani under the CSIR-AI Mission as well as industrial partners M/s Additive Manufacturing Pvt. Ltd, Secundrabad also involved.



Developed SMA actuator mounted on 3D

3) Development of joining process for industrial components through electromagnetic forming

The overall objective of the project is to develop know-how/technology of electromagnetic and electrohydraulic forming process for industrial implementation. The objectives cover both applied and basic research. It is aimed to make the high potential use of this high-speed sheet forming and joining processes available for industrial high-volume production at low costs and short Time-To-Market (TTM). The broad objectives of proposed study can be summarized as given below:

I) Develop EMF technology/know how to manufacture industrial component by electromagnetic joining process ii) Development of prototype illustrative components like tubular joining of dis-similar materials (nozzle of valve for Industrial gas cylinder/ lug-crimping) and flat component (electrical contact finger) iii) Study of comparative formability sheet material in electromagnetic forming/electrohydraulic forming and Conventional process.

Keeping in view of above objectives, dies/setup for comparative study have been designed and fabricated. Tooling design for flat sheet joining and tubular joining has also been carried. A few FEM studied are carried out to design a coil/tooling system for the same. Two alternatives are

explored. Figure 31a shows a design of filed shaper in which we can use circular bitter coil for the purpose. Simulation study shows feasibly of the design but actual fabrication and clamping of flat sheet/jobs are difficult in this design. Alternative design of coil for sheet metal is shown in Figure 31b It has two I sections placed against each other.

This design is very acceptable among researchers but it has less service life.

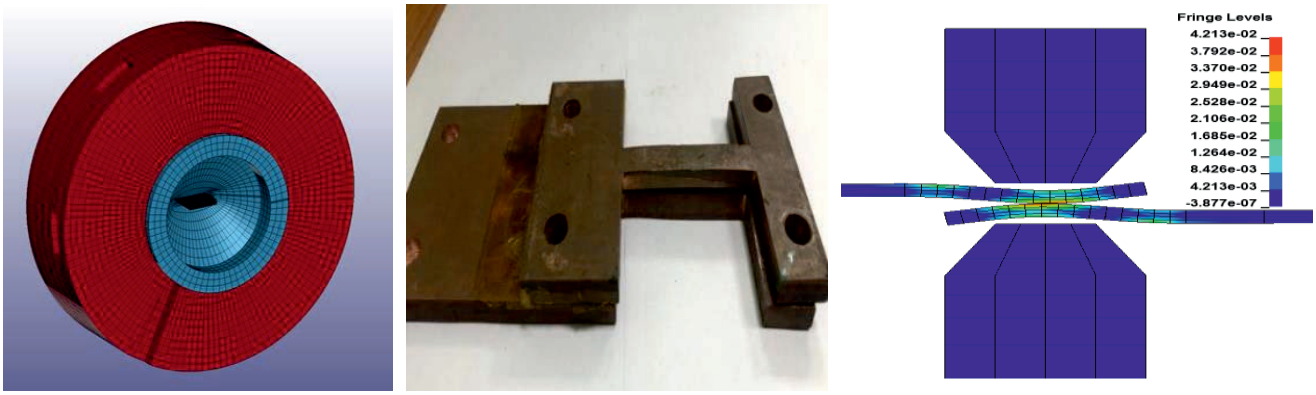
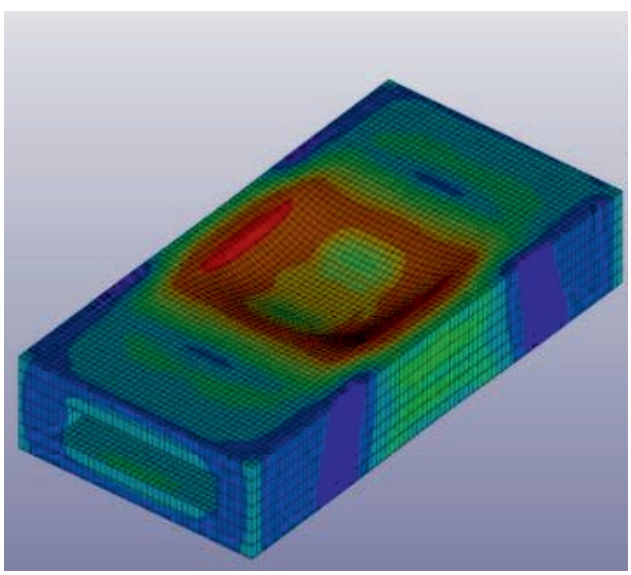


Figure 31a Design of field shaper for flat sheet joining using circular bitter using FEM

Figure 31b Design for flat sheet forming coil (I shaped coil) using FEM and its fabrication



4) Title: Development of solid-state electromagnetic joining technique for materials of interest in aerospace/space

In this project it was aimed to join similar and dissimilar material by electromagnetic technique. The combinations that were taken for study are aluminium to aluminium joining as similar material and aluminium to stainless steel joining as dissimilar material. Different parameters such as design of coil, field shaper, stand-off distance for Al-Al and Al-SS joining were optimized by simulation in LS-DYNA and validate with experiment results.

One laboratory scaled prototype component (waveguide) is developed and performance test was carried out. Picture of the developed waveguide (for X band: 8.2- 12.4 GHz; size: Size = 19.4 mm x 10.2 mm) is shown in Figure32. Result of the performance test is given in Table 1. For example, Figure 32 also shows Reflection coefficient S22 at the output operated in the full range and covers almost full of X band and the value is less than -50db that shows the excellent results. The developed waveguide was tested for mechanical strength, leak proof etc. This technology can be ready for dissemination to industry.

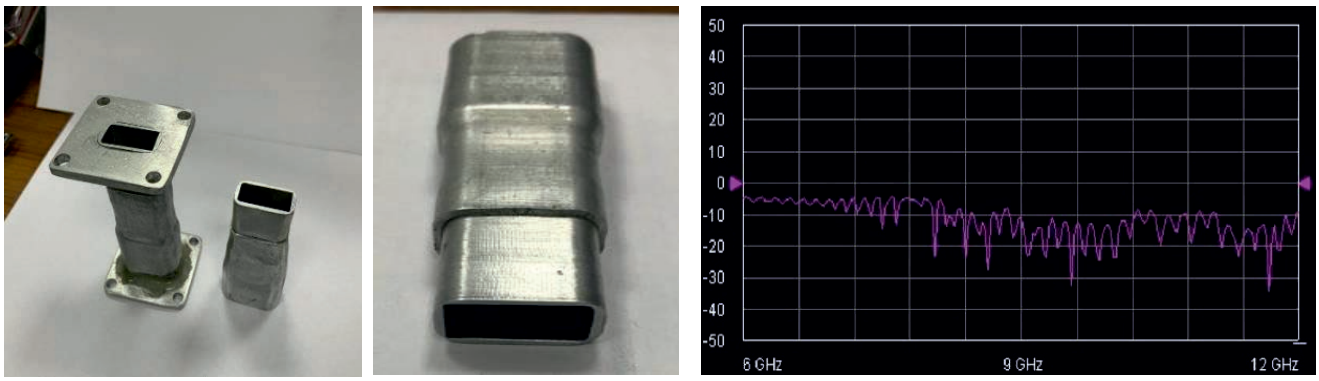


Figure 32 Picture of electromagnetically developed waveguide and Reflection coefficient S22 at the output operated in the full range

Table 1 Performance test of waveguide

S. No.	Parameter	Result
1	Reflection coefficient at input (S11)	Excellent
2	Reflection coefficient at output (S12)	Excellent
3	Transmission coefficient (S21)	Good
4	Insertion loss (S12)	Excellent after 8.5 GHz

Water Source Sustainability study for proposed 2 x 660 MW Thermal Power Project (TPP) at Village Dadri Khurd, Mirzapur, Uttar Pradesh

The project entitled "Water Source Sustainability study for proposed 2 x 660 MW Thermal Power Project (TPP) at Village Dadri Khurd, Mirzapur, Uttar Pradesh" has been taken from Welspun Energy UP Pvt. Ltd. (WEUPPL) subsidiary of Adani Infra (India) limited, Ahmedabad with aim to ensure ecological and environmental safeguard with the withdrawal of 36 MCM (million cubic meters) water from Ganga river at Mirzapur site annually for the proposed project. To fulfill the objectives of the project, the team of Water Resources Management and Rural Technology Group, CSIR-AMPRI, Bhopal has carried out study during the period June 2018 to June 2019 on various aspects of the project such as water availability, river environment and habitat. The purpose of water availability study was to ascertain the sustainability of water supply to the power plant, impact of water withdrawal from the river Ganga. Report and findings were presented before the Expert Appraisal Committee, Thermal and Coal Mining Projects, MOEFCC, N. Delhi which was accepted. Final report was submitted to the funding agency.

General Information

Important Events

CSIR-Integrated Skill Initiative Program(Project NWP-100)

With a vision of a 'Skilled India', Council of Scientific and Industrial Research (CSIR), New Delhi has introduced a skill program to comply with the flagship scheme of the Ministry of Skill Development and Entrepreneurship. The aim of this program is to enable a large number of youth to take up industry- relevant skill training that will help them in securing a better job. To fulfill the same, CSIR-AMPRI, Bhopal has started different skill programs to make youth job oriented by imparting training under CSIR-Integrated Skill Initiative. Under the program, CSIR-AMPRI Bhopal is providing training in following courses for different durations viz. One week / Two weeks / One month and others as per request, in form of training programmes / internships / dissertations etc.

1. Electroplating and Surface Modifications techniques
2. CNC turner, Conventional turner, Welder & Fitter
3. Heat Treatment, Metallographic and Mechanical Characterization
4. Additive Manufacturing / Rapid Prototyping of 3D design/Modeling
5. Water Resource Management & Hydrological Modelling
6. Basic skills in science laboratory techniques
7. Concrete Technology and Testing
8. Water Supply engineering and water quality analysis
9. Renewable Energy
10. Sensors, Actuators and their applications
11. Artificial intelligence and applications

During the year 2019-20, a total of 558 candidates have been trained under different programmes for variable durations. Glimpse of a few training programmes are shown below.

Rapid Prototyping of 3D design/Modeling

CNC Training Batch

National Science Communication Orientation Training

Further under the CSIR-Integrated Skill Initiative, two days workshop on "National Science Communication Orientation training " was organized on 22-23 August 2019 in collaboration with CSIR-NISCAIR, New Delhi at CSIR-AMPRI, Bhopal with 118 participants from pan India. PadmaShri Dr. Vijay Dutt Shridhar, Director, CSIR-NISCAIR, New Delhi and Director, CSIR-AMPRI, Bhopal inaugurated the workshop. A visit to 'Madhav Sapre Sangrahalaya', Bhopal was organized for the participants on the second day.

National Science Communication Orientation training programme

Panel Discussion during National Science Communication Orientation training programme (left) and Visit to 'Madhav Sapre Sangrahalaya', Bhopal (right)

Workshop on 'Advanced Materials for Energy Storage and Conversion Devices'

Training cum workshop was organized on "Advanced Materials for Energy Storage and Conversion Devices" & "Energy Materials and Electrochemical Techniques" on 28-29 Feb. 2020.

Inauguration of two days workshop on "Advanced Materials for Energy Storage and Conversion Devices" & "Energy Materials and Electrochemical Techniques"

Panel Discussion on Advanced Materials for Energy Storage and Conversion Devices and Facilitation of Director, CSIR-AMPRI with laboratory made souvenir

Indian International Science Festival (IISF) 2019 Outreach Program

IIFS 2019 Outreach Programme was organized at CSIR-AMPRI on 17th October 2019 to showcase their scientific achievement and research facilities to students, the general public and local media. The aim of the outreach program is to aware the masses about IIFS, origin and history of IIFS, the role of IIFS in the upliftment of society and the efforts of IIFS in motivating young mind towards science and technology. Outreach program was also conducted to encourage everyone specially the students to actively participate in IIFS 2019 organized in Kolkata from 5-8 Nov 2019.

Chief Guest of the program was Dr. K. S. Tiwari, Director, Director, Bhartiya Dharohar, New Delhi and other dignitaries were Dr. Avanish K. Shrivastava, Director, CSIR-AMPRI, Bhopal, Dr. S. A. R. Hashmi, Chief Scientist, CSIR-AMPRI, Bhopal, Dr. Anil Kothari, Professor, RGTU, Bhopal & Regional Organising Secretary, Vibha, Dr. Sudhir Singh Bhadauria, Professor, RGTU, Bhopal & Secretary General, Vibha and Dr. J. P. Shukla, Sr. Principal Scientist, CSIR- AMPRI, Bhopal.

The program was attended by 140 students from different colleges, 47 School Students, 8 school teachers and all AMPRI officials. Total 295 participants attended. The program comprised

of:

- Insights of CSIR and CSIR-AMPRI, Bhopal
- Details about India International Science Festival
- Popular Lectures
- Interactive Games competition
- Written Quiz competitions
- Laboratory Visits & Exhibition
- Prize Distribution

Address on insights of CSIR and CSIR-AMPRI by Dr. Avanish Kumar Srivastava.

Quiz for college and school students respectively

Participants from Schools and colleges in IISF Outreach program

Student-scientist interaction during IISF Outreach program

Laboratory Visit and Exhibition of products developed by CSIR-AMPRI

Bhopal Vigyan Mela 2019

8th Bhopal Vigyan Mea (BVM) 2019 was organized collectively by CSIR-AMPRI Bhopal and Vigyan Bharti at BHEL Dusshera Maidan, Bhopal during 13th Sep. 2019 to 16th Sep. 2019. BVM is organised to showcase scientific achievement of the country and technological advancements made to students, the general public and local media.

During the 8th edition of Bhopal Vigyan Mela 2019 during 13 Sep. 2019- 16 Sep. 2019, Hon'ble Minister Sh. P. C. Sharma, S&T, GOMP, Hon'ble Minister Sh. Kamleshwar Patel, Panchayat & Rural Development, GOMP, Hon'bleKaptan Singh Solanki, Former Governor, Hariyana & Tripura, Dr. A. K. Srivastava (CSIR-AMPRI), Er. U. Rajababu, Mission Director, Mission Shakti, DRDO, Shri Ashok Pandey, Former Chairman, MP Public Service Commission, Indore, Shri Jayakumar Ji,Special Advisor, Vibha, Shri Praveen Ramdas Ji, Secretary, Vibha, Dr. Manoj Patairiya, Former Director, CSIR-NISCAIR, Delhi, Prof Sudhir Singh Bhadauria, Secretary General, Vibha, Dr. Akhilesh Pandey, Former Chairman, MPPURC, Bhopal, Dr. N. P. Shukla, Former Chairman, MP PCB, Bhopal, Dr. Naveen Chandra, Chairman, EAC, MOEFCC, N. Delhi, Dr. Mahesh Shukla, Chief Gen. Manager, BSNL, Cmdr Dr. O. P. Sharma, Marine Engineer in Navy, and Er. Satya Shri, Deputy Manager, BHEL, Bhopal graced different programs.

Various programs organised were Lectures by Eminent Speakers, Rashtriya Hindi Diwas, National Engineers Day, Skill & Jigyasa Programs, Release of Applied Innovative Research Journal and Vigyan Pratibha Samman to Er. U. Rajababu. Exhibition by 60 reputed Institutes, Industries and models context of various college students (More than 100).

Major Institutes participated were NTPC, ICMR, BHEL, DOAE, HCL, MPMRD, MPPCB, ADANI, BHARAT COKING COAL LIMITED, Jharkhand; MAHANADI COAL FIELD; MANIT Bhopal, IMD Bhopal.

CSIR-Labs Participating in Bhopal Vigyan Mela include CSIR-NBRI, Lucknow; CSIR-IITR, Lucknow; CSIR-CBRI, Roorkee; CSIR-NAL, Bangalore; CSIR-SERC, Chennai; CSIR-CLRI, Chennai; CSIR-NCL, Pune; CSIR-IHBT, Palampur; CSIR-NEERI, Nagpur; CSIR-IMMT, Bhubaneswar; CSIR-NISCAIR, New Delhi; CSIR-CIMAP, Lucknow; CSIR- CSIO, Chandigarh; CSIR-NEIST, Jorhat.

On Sep 14, 2019, Hindi Diwas was celebrated with Prof. Santosh Chaubay, Chancellor, Rabindernath Tagore University as the chief guest.

National Engineers Day was celebrated on 15 September 2019 which was organized by CSIR-AMPRI; at this occasion Dr. Mahesh Shukla, Chief Gen. Manager, BSNL was the chief guest.

Students from KVs, other govt. & Pvt. Schools and Colleges of Bhopal participated (10000) and the total Footfall was more than 50,000

Glimpse of various programs during BVM 2019

Glimpse of various programs during BVM 2019

Publication of Journal "Applied Innovative Research"

CSIR-Advanced Materials and Processes Research Institute (AMPRI) Bhopal in collaboration with CSIR-National Institute of Science Communication and Information Resources, New Delhi has published multi-disciplinary Journal entitled "Applied Innovative Research" with ISSN 2581-8198 (online). Issue 1(2) of the journal was published in June 2019. and combined September & December issue 1(3) was published in December 2019. Water Resources Management and Rural Technology Group is the nodal for publication of the Journal.

Applied Innovative Research was released by Shri P. C. Sharma, Hon'ble S&T Minister, Govt. of Madhya Pradesh in presence of dignitaries including Dr. A. K. Srivastava (CSIR-AMPRI), Er. U. Rajababu, Mission Director, Mission Shakti, DRDO, Manoj Patairiya, Former Director, CSIR-NISCAIR,

Delhi, Prof Sudhir Singh Bhadauria, Secretary General, Vibha, Dr. Akhilesh Pandey, Former Chairman, MPPURC, Bhopal, Dr. N. P. Shukla, Former Chairman, MP PCB, Bhopal and Dr. J. P. Shukla during 8th Bhopal Vigyan Mela 2019.

NWP- 101: Jigyasa Programme

CSIR-AMPRI, Bhopal has undertaken various activities under JIGYASA program during 2019-20. These activities include Important Awareness Days, Summer Vacation Programmes, CSIR Foundation Day, National Children's Science Congress, and Visits of Scientists to Schools / Outreach Programme, Student Apprenticeship programme, Teachers' Workshop, Lab specific activities / Onsite experiments, National Science day, National Technology day and Bhopal Vigyan Mela. In this programme around 958 teachers and 8688 students were participated in different activities. As a result, total number of more than 9646 candidates have been trained.

Summer Vacation Programme

Students of Kendriya Vidyalaya Sangthan, Bhopal, Jabalpur and Raipur regions participated in various activities and they were happy to see the live demonstrations of practical, product development, instrument demonstrations and scientist interactions. Students showed their zeal to learn by actively participating in questionnaires. Students from Navodaya Vidyalaya also visited lab during the National Children science Congress. Popular lecturers and scientist-student interaction programmeswere organized during these visits.

Student Scientist Interaction Programme

Popular lecture at CSIR AMPRI Bhopal

Lecture by Dr. Anjan Ray, Director, CSIR-IIP, Dehradun

Lecture by Dr. A. K. Srivastava, Director, CSIR-AMPRI, Bhopal

Eminent Scientist - Student Interaction : Lecture by Dr. Avanish Kumar Srivastava, Director, CSIR- AMPRI, Bhopal

Lecture by Dr. U. Rajababu, Ballistic Missile Defence (BMD) programme director DRDO

Student Interaction Programme : Lecture By Professor Akhilesh Kumar Pandey, Chairman, Madhya Pradesh Private University regularity board, Bhopal

During the 78th CSIR Foundation Day 2019, Lab Visits, popular lectures, scientist and student's interaction programme were organized and 456 Students and 22 Teachers were participated in this mega event from various KVs and Private schools.

3rd Science Teachers Workshop on "Advancements in Science and Technology" was organized from 10/12/2019 to 13/12/2019 at CSIR – AMPRI, Bhopal. In this workshop, 108 teachers were participated from KVS Bhopal, Jabalpur & Raipur regions and Private schools.

NDA Signed Between CSIR-AMPRI, Bhopal and TRIVISEN a UK Based Start-Up Involved in Water Treatment and Water Monitoring System on 20.02.2020.

CSIR-AMPRI and Trivisen will be working together as knowledge partners to develop efficient solutions for unmet needs in the treatment of water. This will be achieved by harnessing and strengthening the strength of Science & Technology to create products and solutions with high impact on global societies. Trivisen will leverage the water treatment solution developed by CSIR-AMPRI for indigenous use and for export to other countries

As such, the objectives of this collaboration are well-aligned with the strategic plans of both entities and are expected to clear benefits to the larger society through:

- Introduction of existing domestic filters and advanced community level filters to the international market
- Solving ongoing problems in water treatment (Fl and As are high priority pollutants in both the Indian subcontinent and African countries while cases are beginning to emerge globally)
- Creation of export opportunities for technology developed in India and extend the impact of research activities at CSIR-AMPRI
- Creation of potential opportunities for local manufacturing of the material at an industrial scale, in turn generation options for skill development in advanced technology India

Non disclosure agreement was signed between CSIR-AMPRI and Trivisen a UK based start-up to create a new link between India and the United Kingdom by fostering a long-term relationship between the two entities. The NDA aims to carry out activities that are aligned with the Mission & Strategic Plan of both entities and brings benefits to each party.

Seminar on "Bamboo Composite Materials for Structural Applications" in Mizoram

CSIR-AMPRI, Bhopal and Mizoram Science, Technology and Innovation Council (MISTIC), Directorate of Science & Technology, Department of Mizoram co-organized a Seminar on "Bamboo Composite Materials for Structural Applications" at Secretariat Conference Hall, Mizoram New Capital Complex, Aizawl, Mizoram on November 8th, 2019. Speaking at the seminar as the Chief Guest, Dr. K. Pachhunga, Hon'ble Member of Legislative Assembly, Mizoram

and Vice Chairman, Mizoram Bamboo Development Board said that Mizoram accounts for 14% of the bamboo cultivation in India and thus, utilizing the state's rich bamboo resources is one of the top priorities under its 'Bamboo Development Board' and Social Economic Development Policy (SEDP) in Mizoram. He also informed that Mizoram bamboo does not need much care as it grows naturally and Chief Minister of Mizoram is also trying his best to utilize and uphold the usefulness of bamboos for bamboo composites. Mr Davy Lalruatliana, Scientific Officer at MISTIC, presented a paper on "Bamboo resources in Mizoram" and informed that the total area of bamboo forests in Mizoram accounts for 32.07 percent of the state's geographical area.

Dr. A. K. Srivastava, Director, CSIR-AMPRI led the team AMPRI in the meeting. Dr. S. A. R. Hashmi, Chief Scientist, delivered a talk on "Bamboo Composites: A new material of construction". Dr. S. K. S Rathore, Sr. Principal Scientist talked about the significance of bamboo composites in building sectors as construction materials and Dr. S. Murali, Principal Scientist, gave a lecture on "Overview and Prospects of Major Bamboo Species in India for Multipurpose Applications".

Few glimpses of the seminar are shown in photographs below: -

Meeting with Chief Minister Shri P U Zoramthanga, Mizoram

Conference on Fly Ash Utilization & Green Building Materials GREEN ASHCON 2020 & GREEN BUILDCON 2020

Conference on Fly Ash Utilization & Green Building Materials GREEN ASHCON 2020 & GREEN BUILDCON 2020 was jointly organized by Green Ash Foundation, Nagpur, CSIR-AMPRI, Bhopal, M P Pollution Control Board (MPPCB) and Federation of M P Chambers of Commerce and Industry, Bhopal during February 13th-15th 2020 at CSIR-AMPRI, Bhopal.

The conference and the exhibition were inaugurated on February 13th, 2020 at the premises of CSIR-AMPRI, Bhopal. Welcome addresses were given by Patrons of Conference Dr. Avanish Kumar Srivastava, Director CSIR- AMPRI and Shri R S Kori, Member Secretary, MPPCB. Detailed introduction of conference was given by Convener Shri. Sudhir Paliwal. Presidential address was given by Chief Guest of the function Shri Malay Shrivastava, IAS, Principal Secretary, PWD &Environment. Shri Davender Pal Singh Chawla, Vice-President, FMPCCI gave an over view of industrial contributions and limitations. Dr S A R Hashmi gave vote of thanks.

Honourable Minister for Miniral Resourse of M P Government, Shri Pradeep Jaiswal appreciated the timely efforts of organizers for taking up one of the most important issue related to environment. He highlighted the efforts of government to promote stone sand over river sand by keeping rate of royalty low as Rs 25/m3 for stone sand as compared to Rs 125/m3 in view of protecting environment.

Some Glimpses of the Inaugural Day of the Conference & the exhibition.

The three days conference had been graced with Eminent Speakers from different fields- Shri Sudhir Paliwal, Dr. Swapnil Wanjari, VNIT, Nagpur, Dr. S.A.R Hashmi, Chief Scientist, CSIR-AMPRI, Dr S K Sanghi, Chief Scientist, CSIR-AMPRI, Dr P Asokan, Chief Scientist, CSIR-AMPRI, Architect Kiran Kale, Architect Nivedita Singh Dr Manish Mudgal, CSIR AMPRI and Shri Vidyanand Motiram Motghare along with other Invited Speakers.

Several technical paper presentations on optimum and innovative use of Fly ash, Fly ash based geopolymer, engineered wood from Bamboo & Agro waste, Natural fibre and Red mud-based building materials and various other related areas were conducted successfully. Exhibition stalls were setup for Green building material manufacturers, Plant & Machinery Suppliers, Technology Providers and R & D Institutes including CSIR-AMPRI. Poster competitions were also held amongst the participants on two topics: - i) Green Building Materials/ Green Buildings and ii) Fly Ash Utilisation.

The Session mainly focused on the areas:- 1) Fly Ash utilisation scenario in India and Madhya Pradesh 2) Fly Ash utilisation presentation by power plants in Madhya Pradesh (NTPC, MP Power Generation Co Ltd, IPPs etc.) 3) Guidelines & Directives issued by MoEF & CC, CPCB and MPPCB 4) Fly Ash Policy of Central & State Governments 5)Regulatory & Legal framework for Generation and Utilisation of Fly Ash 6) Grinding, Classification and Mechanical activation of Fly Ash for high strength concrete 7) Bulk storage & transportation of Fly Ash 8) Energy Conservation in Fly Ash Handling, Transportation and Utilisation 9) Bioremediation of Waste Lands, Ash Ponds & Restoration through Sustainable Plantation of Bamboo/ Bio Energy Crop 10) Export Potential of Fly Ash and Cenospheres 11) Employment Potential in Fly Ash Utilisation Sector 12) FGD Gypsum Utilization 13) Alumina and other metal extraction best practices and methods 14) Silica & organic carbon extraction from rice husk ash.

The conference on Fly Ash utilization was concluded successfully after a three days program.

The valedictory function was organized on February 15th, 2020. The occasion was graced by Chief Guest Shri Pradeep Jaiswal, Hon'ble Minister for Mining Resources, Govt. of M.P. with the noble presence of Dr. A.K. Srivastava, Director, CSIR-AMPRI, Bhopal. Shri Neeraj Mandloi, PS, MRD, Govt. of M.P., Shri Jitendra Singh Raje, IAS, Director, EPCO, Dr. Sunil Kumar, VC, RGPV, Bhopal, Shri S Ramamoorthy, IAS, MD, MSMC, Shri Vineet Kumar Austin, Director, G&M, M.P., Shri Biswarup Basu, CGM, Environment & Ash Utilization, NTPC were also present during the grand occasion.

Foundation Stone Laying Ceremony at CSIR-HRDC, Ghaziabad

Foundation Stone of "Conference Hall Made of Bamboo Composite Material" at CSIR-HRDC, Ghaziabad was laid by Honorable Director General, CSIR and Secretary, DSIR, Government of India, Dr Shekhar C Mande on March 6th, 2020. The Conference Hall will be built utilizing CSIR-AMPRI's recently transferred technology on Bamboo Composites for Structural Applications.

Dr. A. K. Srivastava, Director, AMPRI, Bhopal led a team of Scientists and staff of AMPRI consisting of Dr. S. A. R Hashmi, Chief Scientist, Dr. S. K. S. Rathore, Sr. Principal Scientist, Mr. Dheeraj, FAO and Shri. Anwar Ahmed Bakhsh, Senior Technical Officer I, participated the ceremony followed by technical discussion with concerned officials.

Workshop on Bamboo-Based Composites for Government Officials and Bamboo Entrepreneurs in Meghalaya

A Workshop on "Bamboo-based Composites for Government Officials and Bamboo Entrepreneurs" was jointly organized by Meghalaya Basin Development Authority (MBDA) and CSIR-AMPRI, Bhopal on March 12, 2020 at State Convention Centre, Shillong, Meghalaya. The workshop was attended by various officials of both MBDA and CSIR-AMPRI and Entrepreneurs/Participants related to bamboo sectors.

Shri Aiban Swer, OSD(MIG) and Director (MBDA) explained about the Genesis of the program and association of CSIR-AMPRI with Government of Meghalaya, Shilong. Dr. S.K.S Rathore, Sr. Principal Scientist, CSIR-AMPRI, presented an overview of CSIR-AMPRI and highlighted the R & D activities carried out. Dr. S.A.R Hashmi, Chief Scientist, CSIR-AMPRI gave his talk on "Environment-Friendly Materials for Construction Industry: Bamboo Composites" highlighting the importance of the bamboo composites for structural applications in construction industries. Dr.S.Murali, Sr. Principal Scientist, CSIR-AMPRI presented "Overview of Bamboo and its Availability in India as a Green Building Material". The presentations were followed by a discussion with the Participants/ Entrepreneurs which then ended with a vote of thanks.

After the lunch break, a meeting was held in the chamber of Shri P. Sampath Kumar, IAS, CEO, MBDA and Commissioner & Secretary to Government of Meghalaya with team of Scientists of CSIR AMPRI Bhopal comprising Dr S A R Hashmi, Dr S K S Rathore and Dr S Murali. Another meeting was held in the chamber of Dr. P.S. Ahamed, IAS, Principal Secretary Agriculture & Head State Bamboo Mission, as well on Technical Collaboration between MBDA & CSIR-AMPRI for Bamboo-based technologies for employment generation in the state of Meghalaya and the various action plans implementation in Meghalaya.

Important Technological Contributions

1. Technology/Knowhow Transfer on Lead Free X-Ray Shielding Tiles

CSIR-AMPRI has converted the red mud (alumina industrial waste), which is rich in Fe_2O_3, TiO_2, Al_2O_3, $CaCO_3$, etc., into X-ray shielding tiles. The tiles were fabricated through ceramic route by incorporating some high Z compounds with red mud. The 15 mm thick tile posses the attenuation characteristics equivalent to 2mm lead. The developed radiation shielding material was accredited by Atomic Energy Regulatory Board (AERB), Government of India. The developed tiles can be used to shield hazardous X-rays that can emerge out of diagnostic X-ray, computerized tomography (CT) scanner, Cath Labs, etc., instead of toxic lead to protect common public, operators and environment. The developed material is nearly three times cheaper than the lead based radiation shielding materials. This knowhow was licensed to Prism Johnson Ltd on June 10, 2019 in presence of Dr. Shekhar C. Mande (DG, CSIR) at CSIR Headquarter, Anusandhan Bhawan, New Delhi – 110001. The industry has already developed joint free radiation shield with sufficient strength of having dimension 30 x 30 x 1.2cm.

Occasion of Know how transfer

First batch of joint free X-ray shielding tiles fabricated by M/S Prism Johnson Ltd.

2. Technology/Knowhow Transfer on Multifunctional Bamboo Composite Material for Modern Housing and Structures

CSIR- Advanced Materials and Prosesses Research Institute (AMPRI), Bhopal, Transferred on 20th February 2020, its knowhow of an environment friendly multifunctional bamboo composite material for modern housing and structures to renowned industry M/s Permali Wallace Pvt. Ltd. in the presence of Dr. Shekhar C. Mande, Director General, CSIR & Secretary Department of Scientific & Industrial Research, Govt of India. Dr. Mande appreciated the technology as breakthrough in this area of research as well as its potential of generating employment at different level.

Occasion of know how transfer

The technology comprises knowhow of manufacturing multifunctional bamboo composite material for modern housing and structures using abundantly available bamboo as a raw material. The newly developed bamboo composite material can serve as a competitive, sustainable and environment friendly alternative material, useful in the construction of smart green buildings as it has very attractive features like, aesthetic appearance, acoustic & thermal insulation. It also possesses excellent stiffness and strength properties essentially required for any structural application in the construction industry. This bamboo composite material has been developed as a multifunctional construction material using a renewable resource material. The property of bamboo composite material is superior to natural products such as teak wood in terms of stiffness, strength, moisture contents, uniformity and consistency.

A finished product of bamboo composite has economical advantages over the finished teak wood as well as bamboo-wood-composites of similar specifications available in the market. The developed bamboo composites material can be converted to panels of different thicknesses with different widths and lengths. These panels have applications as wall-panels, partitions, coverings, decoration laminates, floorings, thermal/ electrical insulations, doors, windows, table tops, false ceilings, roofs etc. The thicker sections can be used as structural elements such as beams, columns, trusses, benches, floor support, decks, frames for doors, windows etc. Bamboo Composites would also provide an option to create fast, affordable, and stylish disaster relief housing to help victims recover with dignity. The transfer of this technology will be advantageous to the bamboo cultivators located in various parts of India and also help in the generation of employment.

Dr. A. K. Srivastava, Director, CSIR-AMPRI informed that India is second largest cultivator of bamboo but it has only 4% share of world trade. The bamboo wood technology has potential of increasing this trade share. He also informed that there are 136 species of bamboo available in India. Dr. S. A. R Hashmi, Chief Scientist, CSIR AMPRI, highlighted the salient features of bamboo based material that can be referred as bamboo wood. The mechanical properties surpass the properties of teak wood, mainly the stiffness and the modulus. It has excellent dimensional stability and significantly low moisture absorption as compared to conventional wood. It will be available in different standard sizes to make it convenient for assembling to different structures and shapes.

Shri Kunal Merchant, Director PWL expressed his excitement on receiving this technology of manufacturing composites using bamboo. He expressed that it has great potential in construction sector as engineered material with aesthetic, acoustic, thermal and structural benefits in a single material with more than 75% bamboo in it which makes it attractive.

Award/Achievements of staff and students

1. Best poster presentation award to Mrs. Medha Mili, Scientist for the paper entitled "Bamboo based Advanced Polymeric Composites" in the International Conference on "ESTEC 2020" held during February 20-22, 2020 at CSIR-NEIST, Jorhat, Assam.
2. 1st rank in poster presentation to Mr. Shesharao Whore, Project Assistant III for the paper entitled "Influence of Chemical Treatments and Evaluation of Mechanical Properties of Bamboo Fiber Reinforced Polymer Composites" in the conference on Flyash Utilization & Green Building Materials held on 13th-15th February, 2020 at CSIR-AMPRI, Bhopal, M.P.
3. Best prize in oral paper presentation to Mr. Venkat A.N. Ch. for the technical paper "Hybrid aluminium closed cell foam for blast resistance applications", presented in a international conference on "Advanced Materials and Processes for Defence Applications (ADMAT-2019),23-25 September, Hyderabad, India
4. Best Paper and Poster Presentation award to Rahul Arya for the paper entitled "Green Conversion of Red Mud into X- ray Shielding Tiles" in the National conference on Advances in Chemical Engineering and Science (ACES), 28-29 February 2020, IISER, Bhopal.

Seminar / Conference Publications / Participations

1. Poster entitled "Graphene Based Nanogenerators For Harvesting Mechanical Energies" by Manoj Kumar Gupta presented at Graphene Week-2019 at Finland during 22-27th September, 2019.
2. Oral talk on "Zinc Silicate-Graphene Piezoelectric Hybrid Nanogenerators For Scavenging Mechanical Energy" by Manoj Kumar Gupta, Dhiraj Kumar Bharti, N. Sathish, Avanish Kumar Srivastavapresented at 12th Asia-Pacific Microscopy Conference (APMC-2020) Hyderabad International Convention Centre, during 3-7th February 2020, Hyderabad, India
3. Paper entitled "High Transparent and Flexible Zinc Silicate-Graphene Based Piezoelectric Nanogenerators: by Dhiraj Kumar Bharti, Manoj Kumar Gupta, Avanish Kumar Srivastava presented at International Conference on Electron Microscopy & Allied Analytical Techniques (EMAAT -2019) at Adventure Resort Kufri, Shimla (H.P.) India. During 07th - 09th June 2019 (Best Paper Award)
4. Paper entitled "Optical, Electric and Dielectric Properties of Hydrothermal Grown Zinc Silicate Nanorods" by Dhiraj Kumar Bharti, Manoj Kumar Gupta, Avanish Kumar Srivastava presented at International Science Festival (IISF 2019), Kolkata, India during 05 – 09th November, 2019
5. Paper entitled "Strain Induced Magnetic and Photoluminescence properties of Mn-doped Zn2SiO4 nanostructures" by Dhiraj Kumar Bharti, Manoj Kumar Gupta, Avanish Kumar Srivastava presented at 12th Asia-Pacific Microscopy Conference (APMC-2020) Hyderabad International Convention Centre, , Hyderabad, India during 03rd -7th February, 2020
6. Poster entitled "Bio Waste Eggshell Membrane/PVDF Derived Flexible Piezoelectric Nanogenerator" presented on International Conference on "Electron Microscope & Allied Analytical Techniques (EMAAT-2019)"which was held at HPU, Shimla on 7-9th June, 2019.
7. An oral talk on "Hybrid Flexible Biodegradable Eggshell/PVDF Based Piezoelectric Nanogenerator" on National Conference on "Physics and Chemistry of Advanced Materials" (NCPCAM-2019) is delivered at MGCU, Motihari, Bihar on 22-23th November, 2019.
8. Workshop attended on "COMSOL Multiphysics Conference-2019" which was held at ITC Gardenia, Bangalore on 28-29th November, 2019.
9. Poster entitled "PVDF Based Piezoelectric Energy Harvester" presented on SERB supported workshop on "Advanced Materials for Energy Storage and Conversion Devices" at CSIR-AMPRI, Bhopal during 28-29th February, 2020.
10. Poster entitled "Stones waste based water resistant composites with enhanced dielectric

constant and mechanical strength" presented in Young Scientist Conference, India International Science Festival (IISF) 2019 at Kolkata, West Bengal during 5-8th November 2019.

11. Poster entitled "Dielectric and mechanical properties of stone waste based hybrid composites" presented in National science communication orientation training programme at CSIR-AMPRI, Bhopal during 21st, August 2019.

12. Poster entitled "Dielectric and Thermal Conductivity Investigation of Fly Ash Based Polymer Composites" presented by Sandhya Singh Tripaliya, Riya Sahu, Ketki Verma, Asokan Pappu, Manoj Kumar Gupta in National Science Communication Orientation Training Program" at CSIR- AMPRI, Bhopal during 22-23rd August , 2019.

13. Poster entitled "High Sensitive Vertical aligned Two Dimension ZnO Nanodiscs based Piezoelectric Nanogenerator" by Ketki Verma, Manoj Kumar Gupta presented at International Conference on Electron Microscopy & Allied Analytical Techniques (EMAAT -2019) at Adventure Resort Kufri, Shimla (H.P.) India during 07 - 09th June 2019.

14. Poster entitled "Vertical Aligned Two Dimensional Zno Nanodisc based Piezoelectric Nanogenerators for Harvesting Waste Mechanical Energy" by Ketki Verma, Dhiraj kumar Bharti and Manoj Kumar Gupta presented in Indo-German Workshop at CSIR-AMPRI, Bhopal during 25-26th February, 2019

15. Attended and showcased the developed product 107th Indian Science Congress at the University of Agricultural Sciences in Bengaluru during 3-7th January, 2020.

AcSIR AMPRI

CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal, under the aegis of AcSIR (Academy of Scientific & Innovative Research (AcSIR – AMPRI) offers an Opportunity to Students for Higher Education in Interdisciplinary Research Areas & to Work with World Class R & D Experts, in the following courses;

- Ph.D. in Engineering (Material Science & Technology)
- Ph.D. in Chemical Science
- Ph.D. in Physical Science
- Integrated Dual Degree Program (IDDP)

M.Tech. + Ph.D. in Engineering (Material Science & Technology)

AcSIR-AMPRI, Bhopal is running PhD courses in Engineering Science since 2014. There are two semesters each year, starting from January and August and students are admitted in both the semester. The selection procedure is stringent, AcSIR invites applications and candidates are selected based on their credentials, for the written examination/ interview by the individual CSIR Institutions.

In 2019-2020 sessions, total 18 students got registered in AcSIR-AMPRI; Ph.D in Engineering:6, Ph.D. in Chemical Science:5 Ph.D. in Physical Science : 3 and Ph.D under IDDP:4. Thirteen students took admission in August 2019 and 5 students took admission in January 2020. As compared to previous year i.e. 2018-2019, admission of students in 2019-2020 has increased by 72%.

Three students were awarded Ph.D. this year and three students submitted thesis. For the progress evaluation of students 14 DAC meeting were conducted.

Presently the number of faculties in AcSIR-AMPRI Bhopal is 46 (Engineering 28, Chemical Sciences 12 and Physical Sciences 6). The courses offered at AcSIR-AMPRI, Bhopal are 28 in Material science and Engineering, 29 in Chemical Sciences and 12 in Physical Sciences.

Pass out students of AcSIR Mr. Shahadat Hussain has joined Khalifa University, UAE as Post Doctoral Fellow, Mr. Pradeep Singh is appointed Asst. Professor, in SATI, Vidisha, Mr. Subhash Nimapure received CSIR-NPDF and joined NPL Delhi, Ms. Roshita David joined Christian Engineering College, Bhilai as Asst. Professor.

The "Tree-Plantation" was organized at AMPRI on 9th August 2019, by AcSIR students. The plantation programme was inaugurated by Dr Anjan Ray, Director CSIR IIP Dehradun in presence of Dr Avanish Kumar Srivastava, Director CSIR AMPRI Bhopal and Dr S A R Hashmi, Chief Scientist and Co-ordinator AcSIR AMPRI Bhopal. The AcSIR Students planted about 100 of trees in AMPRI campus.

AcSIR students have been actively involved as volunteers in organizing mega events like

Conference in Fly ash utilization and Green building materials held during 13-15 Feb 2020. AcSIR students are continuously supporting in all Jigyasa programs and volunteering in acquainting school students with knowledge and satisfying their curiosity.

AcSIR students have published 25 research articles in journals of national repute. IISF 2019 outreach program was organized at AMPRI in October 2019 where Mr. Dhiraj Bharti got 1st prize in poster presentation and Mr. Ranjan Chaturvedi received 3rd prize.

Café coin was inaugurated for AcSIR students at AMPRI Campus.

Staff List

1.	Dr. Avanish K. Srivastava	Director
2.	Dr. R.K. Morchhale	Chief Scientist
3.	Dr. S.A.R. Hashmi	Chief Scientist
4.	Dr. D.P. Mondal	Chief Scientist
5.	Dr. Sunil K. Sanghi	Chief Scientist
6.	Dr. A.K. Singh	Chief Scientist
7.	Dr. P. Asokan	Sr. Principal Scientist
8.	Dr. S.K.S. Rathore	Sr. Principal Scientist
9.	Shri R.S. Ahirwar	Sr. Principal Scientist
10.	Dr. Mohd.Akram Khan	Sr. Principal Scientist
11.	Dr. Manish Mudgal	Sr. Principal Scientist
12.	Dr. J.P. Shukla	Sr. Principal Scientist
13.	Dr. Sanjeev Saxena	Principal Scientist
14.	Shri H.N. Bhargaw	Principal Scientist
15.	Dr. Deepti Mishra	Principal Scientist
16.	Dr. S. Murali	Principal Scientist
17.	Dr. J. P. Chaurasia	Principal Scientist
18.	Dr. Sarika Verma	Principal Scientist
19.	Shri R.K. Bharilya	Principal Scientist
20.	Dr. Archana Singh	Principal Scientist
21.	Dr. Neeraj Dwivedi	Principal Scientist
22.	Dr. Raju Khan	Sr. Scientist
23.	Dr. Meraj Ahmed	Sr. Scientist
24.	Dr. Gaurav Kumar Gupta	Sr. Scientist
25.	Dr. Sathish N	Sr. Scientist
26.	Dr. Sanjay K. Panthi	Sr. Scientist
27.	Dr. Chetna Dhand	Sr. Scientist
28.	Dr. Pradeep Kumar	Sr. Scientist
29.	Dr. Alka Mishra	Scientist
30.	Dr. Satanand Mishra	Scientist
31.	Shri Abhishek Pandey	Scientist
32.	Shri Venkat A N Ch	Scientist
33.	Shri Sriram Sathaiah	Scientist
34.	Dr. Tilak Chandra Joshi	Scientist
35.	Shri Mohammad Ashiq	Scientist
36.	Dr. Surender Kumar	Scientist

37.	Shri Mohit Sharma	Scientist
38.	Shri Nikhil Rajendra Gorhe	Scientist
39.	Dr. Manoj Kumar Gupta	Scientist
40.	Dr. Shabi T. Salammal	Scientist
41.	Mrs. Medha Mili	Scientist
42.	Shri Narendra Singh	Scientist
43.	Shri Shiv Singh Patel	Scientist
44.	Dr. Shiv Singh	Scientist
45.	Dr. Narayan Saha	Prin. TO/ Gr.III(7)
46.	Shri R.K. Chauhan	Prin. TO/ Gr.III(7)
47.	Dr. Ajay Naik	Prin. TO/ Gr.III(7)
48.	Shri P. Banerjee	Prin. TO/ Gr.III(7)
49.	Dr. J.P. Pandey	Prin. TO/ Gr.III(7)
50.	Shri Ajay Kulshreshth	Prin. TO/ Gr.III(7)
51.	Dr. R.K. Soni	Prin. TO/ Gr.III(7)
52.	Dr. Edward Peters	Prin. TO/ Gr.III(7)
53.	Dr. V. Sorna Gowri	Prin. TO/ Gr.III(7)
54.	Shri T.S.V.C. Rao	Sr. TO/ Gr.III(6)
55.	Shri Manoj Kumar Ban	Sr. TO/ Gr.III(6)
56.	Dr.Prabha Padmakaran	Sr. TO/Gr.III(6)
57.	Shri Anwar Ahmed Bakhsh	S E/ Gr.III(6)
58.	Mrs. Sangeeta Gamad	TO/Gr.III(4)
59.	Shri O.P. Chaurasia	TO/Gr.III(4)
60.	Shri Deepak K. Kashyap	TO/Gr.III(3)
61.	Shri Balwant Barkhaniya	TO/Gr.III(3)
62.	Dr. Muhamed Shafeeq M.	TO/Gr.III(3)
63.	Shri Anup Kumar Khare	TO/Gr.III(3)
64.	Shri Khelendra K Naktode	Tech. Asstt./Gr.III(1)
65.	Shri N. Prasanth	Tech. Asstt./Gr.III(1)
66.	Shri R.K. Gurjar	Tech. Gr.II(4)
67.	Shri Abhay Yadav	Tech. Gr.II(4)
68.	Shri Madan Lal Gurjar	Tech. Gr.II(4)
69.	Shri Akhtar Ullah	Tech. Gr.II(4)
70.	Shri Arun Saxena	Tech. Gr.II(4)
71.	Shri A.K. Asati	Tech. Gr.II(4)
72.	Shri S.K. Suryavanshi	Tech. Gr.II(4)
73.	Mrs. Swagatika Pal	Tech. Gr.II(4)
74.	Shri L.N. Sahu	Tech. Gr I(4)
75.	Shri S.K. Batham	Tech. Gr I(4)
76.	Shri S.K. Raikwar	Tech. Gr I(4)

77.	Shri N.S. Jadav	Tech. Gr I(4)
78.	Shri Anil Gond	Tech. Gr I(4)
79.	Shri R.N. Waghmare	Administrative Officer
80.	Shri Dheeraj	Finance & Accts Officer
81.	Shri P.M. Verma	Stores & Purchase Officer
82.	Shri A.K. Jain	Section Officer (G)
83.	Shri Sanjay Vinodia	Section Officer (F&A)
84.	Shri P.K. Shrivastava	Protocol Office
85.	Dr. Manisha Dubey	Hindi Officer
86.	Smt. Shyamala Soman	Private Secretary
87.	Smt. Mini Surendran	Private Secretary
88.	Shri N. Viswanathan	Private Secretary
89.	Shri D.M. Chilbule	Asstt. Section Officer (S&P)
90.	Smt. Asha Vinodia	Asstt. Section Officer (Gen)
91.	Shri Neelesh Jaiswal	Asstt. Section Officer (Gen)
92.	Shri Vijay Nathiley	Asstt. Section Officer (S&P)
93.	Shri Vijay Shrivastav	Asstt. Section Officer (F&A)
94.	Shri Shailendra S. Tomar	Asstt. Section Officer (S&P)
95.	Shri Harihar Singh Yadav	Asstt. Section Officer (Gen)
96.	Smt. Antia Daniel	Receptionist
97.	Shri Mohd. Rafique	Driver /Tech. Gr.II(4)
98.	Shri G. Adinarayana	Security Officer
99.	Shri Sourabh Sethia	Jr. Steno.
100.	Shri Rahul S. Chouhan	Jr. Secretariat Asstt.(S&P)
101.	Shri Praveen Kumar	Jr. Secretariat Asstt.(F&A)
102.	Ms. Seema Bisht	Jr. Secretariat Asstt.(Gen)
103.	Mrs. Trishala Rangari	Record Keeper
104.	Shri R.N. Pradhan	Security Guard
105.	Shri Devtanand Prasad	Tea & Coffee Maker
106.	Shri Dayaram	Safaiwala
107.	Mrs. Asha Golait	Peon

AMPRI in News Media

फ्लाई ऐश फैला रही प्रदूषण, उपयोग करने पर बनाएंगे नीति

भोपाल (नवदुनिया प्रतिनिधि)। प्रदेश के थर्मल पावर प्लांटों से निकलने वाली फ्लाई ऐश (कोयला के जलने से निकलने वाली राख) प्रदूषण फैला रही है। इसका उपयोग करने के लिए नीति बनाएंगे।

यह बात पर्यावरण विभाग के प्रमुख सचिव मलय श्रीवास्तव ने कही। वे नेशनल सीएसआईआर-एम्प्री में शुरू हुए सेमिनार में बोल रहे थे। यह सेमिनार नेशनल सीएसआईआर- एम्प्री (एडवांस्ड मटेरियल्स एंड प्रोसेस रिसर्च इंस्टीट्यूट) के सभागार में शुरू हुआ

सेमिनार को संबोधित करते प्रदूषण नियंत्रण बोर्ड के सदस्य सचिव आरएस कोरी। ● नवदुनिया

कि सेमिनार में निकलने वाले निष्कर्ष फ्लाई ऐश के उपयोग करने की बात कही है। प्रदूषण नियंत्रण बोर्ड के सदस्य सचिव

संयोजक सुधीर पालीवाल ने कहा कि पावर प्लांटों में बिजली पैदा करने के लिए कोयला का उपयोग किया जा रहा है। इससे फ्लाई ऐश निकल रही है। इसका प्रदेशभर में बड़ा स्टॉक जमा हो गया है। इसकी मात्रा करीब 8.94 मिलियन टन है। इसमें से ज्यादातर फ्लाई ऐश का उपयोग नहीं हो रहा है। फ्लाई ऐश थर्मल पावर प्लांट के आसपास के गांव और खेतों तक को प्रदूषित कर रही है। इसका उपयोग करना आवश्यक हो गया है। एफएमपीसीसीआई के उपाध्यक्ष दिवेंदर पॉल सिंह चावला ने कहा कि आने वाले समय में पानी और पर्यावरण को बचाने में

फ्लाई ऐश को लेकर आयोजित तीन दिवसीय कार्यशाला का समापन

नदियों को बचाने पत्थर से बनी रेत को बढ़ावा दे रही है सरकार

सिटी रिपोर्टर ■ भोपाल

नदियों को बचाने के लिए पत्थर से बनने वाली रेत ही आने वाले समय में सबसे बड़ा विकल्प होगी। इस रेत को बढ़ावा देने के लिए प्रदेश सरकार भी प्रयास कर रही है। यह जानकारी शनिवार को फ्लाई ऐश को लेकर आयोजित तीन दिवसीय कार्यशाला के समापन अवसर पर प्रदेश के खनिज साधन मंत्री प्रदीप जायसवाल ने दी। उन्होंने कहा कि प्रदेश की नदियों से निकलने वाली रेत पर प्रदेश सरकार एक सौ पच्चीस रुपए प्रति घनमीटर रायल्टी ले रही है, लेकिन पत्थरों से बनने वाली रेत पर सिर्फ पच्चीस रुपए प्रति घनमीटर रायल्टी ली जा रही है। पत्थरों से

सरकार द्वारा खदानों को नीलामी की जाती है, तो रेत खदानों से अवैध उत्खनन होता है, इससे प्राकृतिक संपदा नष्ट हो रही है, साथ ही सरकार को राजस्व की हानि हो रही है। मंत्री ने फ्लाई ऐश

निष्कर्षों का योजना बनाने में होगा इस्तेमाल

कार्यक्रम के समन्वयक सुधीर पालीवाल ने कहा कि हमारा प्रयास पर्यावरण को बचाने का

दिवसीय कार्यक्रम के बाद जो भी निष्कर्ष निकलकर सामने आए हैं, हम उनका सार तैयार कर सरकार को सौंपेंगे, जिससे सरकार इस दिशा में बेहतर काम कर सके। यह सेमिनार फेडरेशन आफ मध्य प्रदेश, चैम्बर ऑफ कॉमर्स, ग्रीन एरा एक्टिवेटर्स, सीएसआईआर-एम्प्री और मा. प्रदूषण नियंत्रण मंडल के संयुक्त तत्वावधान में सीएसआईआर-एम्प्री के सभागार में हुआ। कार्यशाला में ग्रीन एरकॉन के सुधीर पालीवाल, भारती चक्रवर्ती, अनिता गोटी, एफएमपीसीसीआई के चॉयरस प्रेसिडेंट दिवेंदर पॉल सिंह चावला, एमपी पैरेवी के सदस्य सचिव आरएस कोरी, एम्प्री के डायरेक्टर अतिवारा डॉक्टर, सभी

फ्लाई ऐश के लिए बनेगी नीति

भोपाल ◆ प्रदेश के थर्मल पॉवर प्लांटों में प्रदूषण फैला रही फ्लाई ऐश के उपयोग के लिए सरकार नीति बनाएगी। थर्मल पॉवर प्लांटों में सालाना लाखों टन फ्लाई ऐश निकल रही है, इसमें 40 फीसदी का ही उपयोग हो पा रहा है। यह बात फ्लाई ऐश के

एमपीपीसीसीआर आई के डायरेक्टर

कल से भोपाल में देखें नए साइंस इनोवेशन

दबंग रिपोर्टर ■ भोपाल

हर साल की तरह इस साल भी भोपाल का विज्ञान से संबंधित महत्वपूर्ण और प्रतिष्ठित आयोजन भोपाल विज्ञान मेला 2019 नए प्रयोगों और टेक्नोलॉजी के साथ आयोजित होने जा रहा है। यह भोपाल में मेले का आठवां साल है। मेला स्थित दशहरा मैदान में 13 से 16 सितंबर तक चलने वाले इस मेले का आयोजन भोपाल सीएसआईआर-एम्प्री, विज्ञान प्रसार, नई दिल्ली

रहा है। इस संबंध में काउंसिल ऑफ

बताया कि प्रदेश के राज्यपाल लालजी

सीएसआईआर, नई दिल्ली, भारत सरकार डॉ. शेखर सी मांडे उपस्थित रहेंगे। उन्होंने यह भी बताया कि मेले में प्रसिद्ध वैज्ञानिक व मिशन डायरेक्टर मिशन शक्ति, डीआरडीओ, भारत सरकार डॉ. यू राजाबाबु, का सम्मान भी किया जाएगा। राजाबाबु के नेतृत्व में भारत ने सेटेलाइट को मिसाइल से भेदने की क्षमता हासिल की है। प्रोफेसर सुधीर सिंह भदौरिया, राजीव गांधी प्रौद्योगिकी विश्वविद्यालय ने कहा कि साइंस और

भारत की आइडियोलॉजी और टैक्नोलॉजी का दुनियाभर में सिक्का : सोलंकी

70 स्टॉल्सऔर 100 मॉडलों के माध्यम से प्रदेशभर के हजारों छात्र विज्ञान मेले में हुए शामिल

कुछ खास बातें 8वें विज्ञान मेले की और अगले वर्ष आयोजित होने वाले मेले की

- कार्यक्रम के अंतर्गत 9वें विज्ञान मेला की हुई घोषणा
- टॉप 10 स्टॉल हुए सम्मानित
- अगला विज्ञान मेला डॉ. अब्दुल कलाम के विजन 2020 के थीम पर 25 से लेकर 28 सितंबर तक आयोजित होगा।

हरिभूमि न्यूज ▸▸ भोपाल

सोमवार को भोपाल विज्ञान मेले का आखिरी दिन रहा। जहां मौसम सुबह से ही खुशनुमा रहा, वहीं 8वें भोपाल विज्ञान मेले में छात्रों और मेले में सहभागिता निभाने वाले हर शख्स में उत्साह दिखा। मेले में मुख्य अतिथि के रूप में शामिल हरियाणा और त्रिपुरा के पूर्व राज्यपाल रहे कप्तान सिंह सोलंकी ने कहा कि भारत की आइडोलॉजी और टैक्नोलॉजी दुनियाभर में

डीआरडीओ, इसरो और मल्टीपरपज ब्रिज के बनाए मॉडल

आईईएस ग्रुप के स्टूडेंट्स ने रक्षा अनुसंधान विकास संगठन और भारतीय अंतरिक्ष अनुसंधान संगठन पर आधारित मॉडल बनाए। इन छात्रों का कहना है कि हमने भारत के लिए गर्व करने वाले दोनों लीगल संस्थान डीआरडीओ और इसरो के अब तक लांच की गई सभी मिसाइलों और उनकी उपयोगिता के बारे में बताने का प्रयास किया है। जिसमें 2022 में आने वाली डीएफएचबीएम जैसी सुपरसोनिक एंटी बैलिस्टिक

मिसाइलों के नाम भी शामिल है जिसकी मारक क्षमता 10 हजार कि.मी. से ज्यादा है। जो अभी सिर्फ रूस, चीन और अमरीका के पास है। यही रक्षामंत्र दूरी की मार करने वाली छोटी मिसाइल त्रिशूल, आकाश, पृथ्वी-1, पृथ्वी-2, पृथ्वी-3, नाग इनसे के कई महत्वपूर्ण मॉडल छात्रों ने प्रस्तुत किए। मिलेनियम ग्रुप के छात्रों ने मल्टीपरपज ब्रिज

Pact to bring entrepreneurial opportunities signed at varsity

OUR CORRESPONDENT

PHAGWARA, JULY 31

CSIR-(Council of Scientific and Industrial Research)—AMPRI (Advanced Materials and Processes Research Institute), Bhopal, and Lovely Professional University (LPU) signed an MoU to bring entrepreneurial opportunities for LPU students.

Using AMPRI technologies, students will be apprised of how to make wealth from the waste. The MoU has been signed to undertake joint 'Research and Academics' pursuits in various areas related to nation-building

CSIR-AMPRI Director Dr AK Srivastava and LPU Registrar Dr Monica Gulati after the signing of an MoU at the LPU near Jalandhar. TRIBUNE PHOTO: MALKIAT SINGH

फ्लाई ऐश की मदद से किया जा सकता है लकड़ी और पत्थर का भी निर्माण

भोपाल ◆ फ्लाई ऐश का उपयोग घर में लगने वाले डोर, किचन में उपयोग होने वाले पत्थर सहित अन्य कई सामग्री बनाने में किया जा सकता है। इस क्षेत्र में रोजगार के कई विकल्प हैं। यह जानकारी फ्लाई ऐश के उपयोग पर हो रही

मध्यप्रदेश प्रदूषण नियंत्रण मंडल के

आठवें भोपाल विज्ञान मेले का हुआ समापन, सभी ने की आयोजन की सराहना

विज्ञान में प्रगति के लिए विश्वभर में भारत की सराहना

स्वदेश संवाददाता, भोपाल

भेल दशहरा मैदान में चल रहे चार दिवसीय विज्ञान मेले का सोमवार को समापन हुआ। समापन कार्यक्रम में हरियाणा के पूर्व राज्यपाल कप्तान सिंह सोलंकी मुख्य अतिथि और प्रदेश के पंचायत एवं ग्रामीण विकास मंत्री कमलेश्वर पटेल विशिष्ट अतिथि के

प्रदेश को बधाई देता हूं। उन्होंने कहा कि हमारा देश निरंतर विज्ञान के क्षेत्र में विश्व पटल पर अपनी छाप छोड़ रहा है। विज्ञान में प्रगति के लिए विश्वभर में भारत की सराहना हो रही है। ऐसे में इस तरह के आयोजन और भी सार्थक नजर आते हैं क्योंकि यह आमजन में विज्ञान के प्रति रुचि जागृत करते हैं। उन्होंने कहा कि विज्ञान

ग्रामीण क्षेत्रों की प्रगति में विज्ञान की अहम भूमिका : पटेल

प्रदेश के पंचायत एवं ग्रामीण विकास मंत्री कमलेश्वर पटेल ने मेले में लगे स्टॉल्स और छात्रों द्वारा किए गए अभिनव प्रयोगों की तारीफ करते हुए कहा कि आज जन-जन विज्ञान से जुड़ रहा है और इसके पीछे इस तरह के आयोजन महत्वपूर्ण भूमिका निभाते हैं। उन्होंने कहा कि खासकर ग्रामीण क्षेत्रों की प्रगति

रिसर्च के क्षेत्र में भोपाल की पहचान बने यहां किए जा रहे शोध कार्य

एम्प्री के वैज्ञानिक डॉ. एसके सांघी ने ढूंढा हैवी मेटल लैड से निकलने वाले रेडिएशन से बचाव का विकल्प, एटॉमिक एनर्जी रेगुलेटरी बोर्ड ने भी किया सर्टिफाई

एक्स-रे, कैथ लैब के रेडिएशन रोकेगी एम्प्री की रिसर्च से बनीं टाइल्स

रश्मि ढाके | भोपाल

भोपाल शहर रिसर्च के क्षेत्र में अपनी नई पहचान बनाने की दिशा में तेजी से बढ़ रहा है। यह नई पहचान होगी रिसर्च में आगे शहर की। इस नई पहचान की वजह है यहां के एक से बढ़कर एक रिसर्च कर रहे संस्थान और यहां के प्रोफेसर्स। भोपाल ने पिछले कुछ महीनों में दुनिया में सबसे पहले एक ओर जहां पैंकॉक (मोर) की जीनोम सीक्वेंसिंग की, वहीं दुनिया के 60 देशों में सबसे ज्यादा जिन वैज्ञानिकों की रिसर्च को साइट किया गया, उसमें भी यहां के दो प्रोफेसर्स की पानी से इंडस्ट्रियल डाई हटाने की तकनीक ढूंढने वाली रिसर्च शामिल हुई। इसी शृंखला में एम्प्री भोपाल के वैज्ञानिक डॉ. एसके सांघी ने एक ऐसी रिसर्च की है, जो देशभर के अस्पतालों को जहरीले लैड से मुक्ति दिलाएगी। इस रिसर्च पर सबसे पहले अमेरिकन पेटेंट भी एम्प्री भोपाल को ही मिला। ऐसे में कहा जा सकता है कि यह दिन दूर नहीं, जब रिसर्च के लिए भोपाल वर्ल्ड मैप पर पहचाना जाएगा।

10 सालों में सफल हुई रिसर्च, बनाई रेडिशन रोकने वाली टाइल्स

• डॉ. एसके सांघी (वाएं) अपने बनाए रेडिएशन रोधी टाइल्स के बारे में बताते हुए।

इसी माह आएगी मार्केट में

इन टाइल्स के प्रयोग को जांचने के लिए जून-2016 में महाराष्ट्र के अहमदनगर में मेसर्स साईंबीज हॉस्पिटल एंड शोध केंद्र में तीन एक्स-रे चेम्बर्स, सीटी स्कैन केबिन और कैथ लैब में लगाया गया। इसके बाद इसे पराणु ऊर्जा नियामक बोर्ड ने रिन्यू किया। हाल ही में एटॉमिक एनर्जी रेगुलेटरी बोर्ड ने इन टाइल्स को इस्तेमाल के लिए सर्टिफाई किया और देशभर के अस्पतालों को हानिकारक लैड के स्थान पर इन टाइल्स के इस्तेमाल का सुझाव भी दिया है। महाराष्ट्र की एक कंपनी को हाल ही में इन टाइल्स के साथ पेडेस्टल के लिए इस रिसर्च की टेक्नोलॉजी ट्रांसफर कर दी गई है। यह कंपनी 25 जून तक मार्केट में 9 टन टाइल्स पहुंच देगी।

डॉ. एसके सांघी एम्प्री में चीफ साइंटिस्ट हैं। वे बताते हैं, देश में एक बड़ी समस्या एल्यूमीनियम इंडस्ट्री से वेस्ट के रूप में निकलने वाली लाल मिट्टी यानी रेड मड की है। इस लाल मिट्टी में आयरन समेत कई ऐसे हैवी मेटल्स के ऑक्साइड्स होते हैं। अनुमान के मुताबिक एक साल में देश में करीब 7 मिलियन टन रेड-मड चाय पोडक्ट के रूप में निकलती है। वहीं दूसरी तरफ हॉस्पिटल में बने रेडिएशन चेम्बर्स में लैड का इस्तेमाल होता है, जो इंसानी स्वास्थ्य के लिए हानिकारक है। यह रिसर्च इन दोनों ही समस्याओं हल देती है। रेड मड के हैवी ऑक्साइड्स इससे बनने वाली टाइल्स को इस काबिल बनाते हैं कि लैड के समान ही रेडिएशन रोके। इन टाइल्स को सामान्य सिमेंटिक पेस्ट से दीवारों पर चिपकाया जा सकता है। डॉ. सांघी बताते हैं कि करीब 10 साल में यह शोध पूरा हुआ। एम्प्री के डायरेक्टर डॉ. अवनीश कुमार श्रीवास्तव ने बताया कि एक्स-रे शील्डिंग टाइल्स देश के लिए एक बड़ी उपलब्धि है। जिस तेजी से भोपाल में नई रिसर्च हो रही हैं, इससे रिसर्च फ्रेटर्नटी में भोपाल को नई पहचान मिल रही है।

रिसर्च के क्षेत्र में इससे पहले इन्होंने भी किया भोपाल का नाम रोशन

• डॉ. अर्चना तिवारी

रेटिनोपैथी की कस्टमाइज्ड मेडिसिन

आरजीपीवी की पी. डॉ. अर्चना तिवारी ने रेटिनोपैथी की कस्टमाइज्ड मेडिसिन इंडी. मरीज के ब्लड सैंपल या टिशू की मॉलिक्यूलर लेवल की जांच से पता लगाते हैं कि जीन में किस बदलाव के कारण उसे रेटिनोपैथी हुआ है और इसके अनुसार ही दवा दी जाती है। इससे यह बीमारी अब 99 प्रतिशत तक ठीक हो रही है।

• डॉ. विनीत कुमार शर्मा

मोर और मुर्गा की उम्र में अंतर की वजह

मोर एक ऐसा पक्षी है जिस पर कई वायरल का असर नहीं होता, उसकि विकल्प आबादी से वीमार हो जाते हैं। इसका जवाब दिया आईजर के डॉ. विनीत कुमार शर्मा ने। उन्होंने मोर के जीनोम सीक्वेंसिंग की और बताया कि 99 ऐसे जीन्स हैं, जो मोर को सुदकूत और मजबूत बनाते हैं।

• डॉ. मनीष मुद्गल

फ्लाई ऐश से ढूंढा सीमेंट का आसान विकल्प

एम्प्री भोपाल के साइंटिस्ट डॉ. मनीष मुद्गल ने सीमेंट का ऐसा विकल्प ढूंढ निकाला है, जो कोल थर्मल पावर प्लांट से हर साल निकलने वाले 200 मिलियन टन फ्लाई ऐश के प्रयोग का विकल्प है। यह किसी भी कंस्ट्रक्शन वर्क में इस्तेमाल होने वाली पानी की खपत को भी कम करता है।

पानी में घुले रंगों को पानी से किया अलग

• डॉ. आलोक और डॉ. ज्योति मित्तल | साइंटिस्ट |

पानी में इंडस्ट्रियल वेस्ट के रूप घुलने वाली डाई यानी रंगों को पानी से निकालने पर रिसर्च की है। पानी से रंग को अलग करने के लिए खर वर अवशोषक तैयार किए। यह खर वर एडजॉर्प्शन हैं मुर्गे के पंख, चॉप ऐश और डी-ऑयल्ड सोया, एश शेल और उनमें मिलने वाली मेम्ब्रेन।

Pact to bring entrepreneurial opportunities signed at varsity

OUR CORRESPONDENT

PHAGWARA, JULY 31

CSIR-(Council of Scientific and Industrial Research)—AMPRI (Advanced Materials and Processes Research Institute), Bhopal, and Lovely Professional University (LPU) signed an MoU to bring entrepreneurial opportunities for LPU students.

Using AMPRI technologies, students will be apprised of how to make wealth from the waste. The MoU has been signed to undertake joint 'Research and Academics' pursuits in various areas related to nation-building.

CSIR-AMPRI's Director Dr A K Srivastava and Registrar, LPU, Dr Monica Gulati signed the MoU on behalf of their respective institutions.

CSIR-AMPRI Director Dr AK Srivastava and LPU Registrar Dr Monica Gulati after the signing of an MoU at the LPU near Jalandhar. TRIBUNE PHOTO: MALKIAT SINGH

present works are also going on for hybrid composites from fibres and waste particulates.

In order to save the trees

able green materials with lot of recycling opportunities. Informing about more than 50 types of solid and liquid wastes he advised to work for

from the expertise and guidance of eminent scientists of AMPRI. He advised agriculture department of the uni-

हर बच्चों तक पहुंचे विज्ञान की अद्यतन जानकारी : डॉ. श्रीवास्तव

■ भारत अंतर्राष्ट्रीय विज्ञान महोत्सव- 2019 का आयोजन होगा नवंबर में, दी जानकारी

स्वदेश संवाददाता, भोपाल

कार्यक्रम में भारी संख्या में विद्यार्तियों एवं जन सामान्य ने भाग लिया। कार्यक्रम के मुख्य अतिथि के रूप में डॉ. कृपा शंकर तिवारी ने देश की पर्यावरणीय समस्यायों एवं उनके निराकरण से सम्बंधित विषयों में प्रकाश डाला। डॉ. अवनीश कुमार महासचिव, विभा ने भारत अंतर्राष्ट्रीय विग्यान महोत्सव-2019 के बारे में विस्तार से जानकारी दी। उन्होंने बताया कि यह महोत्सव प्रतिवर्ष मनाया जाता है जिसका आयोजन विज्ञान एवं प्रौद्योगिकी मंत्रालय एवं विज्ञान भारती के द्वारा किया जाता है

15 नवदुनिया भोपाल, गुरुवार 07 नवंबर 2019

देश-दुनिया

www.naidunia.com

दुनिया का सबसे पुराना अखबार लंदन गजट

1665 में आज ही लंदन गजट पहली बार प्रकाशित हुआ था। उस समय इस अखबार को द ऑक्सफोर्ड गजट कहा जाता था। अंग्रेजी भाषा में छपने वाला यह अखबार आज भी हर रोज प्रकाशित होता है। यह ब्रिटेन में सबसे पुराना लगातार प्रकाशित होने वाला अखबार है।

1917 में आज ही लेनिन की बोल्शेविक पार्टी की अगुवाई में रूस के मजदूर वर्ग और मेहनतकश लोगों ने जार के शासन का तख्तापलट करने के लिए बोल्शेविक क्रांति की शुरुआत की थी। इस क्रांति को अक्टूबर क्रांति के नाम से भी जाना जाता है।

सर रोन

भारत के महान भौति ही रामानुजम् से हुआ नोबेल पुरस्कार विज पहले ही उन्होंने भौ

पराली से बनाया जा सकता है प्लाईबोर्ड, प्रदूषण से मिलेगी राहत

नवदुनिया विशेष

कोलकाता से गौरभ खंडेलवाल

नई दिल्ली एनसीआर समेत आसपास के लगे राज्यों में प्रदूषण फैलाने वाली पराली (नरवाई) का व्यावसायिक उपयोग ईजाद किया जा चुका है। इस पर अमल से किसानों को न सिर्फ पराली जलाने की जरूरत नहीं पड़ेगी बल्कि पराली उनके लिए आमदनी का जरिया भी बन जाएगी। इस समस्या का हल काउंसिल फॉर साइंटिफिक एंड इंडस्ट्रियल रिसर्च के अधीन आने वाली भोपाल की एडवांस मटेरियल एंड प्रोसेस रिसर्च इंस्टीट्यूट (एम्प्री) ने खोज निकाला है। एम्प्री के सिंथेसिस डेवलपमेंट सेल के चीफसाइंटिस्ट और सीनियर प्रिंसिपल साइंटिस्ट डॉ. अशोकन पप्पू ने इस नरवाई से प्लाईबोर्ड और दीमक प्रूफ बोर्ड बनाने की तकनीक ईजाद की है। जिसे पहले आयोजित अंतरराष्ट्रीय विज्ञान महोत्सव 2019 में प्रदर्शित किया गया है।

डॉ. अशोकन पप्पू

भोपाल एम्प्री के सीनियर प्रिंसिपल साइंटिस्ट डॉ. अशोकन पप्पू ने विकसित की तकनीक

भोपाल के एम्प्री द्वारा पराली से तैयार किया गया प्लाईबोर्ड। ● नवदुनिया

2 वर्ग फुट का बोर्ड बनाने में लगेगी 600 ग्राम नरवाई

डॉ. अशोकन पप्पू के मुताबिक एक वर्ग मीटर का बोर्ड बनाने के लिए लगभग 10 ग्राम नरवाई लगती है, यानी 2 वर्ग फुट का बोर्ड बनाने में लगभग 600 ग्राम नरवाई की जरूरत होगी। यह बोर्ड प्लाईबोर्ड की तरह ही मजबूत होता है। जिसे घरों में कार तक में उपयोग में लाया जा सकता है। नरवाई से बनाए गए बोर्ड का उपयोग दरवाजे, छत या फॉल्स सीलिंग, फ्लोर, दीवार की टाइल्स और पार्टिशन बनाने के लिए किया जा सकता है।

प्लाईवुड जितना ही आएगा खर्च

डॉ. पप्पू के मुताबिक नरवाई से बने बोर्ड प्लाईबोर्ड से महंगा नहीं होगा। एटि प्लाईबोर्ड 10 रुपए वर्गफीट में उतना ही नरवाई से बना बोर्ड 11 रुपए वर्गफीट का पड़ेगा।

किसे क्या फायदा

पर्यावरण

- नरवाई नहीं जलेगी तो प्रदूषण कम होगा।
- कंपनी प्लाईबोर्ड बनाने के लिए पेड़ नहीं काटेगी।

किसान

- नरवाई नहीं जलेगी तो फसलें और अन्य जानवर जाम नहीं लगेगी।
- कंपनियां नरवाई के लिए किसानों को पैसा दे सकती हैं, तो इससे अतिरिक्त लाभ होगा।

आम लोगों को

- सस्ता रजिस्टेंट होगा
- दीमक प्रूफ होगा बोर्ड

सरकार से मांगे सात करोड़ इंडस्ट्री भी ले सकती हैं लाइसेंस

डॉ. अशोकन पप्पू के मुताबिक नरवाई से प्लाईबोर्ड बनाने के लिए केंद्रीय विज्ञान एवं प्रौद्योगिकी विभाग से उन्होंने सात करोड़ रुपए की मांग की है, ताकि इसका उत्पादन शुरू किया जा सके। तात्कालिक तौर पर जहां से उन्हें यह राशि नहीं मिली सकी है। डॉ. पप्पू के मुताबिक नरवाई से बोर्ड की फैक्ट्री शुरू करने के लिए इस राशि की जरूरत है। एक तकनीक तैयार है, इसलिए निजी कंपनियां भी इसका लाइसेंस लेकर फैक्ट्री शुरू कर सकती हैं। हालांकि मौजूदा प्लाईबोर्ड फैक्ट्री बोड़ा बहुत परिवर्तन कर मौजूदा मैटेरियल में भी इसका उत्पादन शुरू कर सकती हैं।

न्यूज गैलरी

प्रधान न्यायाधीश रंजन गोगोई 17 नवंबर को दो दिन के नेपाल दौरे

फ्लाईऐश से बना सकते हैं घर के दरवाजे और किचन के पत्थर

एम्प्री में संगोष्ठी में वक्ताओं ने दी जानकारी

सिटी रिपोर्टर . भोपाल

फेडरेशन ऑफ मप्र चेंबर ऑफ कॉमर्स की ओर से आयोजित तीन दिवसीय इंटरनेशनल सेमिनार के दूसरे दिन शुक्रवार को थर्मल पॉवर विद्युत संयंत्रों में कोयले के जलने से प्राप्त उप उत्पाद फ्लाइऐश के उपयोग पर चर्चा हुई। एम्प्री में आयोजित इस सेमिनार के दौरान फ्लाईऐश यूटिलाइजेशन एंड ग्रीन बिल्डिंग मटेरियल विषय पर प्रदर्शनी भी लगाई गई। यहां विशेषज्ञों ने फ्लाईऐश के उपयोग पर विचार-विमर्श किया। साथ ही सीमेंट, ईंट, सड़क निर्माण, बांधों, फ्लाइओवर, बंजर भूमि के सुधार, खानों के भराव और आवासीय एवं औद्योगिक भवनों के निर्माण में इसके इस्तेमाल की संभावनाओं पर चर्चा की। सीएसआईआर

आज रेत के विकल्प पर होगी चर्चा

कार्यशाला के आखिरी दिन शनिवार को नदियों से हो रहे रेत उत्खनन के प्रभाव और उसके विकल्प पर

फ्लाई ऐश को लेकर बोले खनिज मंत्री

नदियों को बचाने पत्थर की रेत को दे रहे बढ़ावा

भोपाल ● नदियों को बचाने के लिए पत्थर से बनने वाली रेत ही आने वाले समय में सबसे बड़ा विकल्प रहेगी। इस रेत को बढ़ावा देने के लिए प्रदेश सरकार भी प्रयास कर रही है। फ्लाई ऐश को लेकर आयोजित तीन दिवसीय कार्यशाला के समापन पर शनिवार को खनिज साधन मंत्री प्रदीप जायसवाल ने यह बात कही। मंत्री ने कहा कि प्रदेश की नदियों से निकलने वाली रेत पर प्रदेश सरकार 125 रुपए प्रति घनमीटर रायल्टी ले रही है, लेकिन खदानों को नीलामी की जाती है, तो रेत खदानों से अवैध उत्खनन होता है, इससे प्राकृतिक संपदा नष्ट हो रही है, साथ ही सरकार को राजस्व की हानि हो रही है।

समन्वयक सुधीर पालीवाल ने कहा कि हमारा प्रयास पर्यावरण को बचाने का है। यह सेमिनार फेडरेशन ऑफ मध्यप्रदेश, चैम्बर ऑफ कॉमर्स, ग्रीन एश फाउंडेशन, सीएसआईआर-एमप्री और मप्र प्रदूषण नियंत्रण मंडल के सयुंक्त तत्वावधान में सीएसआईआर-

केजीएमयू में रेडिएशन कवा करने को एमओयू पर हस्ताक्षर

इंडस्ट्रियल वेस्ट से निर्मित मैटेरियल्स पर्यावरण के लिए होंगे लाभकारी

लखनऊ (एसएनबी)। सीएसआईआर- एएमपीआरआई भोपाल और किंग जॉर्ज चिकित्सा विश्वविद्यालय के बीच मंगलवार को एक मेमोरेंडम ऑफ आउटस्टैंडिंग (एमओयू) पर हस्ताक्षर किया। इस करार के तहत सीएसआईआर एएमपीआरआई, भोपाल नए उच्च स्तरीय मेटेरियल्स का निर्माण करेगा, जोकि रेडियेशन शिल्डिंग के रूप में पहले के मुकाबले लाभकारी एवं सस्ता होगा।

इस मेटेरियल्स का निर्माण इंडस्ट्रियल वेस्ट से किए जाने के कारण यह पर्यावरण के

परिहार, डा. मधुमति गोयल, डा. तीरथराज भोपाल के निदेशक डा. एके श्रीवास्तव ने सकेंगे। उन्होंने बताया कि वेस्ट मेटेरियल से

CSIR-AMPRI, Bhopal and Medical varsity ink MoU

विज्ञान मेले का समापन, मप्र पॉवर ट्रांसमिशन कंपनी लिमिटेड को प्रथम पुरस्कार

विज्ञान हमारी दिनचर्या का हिस्सा हम इससे अछूते नहीं रह सकते

भोपाल। नवदुनिया रिपोर्टर

मेले दशहरा मैदान में चल रहे चार दिवसीय विज्ञान मेले का सोमवार को समापन हुआ। समापन कार्यक्रम में बतौर मुख्य अतिथि हरियाणा के पूर्व राज्यपाल कप्तान सिंह सोलंकी ने कहा कि हमारा पेरा निरंतर विज्ञान के क्षेत्र में विश्वपटल पर अपनी छाप छोड़ रहा है। विज्ञान में प्रगति के लिए विश्वभर में भारत की सराहना हो रही है। ऐसे में इस तरह के आयोजन और भी सार्थक नजर आते हैं, क्योंकि यह आमजन में विज्ञान के प्रति रुचि जागृत करते हैं।

विज्ञान हमारी दिनचर्या का हिस्सा है और हम कहीं भी इससे अछूते नहीं हैं। यहां तक कि जल जो हमारा जीवन है जब हम उसे पीते हैं तो विज्ञान को ग्रहण करते हैं, लेकिन इसके बाद भी विज्ञान कुछ लोगों के लिए असहज करने वाला विषय है। मुझे उम्मीद है साल दर साल यह आयोजन भोपाल की जनता को विज्ञान के और भी करीब लाएगा। मेले का आयोजन भोपाल सीएसआईआर-एमपी, विज्ञान प्रसार, अखिल भारतीय

मेले दशहरा मैदान में विज्ञान मेले के समापन समारोह में प्रतिभागी उपक्रमों के विजेताओं को पुरस्कृत करते कप्तानसिंह सोलंकी। ● वि.

डीपी बडकुल, अधीक्षण अभियंतागण आरके मालवीय, एनपी गुप्ता, प्रशांत पनवलकर, आशीष जैन उपस्थित थे।

और इसके पीछे इस तरह के आयोजन महत्वपूर्ण भूमिका निभाते हैं। उन्होंने कहा कि खासकर ग्रामीण क्षेत्रों की प्रगति के

तरीका बताते हैं, उन्हें अपनाया जा सकता है और कार्बन माप में रेसीसिज को बचाया जा सकता है।