CSIR-AMPRI

ANNUAL REPORT
2013-14

CSIR-Advanced Materials and Processes Research Institute, Bhopal

Annual Report
2013 - 14

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CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal

Published by

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Acknowledgement

All Project Leaders, Teams and all Staff Members of CSIR-AMPRI, Bhopal

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From Acting Director's Desk

During the last few years, the world has witnessed startling technological advancements in the development of advanced materials. These advanced materials have redefined different sectors of industries all over the world. The latest notion in material/component manufacturing and design is lightweight, higher strength, cost effective and environment friendly materials. It advocates the need of protecting the nature along with sustainable development. However, development of such materials to meet the demand of user industries and strategic sectors puts a great challenge before the scientific community.

Newly developed lightweight alloys and composites, metal foams, shape memory materials, polymers and their composites, geo-polymer based green concrete (cement free), materials and products from industrial and other wastes, hybrid materials and bio-materials etc. are envisaged to go a long way towards substantially improving the quality of life by way of making available improved products. There is no doubt that new and innovative materials would shape our life in future.

It is a well accepted fact that new technologies are no longer driven only by the scientists. The society/industry has to participate in the projects right from inception for the development of technologies having strong societal/economic impact. This new way of carrying out research implies addressing different issues, not only from technological standpoint but also socio-economic and cultural public acceptance point of view.

In the area of new material development CSIR-AMPRI Bhopal has always been in the fore front. It becomes a matter of pride for all of us at CSIR-AMPRI that we transferred two technologies to the industries during 2013-14 and are focused to transfer some more in the years to come.

Furthermore, our research on MMC's, Metallic Foams, Polymeric Foams, Geopolymers, Radiation Shielding Materials and Nano-structured Materials etc. is poised to make an impact on industries as well as on the society at large in near future. Our ECF improved significantly in the last year and applications have been filed for grant of Intellectual Property Rights to some of our recently developed processes/materials.

This Annual Report places on record our efforts to excel in the areas of our R & D activities and results achieved.

I take this opportunity to gratefully acknowledge the guidance and support from The Director General, CSIR and Dr. G. Sundararajan, Chairman, Research Council, AMPRI and distinguished members of RC. I deeply appreciate the untiring efforts by all members of CSIR – AMPRI for taking the Institute to newer heights.

September 26, 2014

(DR. NAVIN CHAND)
Acting Director, CSIR-AMPRI
Bhopal

About CSIR-AMPRI, Bhopal

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 the then Bhopal (now Barkatullah) University campus. It subsequently found a place in the present premises in December 1983; the premise which was originally built to accommodate a Cooperative Training College. The laboratory initially had about 15 scientists, with 10 of them specializing in metallurgy/materials science. This was the core strength of the institute at that time.

The institute carried out projects on the synthesis and characterization of aluminum-graphite metal matrix composites and natural fibres. Gradually the scope of R&D broadened to include waste to wealth (building materials and wood substitute), mineral processing, environmental impact assessment, water resource modelling 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 agricultural soil reclamation etc., it became visible as a promising institute for rural technologies specific to problems related to the state 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 change from Regional Research Laboratory, Bhopal to Advanced Materials and Processes Research Institute (AMPRI) is 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; nano-materials; 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 and Future Perspectives

The present manpower includes 43 scientists (against the sanctioned strength of 56) that are well trained in different disciplines of materials science and other related areas along with 86 supporting staff. 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, pressure die casting machine, semisolid processing unit, rolling mill, Mg melting unit etc. FESEM, cryomilling unit and those related to nanoscale R&D are being established.

The current activities of AMPRI are broadly categorized under:

- Lightweight Materials

- Nanostructured Materials
- Smart and Functional materials
- Waste to Wealth
- CSIR-800

In the category of lightweight materials, important activities relate to Al metal matrix composites, polymer matrix composites, Al foam and Mg-based alloys. 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 in the offing.

In the area of Waste to Wealth, the institute largely worked on the utilization of flyash and Redmud. The institute has developed wood substitute technology using redmud, flyash and natural fibers and has potential applications for making doors, panels, partitions and furniture. AMPRI has developed Radiation Shielding Materials from Red Mud and holds a US Patent on the work. The potential applications of this technology will be for the shielding of gamma and neutron in nuclear power plants and for diagnostic X-ray shielding in X-ray and CT scan rooms.

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

The overall objective of AMPRI is to achieve a world-class status in the area of engineering materials, components and processes development. Accordingly, the HR Profile and S&T infrastructure would address to the needs of 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 of the future.

Vision

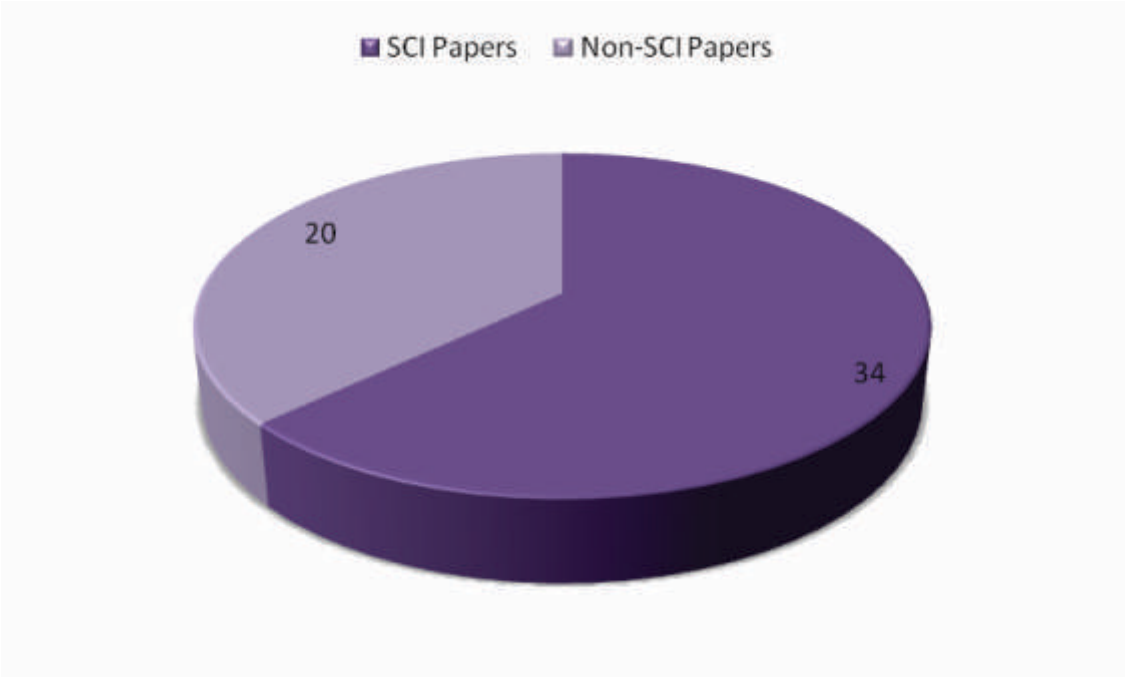
CSIR-AMPRI, Bhopal is committed to develop innovative, cutting edge, internationally competitive, energy efficient and environment friendly technologies / products in the area of advanced materials for societal benefits and to contribute to the Nation's Economy.

Mandate

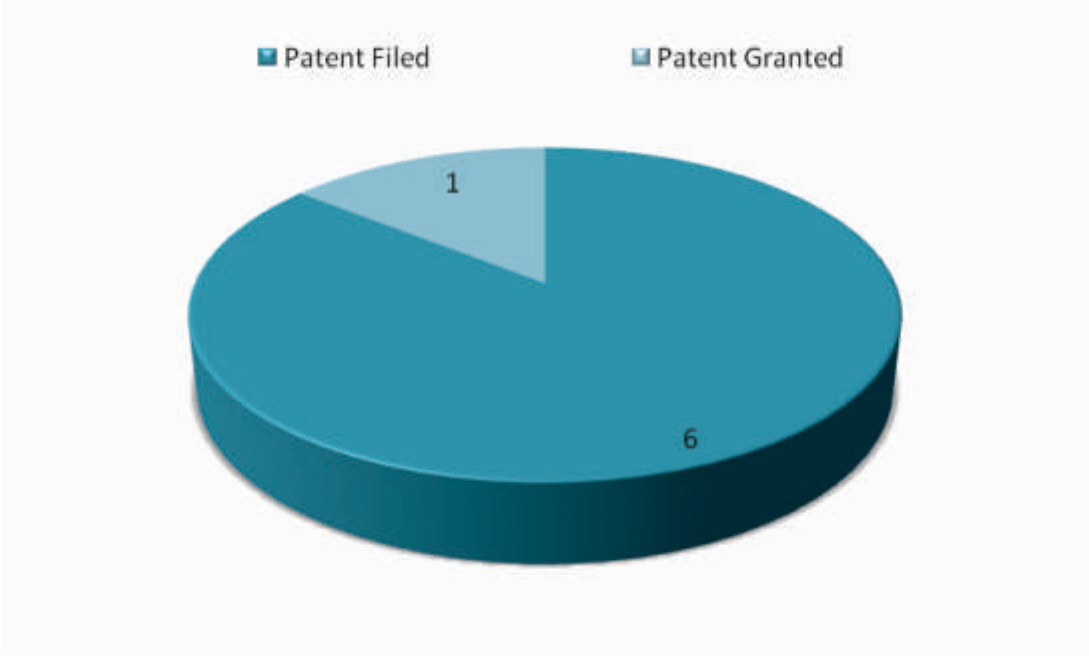
- Research & Development on Engineering Materials for Strategic High Performance and Societal Applications.
- Materials, Processes and Technology Development for Component / Products for a variety of engineering materials, including Metals & Alloys, Composites, Polymers, Building Materials and materials 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.

R & D Performance for Year 2013-14

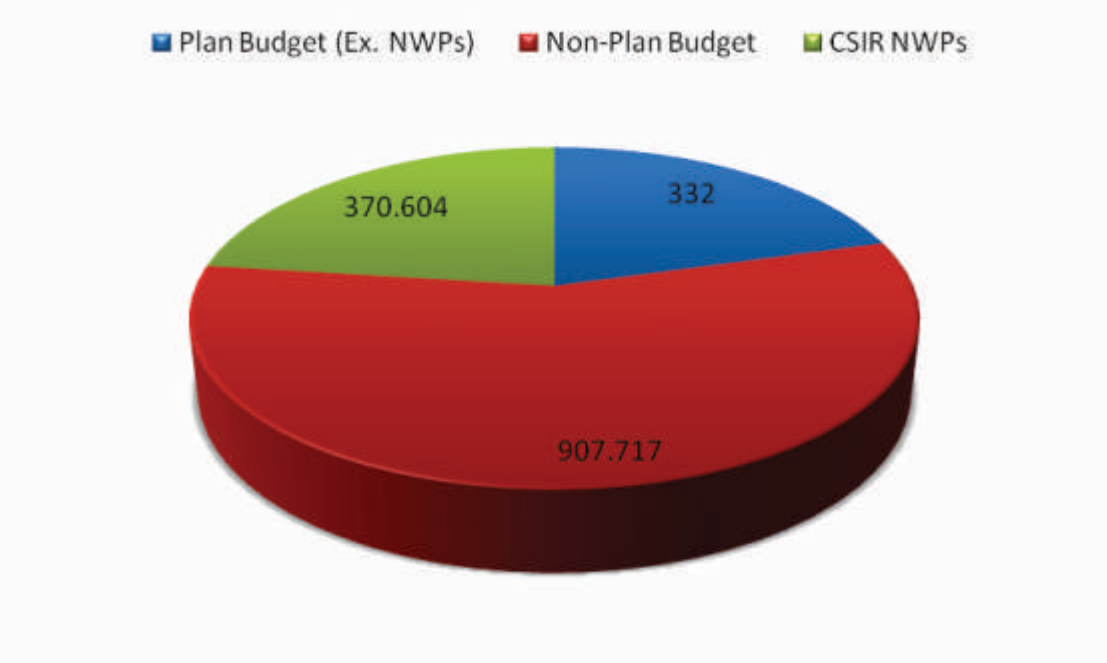
Research Publications



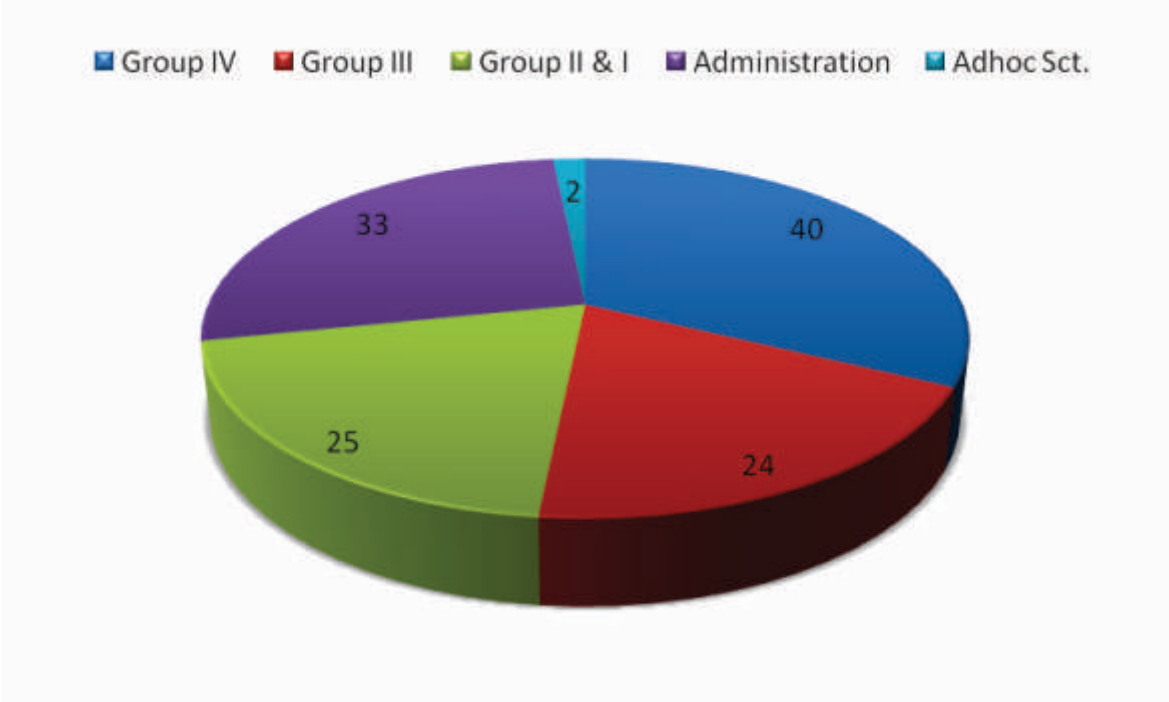
Patents



Budget (Rs. In Lakhs)



Human Resources



R&D Projects

CSIR XII Plan Projects

1. Novel energy effective metallic materials for engineering applications, Nodal Lab: AMPRI, ESC 0101
2. Design and development of thermo responsive & magnetic shape memory materials and devices for engineering applications, Nodal Lab: AMPRI, ESC 0201
3. Development of Ti foams for bone-scaffold applications (ESC 0103) (Under CSIR-network project "Development of novel CSIR technologies for manufacturing tailored and patient specific bio-ceramic implants and biomedical devices at affordable cost (BIOCERAM)", Nodal Lab: CGCRI, ESC 0103
4. Advanced ceramic materials and components for energy and structural application (CERMESA) Nodal Lab. CCSIR-CGCRI , ESC 0104
5. Development of spatial decision support systems (SDSS) and hydrological modeling for assessment and management of nutrient and pesticide pollution load as nps pollution in agricultural watersheds , Nodal Lab: NEERI, ESC 0306
6. Molecules to materials to devices (M2D) nodal laboratory:CSIR-NIIST, CSC 0134
7. CSIR Knowledge gateway and open source private cloud infrastructure (KNOWGATE), Nodal Lab. :CSIR-NISCAIR, ISC 0102
8. K values recovery from land based secondary mineralogical resources and development of SRBN/SRMN product(s): Part of KTEN, a CSIR -SFC project , Nodal Lab CSMCRI

Grant-in-Aid (GAP) Projects

1. Development of porous bioactive Ti-based composite for bio-implant application, DBT, New Delhi
2. Demonstration of the competence to develop automobile components using electro magnetic forming (EMF) process, TIFAC, DST
3. Utilization of low cost minerals of Madhya Pradesh for the development of hyperbranched aluminosilica (HAS) and mesoporus to silica to sequester the effects of green house gases, MPCST, Bhopal
4. Synthesis and characterization of nanomaterials for engineering applications, MPCST, Bhopal
5. Development and optimization of processes for permanent hydrophilic and hydrophobic surface coatings with nano particles for multifunctional finishing of textiles, DST. New Delhi.
6. Development of cast in-situ Cu based composite for naval applications, NRB
7. Development of design mix of irradiation shielding concrete, using advanced shielding materials, BRNS, Mumbai

8. Characterizing numerical SZW evaluation for determining ductile material's fracture toughness (JSZW), BRNS, Mumbai

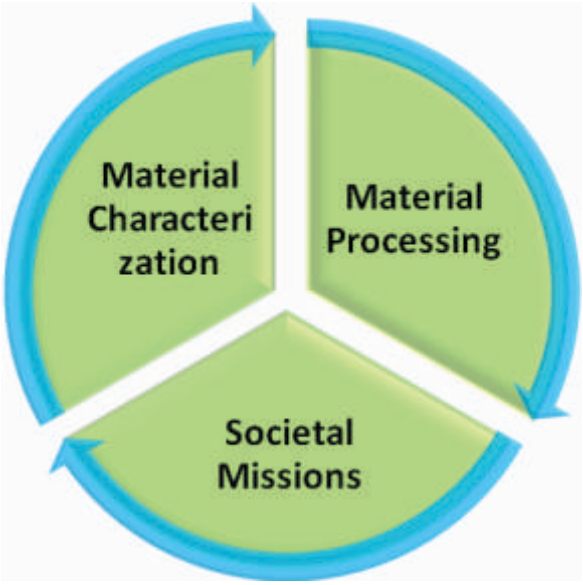
Sponsored Projects

1. Utilisation of variety of fly ashes available at M/s JSPL, Raigarh, for developing cementatious LSA (Ligno-Silico-Aluminoius) materials for non- structural applications, JSPL, Raigarh
2. Development of aluminium alloy silicon carbide metal matrix composites & analysis as per specs, NSTL, Vishakhapattanam
3. Feasibility studies on variety of fly ashes available at M/s Sesa Sterlite Ltd. (Vedanta group Co) Lanjigarh, Dist. Kalahandi , Odisha for development of cement free concrete of varying grades depending upon characteristics of fly ashes and aggregates for non structural applications, SSL Odisha

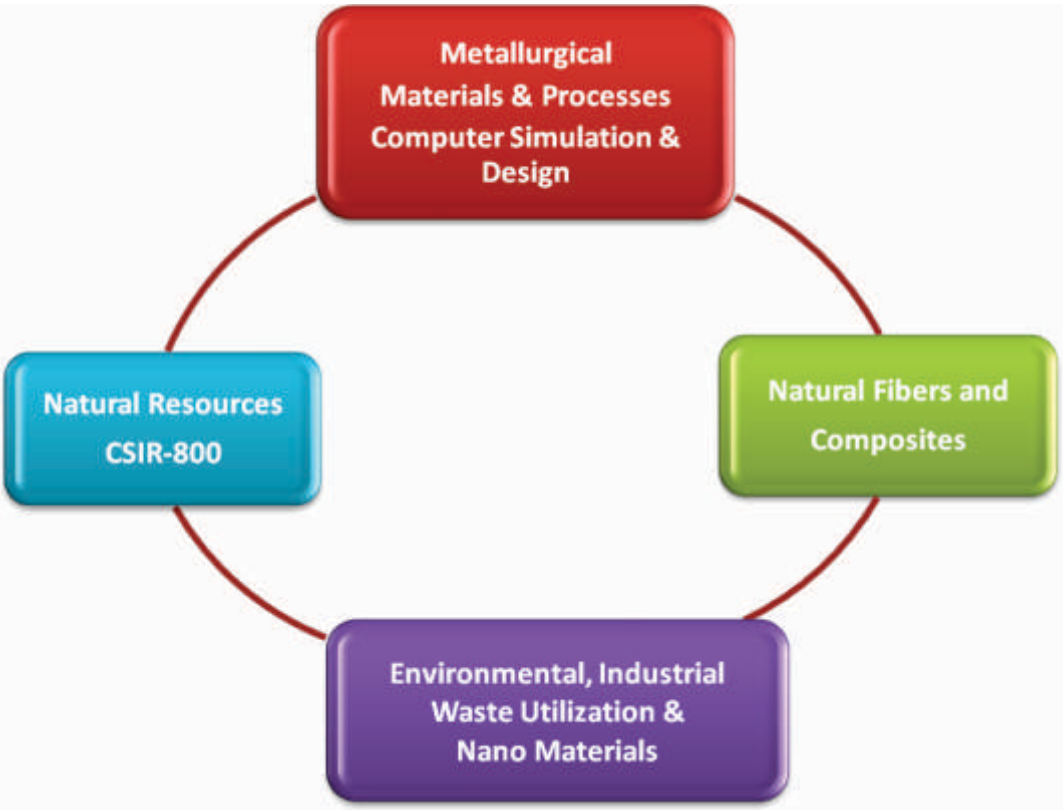
Consultancy Projects

1. Turbine blade failure analysis, STPS, Sarni
2. Impact of PoP made idol structures on immersion in water bodies, MPPCB, Bhopal.

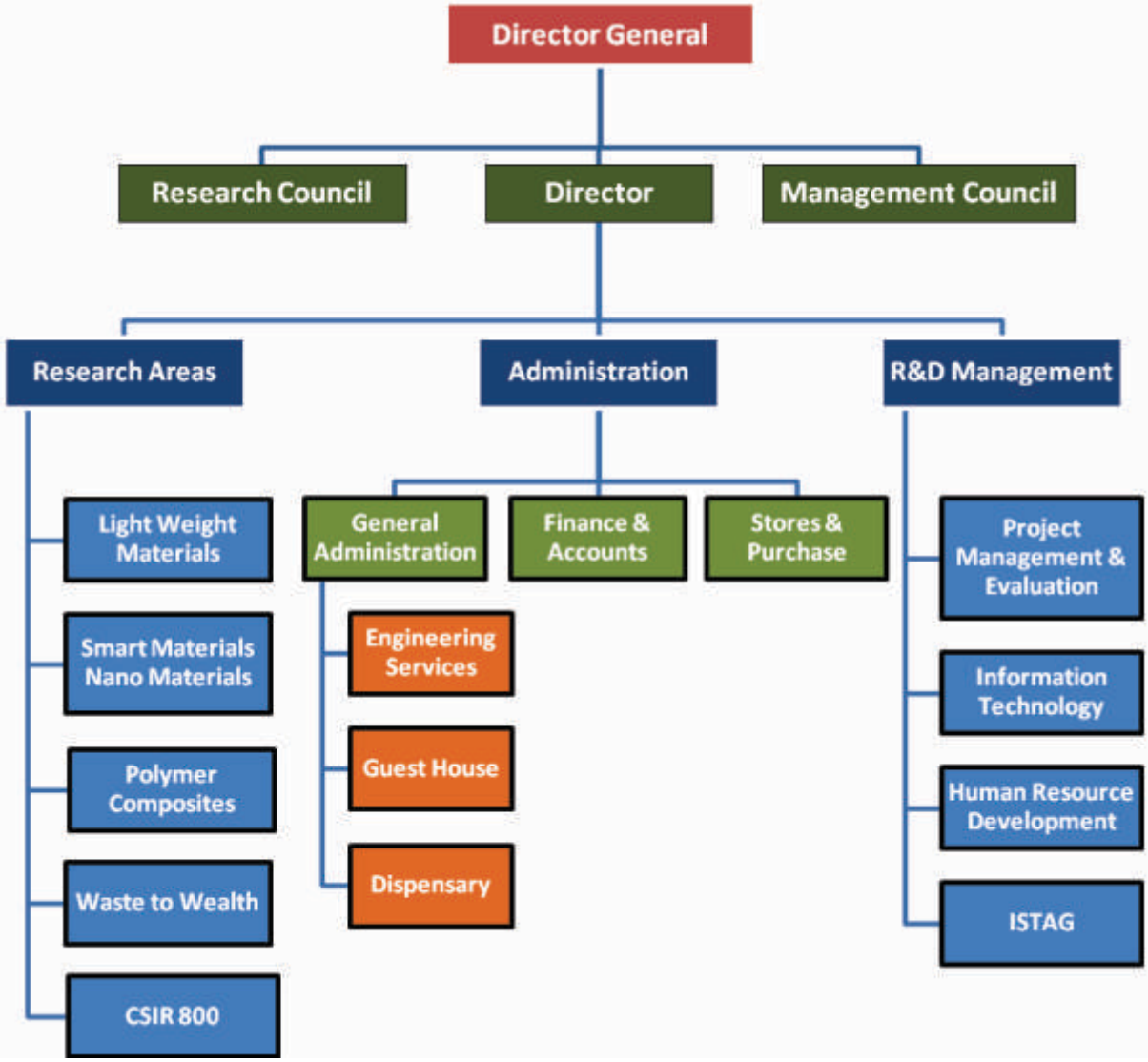
Core Expertise



R & D Activities

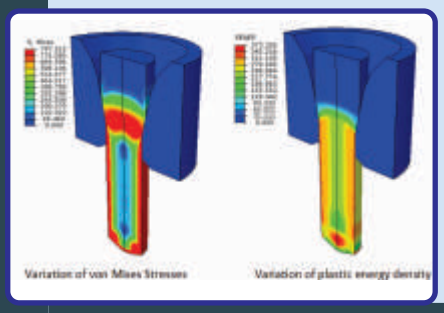


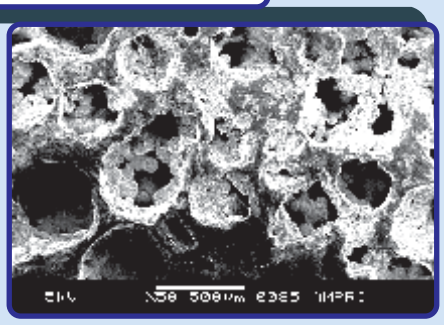
Organization Chart



R & D Activities

Ongoing CSIR XII Plan Projects





Novel Energy Effective Metallic Materials for Engineering Applications

Objectives:

This project essentially deals with the development of lightweight energy efficient materials with improved characteristics. Important activities under the project include material development followed by fabrication of components for different engineering applications and their performance evaluation. Typical materials types to be studied include high strength Al and Mg alloys, and their MMCs and Al/Steel/Ti foam. Efforts would be directed towards the development of materials and optimization of processing parameters / steps and making of application oriented engineering components in consultation with manufacturing / user agencies. Computer simulation and modeling is proposed to be one of the important activities for more effectively optimized different material and experimental variables. It is also planned to involve various educational as well as research institutions in order to effectively implement various activities. Further, this will be a CSIR network project partnered by CSIR-IMMT, CSIR-CMERI, CSIR-NIIST, CSIR-NAL.

Salient Features:

Internationally high strength aluminium alloys are well accepted. Attempts have been made to design and develop above alloys following processes like mechanical alloying through high energy ball milling, cryo-milling, cryo-rolling, melt atomization under controlled gas flow rate to form atomized amorphous and nanocrystalline aluminium alloys, amorphous aluminium alloys through melt spinning route, severe plastic deformation etc. For some strategic applications, these alloys are being produced. However, the cost of production is significantly high and the process / material is yet to be commercialized for general applications. Till now, amorphous aluminium alloys so produced exhibit yield strength up to 700 MPa (Al-Y-Ni) and ductility ~20%. Recently, nanostructured Al-7075 alloy has been produced by high pressure torsion (HPT) process with UTS ~1000 MPa and ductility ~5%. However, these developments are limited to a laboratory scale only in general.

In India, aluminium alloys are being commercially produced and used in several sectors. But limited attempts have been made for producing high strength and ultra high strength aluminium alloys suitable for room temperature as well as elevated temperature applications. The activities in this direction need to be sharpened and investigation to be carried out in a systematic manner to take advantage of the past experiences on the subject.

Since the last decade, considerable attention has been paid to the development of porous and/or cellular metallic materials for a wide range of applications. These metal foams have been found to contain porosity ranging from 50% to 95%. Out of different metallic systems, majority of the work has been carried out on aluminium and its alloys. The density of aluminium foam so far achieved is around 0.15 gm/cc. Depending on the pore morphology, metal foams could be classified into two groups: namely the nature open cell and closed cell foams. One has to select appropriate foams depending on the nature of applications. For example, open cell foams could be used as heat exchanger, CO_2/SO_2 scrubber, catalyst, batteries etc. because of their significantly large exposed surface area. On the other hand, closed cell foams could be used as insulator, energy absorption, shock and blast resistance, vibration control etc. Worldwide considerable efforts also have been made towards the development of processes for making metal

foams based on aluminium, Ti, Ni, Steel, copper with an objective to have uniform distribution of pores with controlled size range and porosity (density) level. However, very limited work has been carried out in the country. Some work also has been carried out at AMPRI Bhopal which needs to be propagated further to arrive at a meaningful conclusion.

Mg-alloys are being well accepted worldwide because of ultra lightness and abundant availability of Mg. The main drawback of these alloys are (i) higher reactivity, (ii) low ductility, (iii) lower strength especially at higher temperatures, (iv) high corrosivity, (v) poor Weldability etc. Because of these limitations, mg alloys could not be used on a large scale in automobile, aerospace, naval and other engineering sectors. However, Mg-alloys have found application to some extent in electronic and IT industries especially in mobiles, laptops, computers etc. Attempts have also been made to design and develop rare earth aided magnesium alloys for higher strength, fatigue and creep resistance. Severe plastic deformation of magnesium alloys has been performed to produce ultrafine grained magnesium alloys with superior strength and ductility. Most of the Mg alloys casings or thin walled castings are produced through high pressure / low pressure die casting route. Magnesium alloys need to be processed under a controlled atmosphere. These alloys are being commercially produced in USA, Germany, China and Japan. The countries are also paying considerable attention to solve the shortcomings of these alloys through design and development of new alloys / processes. In order to improve strength, corrosion and deformability of Mg alloys, several methods have been proposed namely i) addition of Ca, Ce, Y, Si, N, Zr etc. (ii) Mg-alloy based nano-particle reinforced composites by friction stir processing, (iii) mechanical alloying, (iv) severe plastic deformation etc. Some work has been done at NPL and AMPRI pertaining to study the deformability characteristics of Mg alloys.

Internationally near about 74 companies are producing Al-matrix composites with a production of 0.5 million tonne per annum. Most of the components made out of composites have potential for application in the automobile sector namely piston ring, piston groove (Toyota); Piston crown, Piston, cylinder liner (Ford), cylinder liner, piston (Honda), Drive shafts, connecting rods (GM, Honda, DWA Technologies), Hybrid brake drum (US army's Tank Automotive Research & Development), Plymouth prowler brake rotors and EV1 brake drums (GM). Some of the MMC components finding applications in aerospace sectors include F16 fighter aircraft ventral fins and fuel access covers, electronic packaging etc. (GM EV-1). Reinforcements used in these composites are mostly discontinuous fibres (Saffil: Al_2O_3 and aluminium silicate), Whiskers (SiC, B4C), particulates (SiC, Al_2O_3, Fly ash, graphite, SiO_2, Zircon, natural minerals) and Carbon nano-tubes (up to 5 vol %). The commercial processes used are mostly stir-casting (mechanical stirring: >10 micron particle size, up to 30vol %), Squeeze casting; melt infiltration (fibre and whisker, particles more than 50 vol %) etc. It is envisaged that recent casting processes should be supported by the computer simulation to optimize the parameters for mould filling and also understand the last freezing zone. One of the critical areas of modernization is the use of computer simulation for casting process design and optimization. Computer simulation creates a virtual environment to iteratively test new tooling layouts and process parameters before actually implementing them on the shop floor. This avoids/minimizes costly trials and saves time, energy and materials. Such virtual test environments have become an integral part of most foundries in the Western countries. The technology penetration is however, negligible in India owing to high cost of imported software, difficulty of use, and lack of local technical support. Substantial work has been carried out at AMPRI towards the development of MMCs and components thereof in association with various manufacturing / user agencies. However, the activities need to be carried out more systematically to analyze limitation of the material system and come out with appropriate solutions.

Aerospace/engineering components undergo a lot of wear and abrasion in harsh service environments. Hard chrome coatings are used to meet the required tribological resistance. However, due to environmental issues connected with use of the coatings have led to the development of alternate coatings. High velocity oxy-fuel (HVOF) method is reported to produce dense, coatings with limited impurities and finds better suitability for tribological applications. Replacement of hard chrome coating by HVOF deposited WC-Co is being adopted at present. However, limited research has been focused on oxide and carbide-oxide based coatings as replacements. The present study will focus on developing cost effective carbide and oxide based coatings with hardness equivalent to that of hard chrome. Carbon based hard coatings mainly diamond like coatings (DLC) have been applied to reduce the coefficient of friction and thereby improving the service life of some of the engineering components. However, the formed DLC coatings on large/ complex shaped components do not have uniformity. It is proposed to develop diamond like nanocomposite (DLN) based hard and low friction coatings by PECVD and plasma immersion ion implantation (PIII) techniques. The novelty of the proposal is elimination of cumbersome substrate rotation for complex objects and independent control of growth process.

It is also proposed to develop nanostructured tribological coatings (such as TiAlSiN nanocomposites, carbides, oxides, composite of carbides and oxides, and carbon based hard coatings) using reactive sputtering, high velocity oxy-fuel (HVOF) and plasma enhanced chemical vapor deposition (PECVD) methods. The transition metal nitride based nanostructured coatings exhibit very high hardness, toughness and very high thermal stability. Because of these reasons the nanostructured coatings have great potential for dry machining of difficult to machine engineering materials (e.g., stainless steel, hardened die steel, tough sintered Co-alloys, Ni-based steels, Al alloys, Inconel superalloys, titanium-based alloys, carbon composites, etc.). These coatings can also be used for stamping, dry tapping, hobbing and other applications. In addition, these coatings have a great potential in other manufacturing/processing applications.

CSIR-Advanced Materials and Processes Research Institute, Bhopal has been pursuing R&D activities in the area of developing lightweight energy efficient materials and components thereof for various engineering applications. Since its inception as the then Regional Research Laboratory in 1981, AMPRI has worked towards the development of a variety of polymeric and metallic lightweight material systems. The Institute has been active as a nodal agency in implementing a CSIR network project (NWP 0028) dealing with the Development of Lightweight Materials for Engineering Applications under the current five year plan. This has led to the development of Al MMC brakedrum and Al foam filled members for automobile applications in association with private industries like Mahindra & Mahindra, while interaction with other industries like Ashok Leyland, Tata Motors, Eaton Corporation and General Motors is in the offing.

An appraisal of the above suggests that AMPRI has generated considerable expertise in the area of lightweight material component development of direct relevance to various user and manufacturing agencies. However, the activities need to be paid more focused attention at different levels. This could be realized more effectively by pursuing the matter further in the form of a Supra Institutional Network Project (SINP) during the 12th five year plan. Accordingly, AMPRI desires to undertake an SINP on Novel Energy Effective Materials for automobile and general engineering applications in association with other Institutes.

Design and Development of Thermo Responsive & Magnetic Shape Memory Materials and Devices for Engineering Applications

Objectives:

- *Closed and Open cell SMA Foams*: The focus would be on synthesis and processing of closed cell and open cell SMA foam for impact and energy absorbers and insert for control fluid (liquid/gas) flow using liquid and powder metallurgy route. The set goals include arriving at optimised process for developing closed and open cell foams from both Cu-Al and Ni-Ti based alloy compositions with reproducible physical characteristics like uniform cell size [in the range of 0.05 to 1 mm], porosity [upto 70%] and shape memory properties with pseudo-elastic strain 3% and thermal stability.
- *Cu-Al based Shape Memory Alloys with High Temperature Stability and High Mechanical Properties including High Ductility*: The focus would be to develop low cost/better performing metallic Shape memory Alloys components for general engineering sectors from Cu-Al based SMAs through alloying alterations and heat treatment adopting both liquid and powder metallurgy routes. The set goals are attaining optimized alloys composition and heat treatment cycles to maximize the Shape Memory Effect [SME] and thermal stability in the wire and strip form. The systems to be undertaken for the studies can be broadly classified as (i) compositions for improved mechanical properties– Cu-Al-Ni system (ii) Good or high transformation temperatures (370 to 470 K) - Cu-Zn-Al and (iii) compositions for high ductility – Cu-Al-Mn series.
- *Nano-structure Ni-Ti SMA alloy*: Develop a novel, cost-effective process for the synthesis and subsequent processing of shape memory NiTi alloy and their composites containing TiC/TiB_2 particles.
- *Carbon Nano Tube (CNT)/nano particles dispersed Shape Memory Polymers*: Improve recovery stress, higher conductivity and switching efficiency of Shape Memory Polymers by reinforcing them uniformly with Carbon Nano Tube (CNT)/nano particles.
- *Magnetostrictive (Magnetic shape memory) alloys*: Develop high efficiency Magnetic Shape Memory (MSM) and Ferro-magnetic Shape Memory (FSM) Material [Magnetostrictive material] suitable for automotive and aerodynamic applications from (i) Cu-Mn-Al system (ii) Ni-Mn-Al/Ni-Mn-Ga system (iii) Fe-V-Al system (iv) Fe–30Pd–2Rh and (v) Ni–Fe–Ga alloys with different additives [such as Tb, Ga, Rh, etc.]. The processing parameters and the synthesis route shall be optimised to develop high value magnetostriction.

The outcome is expected to be the following:

- Optimized alloys composition and heat treatment cycles to maximize the Shape Memory Effect and thermal stability of SMAs
- Data bank on information pertaining to newer versions of shape memory materials
- Demonstrative SMAs in the form of wires and coils
- Demonstrative foams with shape memory effect in the form of plates and slabs

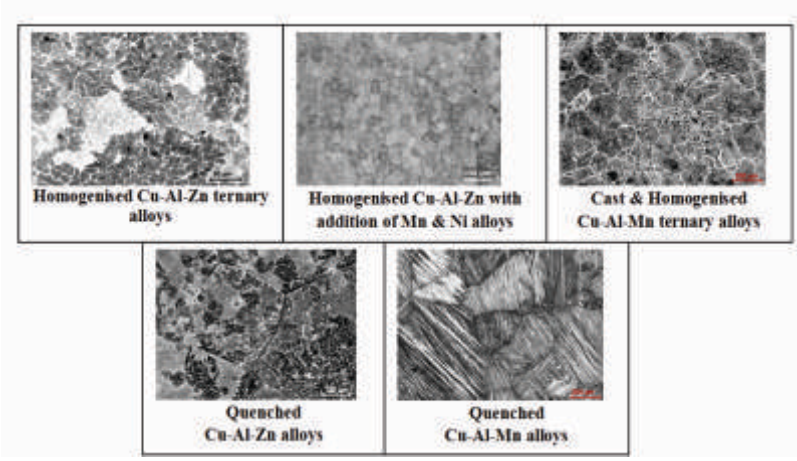
- Flexible electronic devices such as tape, rod, and wire
- Demonstrative prototype components from the above

Salient Features:

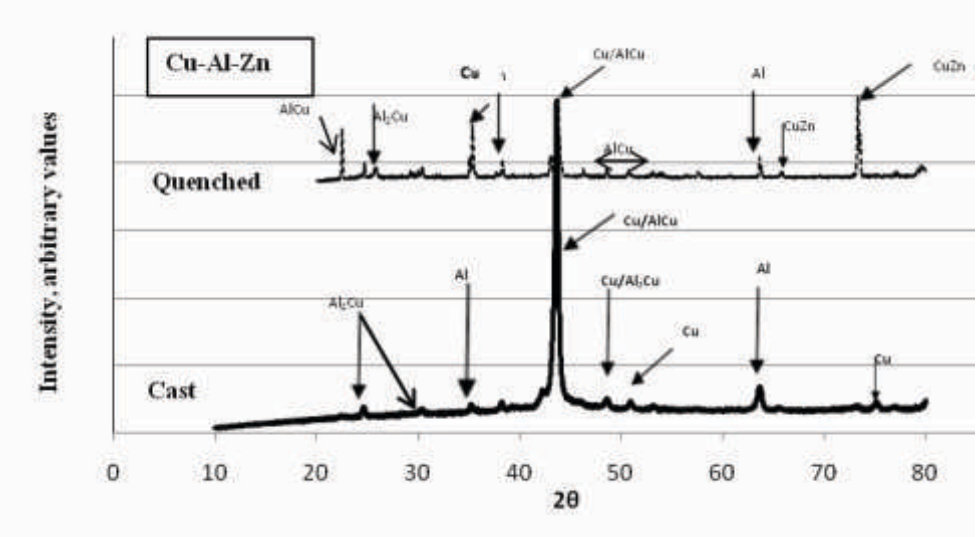
In an attempt to make shape memory materials under the ongoing CSIR project, attention is being given on synthesis and development of (i) newer class of shape memory polymers through reinforcement (ii) cost effective and more sensitive SMAs by improving the transition temperature and performance of already existing SMMs through proper composition, heat treatment etc. (iv) fabrication of new SMAs including porous and amorphous/nano crystalline types.

Cu-based shape memory alloys [SMAs] are being seen as prospective alternatives to the more commonly used Ni-Ti ones in applications that do not require biocompatibility due to its low cost. However, inspite of its being in the forefront of R&D since long, Cu-based SMAs are still in its developmental stage and seldom commercially available due to defects like low transition temperatures, poor mechanical properties, low ductility and stabilisation of martensite phase or fatigue. In this direction, at CSIR-AMPRI, Bhopal attempts are being made to improve the transition temperatures and amount of martensite formation in Cu-Al alloys with ternary additions of Mn, Ni and Zn in varying proportions to study the effect of each addition either alone or as combination with the other elements. The effect of these ternary and/or quaternary additions has been studied on the phases precipitated through micro-structural analysis and X-ray diffraction studies in the cast, homogenised and quenched conditions. The alloys have been subjected to heat treatment cycles to improve upon the microstructure and precipitate the required martensite phase.

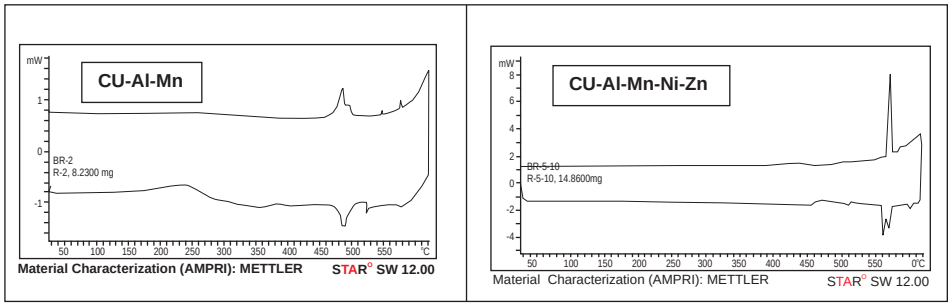
The grain structure with α+β phases is visible in the cast and homogenised condition of the alloys; which is a pre requisite for martensite formation on quenching. grain size is significantly less (in most cases uniform) in the homogenised samples. Quenching from high temperatures result in the desired martensite formation; in Cu-Al-Zn alloys, the precipitated martensite phase is flower shaped typical of γ-phase is observed whereas plate- or spear-like martensite [the zig-zag ' phase, most commonly observed in Cu-based SMAs] has been observed in quenched Cu-Al-Mn alloy. X-ray diffraction pattern of the quenched samples confirm formation of martensitic phases; corroborating the potential of these alloys as shape memory materials. The DSC studies indicate clear transformation peaks in all the samples; significantly high transformation temperatures have been recorded in Cu-Al-Mn alloys than conventionally reported. Studies indicate that whereas the alloys without quaternary additions would be better suited for its shape memory properties, ternary alloys would be better suited for higher transition temperatures.



Microstructure of SMA alloys in homogenised and quenched conditions



X-ray Diffraction peaks of an alloy



DSC peaks showing transformation temperatures

Shape Memory Polymers have numerous advantages like high recoverable strain, low cost, easy formability and response to a wide range of stimuli, including heat, moisture, solvent or change in pH value, light, stress etc. SMPs possess exceptional shape memory strain but their low mechanical strength, particularly low recovery-stress often results in limited applications. To overcome these difficulties various functional fillers have been added to SMP matrix and are being investigated. Among these fillers Carbon-Nano-Tubes (CNTs) have been extensively studied due to their superior thermal, mechanical and electrical properties.

The Multi Walled CNT (MWCNT) reinforced shape memory polyurethane (SMTPU) films were casted with different loading of MWCNT. Figure 1 shows stretching stresses as well as recovery stresses for 0, 1, 2, 3 and 5phr MWCNT reinforced SMTPU. Stretching curves show the stresses developed during stretching of samples in hot water bath at 75 °C, nearly 20 °C above the glass transition temperature, Tg. The samples were brought to room temperature at 25 °C under same clamped conditions and thereafter were relaxed to attain a temporary shape/ deformed length that was slightly less than that of the stretched length. The samples were re-clamped without stress and the temperature of bath was brought to 70 °C. Under this condition recovery stresses developed in the test specimen as shown in Fig 1. and were determined using test setup developed for the purpose in CSIR-AMPRI, Bhopal.

The slope of the curves increased with the increase in MWCNT content indicating an increased modulus of MWCNT reinforced SMTPU with increased reinforcement. Recovery-stresses also showed a rising trend with reinforcement. The increase in stress can be attributed to the effective transfer of stress to the

MWCNTs through the interfacial shear stress between MWCNTs and the polymer. Recovery-stress of specimen shows two segments; highly sensitive to strain at higher strain and less sensitive to strain at lower strain values.

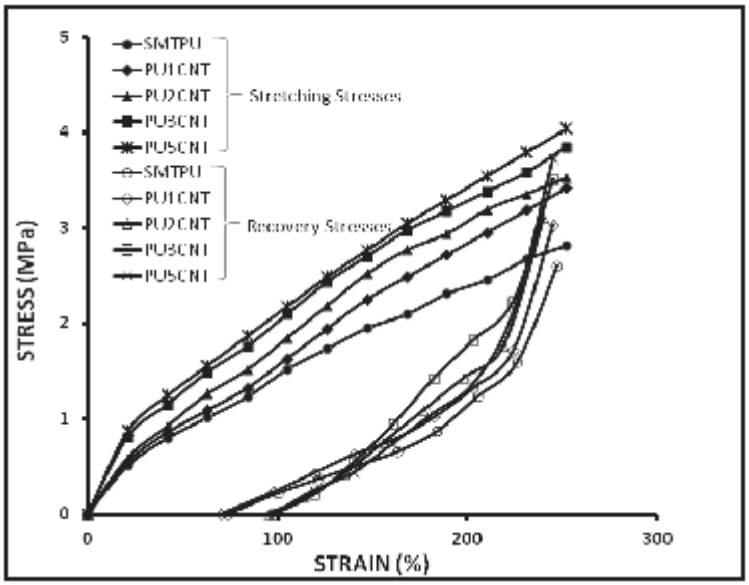


Fig 1 : Stretching stresses as well as Recovery stresses for 0, 1, 2, 3 and 5phr MWCNT reinforced SMTPU

FESEM was used to observe the microstructure of MWCNT reinforced SMPU as shown in Fig 2 wherein MWCNT was observed distributed in SMPU.

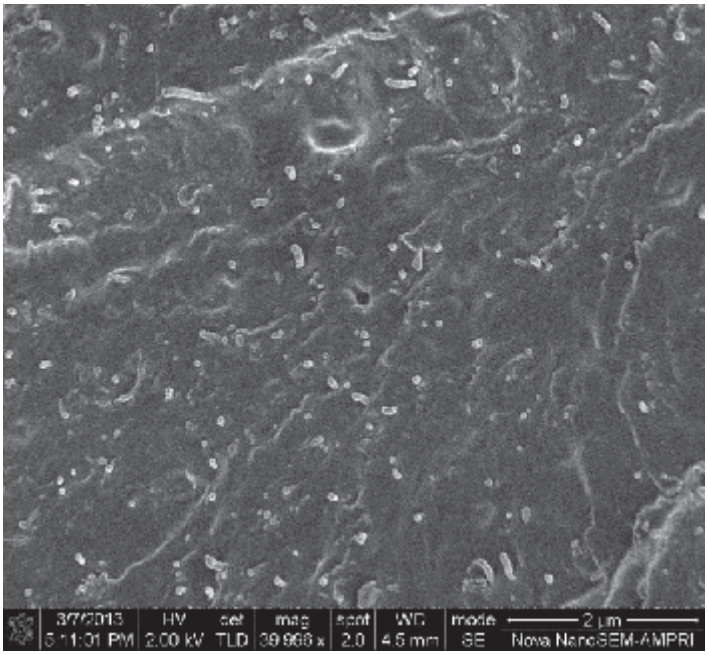
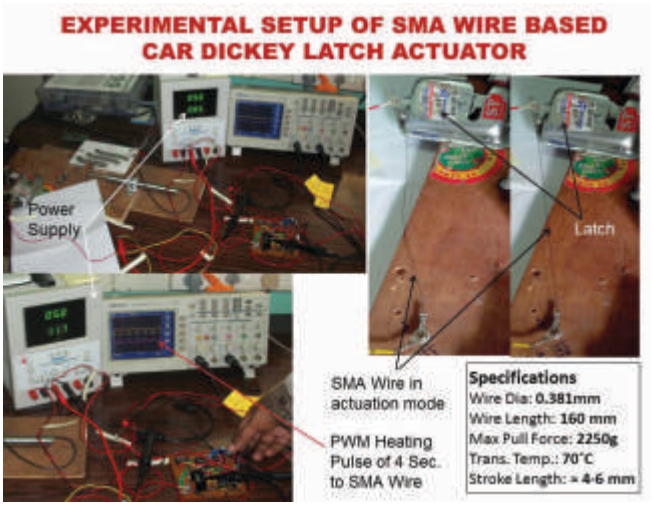
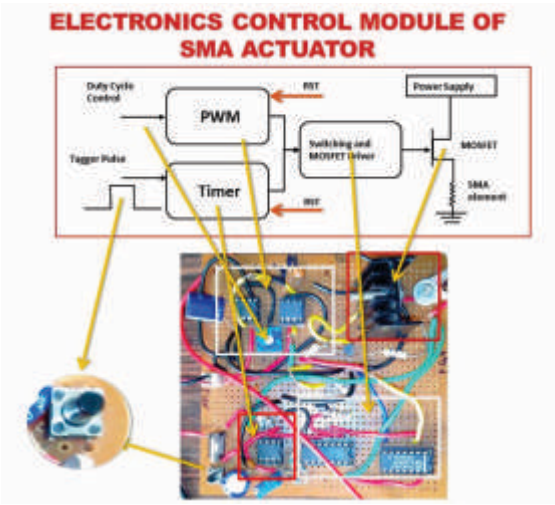


Fig 2 : Microstructure of MWCNT reinforced SMPU

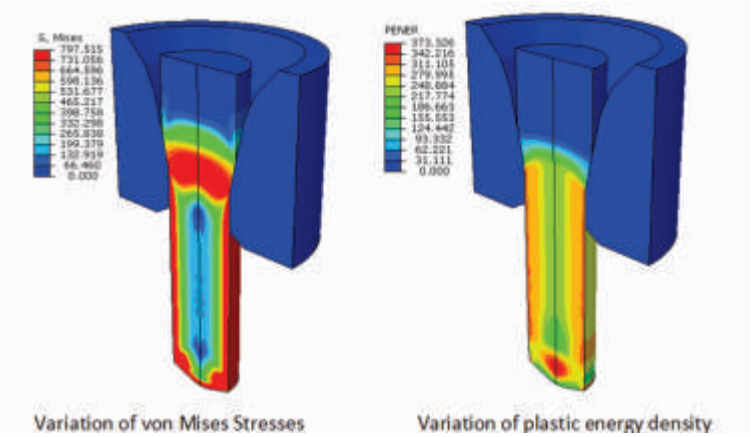




SMA Actuators :

Keeping in mind the need for fabricating SMA actuators from the material to be developed at the Institute, an attempt is being made to fabricate the same using commercially available Ni-Ti SMA wire. The following actuators have actually been developed and tested.

Simulation of Wire Drawing Process of SMA material: Computer based analysis of metal forming process has become popular in recent years. The difficulty of understanding the mechanics of wiredrawing process can be overcome with the help of FEM based software. With the help of these numerical tools the variation of stress, strain and energy, onset of defects and different process parameters can be evaluated. In the present study the deformation behaviour of NiTi alloy during wire drawing process has been studied. The wire drawing of the NiTi alloy with Ni 50.5 % and Ti as 49.5 % composition has been used in the present study. The geometry of wire drawing die has been taken from ASM handbook. Various percentage reductions (20% to 40%) in diameter in every pass are considered in the present study. The variation of maximum energy dissipation, drawing force, reaction force on the die due to the variation of friction coefficient (0.1 to 0.5) is also studied for the material. Room temperature material stress strain curve has been used in the FEM analyses. In the model the drawing force is applied at the lower end of the wire and the die is taken as fixed and very rigid. The present non-linear FEM analyses are carried out using commercially available ABAQUS software. Figure showed the variation of vonMises stress and plastic energy density in the drawn wire of NiTi alloy.



Variation of von Mises Stresses

Variation of plastic energy density

Development of Ti foams for Bone-scaffold Applications

Objectives:

- To develop open cell Ti and Ni-Ti foam with Porosity: up to 80 %, cell size 0.5 to 2 mm, strength: 30 to 80 MPa, Modulus: 10 to 30 GPa, through powder metallurgy route.
- To design and development of Ti and Ni-Ti foam Products: (i) Cylinder and blocks: 40 mm x 20 mm, (ii) discs of 40 mm x 10 mm for bone scaffolds.
- Invitro analysis of the developed foams and to explore its use as bone scaffolds.

Salient Features:

Ti and its alloys are biocompatible to human bodies. Therefore these materials have huge scopes for joint replacements. However, even though these materials are bio-compatible, its mechanical properties as well as microarchitechtural structure should also be compatible with bones for much faster recovery and effective performances. Otherwise, there may be possibility of stress concentration at the interface which will lead to infection and loosening of the joint. In this direction it is aimed to make bioactive Ti-foams from pure Ti and/or its alloys. The cellular structure of these foams materials can be tailor made by varying the cell size and cell volume fraction with the variation of size of space holders and their volume fraction. In addition the foam structure can be made to functionally graded structure according to the bone structure with the variation of size and concentration of space holder from surface to the centre while making these foam using space holders. CSIR-AMPRI has initiated work on Bio-compatible materials like bio-active Ti-foams of varying cell sizes and porosities for bone-implants and bone regeneration as a part of 12th Five year plan project (BIOCERAM) under the nodal laboratory of CSIR-CGCRI, Kolkata.

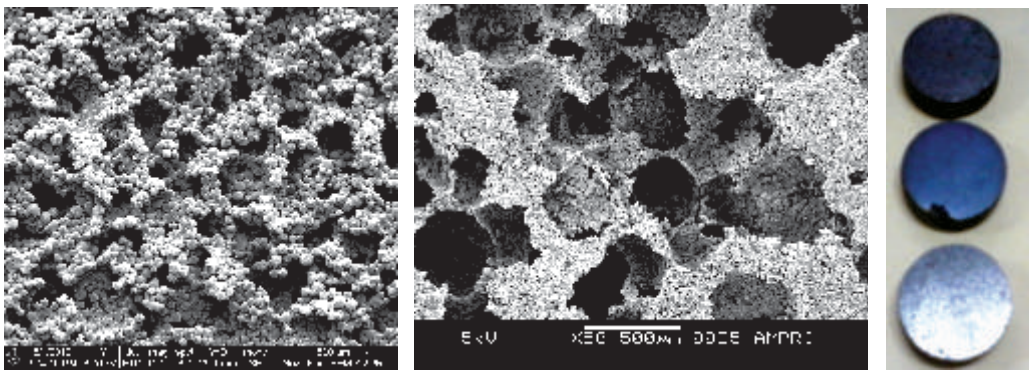
Contribution/achievement

- ✓ Laboratory scale process developed for making open and closed cell Ti foams using powder metallurgy routes with the use of different kinds low cost space holders like NaCl, ammonium bi carbonate, acrowax and cenosphere.
- ✓ Open Cell Ti foams with porosity up to 85%, strength upto 86 MPa and modulus up to 15 MPa have been made. Foams having these characteristics are comparable to those of human bones. Thus these foams may be used for bone scaffolds or bone regeneration
- ✓ Ti-foams with hybrid porosity (coarse cells and very fine cells preferably in the cell walls/edges. (So far no such foams are reported in the literature. It is expected that this type of foams will help in easy fluid flow and tissue growth as well as good strength and ductility.
- ✓ HAP coated Ti-foams have been prepared. These foams exhibit better strength and modulus than

the uncoated ones. It is expected that these foams would be more bio-mimetic than the uncoated foams.

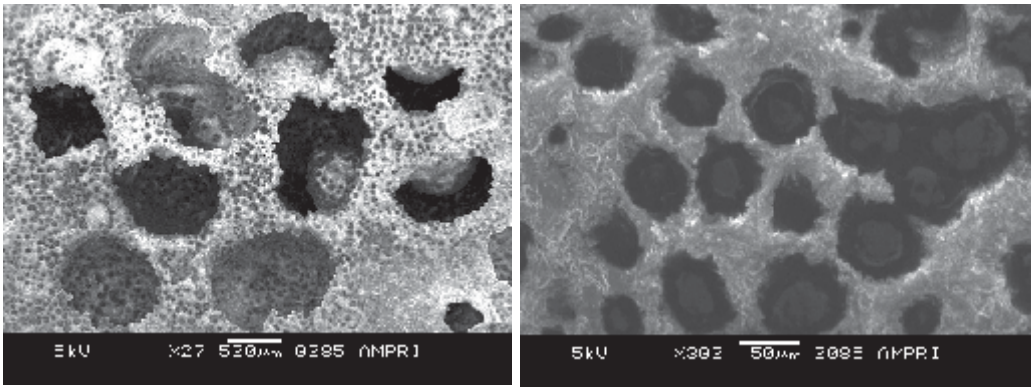
- ✓ HAP foams with porosity up to 85% were also made. These foams have relatively less strength. However, this foam can be infiltrated or coated with gelatin or any bioactive protein for using as bone grafts and or drag delivery.

Invitro and invivo studies to be carried out for detailed understanding about the suitability of these materials for bio-implants applications. However, the knowhow is available for synthesis of above mentioned porous materials with varying porosities, pore sizes and engineered mechanical properties at affordable costs.



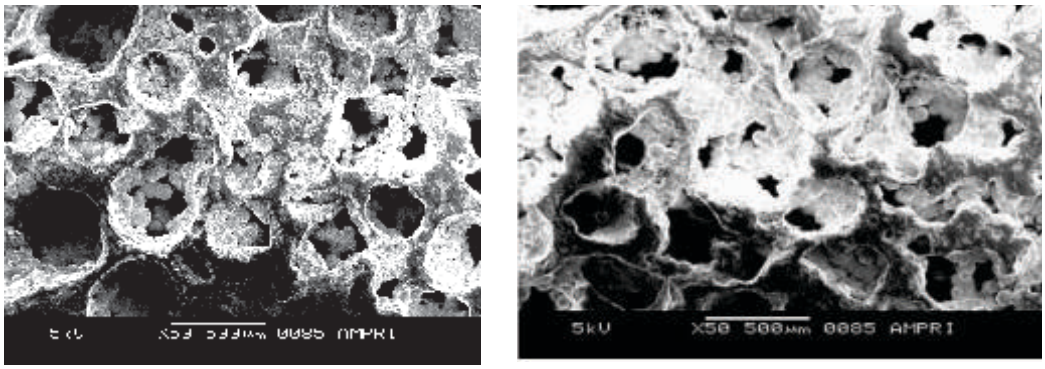
(a) (b) (c)

Open Cell Ti-foams made with (a) NaCl as space Holder and (b) ammonium bi-carbonate as space holder and (c) Ti-foam pallets



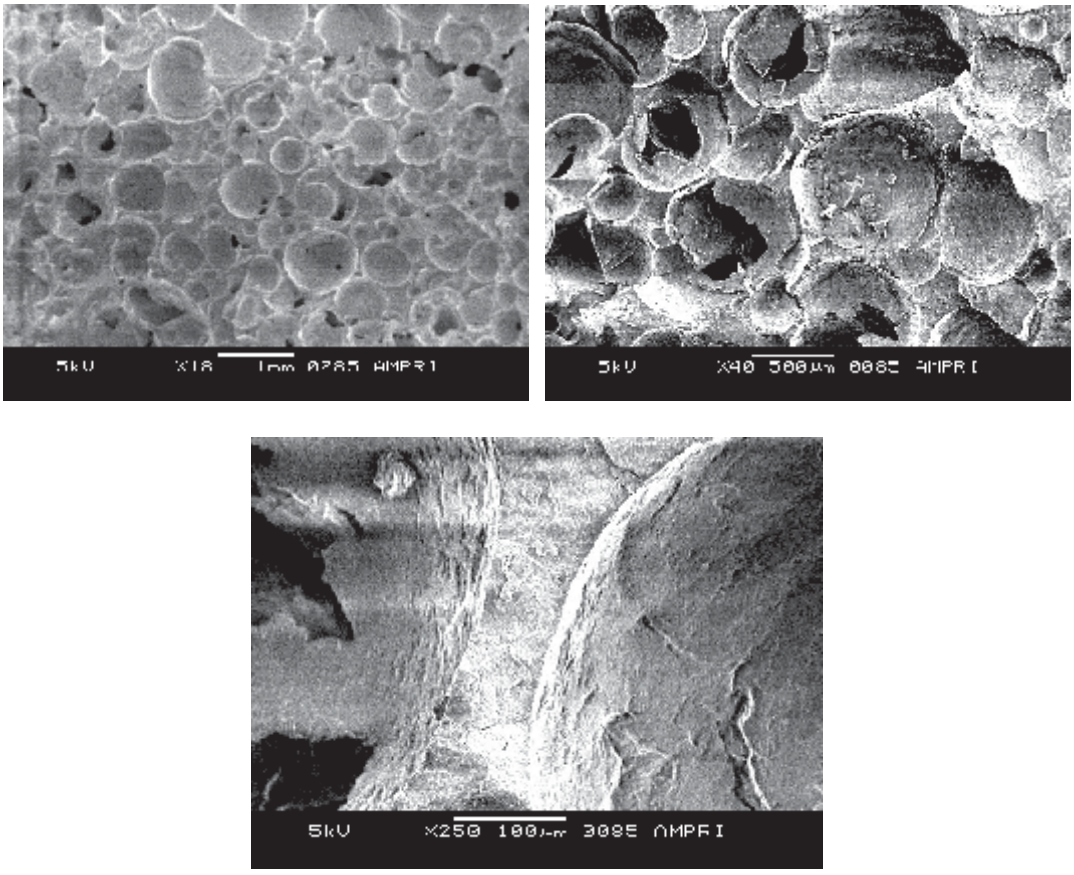
(a) (b)

Microstructure of open cell Ti-foam with bi-modal cell size (a) overall microstructure and (b) microstructure of cell wall



(a) (b)

Microstructure of HAP coated Ti-foams (a) Coating for 2 hrs and (b) Coating for 4 hrs.



HAP foams at different Magnifications showing uniform distribution of pores and thin cell wall

Advanced Ceramic Materials and Components for Energy and Structural Application (CERMESA)

Salient Features:

The project is aimed to develop composite layer armor to reduce the weight of the ordnance vehicles in protecting against medium caliber threats at the request of ordnance development council (ODC), OFB, Min. of Defence. These composites are layer hybrid and consist of metal, ceramic and other materials like polymers, rubber and glass fibers. Since the kinetic energies of the medium caliber projectiles are high and have values in the range of 180-200kJ, thick advanced ceramics and glass – ceramics are needed to be used. These ceramics are needed to be processed in an innovative way to reduce the cost and increase the efficiency. CSIR - CGCRI alongwith partner laboratories, CSIR-AMPRI and CSIR- SERC have demonstrated in the last 11th Five year plan the ability to produce effective prototype armor panel for protection against small caliber threats. The project is, therefore, based on the expertise developed during the 11th Five Year Plan period. Novel material design approach like multilayer ceramic structure, nanocomposites like SWNT dispersed AlN and SiC and ceramic particulate composites like TiB_2- Al_2O_3 will be utilized in the project. Modeling and simulation of the impact events will be an essential part of the project and effort will be made to reduce the number of experiments and narrow down the gap between the simulation and experimental results. Main approach of the project will be to optimize the structure of the test panel from the choice of different materials like metal, ceramic and others for the effective reduction of weight of the panel than that conventionally being used i.e. armor grade 4340 steel. The involvement of CSIR-AMPRI is to develop a strong and tough Al alloy plate which would act as a backing material to stop the bullet. The key milestone of the project is to develop an optimized test panel of the armor for the protection against 30mm projectile with kinetic energy between 180-200kJ. The next step is to scale up the panel dimension and optimize the structure with performance from the evolved stress analysis under dynamic loading conditions. Scaling up of the process for the production of large number of ceramic tiles needed for the fabrication of the minimum engineered panel will also be taken up in this program. The effect of fabrication process on the interface strength of the different material components will also be looked into in this program. Finally the documentation and the engineering analysis of the successful panels will be made for a complete technology package needed to the defence industries. The main objective of the project is to develop a lightweight protection system for ordnance vehicles against medium caliber threat (180-200kJ). Size of the armor panel will be 1000mm x 500mm.

Molecules to Materials to Devices (M2D)

Objectives:

The recent "parallel biology" approach has already accelerated genomics research considerably, by providing at faster rate "generic" massive information (genome, proteome, etc.), obtained in dedicated large facilities. This is only a beginning, however, and point of care (POC) systems bear the promise to improve considerably user-friendliness, flexibility and cost-effectiveness for the analysis of both biological and non-biological fluids, as compared to present robots and analytical equipment.

The development of POC requires highly interdisciplinary efforts, involving competences in physics, chemistry, analytical science, biology and informatics. Molecular interactions and transport are at the heart of POC, since they provide the mechanistic origin of the desired separations/analyses, and they are also at the origin of many potential problems. Most macroscopic separation methods cannot be transposed directly to the chips format, but other mechanisms very difficult to put to work in the macroscopic world are much more easily implemented on a smaller scale, so the switch to POC requires a deep reconsideration of current separation mechanisms and a strong innovation drive.

A second bottleneck in the application of microfluidic separation system is the detection. For mass sensitive detectors the low sample capacity is the problem: for concentration sensitive detectors, it is the small peak volume in which the detection has to be performed. Limits of detection are therefore still inferior.

In the present research project a strong emphasis is put on the improvement of existing techniques of detection and their adaptation to the micro scale of the separations. The CSIR-AMPRI will developed analytical methods for Microfluidic separation and detection of bio–molecules. The work plan for CSIR-AMPRI is as follows:

- Functionalization and characterization of fluorescence and electrochemical materials synthesized by NIIST, NCL, CECRI, CSMCRI, CLRI, NEIST and IICT for sensor applications.
- Microfluidics support for detection of analyte by Raman active probes.
- Fluorescence and electrochemical detection of S containing biomolecules (cysteine, methionine & glutathione).
- Application of fluorescent markers for various diseases like Alzheimer's, Cancer and Filariasis and sensors for explosives; Studies for exploring possibilities for probable application as biomarker or imaging reagents and analysis of biological samples.

Salient Features:

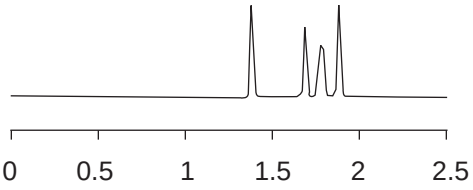
Fabrication of microfluidics channels:

Microfluidics channels with different dimensions and different injection volumes have been designed and molds of the same has been prepared using soft lithography techniques. Microchips were prepared using PDMS by replica molding.

Separation of biomolecules with microchip based capillary electrophoresis:

Simple and rapid determination of sulfonamides by capillary zone electrophoresis with fluorescence detection

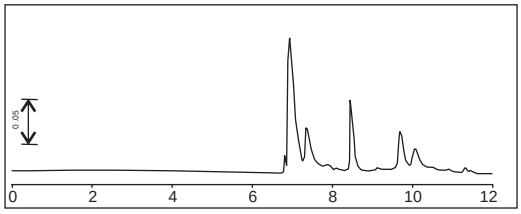
A simple and sensitive capillary electrophoresis method with fluorescence detection was developed for the determination of sulfanilamide sulfamerazine sulfacetamide sulfanilic acid in water. The sulfonamides were extracted from lake water, derivatisatized with fluorescamine and determination of sulfonamide was achieved within 2 min by using 20 mM borate buffer of pH 9.5 at an applied voltage of 25 kV. Detection was performed using UG-11 excitation filter and 495 nm emission filters. A fast, simple and sensitive method with limit of detection in the range 0.89 to 1.43 n mol L^{-1} for all the four sulfonamide with good recoveries 80-110% is seen. Inter-day and intra-day validation of the separation method shows fairly good results. The detection and quantification limits for this newly developed method are low enough to determine residues of these drugs in lake water.



Peaks: *, electro-osmotic flow; 1, sulfanilamide; 2, sulfamerazine; 3, sulfacetamide; 4, sulfanilic acid.

Separation of basic protein by capillary electrophoresis using capillary coated with poly-vinyl alcohol.

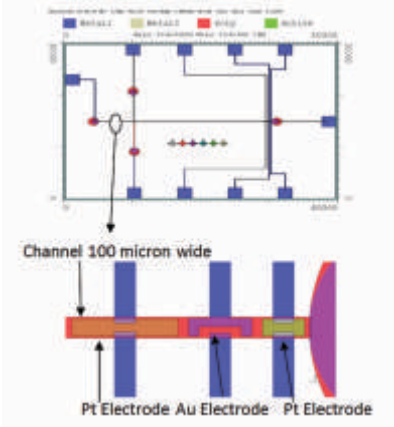
In aqueous capillary electrophoresis the electroosmotic flow can be strongly suppressed by coating the inner surface of the capillary. In the present work hydrophilic coating of 4 % poly-vinyl alcohol (PVA) has been used for the analysis of basic proteins. The coating is simple and easy to obtain. The separation of Ribonuclease and α- chymotrypsin has been uniquely done with other three basic proteins (Lysozyme, Cytochorome-c and Trypsin) using a buffer 11.60 mM sodium acetate and 18.40 mM acetic acid at pH 4.5 in addition to positive power supply of 20 KV at 25 ºC. Detection was performed using UV detector at 230 nm. The proposed PVA coated capillary provides reproducible separation of five basic proteins in 11 minutes with RSD values for migration time lower than 2.00 % (n = 6) for all the five basic proteins has been seen. The stability of coated capillary has been checked up to around 40 runs. The contact angle measurement, viscosity measurement and SEM (Scanning Electron Microscope) for 4% PVA have been studied to make it compatible with future micro-chip applications.



Electropherogram of basic proteins in a PVA coated capillary with pH 4.5. Basic proteins (1) lysozyme ; (2) cytochrome-c; (3) ribonucleaseA; (4) trypsin;(5) -chymotrypsin (1mg ml^{-1}of each protein) is injected by pressure.

Fabrication of electrochemical cell integrated with microfluidic channels.

An electrochemical cell using several microelectrodes and high voltage decoupler has been fabricated with the help of CEERI Pilani and integrated with microfluidic channel.



CSIR Knowledge gateway and Open Source Private Cloud Infrastructure (KNOWGATE)

Objectives:

The major objectives/deliverables of comprehensive CSIR knowledge gateway are as follows which are in advanced stage of development at KRC, AMPRI

- To enhance the capacity and capability of CSIR computing power through CSIR private cloud infrastructure and Open Source Software Technology Solution Cell (OSSTSC)
- To provide CSIR-KRCs an Integrated Library Management Solution using open source Software (KOHA Software has been installed as ILMS and all the data from Libsys has been migrated to KOHA) The Server has been installed and Pc and barcode Scanner procured.
- To share information resources among CSIR laboratories by creating CSIR Distributed Library: catalogue sharing, inter library loans, & referral service for document supply service
- To analyse CSIR research, technology and related data using multi-dimensional analysis regarding this the work of collecting Patent data is complete and has been send to Nodal Lab

Salient Features:

Over the last few years, there have been rapid advances in technology across various sectors, be it open source cloud computing, big data, knowledge management, performance management, business intelligence etc. Cloud computing specifically has established itself as a proven computing model, with several deployments across public and private sectors for provision of hardware infrastructure or software-as-a service. In the S&T sector cloud computing can be leveraged as a catalyst for process transformation and service innovation. This computing model becomes even more meaningful for R&D organizations, when we consider the emerging paradigms of modern science, i.e., considering shifts from observation, thinking and computational science to data intensive research/data driven decision making. This project aims to facilitate micro-analyses for intelligent information. The project will have far reaching applications with many tangible and intangible benefits that can be harnessed by not only CSIR but also by various other S&T agencies. The project ISC0102 has NISCARE as the nodal lab and all 39 KRC of the labs of CSIR as participating labs.

The cloud infrastructure is in process of being implemented at NISCAIR, which will be accessed as a service from any CSIR Labs. This platform will be used by individual Knowledge Resource Centers (Kris) of CSIR laboratories for their computational needs. Further, a small Open Source Software Technology Solution Cell (OSSTSC) which is being proposed will provide the Open Source Software (OSS) solution for library automation, institutional repositories/digital libraries and network security and management. Technical support will be provided to all CSIR-KRCs through OSSTSC. Many Indian libraries do not have requisite infrastructure and expertise for library automation, digital libraries and network management and security. A large number of Indian and SAARC libraries are interested in implementing a low cost software solution for library automation and institutional repositories. There is few good open source software for these purposes. However, these software need to be customized to suit specific need of institutions. By setting up OSSTSC,CSIR can provide the low cost solutions to the community engaged in information dissemination.

The ultimate aim of KRC is to supply researchers with all the materials that they need in order to do research, become more educated and empowered. One of the fundamental tools that we use in order to work toward that ultimate aim is the union catalogue as an indispensable element of any effective system

of resource-sharing. Union catalogues have been so successful and ubiquitous that it is easy to overlook the contributions to library services they have made and are continuing to make. In a way, it is a technological marvel that any one any where in the world with access to a computer and the Web can check on the vast holdings of the large libraries and, working through linked inter-library loan systems, obtain items that may not be available in their own KRC.

Presently CSIR KRCs are using different proprietary software for library management and very few have Online Public Access Catalogue (OPAC) available on Internet. Therefore, resource sharing among all CSIR KRCs is inadequate. Most of these proprietary software do not conform to international standards like Z39.50/SRU. Hence importing/exporting of available catalogue from/to resources like Library of Congress or CSIR KRCs is not possible. This unnecessarily duplicates the cataloguing/classification efforts for new resources. Use of proprietary software also has high maintenance &support cost and does not permit migration of data due to its undisclosed software architecture leading to vendor locking.

To overcome these problems, it is proposed to create CSIR distributed library/ virtualized union OPAC of CSIR holdings using Z39.50 protocol & Open source integrated library management software. This will allow federated search on CSIR knowledge resources. Further, the technical support to all KRCs will be provided through the OSSTSC being setup under this project which is under advanced stage of development.

There is no automated system for analyzing there search & technology data of CSIR at consolidated level. Currently the information is scattered across different Labs because of which the current data is available only on request & is not available at any central place. Hence need for creating a tool with provision for storing centralized data was felt.

CSIR needs to retain and enhance its competitiveness globally, by leveraging these fast pace technology transitions. Therefore, The execution work has following modules to develop a CSIR wide knowledge gateway-

Description

CSIR Cloud Capacity and Capability Building: CSIR Open Source Cloud Computing,

Infrastructure and Open Source Software Technology Solution Cell (OSSTSC)

CSIRCat	CSIR Distributed Library/ Virtualized Union OPAC of CSIR Holdings, using Z39.50 protocol & Open Source Integrated Library Management Software
CSIRTrend	Multi-dimensional Analysis System (MDAS) - Extended information access for enabling excellence

K Values Recovery from Land based Secondary Mineralogical Resources and Development of SRBN/ SRMN product(s)

Objectives:

- To study recovery of K values from secondary mineralogical resources (glauconitic deposits) through chemical/physical /bio-chemical means
- To develop SRBN/SRMN compositions of potash

Salient Features:

Potassium is one of the three essential plant nutrients, along with Nitrogen & Phosphorus. More than 95% of world's total production of potassic chemicals is consumed as fertilizer. More than 72% of Indian soil demands immediate potash replenishment.

K Fertilizer demand is almost universal but more than 87% of the total production comes from only about half a dozen countries. There is no production in our country and we are totally dependent on imports. The demands have been increasing over the years to cater to food requirement of ever-growing population.

As on date, there are no proven & viable land based Potash reserves in India. In view of the magnitude of India's potassic fertiliser requirement it is essential to approach the issue with multi-disciplinary, concerted, focused & mission-oriented approach with the core objective of utilisation of wide variety of indigenous potassic feedstocks. Hence, it is of strategic importance to build manufacturing capability backed by technological competence utilising indigenously available resources.

KTEN Project proposes to capitalize on and augment CSIR's competence in exploiting different indigenous feedstock (viz., natural bittern of GRK, potash rich sea weed, bio ash/char, potassic minerals etc.) to build-up robust technological solutions for manufacturing of potassic fertilisers. On national perspective, this endeavor will enable the country to develop potassic fertiliser manufacturing capacities & to address associated critical issues like food security & subsidy.

KTEN Project aims to develop a gamut of viable & holistic technological solutions by effectively utilizing wide variety of indigenous feedstocks with the core mandate to make indigenous potassic fertilizer available in required amounts while being cost-competitive vis-à-vis imported MOP & implementation of pilot scale technology demonstration facilities.

It is envisaged that, as a result of the technology development initiatives of CSIR, by 2017, India will produce 5% of its annual consumption of potassic fertilisers in the country (ca. 2.5 lakhs MT/annum). The interventions envisaged in this project should take self reliance to a much higher level if the technologies are successfully developed, scaled up and commercialised. A sizable impact on the subsidy bill is also envisaged.

The project is expected to generate additional technology related IPR to provide the much needed impetus for technology implementation at commercial scale. Accordingly, expertise, infrastructure and commitment of six premier CSIR laboratories, has been devoted to meet the goal of the project with several sub components catering to different identified objectives.

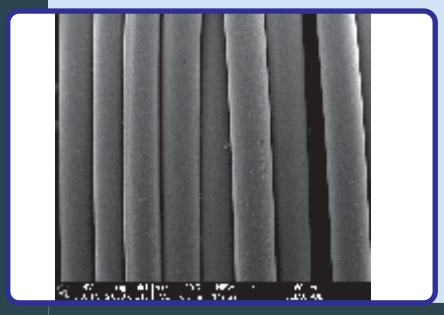
CISR-Central Salt & Marine Chemicals Research Institute, Bhavnagar, the coordinating institute of the KTEN project allocated a sum of Rs. 25 lakhs for undertaking R&D work on land based secondary resources of potash particularly glauconitic under the exploitation of mineralogical resources sub component, based on the past work done by and experience of the PI.

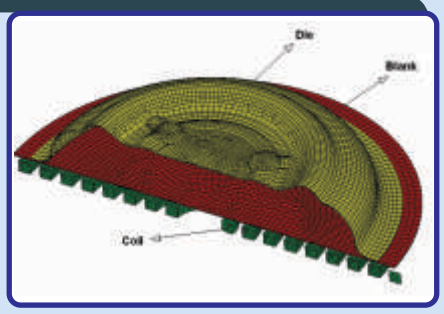
Accordingly, the work was initiated at AMPRI, Bhopal for harnessing the potential of glauconitic deposits through a mix of chemical / physical /bio-chemical/ routes.

Contacts were established with the GSI and interactions were made to help visit and identify the deposit areas of Gujarat, which were selected by the PI to focus upon initially. Two field visits were made by the PI along with the GSI officials to some deposits in the remote locations, partly accessible through select vehicles. Sampling from some locations identified was carried out as per sampling plan prepared and the samples collected were got transported to AMPRI.

The samples were pounded to bring to desired size and smaller portions were taken out through coning and quartering for analytical work. Necessary equipments, chemicals, glasswares and laboratory wares were identified and procured and supporting lab infrastructure was built up and strengthened. Schemes for experimental work were chalked out for maximum utilization of the K values of the samples collected and to develop some potential bi-/multi nutrient compositions. R & D work is underway.

Ongoing GAP Projects





Development of Porous Bioactive Ti-based Composite for Bio-implant Application

Objectives:

- Optimization of process parameters for the development of titanium based porous bio-mimetic component by powder metallurgy route.
- Designing of surface with an improved wear resistance, corrosion resistance and biocompatibility by modification of the surface microstructure and composition using advanced surface processing. The techniques which would be applied would include plasma spraying and sol-gel coating.
- A detailed characterization of microstructures, composition and phases of the surface and correlate with process parameters to achieve optimum process parameters.
- Evaluation of mechanical properties (strength, toughness, wear resistance, fatigue and fretting properties), electrochemical behavior (corrosion) and bio-compatibility under simulated body environment thorough evaluation of cytotoxicity using general cell lines such as L-929 fibroblasts as per international standards.

Salient Features:

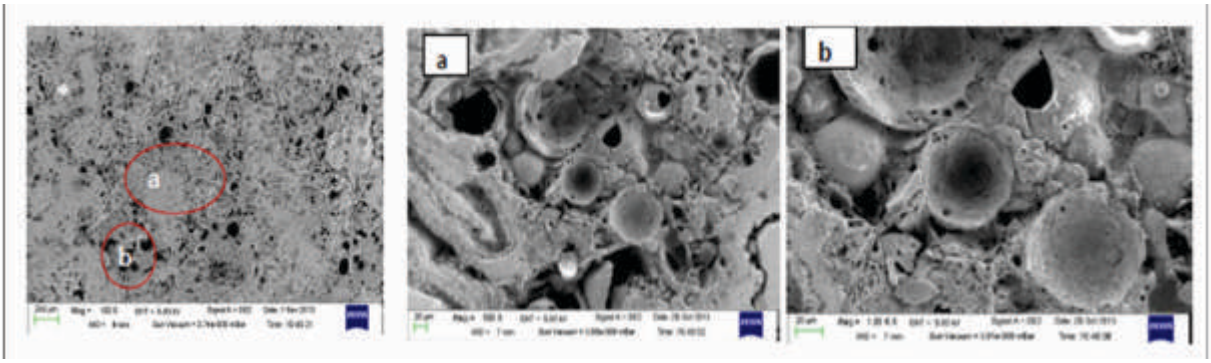
(i) Ti-cenosphere porous Ti-based composites with porosities upto 65% have been made through powder metallurgy routes. The compaction pressure is precisely controlled to avoid cenosphere breakage. The foams are made where cenosphere breakage is limited to less than 10%. The green pallets are sintered at varying temperatures (1000, 1100 and 1200°C) under vacuum (10^{-4} mbar).

(ii) Pallets are also effectively sintered in a microwave sintering facility.

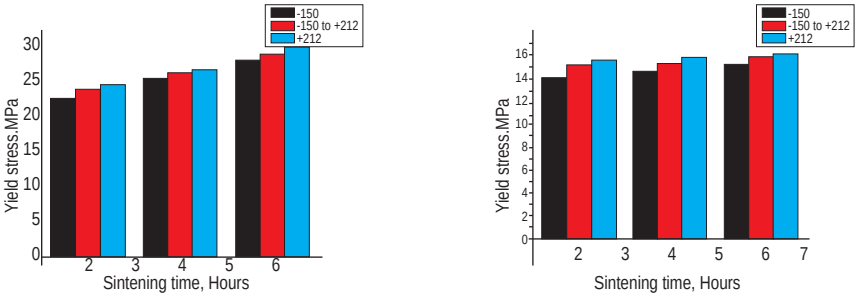
(iii) The microstructural characterization, mechanical property evaluation and corrosion behavior in simulated biofluids are studied. These porous Ti-based composites exhibits excellent strength and modulus which are comparable to different types of bones. The corrosion resistance of these foams in biofluid is better than that of bare alloys or pure titaniums.

(iv) Strength and modulus, corrosion resistance and wear resistance of these foams improved when sintered at high temperature. However, density and porosity reduced. Microwave sintering provides more strength and modulus.

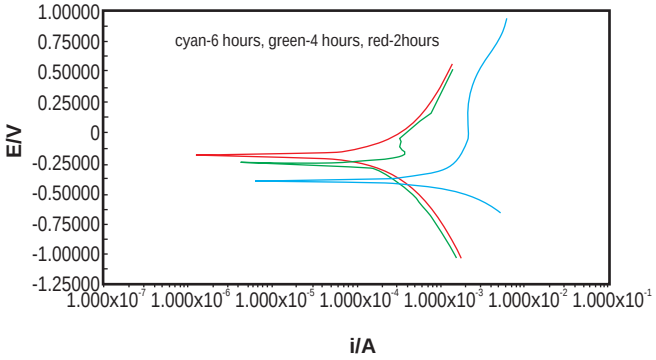
These foams again will be coated with Hap to improve its biocompatibility. All these porous Ti-composites will be subjected to invitro analysis and toxicity analysis using L929 fibroblast cell liner. However, the knowhow of the process is well developed and it could be explored for engineering application like energy absorption, sound absorption and vibration control at high temperature and adverse environment.



Ti-cenosphere syntactic foam (porous Ti-composites) made through powder metallurgy route



(a) yield strength and (b) young's modulus of Ti-cenosphere syntactic foam when sintered at 1200°C



Tafel plots for Ti-cenosphere syntactic foams sintered at 1200°C

Demonstration of the competence to develop automobile components using Electro Magnetic Forming (EMF) process

Objectives:

1. Literature review.
2. Material deformation study and pre & post EMF characterization.
2. Design of die and coil for EMF
3. Illustrative prototype component.

Salient Features:

Project was sponsored by TIFAC New Delhi and it was executed in consortium mode. Other partners were IIT Bombay, IIT Delhi, IPR Gandhinagar, WIL Chennai, BIL Chennai and CMTI Bangalore. The work was divided into two work packages; one on simulation and design aspect and another on deformation of

material with Electromagnetic force viz development of illustrative components. A 2D self run FE code was developed by IIT Bombay to simulate Electromagnetic forming problem, whereas IIT Delhi explored application of commercially available FE software for EMF problem and studied their feasibility for the same. AMPRI work was related to pre and post EMF characterization of material and its deformation behavior. FE simulation for coil design and material deformation study was also carried out. Fig 1 shows a FE simulation study of deformation of sheet due to flat spiral coil. Fig 1 (a) shows the FE mesh and 1(b) shows contour of current density and vector fringe of sheet at different point of time during deformation. Fig 2 (a) and (b) shows magnetic flux density and force distribution on sheet for three different types coil (i.e coil with number of turns 3, 4 and 5). So the deformation study and coil design can be carried out using FE simulation using available software. Fig 3 shows identified illustrative component (wheel disc) that is envisaged. AMPRI acknowledges LSTC for providing LSDYNA (Ls980beta version) to carry out these initial trial simulation work using EMAG module.

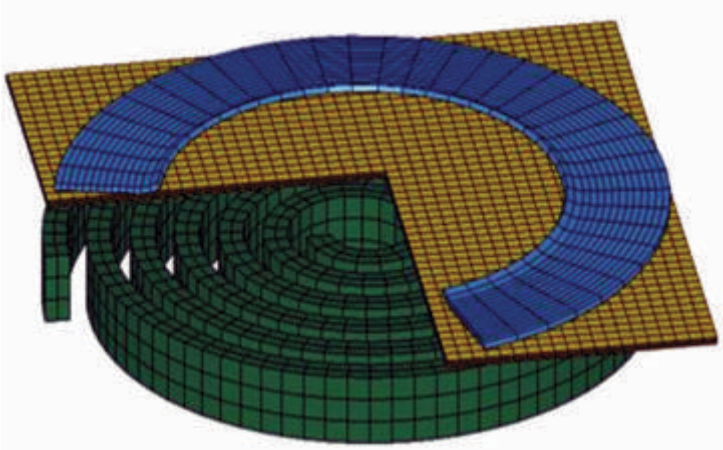


Fig 1(a) FEM Mesh of the EMF case. Only ¾ of the sheet and blank holder is shown

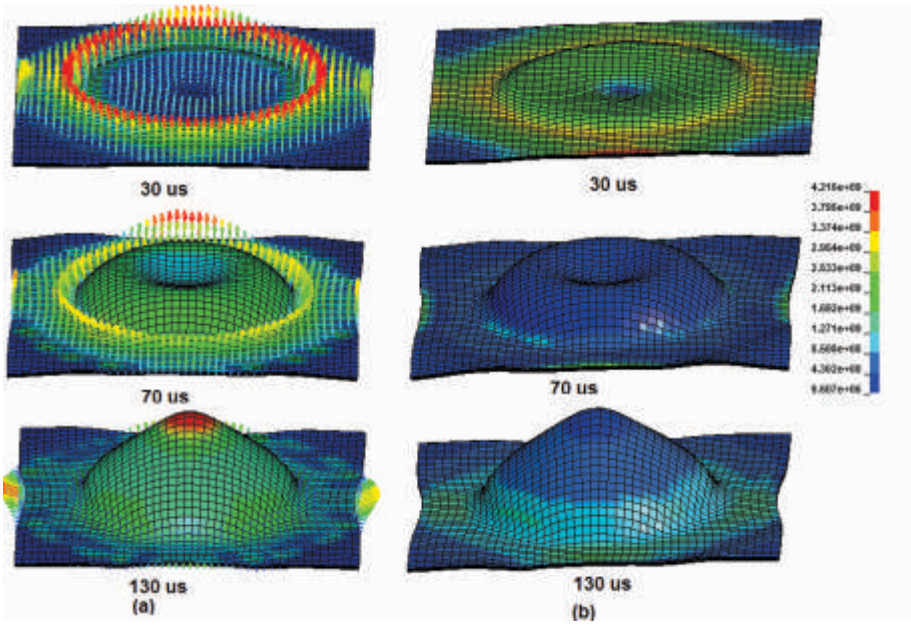


Fig 1 (b) current density and deformation history at 30 (top), 70 (middle) and 130 s as sheen from top side and (b) Vector fringe of force on the sheet at middle cross section of sheet at 30 (top), 70(middle) and 130 s (bottom)

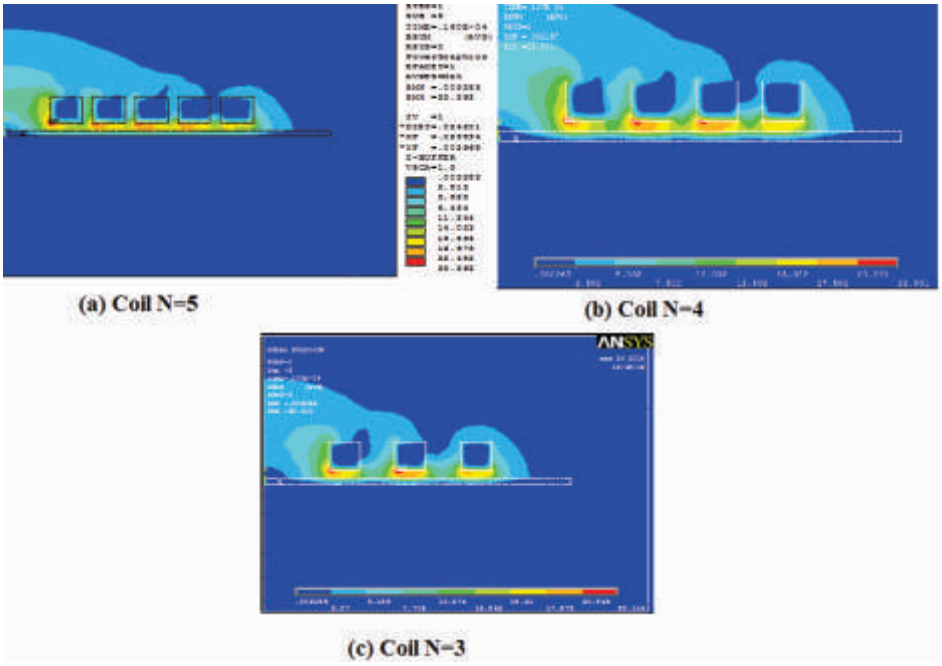


Fig. 2(a) Magnetic flux density at the time of peak current amplitude for all coils

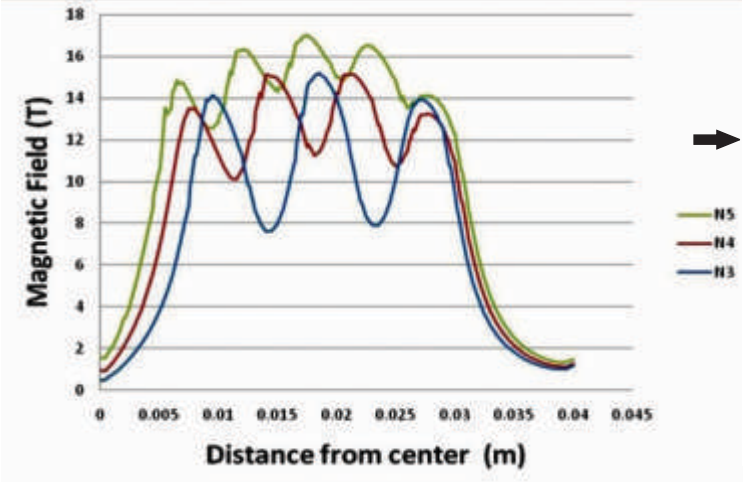


Fig. 2 (b) Magnetic flux density across top surface nodes of the work piece for all three types of coil at the time when the current amplitude is highest.

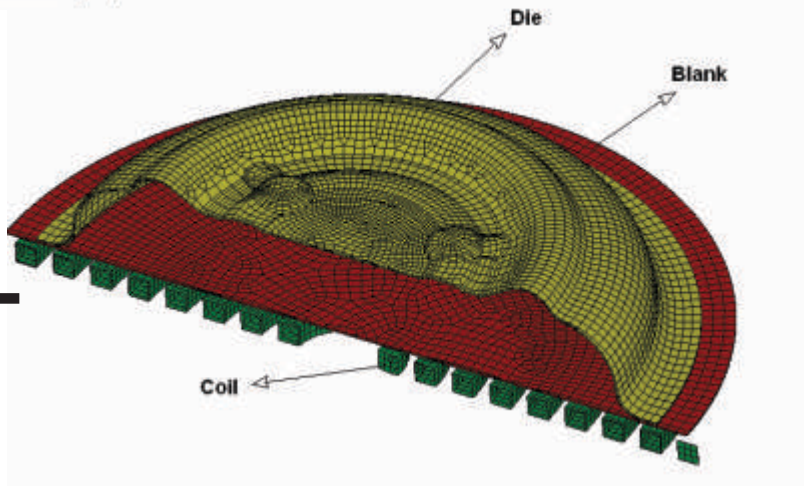


Fig. 3 Identified Illustrative component

Utilization of Low Cost Minerals of Madhya Pradesh for the Development of Hyperbranched Aluminosilica (HAS) and Mesoporus Silica to Sequester the Effects of Green House Gases

Objectives:

The main objective of the proposal is to synthesize HAS and mesoporus material having high surface area, capacity and robust ability for recycling to capture greenhouse gases with special reference to carbon dioxide (CO_2) from the sources from where it is released to atmosphere.

Salient Features

The proposed project work is of prime importance because it has two fold benefits. First, it shall help in developing a techno-economic feasible process to mitigate the greenhouse gas emission problem to a larger extent and second, it would pave the way for proper utilization of huge amount of low-grade minerals of Madhya Pradesh which has been not exploited so far for the development of newer materials such as HAS and mesoporus silica.

Synthesis and Characterization of Nanomaterials for Engineering Applications

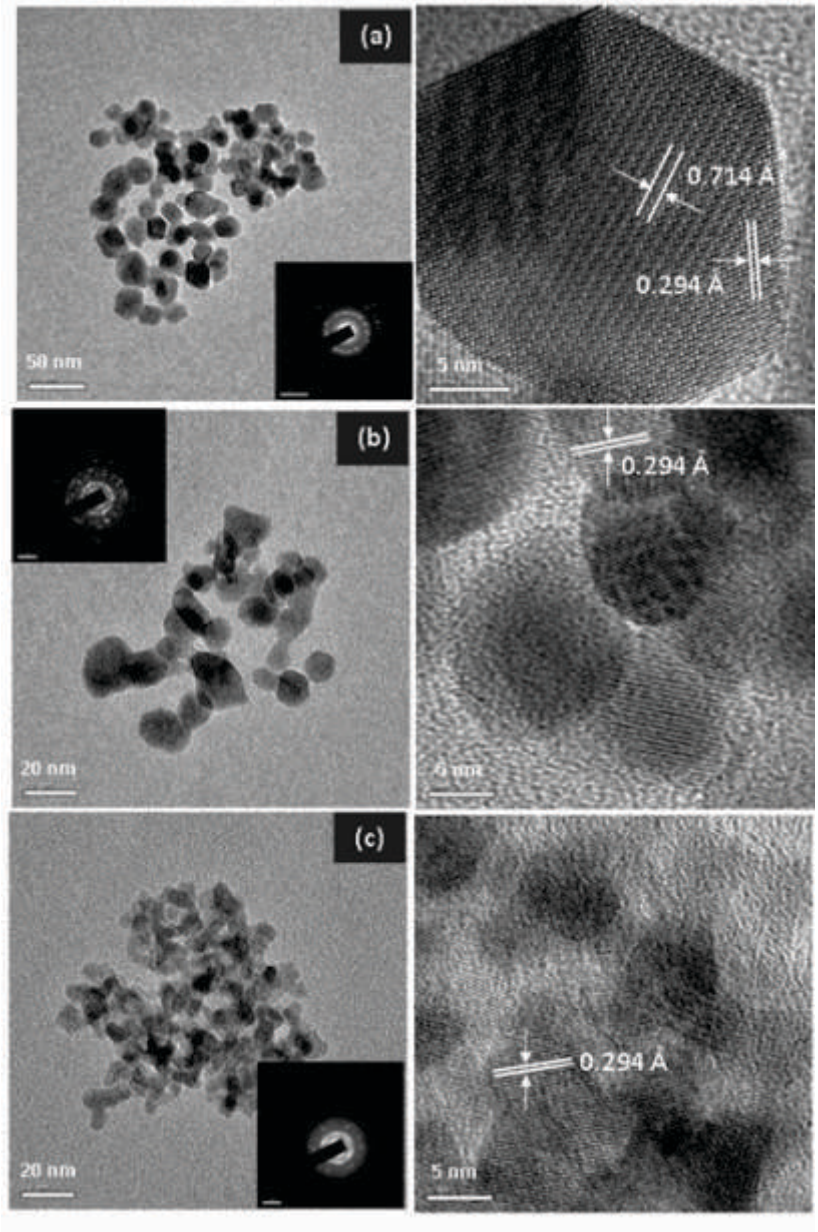
Objectives:

Synthesis and characterization of nano-materials for engineering applications

Salient Features:

- **Synthesis of Indium Oxide nano particles by sol-gel method**

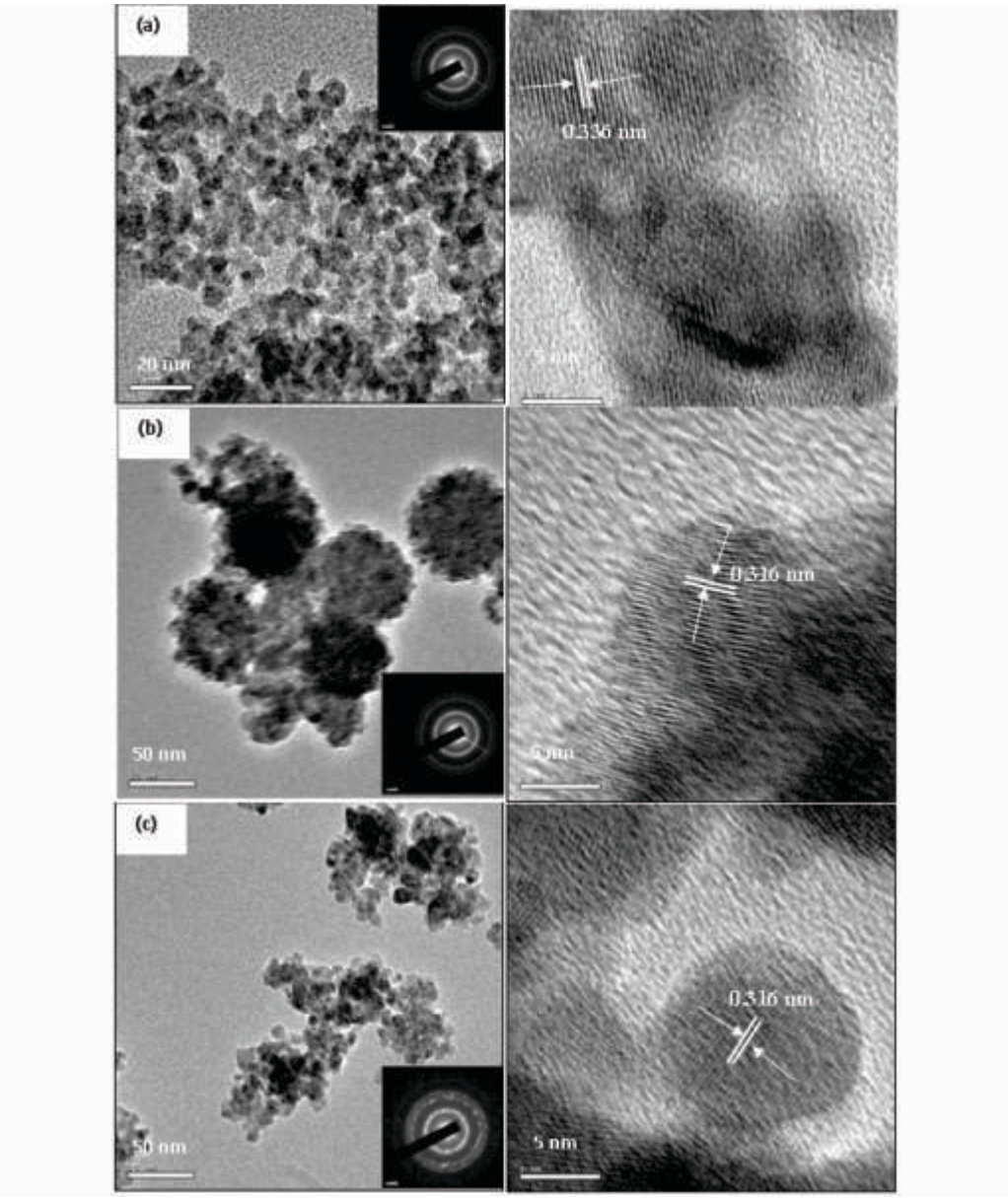
Nano sized cubic In_2O_3 particles were synthesized by aqueous sol-gel route at a lower calcination temperature of 400°C and were characterized by XRD studies, FTIR spectroscopy, HRTEM , TGA analysis , Optical absorption studies and Photoluminescence studies. The crystallite size is observed to be between 8-17 nm while the particle size is estimated to be ~ 20-30 nm in the calcinations temperature range of 400–800°C. The synthesized samples have a band gap of 3.90 + 0.02 eV.



HRTEM images of the indium oxide nano-particles obtained by heating the precursor at 800°C, 600°C and 400°C *(*a to c respectively)

➢ Synthesis and characterization of Cadmium Sulphide nano-particles:

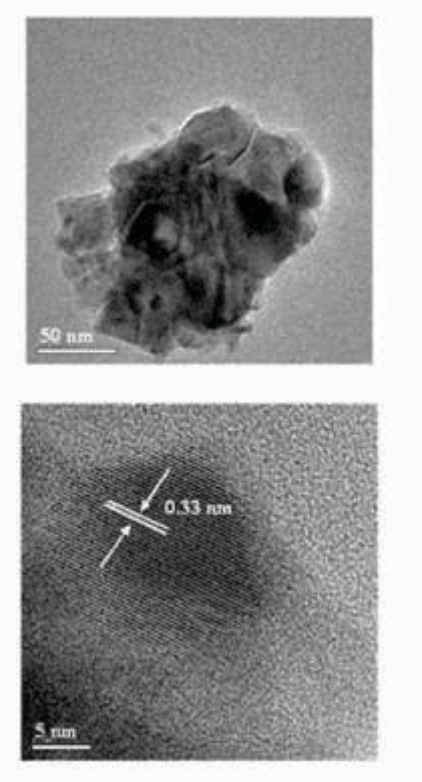
CdS nanoparticles were prepared by emulsion/arrested precipitation methods using thioglycolic acid, potassium pyrosulfate and EDTA as capping agents. Crystallite sizes have been found to be 3.7 nm, 6.8 nm and 13.9 nm respectively. The synthesized particles have been found to act as photo-catalysts for photo-degradation of crystal violet and methylene blue synthetic dyes.



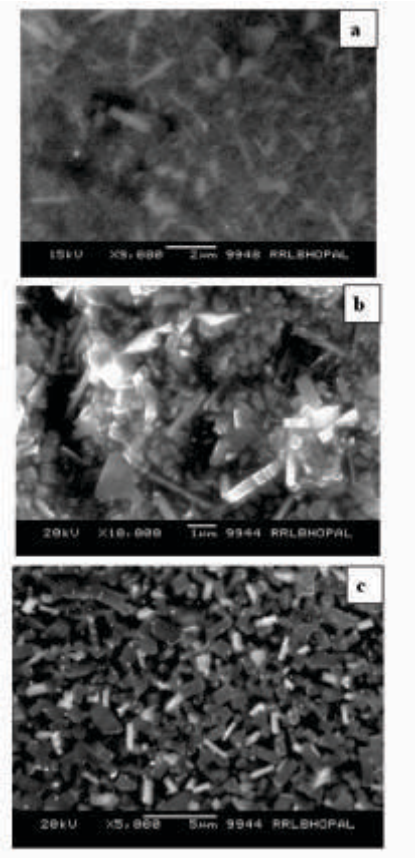
HRTEM images of CdS-T, CdS-K and CdS-E samples

➢ Synthesis and characterization of Aluminium Titanate nanoparticles:

For synthesis of Aluminium Titanate nanoparticles, aluminum metal and commercial titanium dioxide have been used as starting materials to prepare respective sols which on mixing form gel. This gel yields stable β–Al_2TiO_5 phase on calcinations in the temperature range 800-1500 °C, (which includes the thermal instability range of 800 – 1280 °C for aluminum titanate).The crystallite size in the β-aluminum titanate powder obtained by calcination of the AT precursor at 1000 °C is observed to be between 17-26 nm. The sintering of the pellet made from this powder shows the presence of rod shaped crystals of length in the sub-micron range.



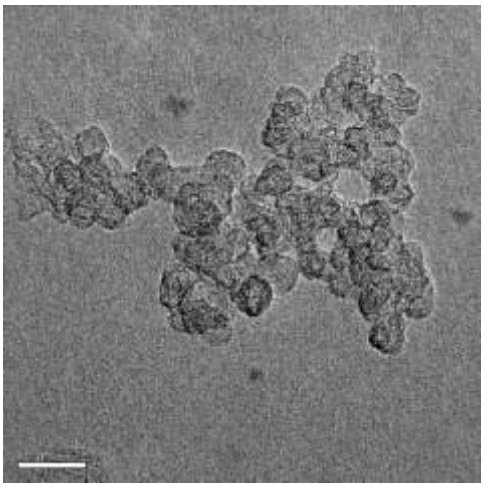
HRTEM micrographs of the sample fired at 1000 °C for 2 h



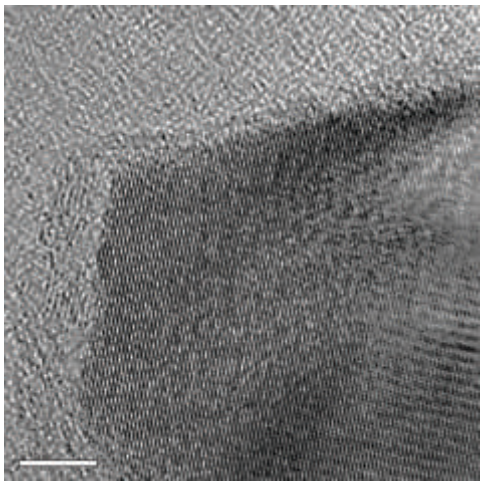
SEM micrographs of polished pellets sintered at 1350, 1425 and 1500°C

➢ Synthesis and Characterization of Tungsten Carbide nanoparticles:

Very fine nanoparticulate crystals of Tungsten carbide can be synthesised by sol gel method involving precursors of WO_3 and Carbon soot . The crystallite size of the WC powder obtained by calcination of the WC precursor at 1500 °C is observed to be between 17 -50 nm. The method described above provides a rapid synthesis of a well defined nanocrystalline WC product.



HRTEM image of tungsten carbide synthesized at 1500 °C



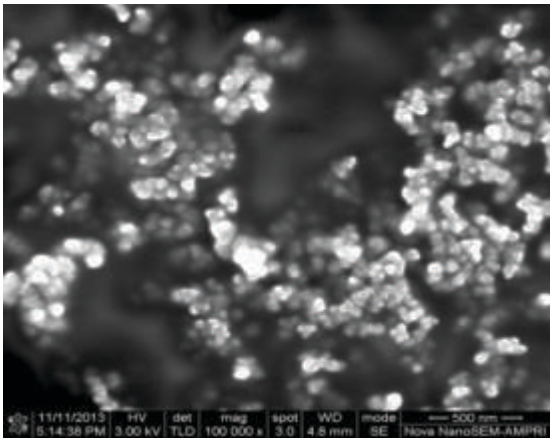
HRTEM image of tungsten carbide synthesized at 1500 °C

➢ Synthesis and Characterization of nano-size $BaWO_4$ using microemulsion method and its Photoluminescent Study

$BaWO_4$ nanopowder was synthesized via microemulsion method. The XRD pattern confirms the presence of single phase tetragonal scheelite structure with average particle size of 40.8 nm. Band gap of the sample was found to be around 4.4 to 4.8 eV which is close to that found in the literature. FESEM image shows the presence of spherical morphology with polydisperse particle size. EDS spectra confirms the presence of Ba, W and O in the ratio 1.2:1:4 which is close to the stoichiometric ratio. Thermal decomposition of the sample at different temperature shows that the as synthesized compound is highly

stable with average weight loss of 2%. The PL emission peaks of the $BaWO_4$ are in the spectral region at 426-432 nm.

a



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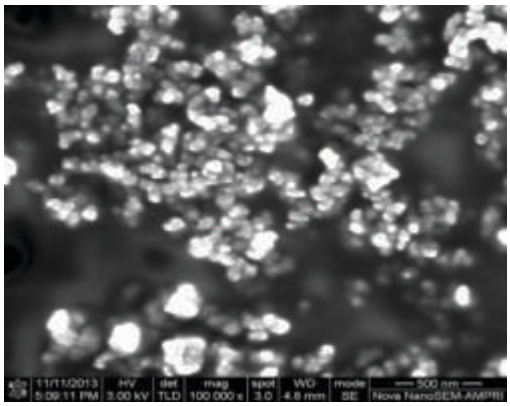
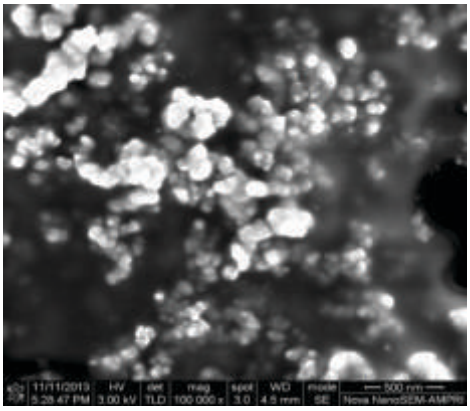


c



FESEM images of $BaWO_4$ at different temperatures

Development and Optimization of Processes for Permanent Hydrophilic and Hydrophobic Surface Coatings with Nano particles for Multifunctional Finishing of Textiles

Objectives:

The ultimate goal of the proposed study is to establish fundamental principals and develop and optimize the process for the production of nanofinishings using polymer nano composites based on copolymers in combination with inorganic nanoparticles to improve the functionalities like UV resistant, antibacterial and flame retardant finishes.

Specific objectives are details according to the four research directions are the following:

- To obtain hydrophobic polymer able to behave as a matrix for the dispersion of nanoparticles with high ability to bind the surfaces, providing them with highly durable water repellency associated with other functionalities directly coming from nanoparticles performance.
- To obtain hydrophilic co-polymer able to behave as a matrix for the dispersion of nanoparticles with high ability to bind the surfaces, providing them with the capacity to moisture regulation associated to other functionalities directly coming from nanoparticles performance.
- To modify substrates by chemical or physical methods to promote irreversible binding of the nanocomposite formed by the polymer and dispersed nanoparticle.
- To achieve permanent functional properties by selecting the adequate system of nanoparticles dispersed in polymer matrix and to control characteristics of final products.

Salient Features:

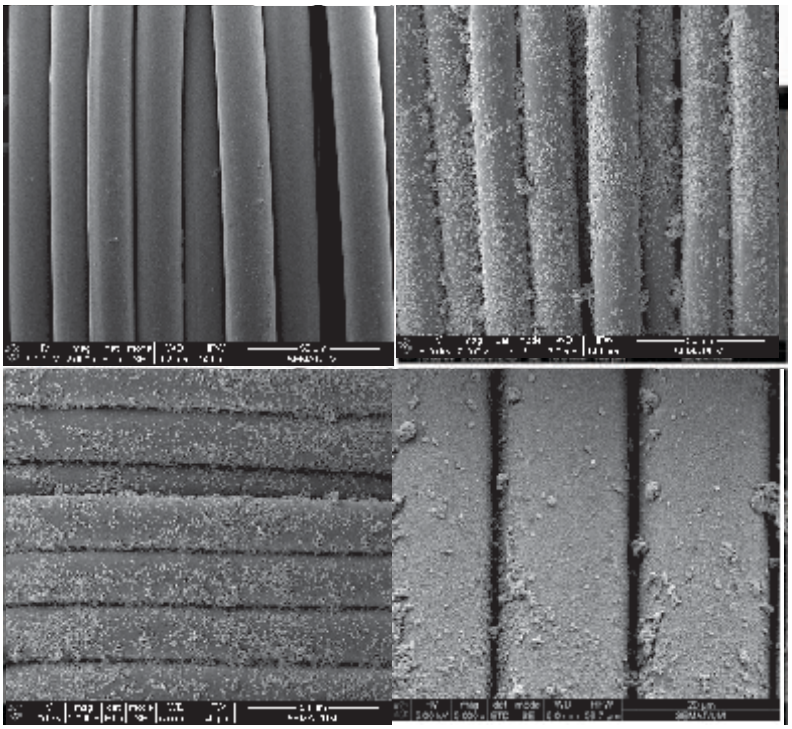
- Zinc Oxide Nano finishings for Multifunctional textiles (UV Protective and Water repellent)

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 a huge number of additional functionalities which are increasingly demanded by the textile industries. In the present work, zinc oxide nanoparticles were prepared by wet chemical method and ZnO–PMMA nanocomposites were prepared by dispersing the ZnO nanoparticles in solution of poly(methylmethacrylate) (PMMA) and applied on polyamide fabrics

The broad band absorption of detrimental UV radiation and high transmittance of natural visible light make the ZnO–PMMA nanofinishing a very efficient UV protection for the UV shielding polyamide fabrics.

The dispersion of ZnO nanoparticles is uniform in the polymer matrix PMMA at nanometer level as evidenced by the SEM analysis. The results provided a very easy and economical method for fabricating superhydrophobic and UV protective polyamide fabrics.

· High performance polymers exhibiting multifunctional characteristics can be achieved by the introduction of inorganic nanoparticles like ZnO(Zinc oxide) into the functional polymers. In the present work a copolymer epoxy poly(dimethylacrylamide) was synthesized to disperse the ZnO nanoparticles.



SEM micrograph of the (a) untreated polyamide fabric and (b) polyamide fabric treated with 0.1% ZnO, (c) 0.5% ZnO, (d) 1% ZnO

The aim of the work is to develop a new method/process/material for the dispersion of nanoparticles and evaluation of the performance of these composites. FT-IR measurements showed that the adsorption of polymers on nanoparticles surface derived from the formation of hydrogen bond from the hydrophobic effects of substituents on nitrogen atom. These hydrophobic groups could hinder water molecules replacing the adsorbed polymer molecules and markedly improved the dispersion of ZnO nanoparticles in polymer. Characteristic absorption bands are attributed to the asymmetric stretching of C-N-C at 1130–1191 cm^{-1}. The characteristic vibrations of –OH on the ZnO surface at 1024 cm^{-1} and 3450 cm^{-1} are also observed. The existence of –OH is important for the modification of ZnO particle surface with PNIPAM.

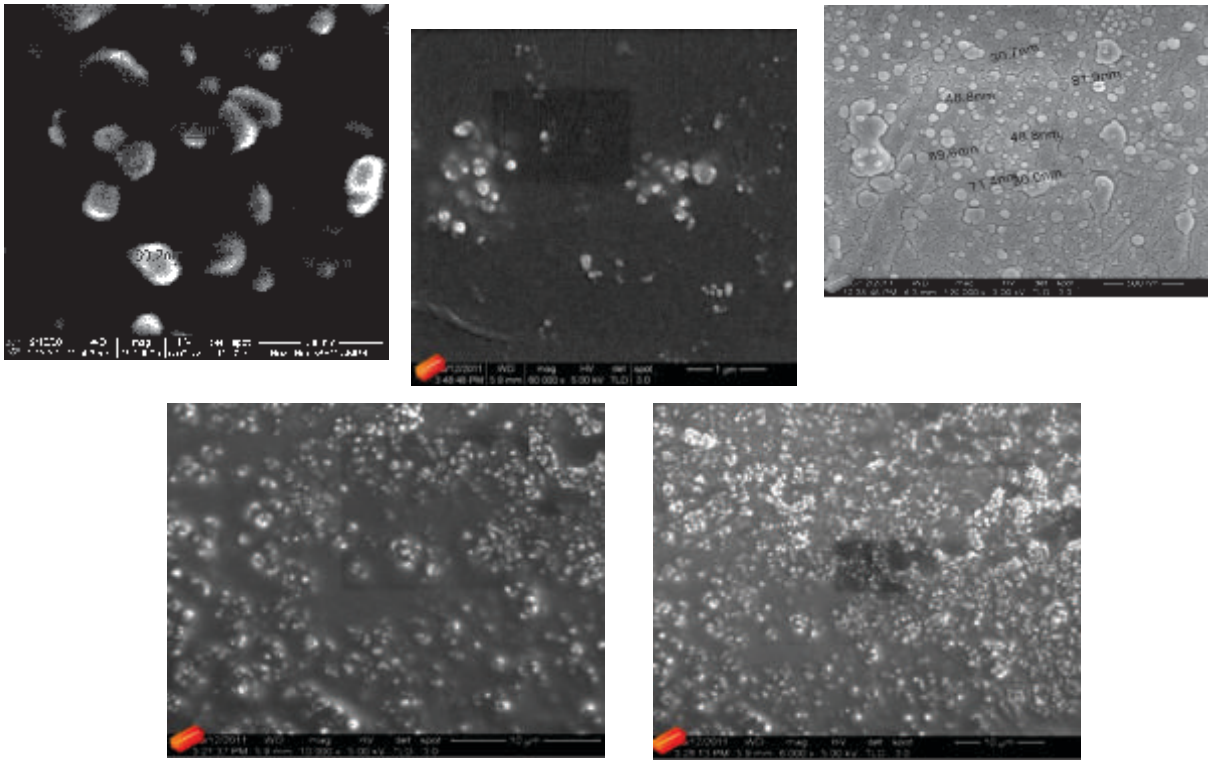
The present study shows that inter phase chemical links between the ZnO and the polymer chain prevent the agglomeration of ZnO nanoparticles making their distribution more homogeneous in polymer as evidenced by SEM analysis.

It was also found that the mean particle size of the dispersion was increased with increasing ZnO content. The results were consistent with SEM observations. Dimensions of the aggregate particles are significantly larger due to the increase in the concentration of nanoparticles which leads to increase in aggregation of the nanoparticles at higher concentration. The ZnO nano particles display uniform particle morphology at lowest concentration.

The value of zeta potential results how the PNIPAM can absorb on to the ZnO nano particles and impart –ve charge to the surface of the nano particles.

Novel Copolymer for SiO_2 Nanoparticles Dispersion

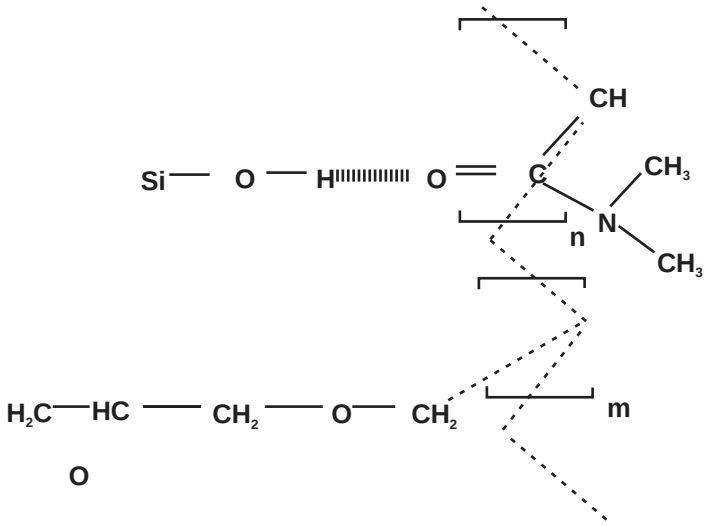
High performance polymers exhibiting multifunctional characteristics can be achieved by the introduction



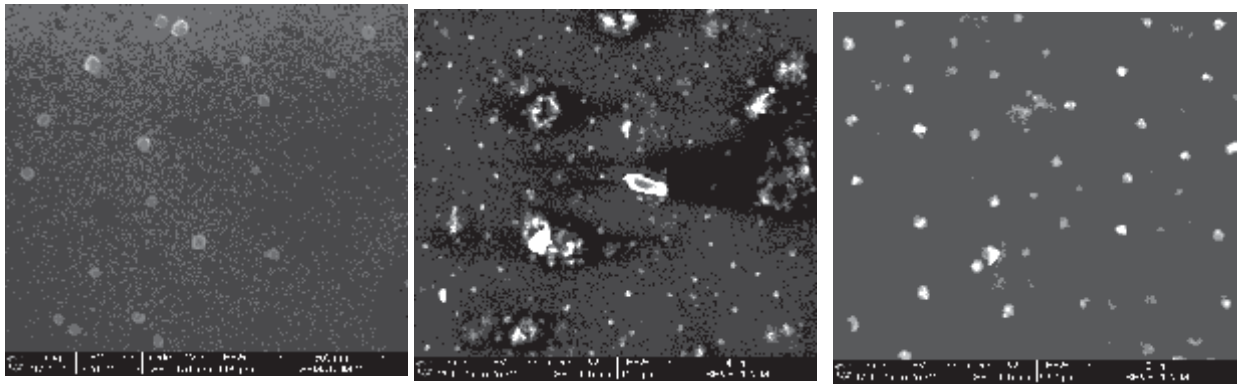
SEM micrographs of PNIPAM – ZnO nanocomposites with different % ZnO.

of inorganic nanoparticles like SiO_2 into the functional polymers. In the present work a copolymer epoxy poly(dimethylacrylamide) was synthesized to disperse the SiO_2 nanoparticles. The aim of the work is to develop a new method/process/material for the dispersion of nanoparticles and evaluating the performance of these composites

The present study shows that interphase chemical links between the silica network and the polymer chain prevent the agglomeration of silica nanoparticles making them their distribution more homogeneous in polymer as evidenced by SEM analysis.



Adsorbing model of the polymer on silica



(a) (b) (c)

(a) SEM of silica nanoparticles, (b) SEM of polymer adsorbed raw silica (c) SEM of polymer adsorbed

With this new procedure, we have created a tool to obtain a broad range of new inorganic/organic hybrid materials in a very easy way.

Development of Cast in-situ Cu based Composite for Naval Applications

Objectives:

To begin with, copper-based composites containing 5 and 10%TiC particles have been synthesized by in-situ SHS process

Attempts were made to synthesize cast Cu-5TiB_2 composites by in-situ SHS process. It has been observed that the reaction between Ti and B to form TiB_2 in the melt during the process became too fast to control leading to splashing of the melt and catching of fire. Accordingly, the idea of synthesizing Cu-TiB_2 composites by liquid metallurgy route has been dropped and powder metallurgy (P/M) process has been thought of to prepare the composites.

- The microstructural feature of the samples were examined with the help of SEM (JEOL-JSM5600) equipped with energy dispersive X-Ray spectroscopic (EDXS) facility. Samples were polished metallographically and etched suitably.
- The phases present in the composite were identified using a Brucker (Germany) make X-Ray diffractometer (XRD) using Cu_{ka} radiation at 40 kV and 40 mA and scan rate of 2°/min.
- A Brinell cum Vickers hardness tester was used at an applied load of 5 kg for the hardness measurement.

Salient Features:

Tensile and Compression Tests **:-** Tensile and compression tests were performed using an Instron 8801 universal testing machine at a strain rate of 10^{-3}/s. The tensile specimens were of 4 mm diameter and 22 mm gauge length as per ASTM standards while compression tests were performed on 12 mm long and 8 mm diameter samples.

Abrasion wear test**: -** Figure 3 shows the bar chart of comparative wear rate of bronzes and-TiC composites at a linear speed of 3 m/sec and an applied load of 10 N for a traversal distance 500 m. In general, Al-bronze (AB) exhibited higher wear rate while AB-10TiC composite experienced minimum wear rate. The wear rate of these materials followed the following sequenc**es:** AB >Nickel- Al-bronze (NAB) > AB-5TiC > AB-10TiC.

Results:

The microstructural features of Al-Bronze with 5 and 10%TiC are shown in Figures 1a & b respectively. The morphology of the TiC particles was by and large spherical. The interfacial bonding of the TiC particles with the matrix was found to be reasonably sound. The microstructure of the nickel-aluminum bronze (NAB) is shown in Fig. 1. (c) Which consists of Cu-rich solid solution (aphase) and martensitic beta-phase. The microstructural features of Cu with 5 and 10%TiB_2 are shown in Fig.1.(d) and (e) The influence of ball milling on the size of the TiB_2 particles is also evident in terms of the refinement of size. The interfacial bonding of the TiB_2 particles with the matrix was found to be reasonably sound. The XRD pattern of the as cast Al-bronze,NAB and $CuTiB_2$ is shown in Fig. 2.

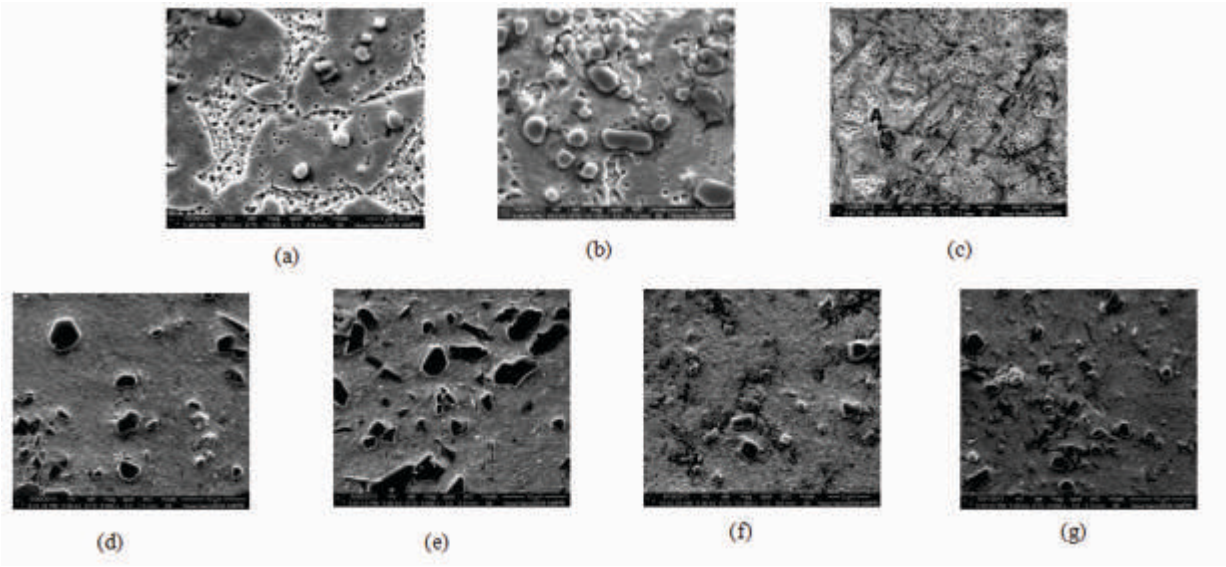


Fig. 1: Microstructure of (a) Al-Bronze-5 wt% TiC and (b) Al-Bronze-10 wt% TiC composites showing uniform distribution of TiC particles (c) Microstructure of NAB alloy showing Cu rich a regions, martensitic ßphase and Fe- based intermetallics (d) Microstructure of P/M processed Cu-TiB_2 composites prepared using the unmilled Cu+5TiB_2 powder, (e) the unmilled Cu+10TiB_2 powder, (f) Cu+5TiB_2 powder milled for 16 hrs at 5:1 ball to powder ratio and (g) Cu+10TiB_2 powder milled for 16 hrs at 5:1 ball to powder ratio

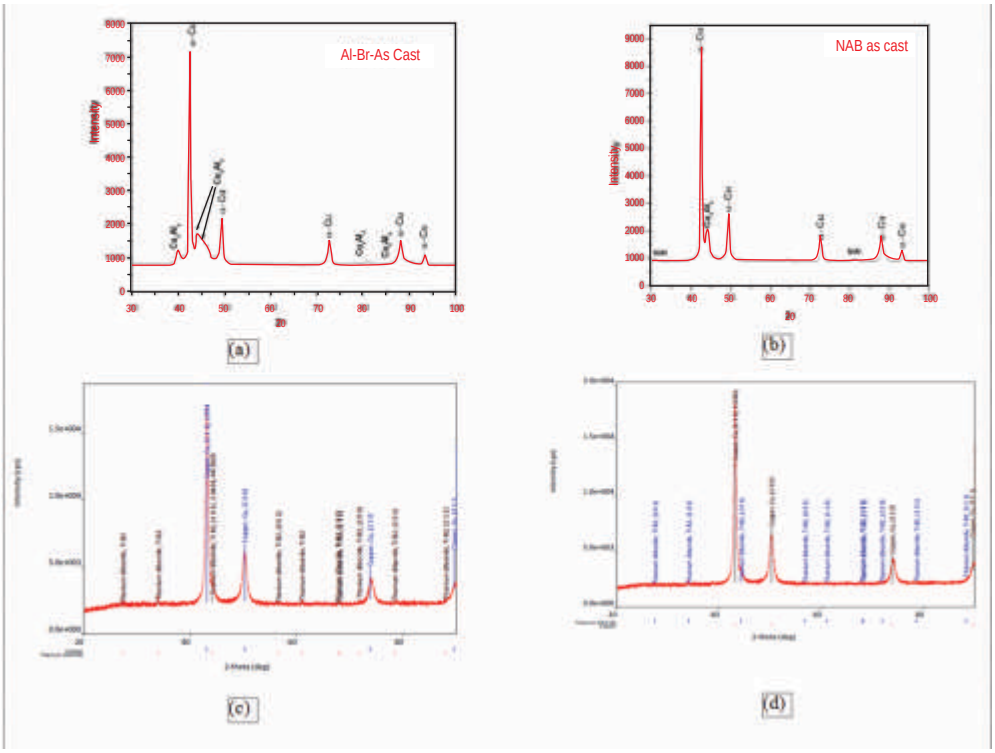


Fig. 2: (a)XRD pattern of as cast Al- Bronze showing Cu- rich aphase (b) XRD pattern of as cast Ni-Al- Bronze (NAB) showing Cu- rich aphase and Ni-Al intermetallic on top (c)XRD of Cu-5%TiB2 (d) Cu-10% TiB2 (BPR- 5)and milling time 16 hrs

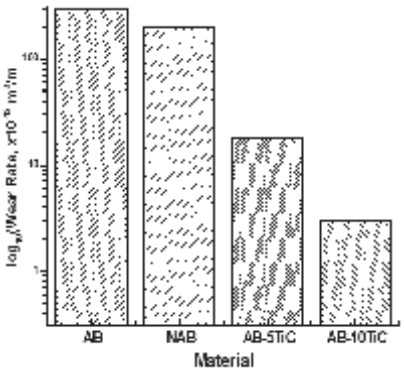


Fig.3 Abrasive wear rate of bronzes and AB-TiC composite tested at an applied load 10 N for a traversal distance 500 m at linear velocity 3 m/sec

Material/ Props	Hardness (HV)	Density (g/cc)	UTS (MPa)	Strain %
NAB	224± 01	7.54	648	3
Al-Bronze	182± 01	7.42	465	5.5
AB-5TiC	203 ± 03	7.19	450	2.7
AB-10TiC	261 ± 02	6.89	415	1.8

Development of Design Mix of Irradiation Shielding Concrete using Advanced Shielding Materials

Objectives:

Development of design mix of radiation shielding concrete, using advanced "Chemically formulated and Mineralogical designed - multi-component- multi phases containing " shielding materials, using industrial waste namely red mud shall be carried out at CSIR – AMPRI, Bhopal in collaboration with NPCIL, Mumbai

The various activities carried out are as follows:

- Preparation of a) high density aggregates by ceramic processing of red mud, followed by b) grinding of the coarse aggregates to obtain the medium and fine grade aggregates of the desired dimensions.
- Optimization of the ceramic processing parameters.
- Development of design mix using multi – component and multi ceramic phases containing shielding aggregates.
- Physical, mechanical, chemical, mineralogical and morphological characteristics of the various aggregates.
- Mix proportions, compositions of mixtures of shielding concrete, mixing, curing and testing of specimens.
- Evaluation of physical properties of developed mix concretes and mechanical properties etc.
- To understand and evolve plausible reaction mechanism, mechanistic investigations using X-ray powder diffraction, Scanning Electron Microscopy etc.

Salient Features:

Developed radiation shielding concrete possess following salient features:

- Non toxic - as it is lead free.
- The basic raw material is the waste namely - Red mud
- It is chemically formulated and mineralogically designed materials
- The novel advanced shielding materials will be consisting of grades of aggregates ranging from e.g. coarse with 3800- – 4200kg/m^3, medium – 3000- 4000kg/m^3 and fines with 2800- 3000kg/m^3.
- Posses better heat resistance.
- The materials contain multi elements/ multi ceramic phases and the multi layered crystal structures.
- The matrix posses particles ranging from sub micron to micron and can be further reduced to nano sizes.
- Corrosion resistant.

- The advanced shielding concrete system is presently seems to be relatively cheaper but its widespread use, for example in making total residential as well as all official establishment of nuclear power plants radiation proof will certainly make it economically feasible.

Sintering of red mud at semi pilot plant level with additives at CDGI, Firozabad for development of shielding aggregate

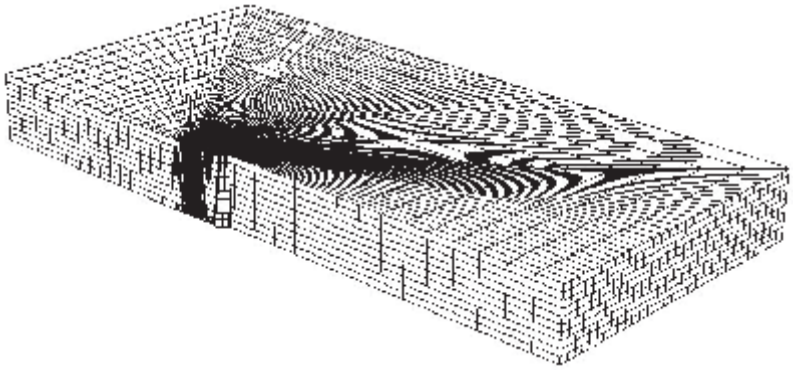
Characterizing Numerical SZW Evaluation for Determining Ductile Material Fracture Toughness (JSZW)

Objectives:

- To establish new methodology of numerically predicting geometry independent fracture toughness (JSZW) of ductile material.
- Validating the new numerical SZW methodology based on ASTM standard recommendations.
- Characterization of different fracture specimen geometry for the evaluation of SZWc based initiation fracture toughness (JSZW).
- Establishing the SZW methodology under mix mode fracture condition.
- Developing understanding of standard fracture specimen behaviour during the blunting process and in smooth tensile specimen test based on crack tip constraint using the 3D FEM results.
- Validation of numerical simulation results with experimental results.

Salient Features

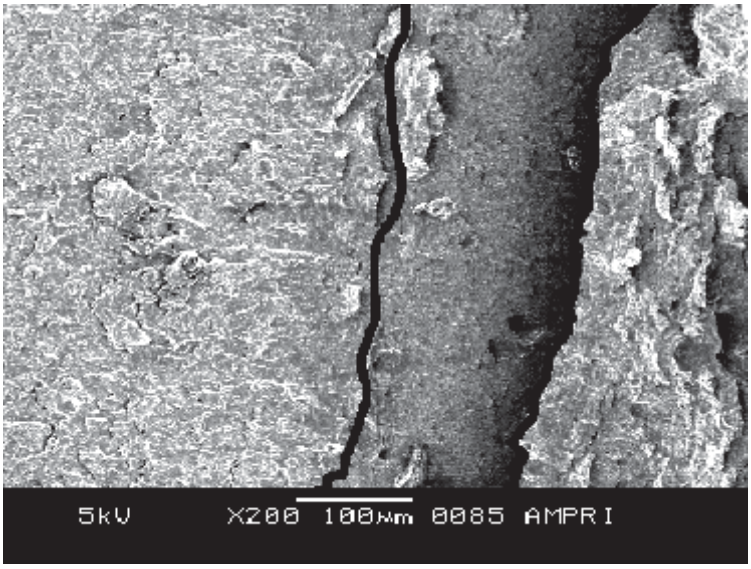
The problem in critical stretch zone width (SZWc) experimental evaluation is in identifying the size of stretch zone on a blunted crack front, as this requires a high degree of precision and expertise in measuring the SZW. Recently, the dependency of SZWc on the fracture specimen thickness has been numerically predicted. Thus to obtain geometry independent SZWc based evaluation of initiation fracture toughness (JSZW) value, there is a need to understand the variation of SZWc with geometry which may include fracture specimen thickness, initial crack size, fracture specimen geometry and the type of loading. The present work attempts to predict numerically this variation using the newly developed energy based numerical evaluation method of critical SZW prediction. To have better understanding of the variation of fracture parameter across the thickness three dimensional (3D) finite element method (FEM) model of fracture specimens have been used. The study has been conducted using Mod 9Cr1Mo steel material supplied by IGCAR and also on 20MnMoNi55 material supplied by BARC. The variation of critical SZW is also evaluated experimentally by varying the relative crack size and the thickness of fracture specimen.



FEM mesh of CT specimen

Compact Tension Specimen

Fracture Surface of Tested Compact Tension Specimen



Demarcated Critical SZW Region Observed on SEM

Ongoing Sponsored Projects

Utilisation of Variety of Fly Ashes Available at M/s JSPL, Raigarh, for developing Cementatious LSA (Ligno-Silico-Aluminoius) Materials for Non- Structural Applications

Objectives:

Development of a novel process for making Fly ash based LSA cementitious materials useful for making Cement Free Concrete of varying grades for non - structural applications depending on the characteristics of fly ashes and aggregates available at M/s JSPL, Raigarh (C.G.)

Salient Features:

- Developed Advanced Ligno-Silico-Aluminous Materials
- Prefabricated Materials
- Material: Manmade on Site
- Cube: (15 cms x 15cms x 15 cm)
- Irrigation Channel
- Panel (1 x 1 feet)
- Materials - By Mechanization
- Panel 2 x 2 feet

Properties Obtained

Property	Value
Density (Kg/m^3) (IS 2185-1978 Part I and II)	1200-2500
Compressive Strength (MPa) (IS 2185 1978 Part II)	20-35
Flexural Strength (MPa) (IS 516 -1959)	3-4
Water Absorption (%)(IS 2185-1978 Part I and II)	5-8
Machinability	Possible
Mouldability	Possible

On-site Manual Preparation of Panels:

Development of Aluminium Alloy Silicon Carbide Metal Matrix Composites & Analysis as per specs

Salient Features:

Aluminum composites have better specific strength and stiffness as compared to the matrix alloys. Additionally, aluminum composites exhbits around 100 times better damping capacity than that of the aluminum alloy. Further more, the vibration emitting from the motors of the torpedoes will affect the functioning of the torpedoes. It is therefore necessary that most of the vibration produced should be absorbed by the structural material (composite material) and noise level will minimize which improves the performance. As far as the cost is concerned, aluminium composite cost is almost comparable to that of aluminum alloy. However, machining cost will be marginally higher in case of composites. Thus, with the addition of marginal cost, the performances of torpedoes could be improved significantly if the aluminum alloys are replaced with aluminum composites. The proposed work will also generate expertise and competence in the area of aluminum composites for such applications and especially in making fine particle dispersoid composites. Furthermore it will help in generating data bank which could be base for developing new generation torpedoes and in finding applications in new and strategic areas. Through this project work capacity and confidence will be built up for high performance product development.

Feasibility Studies on Variety of Fly Ashes Available at M/s Sesa Sterlite Ltd. (Vedanta group Co) Lanjigarh, Dist. Kalahandi , Odisha for Development of Cement Free Concrete of Varying Grades Depending upon Characteristics of Fly Ashes and Aggregates for Non Structural Applications

Objectives:

Development of a novel process for making Fly ash based LSA cementitious materials useful for making Cement Free Concrete of varying grades for non-structural applications depending on the characteristics of fly ashes and aggregates available at M/s Sesa Sterlite Ltd. (Vedanta group Co) Lanjigarh.

Salient Features:

- Chemical, morphological and mineralogical characterisation of fly ash received from M/s Sesa Sterlite Ltd. (Vedanta group Co) Lanjigarh, Dist. Kalahandi, Odisha has been carried out.
- Experimental studies were carried out by varying parameters for testing of fly ashes for making cement –free concrete.
- The sample has shown potential of making cement free green concrete and prefabricated materials.

Experimental Photographs

Ongoing Consultancy Projects

Turbine Blade Failure Analysis

Objectives

a. To find out the root cause of the failure

b. To formulate remedies to avoid failure

Salient Features

M.P. Power Generating Company Ltd. has approached CSIR-AMPRI for the failure investigation of the LP turbine blade of 210MW. Under the field investigation, visual examination was carried out. Additionally, the plant record data collected to have comprehensive understanding about the service exposed condition. Fig. – 1 shows the turbine, of which blades have been failed. The failed blade along with two adjacent blades brought to Laboratory for further study, examinations and analyses (Fig.– 2).

FIG.1

FIG. 2

The Laboratory Investigation, Visual Examination, Non-destructive Examination, Finite Element Analysis, Metallographic study, and Testings have been performed to have proper understanding about the root cause of the failure. Fig. – 3 illustrates the Liquid Penetration Test (LPT) in Fluorescent Mode carried out for the broken blade pieces and Fig. 4 shows the tensile tested specimens of a blades (19) brought for the Laboratory Investigation.

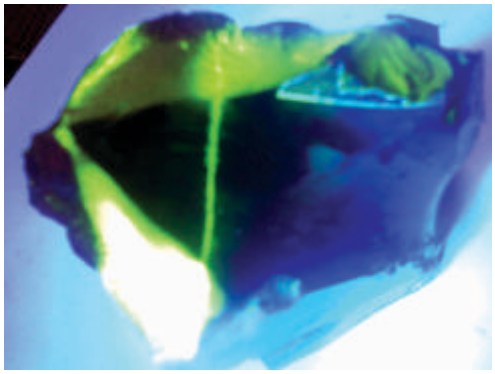


FIG. 3: LPT (FLUORESCENT DONE FOR A BROKEN BLADE PIECE

FIG.4:TESTED TENSILE SPECIMENS (19)

Impact of PoP made Idol Structures on Immersion in Water Bodies

Objectives:

The objectives of the study would be to set up lab scale facilities for experimental evaluation of the impact made by the immersion of idol structures on the water bodies.

- Setting up of lab scale facilities in the laboratory to carry out experimental work of idol immersion using large size tanks.
- Setting up of one water tank as reference medium for the study and immersion of PoP made idol structures in one tank and earthen clay/soil made idol structures in another tank in the laboratory.
- Periodic collection of samples from the set-up lab scale water bodies (large size water tanks) before and after the immersion of idol structures and characterization of water sample used for the reference purpose.
- Detailed physico-chemical characterization of water samples collected at regular intervals from idol immersed tanks and its analysis for parameters like pH, alkalinity, hardness, total solids, chlorides, sulphates, DO, BOD, COD etc.
- Determination of heavy metals like iron, copper, lead, manganese, cadmium, chromium, nickel present in the water samples before and after the immersion of idols in the water tanks through AAS technique.
- Comparative study on the results collected before and after the immersion of different types of idol structures and its overall impact on the water quality.
- Preparation of the final report incorporating the findings of the study and submission to M.P. Pollution Control Board, Bhopal.

Impact of idol immersion on the quality of water bodies

The immersion of PoP made idol structures pose threat to the environment when they are immersed in the water bodies. The metal content present in the idol structures pollute the water bodies and make the water unsafe and unfit for drinking and other purpose. The clay/natural soil made idols are more environment friendly in nature. The approach of the present study is to study the impact of PoP made idol structures on water quality after immersion in water bodies. The impact of idol immersion causing any possible nuisance on the water quality shall be studied at the lab scale experimental level and results shall be presented in

Societal Activities

Prefabricated Composite Panels for Rural Housing

Most of the people in rural areas live in Kucchha houses with little basic amenities including that of toilet facilities. This is a matter of serious concern especially for women population as they have to go to the long distance in rainy/winter seasons and many times using dark roads to areas under extreme unhygienic conditions. Conventional construction methods are also time consuming and need skilled labor at site. To overcome these difficulties, CSIR-AMPRI has developed an alternative cementitious binder material for housing applications, utilizing fly ash from thermal power plants (90%) and alkali. This material does not require water for curing and also sets faster. This material can be casted in place of cement to produce wall panels, columns, roofing sheets etc. in combination with aggregates/stone dust/sand and wire mesh etc. using local manpower at site. The building components can also be made at a centralized facility and transported to construction site to erect houses rapidly. Toilets for rural applications can be made from the prefabricated components and erected at site. A large number of compositions have been developed based on requirement.

Fly Ash

Fine aggregates

Alkaline Activator

Welded mesh

Raw materials mixing

Sample cubes of size 7.06 cm × 7.06 cm × 7.06 cm

Determination of Compressive strength

Raw Materials used and casting of sample cubes of cement free mortar

Mixing of materials

Mould filled with prepared Mix

Prepared Panels

Manual preparation for Panels of size 60 cms × 60 cms × 2.5 cms

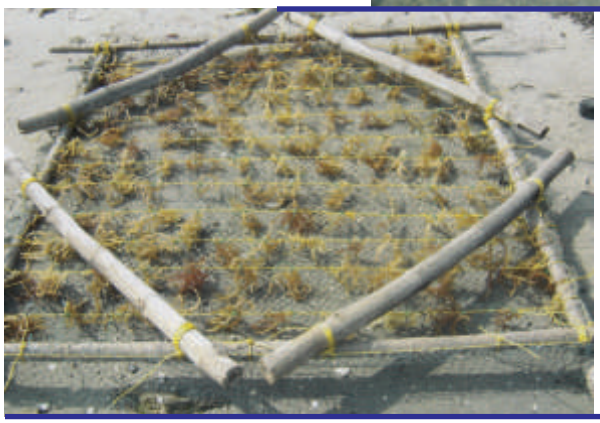
Reinforced Bamboos for Rafts

Reinforced bamboos are developed at CSIR-AMPRI, Bhopal by reinforcing the surface of the bamboo to improve its performance. Reinforced bamboo can provide better strength in perpendicular direction, can be nailed and are moisture resistant due to the presence of polymer on the surface.

CSIR-CSMCRI (Mandapam Centre) started field trials for sea weed growing in the sea by using the reinforced bamboo raft developed by CSIR-AMPRI Bhopal.

Method of tieing the reinforced bamboo

Method of making Raft



Preparation of sea weeds growing

Important Events

Technology Day Celebration

On May 10, 2013, the Technology Day Celebrations were Inaugurated by the Chief Guest - Dr. Krishan Lal, President, Indian National Science Academy (INSA) in a simple function, where, Dr. Vinod Kumar Singh, Director, Indian Institute of Science Education and Research (IISER), Bhopal, Dr. Pramod Kumar Verma, Director General, Madhya Pradesh Council of Science and Technology (MPCST), Bhopal and Dr. Appu Kuttan K.K., Director, Maulana Azad National Institute of Technology (MANIT), Bhopal were the Guests of Honour. Dr. Navin Chandra, the then Acting Director welcomed the Guests and stressed the need for developing relevant Technologies for Utilization in Industries to place the country in forefront of Technologically developed countries. Dr. Krishan Lal, delivered the Technology Day Lecture on the topic, "Advances in Understanding Real Structure of Materials". Dr. V. K. Singh appreciated the Technologies developed by CSIR laboratories in last 70 years and emphasised that AMPRI must focus on this task. Dr. P.K. Verma stressed that AMPRI being the only laboratory of CSIR in the state of MP, should also contribute to the Technological Development of the State to improve economic condition of the population, especially the weaker Sections. Dr. Appu Kuttan stressed the need for collaboration between National R & D Institutions and Educational Institutes and welcomed the lead taken by CSIR-AMPRI in its efforts to network leading Educational and R & D Institutes located in Bhopal. Shri P.D. Ekbote, Chief Scientist, AMPRI proposed the Vote of Thanks.

Technology Day Celebration

Workshop on Innovative Welding Technology

A workshop on "innovative Welding Technology" was organized at AMPRI Bhopal under MSME-CIC Initiative programme for fabrication Industries of Govidpura and Mandideep on May 18, 2013. Dr. Navin Chandra, the then Acting Director, welcomed the guests. Dr. Uttam Ganguly, a leading industrialist & Technocrat stressed upon the need of such professional workshops. Shri V.P. Sharma, MSME-

Development institute elaborated the assistance and facilities provided by the Ministry of MSME for micro, medium and small enterprises in Madhya Pradesh as well as India. Experts Shri H.K. Gupta, BHEL; Dr. Lakshmi Raman of Railway Coach Factory and Mr. R.S. Solanki, scientist, AMPRI spoke on 'Digital Manufacturing', 'Intricacies in Rehabilitation of Railway Coaches' and 'Advancements in joining processes' respectively. Dr. S. Das and Dr. O.P. Modi, scientists, AMPRI described the R&D activities being carried out by CSIR and AMPRI. Dr. A.K. Jha, Chief Scientist & Nodal Officer for CSIR-MSME-CIC Initiative emphasized the need of R&D and innovative inputs for the promotion and upliftment of MSME in India. The workshop was attended by a large number of professionals from Industries, scientists, technocrats, faculty & students of engineering colleges.

Workshop on Innovative Welding Technology

Workshop on Tribology: Machine, Materials and Maintenance

Tribology Society of India (TSI), Bhopal Chapter in association with CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal organized a workshop on "Tribology: Machine, Materials and Maintenance" on JULY 6, 2013 in CSIR-AMPRI Auditorium. Inaugurating the workshop, the Chief Guest, Shri R. K. Datey, Chief Executive, S.S. Thermal Power Plant, Khandwa felt that the subject is of direct relevance to the wear related problems experienced in their thermal power plants. Prof. Appu Kuttan K.K., Director, MANIT Bhopal gave the presidential address highlighting the role of tribological studies in machine maintenance. Dr. Anish Upadhyaya, Professor , IIT Kanpur and Dr. Jyotsna Dutta Majumdar, Professor ,IIT Kharagpur, Guests of Honour expressed their views pertaining to the significance of tribology in practice in finding solutions. Dr Navin Chandra, the then Acting Director, CSIR-AMPRI Bhopal spoke on CSIR in general and AMPRI in particular. Dr O.P. Modi, Chairman, TSI Bhopal Chapter welcomed the august gathering and highlighted the work carried out at AMPRI in the area of Tribology of Materials. He also elaborated the theme of the seminar and its importance in the present context. The Organizing Secretary of the workshop, Dr D.P. Mondal proposed the vote of thanks. Dr A.K.

Jha, Chief Scientist, AMPRI was the Convener of the Inaugural function.

Two Technical sessions namely i) Wear behavior of materials and ii) surface engineering were also organized during this Workshop in which experts in the field from Industries and IIT's, CSIR-AMPRI Bhopal delivered their invited lectures. The Workshop was attended by around 170 participants from different organizations like MANIT Bhopal & other Engineering colleges, important industries like BHEL, Andritch Hydro, MPEB along with CSIR-AMPRI.

A view of the dais

CSIR Foundation Day Celebration

Council of Scientific & Industrial Research (CSIR), which is one of the largest S&T bodies in the country, celebrates its Foundation Day on September 26 every year. One of its constituent institutes, Advanced Materials and Processes Research Institute (AMPRI), Bhopal is its only laboratory in the Central India. AMPRI, Bhopal celebrated 71st CSIR Foundation Day on September 26, 2013 at the AMPRI auditorium.

Prof. Pradeep Mathur, Director, Indian Institute of Technology, Indore was the Chief Guest and Prof. Akhilesh K. Pandey, Chairman, M.P. Private Universities Regulatory Commission, Bhopal; Prof. Pramod Kumar Verma, Director General, M.P.Council of Science and Technology and Dr. M.Sathya Prasad, General Manager, Technical Centre, Ashok Leyland Limited, Chennai were the guests of Honour.

At the outset, Dr. S.Das, Chief Scientist and Head, Publicity and Public Relation, AMPRI welcomed the distinguished guests.

Dr. Navin Chandra, the then Acting Director, CSIR – AMPRI in his address highlighted the importance of the occasion and talked about the history of establishment of CSIR. He also underlined the achievements of CSIR and AMPRI.

In his address Prof. P.K.Verma spoke about the contribution of CSIR in Indian S&T scenario. He said that networking and sharing of resources is important for development. He said that today many people from

villages are migrating to cities due to lack of employment there. We have to provide S&T input for their activities for their growth, he said. He also underlined the role of CSIR – 800 programme in this context. He said that scientific process should be exclusive and development should be inclusive and there should be synergy between both of them.

Prof. Akhilesh K. Pandey underlined the importance of indigenous technology. He said that with borrowed technologies we can establish good industries, but our national pride comes with our technologies itself. He emphasized the need to collaborate with the private universities.

Prof. Pradeep Mathur in his address underlined possible role of S&T in addressing social issues like road accidents, infant mortality and women's safety. Science and Engineering have to work together, boundaries between the disciplines are melting away and this is the way we can go futher, he said.

Sh. Ram Sarup, Contorller of Administration proposed the vote of thanks.

The chief guest also presented the recognitions and awards. Mementoes were given to the staff for completing 25 years of service in CSIR. In-house awards for achievements by the staff were also presented on this occasion. Prizes for quiz organized by IIM, Bhopal Chapter were also given away.

In the Technical Session a lecture was delivered by Dr M. Sathya Prasad on "Foundation for Indianizing Engineering Innovation"

In the afternoon an Open Day Programme was organized for the students, entrepreneurs and general public to help them in getting acquainted with the activities of AMPRI and CSIR. A large number of Engineering students interacted with the scientists. The students presented their quarries and the scientists attended them.

CSIR Foundation Day

Inauguration of the Exhibition

College students during the Open Day exhibition

National Science Day Celebration

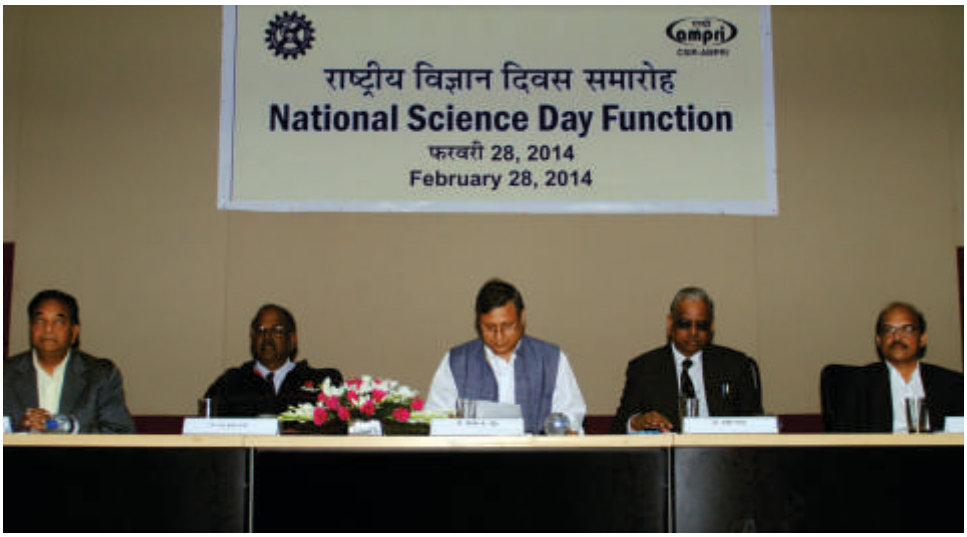
National Science Day was celebrated on February 28, 2014 at CSIR-Advanced Materials and Processes Research Institute, Bhopal. This day is celebrated every year to commemorate the discovery of 'Raman Effect' by eminent scientist Sir C.V.Raman.

Prof. V.K.Singh, Director, IISER, Bhopal was the Chief Guest and Prof. Appu Kuttan K.K., Director, MANIT; Bhopal was the Guest of Honour at the function. At the outset, Dr. Navin Chandra, the then Acting Director welcomed the guests and highlighted the importance of this celebration and commitment of AMPRI to vigorously pursue Science and Technology in the service of the nation. He also informed that in the current financial year two technologies have been licensed by AMPRI for commercial utilization by industries.

Prof V. K.Singh delivered the Science Day Lecture on “Organic Synthesis: From Creativity to sustainability and human well being” on the occasion. He also highlighted this year’s theme of the celebration- Fostering Scientific Temper. Dr. Appu Kuttan K.K. delivered a talk on “Recent trends in manufacturing”. In an interesting manner he underlined the historical resume of manufacturing and said that engineering and science are working very closely today.

Dr. S.S. Amritphale and Dr. B.K.Prasad, Chief Scientists introduced the guests. Dr. Sunil K. Sanghi, Sr. Principal Scientist presented the vote of thanks.

In the afternoon, poster presentation session was organized for the research fellows and the best posters were awarded.



A view of the dais

Experts examinig the posters

Experts examining the poster session

Workshop on Entrepreneurship Development

"Entrepreneurship Development Workshop" organized by Council of Scientific and Industrial Research, New Delhi & CSIR-Advanced Materials and Processes Research Institute, Bhopal Supported by Ministry of Micro, Small and Medium Enterprises, Government of India at CSIR- Advanced Materials and Processes Research Institute (AMPRI) Bhopal on March 28, 2014. The entrepreneurship development workshop envisaged to provide S&T inputs to the entrepreneurs, budding entrepreneurs, MSME's and others for enhancing their competitiveness, enlarging their product range, improving quality of products and introducing environment friendly green technologies by disseminating technologies/processes developed and expertise available at CSIR-AMPRI Bhopal. The networking of scientists and entrepreneurs is essential for introducing latest and innovative technologies in industries for the development of the nation. Keeping in view this, the workshop was conducted with the prime objective of collaboration with the prospective entrepreneurs in the identified sectors to prove/validate the innovative industrial improvements, which pertain to the utilization of innovative expertise for the technological inventions in following sectors:

(a) Materials for construction industry

(b) Metallurgical components

(c) Fibre and polymer based materials

The inaugural function was held in CSIR-AMPRI auditorium. Dr. D. S. Mandloi, Director, MSME Development Institute, Indore; Dr. G. Singh, Former Director, CIAE Bhopal; Dr. J. S. Chouhan, Prof. and Head, Deptt. of Civil Engg., SATI Vidisha, Dr. A.K. Jha, Chief Scientist & coordinator MSME from AMPRI and Dr. Navin Chandra, the then Acting Director, CSIR-AMPRI Bhopal were the eminent persons present

on dais. Further, eminent industrialist like Shri C. P. Singh, President and Shri Rohit Jaiswal, Secretary, from Khurai Agricultural Association, Shri R.S. Kharab, President, Govindpura Industrial Association, Bhopal, Shri Omprakash Chouksey, President M.P. Krishi Upkaran Nirmata Sangh, Shri Kapil Gupte from High Fly Ash Cluster Private Limited and many important industrialists were also present. There were a very large number of participants from MSME sector from different parts of the country such as Noida, Hisar, Pune, Mumbai, Raipur etc. A total of about 160 participants took part in the one day Entrepreneurship Development Workshop.

A view of the dais

Entrepreneurs and AMPRI Scientists during Workshop

General Information

Research Council

Dr. G. Sundararajan Director International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI) Balapur P.O., Hyderabad -500005(AP)	Chairman
Dr. T. Jayakumar Distinguished Scientist & Director, Metallurgical & Materials Group Department of Atomic Energy Indira Gandhi Centre for Atomic Research Kalpakkam - 603102	External Member
Prof. Vinod Kumar Singh Director Indian Institute of Science Education and Research Indore Bye pass Road, Bhauri Bhopal - 462030	External Member
Prof. B.S. Murty Dept. of Metallurgical & Materials Engineering Indian Institute of Technology Madras Chennai-600036	External Member
Prof. Umesh Waghmare Theoretical Sciences Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur P.O., Bengaluru-560064	External Member

Dr. M. Sathya Prasad General Manager, Advanced Engineering Technical Centre, M/s. Ashok Leyland Vellivayal Chavadi, Chennai - 600103	External Member
Prof. Pramod K.Verma Director General M.P. Council of Science & Technology Vigyan Bhawan, Science Hills, , Nehru Nagar Bhopal -462003	Agency Representative
Dr. M. Lakshmi Kantam Director , CSIR-Indian Institute of Chemical Technology, Uppal Road, Hyderabad- 500007	DG Nominee
Dr. Nagesh R. Iyer Director CSIR-Structural Engineering Research Centre CSIR Road, Taramani, Chennai - 600113	Sister Laboratory
Prof. B. K. Mishra Director CSIR-Institute of Minerals & Materials Technology Bhubaneswar - 750013	Cluster Director
Dr. Navin Chandra Acting Director Advanced Materials and Processes Research Institute Hoshangabad Road, Near Habibganj Naka Bhopal-462026	Director
Head or his Nominee Dr. Sudeep Kumar Planning & Performance Division (PPD) Council of Scientific and Industrial Research	Permanent Invitee

Management Council
(up to 31 December, 2013)

Dr. Navin Chandra Acting Director Advanced Materials and Processes Research Institute	Chairman
Dr. S. R. Wate , Director, NEERI, Nagpur	Member
Shri P. D. Ekbote, Chief Scientist and Head, PPD	Member
Dr. O P Modi, Chief Scientist, AMPRI Bhopal	Member
Sh. A. K. Singh, Sr. Principal Scientist	Member
Dr.Raghuvanshi Ram, Principal Scientist	Member
Dr. Sanjay Panthi, Sr. Scientist	Member
Dr. N. Saha, Sr. Tech. Officer	Member
Shri Ajay Kumar, FAO	Member
Sh. Ram Sarup COA	Member Secretary

Management Council
(from 1 January, 2014 onwards)

Dr. Navin Chandra Acting Director Advanced Materials and Processes Research Institute	Chairman
Dr. S. R. Wate , Director, NEERI, Nagpur	Member
Sh. P.D. Ekbote, Chief Scientist and Head PPD	Member
Dr. S.S. Amritphale, Chief Scientist	Member
Sh. H.N. Bhargaw, Principal Scientist	Member
Dr. D P Mondal Senior Principal Scientist	Member
Sh. Meraj Ahmed Scientist	Member
Dr. Ajay Naik Sr. Tech. Officer	Member
FAO	Member
COA	Member Secretary

Patents

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Technologies / Knowhow Transferred

Green Cement Technology/Knowhow to JSPL, Raigarh

On the Technology Day, the May 11, 2013, technology transfer documents for licensing of the process for making fly ash based cementitious materials useful for making Cement Free Concrete of varying grades, depending on the characteristics of fly ashes and aggregates for non-structural applications was signed between CSIR-AMPRI and Jindal Steel and Powers Ltd (JSPL), Raigarh. The process is useful for making concrete suitable for road laying, repair and other applications and completely obviates the use of cement and thus also does not require water during the curing process needed in the conventional concrete. The avoidance of cement in the concrete has further advantage of reducing the carbon dioxide load in environment as otherwise each ton of cement production leads to the generation of one ton of carbon di oxide – a Green House Gas. The Process has been licensed to JSPL on non-exclusive basis for their internal use.

Signing of agreement between CSIR-AMPRI and Jindal Steel and Powers Ltd. (JSPL)

Hammer Tips for Sugar Mills

Sugar production has gained the shape of a well recognized industry in the country. There are around 400 sugar mills operating in different parts of the country to realize the production of sugar through the processing of cane. Hammer Tips are the most essential component of a Fibrizer unit of a sugar mill used for fibrizing the sugar cane. A sugar mill consists of several processing units and each processing unit in the turn involves the use of 100-200 hammer tips depending on crushing capacity. This suggests the requirement of around 1.50 lakhs of Hammer Tips by all the mills in the country every year involving a considerable financial investment (~ Rs. 30 crores), the major portion of which is drained out of the country as foreign currency towards the import of hard, impact and corrosion resistant tip material. Thus, large monetary savings can be envisaged through the indigenization of the manufacturing of the Hammer Tips.

Fibrizer Hammer Tip components have been developed at CSIR-AMPRI, Bhopal for the use in Sugar Mills under a project entitled “Development of cost effective Fibrizer Hammer Tips for Sugar Mills” sponsored by “TIFAC, Sugar Technology Mission, New Delhi. The study comprises laboratory scale investigation on the existing hammer tip component material and development of a modified version of the hammer tip material involving compositional and microstructural modifications. Hammer tips were fabricated using the developed material and their performance evaluated under actual working conditions in a sugar mill. The developed components are envisaged to be cheaper by around 40% as compared to the conventional imported ones with improved performance, thereby leading to a substantial monetary savings in view of the large volumes of consumption of the component in various Sugar Mills in the country.

With a view to translate the outcome into practice, the developed knowhow has been transferred by CSIR-AMPRI, Bhopal on January 6, 2014 to an industry namely M/s Asugar Engineering Services, Pune. In lieu of the knowhow transfer, CSIR-AMPRI, Bhopal has received one time license fees while royalty is also to be paid by the party in the due course of time.

Transfer of Technology of Hammer Tips for Sugar Mills

MSME Activities

Activities related to support to MSME were undertaken by AMPRI. A common problem of the fabrication industries engaged in making materials for electrical machines is disposal of polymer and ceramic waste. Rejects, cuttings, dust, machining chips etc. can't be thrown out due to environmental pollution implications. Concerned industries were visited and a project was formulated for grading and utilizing the wastes for making building materials, for support from DSIR-DST, New Delhi. Visits were made to MSME Development Institute, Indore, DSIR-DST, New Delhi for discussions regarding MSME'S benefits and projects.

A workshop on “innovative Welding Technology” was organized at AMPRI Bhopal under MSME-CIC Initiative programme for fabrication Industries of Govidpura and Mandideep. An Entreprenuer Development Workshop was organized for budding and existing industrialists of Bhopal in which technologies developed by CSIR-AMPRI were promoted.

Further, scientists represented CSIR-AMPRI in meetings at local and national levels organized by different Centres of CII, Engineering Export Promotion Council, Govindpura Industries Association, Bhopal, Pithampur Auto Clusters, pithampur. A number of meetings conducted by MP Govt. Offices, such as, Dept. of Industries, Laghu Udyog Sangh, IL & FS etc. were attended to provide technical inputs for vendor development and industrial growth of the countries. Participation was made in MP Govt. meetings for formulating programmes for growth of manufacturing industries of the country.

Industrial Expo 2014

India Engineering Sourcing Show 2014

Laser Particle Size Analyzer

Make : Horiba

Model : Partica LA-950v2

Range : 0.01 to 3000 µm

Mode : Wet & Dry

Particle size influences many properties of particulate materials and is a valuable indicator of quality and performance. It is very important to control particle size and distribution for research and development, as well as quality control, of particulate substances and products. Particulate substances are used in various fields from state of the art technology such as in food, pharmaceuticals, and chemistry to daily consumer products. The size and shape of powders influence flow and compaction properties. Larger and more spherical particles will typically flow more easily than particles of smaller or high aspect ratio.

Differential Scanning Calorimeter (DSC)

Make : Mettler Toledo

Model : Star DSC 1

Range : -150^{0} C to 600^{0} C

Automatic Sample handling up to 34 samples

To study the change in properties of a material with temperature, thermal analysis techniques are employed. In Differential Scanning Calorimetry (DSC), the difference in amount of heat required to increase the temperature of sample and reference is measured as a function of Temperature. In this experiment, the sample and reference maintained nearly at the same temperature throughout the experiment. A highly sensitive ceramic sensor is used to measure the difference between the heat flows. The result of a DSC experiment is a curve of heat flux versus temperature or versus time. There are two different conventions: exothermic reactions in the sample shown with a positive or negative peak, depending on the kind of technology used in the experiment. This curve can be used to calculate enthalpies of transitions. Differential scanning calorimetry can be used to measure a number of characteristic properties of a sample. Using this technique it is possible to observe fusion and crystallization events as well as glass transition temperatures Tg. DSC can also be used to study oxidation, as well as other chemical reactions.

AcSIR Activities

The Academy of Scientific and Innovative Research (AcSIR) has been established in July, 2010 and later formalised under Parliament's Academy of Scientific and Innovative Research Act, 2011 vide the Gazette of India No.15 dated February 7, 2012 and notified as an Institution of National Importance on April 3, 2012. It is envisaged to emerge as a world class institution. The main objective of AcSIR is to prepare the young and talented minds for the futuristic S&T requirements of the country using the multidisciplinary R&D expertise and facilities available at all the institutes of CSIR.

AcSIR activities commenced at CSIR–AMPRI from December, 2010. Ph.D. Program in Engineering (Materials Science and Technology) has been initiated at CSIR-AMPRI, Bhopal from January 2014 under the aegis of AcSIR by giving admission to five students. It is proposed to offer Ph.D. at AMPRI in the areas of Lightweight and high strength materials, Shape memory materials, Nanostructured alloys and composites, Natural resources and waste utilization, Natural fibre based construction materials, Radiation shielding materials, Microfluidics, and Environmental, Applied and Industrial Chemistry. In order to effectively run various activities of AcSIR-AMPRI, Director-AMPRI inaugurated the newly allotted blockon January 13, 2014.

Inauguration of AcSIR-AMPRI Block

Knowledge Resource Centre

Knowledge Resource Centre popularly known as KRC is a new terminology for the Technological Information Centre and earlier library established at different CSIR Institutes. It may be mentioned that, it has become imperative to give the available technical/scientific information/expertise and other related aspects a wide publicity so that one could take advantage of each others' resources and move forward more effectively in the changing scenario of information technology. To fulfill this objective, CSIR has become the leading agency towards the establishment of a National Knowledge Resource Consortium (NKRC) with DST as one of the members at present. The number of agencies to join NKRC is to grow substantially in the near future. One of the objectives of NKRC is to jointly subscribe various print/electronic resources available through different agencies and share each others' resources (including the existing ones) effectively. This helps to avail the facilities on an economical basis by avoiding/minimizing duplication and make interaction with each other live.

Needless to say, the above objective of NKRC cannot be fulfilled unless information about institutions/personnel is available on a common platform to make it accessible to the concerned ones. Preparation of an Institutional Repository (IR) under the CSIR's Open Acess (OpAc) policy thus becomes essential in the entire exercise. The repository is supposed to contain a soft copy of the complete collection of information about the achievements and various R&D and other activities of the concerned Institute as well its personnel. Various items to be included in the IR are theses, work reports, annual reports including other (weekly, monthly, quarterly, half yearly) reports generated at the institute from time to time, project proposals, project reports, research publications, books authored by the staff members, work experience and achievements of different staff members. Added to that is the online display of resources procured/subscribed by a CSIR-institute. All the information needs to be up to date and for total life span of the Institute i.e. right from the inception of the Institute till date

Keeping in view the large quantum of work involved towards establishing the IR by different CSIR-Institutes, a network project namely KNOWGATE has been formulated at CSIR level. The project is being led by CSIR-NISCAIR, New Delhi while almost all Institutes/labs of CSIR are participating. The work derives strength from the fact that the use of information technology tools to handle large amount of data/information across various sectors has become a primary need of the present scenario. Further, open source, large data/ information collections, knowledge management, performance management etc. could be managed through cloud computing. In S&T, cloud computing can be leveraged as a catalyst for process transformation and service innovation. At present CSIR-AMPRI KRC is using proprietary software for library management system called "LIBSYS" for managing its resources. To make the information storage, retrieval and sharing exercise more effective, activities pertaining to the creation of a CSIR distributed library/virtualized union OPAC system with CSIR holdings using Z39.50 protocol & Open source integrated library management software is in progress. The major objectives of the comprehensive CSIR Knowledge Gateway (KNOWGATE) programme are to (a) enhance the capacity and capability of CSIR computing power through CSIR private cloud Infrastructure and Open Source Software Technology Solution Cell (OSSTSC), (b) provide the knowledge resource centres (KRCs) of different CSIR Institutes

an Integrated Library Management Solution using open source software, (c) share information resources among different CSIR laboratories by creating CSIR Distributed Library: catalogue sharing; inter library loans & referral services for document supply and (d) analyze CSIR research, technology and related data using multi-dimensional analysis.

With regard to the preparation of AMPRI-IR, work is in progress at its Knowledge Resource Centre (KRC). In this direction, an open source software solution for digital library and integrated library management system (ILMS) has been customized. Nearly 9,033 entries of books, journals etc. have been migrated to the newly developed ILMS. This includes Open Public Access Catalogue (OPAC) which is compatible with Z39.50 protocol. Moreover, a multi dimensional analysis system is also under development. The AMPRI-IR also displays nearly 700 research publications authored by AMPRI-staff, annual reports, quarterly reports, Agrasar (Quarterly publication) etc. For the general public, access of research publications through the AMPRI-IR has been limited at present to the extent of abstract only in view of copyright issues involved.

Lectures Delivered

I. B. Singh : Synthesis of γ MnOOH and β MnO2 nanowires and their electrochemical capacitive behavior, 10th Pacific Rim Conference on Ceramic and Glass Technology, San Diego CA. June 2-7,2013

R.K. Rawlley : Training workshop on 'climate change impacts on water, sanitation & health', Lal Bahadur Shastri National Academy of Administration (Govt. of India) Mussoorie, June 26-27, 2013.

P. Asokan. : Jarosite waste recycling in composites and opportunities, Interactive meeting for jarosite waste immobilisation and recycling and collaborative research programme HZL, Udaipur, Rajasthan, July 17, 2013.

M. D. Goel : Invited lecture during short term course titled "Blast Resistant and Anti-Terrorism Design" at Department of Civil Engineering, Indian Institute of Technology (IIT) Delhi, India, August 2-3, 2013.

M. D. Goel : Invited lecture at Mansarovar Institute of Science and Technology Bhopal, M.P., India on "Numerical Simulation in Engineering" during one day workshop on "Materials Characterization and Engineering" on August 30, 2013.

I. B. Singh : Development of sol-gel nano- structured ceramic coatings on metals/alloys for oxidation resistance purposes" 51th NMD and 67th ATM, Indian Institute of Metals, Deptt of met Eng. IIT, BHU, Varanasi Nov 12-15, 2013

O. P. Modi : Invited Lecture on" Copper-based shape memory alloys by P/M route for smart applications" in 51st NMD, 67th ATM of IIM , organized by IIT, BHU, Varanasi during Nov. 12-15,2013.

S. Das : Aluminium Foam: A Potential Functional Material NMD-ATM of Indian Institute of Metals, IIT, BHU Varanasi, November 12-15, 2013 .

P. Asokan. : Fly ash based technologies developed by CSIR-AMPRI Bhopal, 3rd Annual international Summit "Fly ash utilisation", NDCC Convention Centre, New Delhi, Dec 17-18, 2013.

S. Das : Recent Trends and Future Prospects of Light Metals Casting Technologies, The Second International Conference on INTELLIGENT ROBOTICS, AUTOMATION AND MANUFACTURING (IRAM 2013) December 16-18, 2013 at IIT Indore, MP.

M. D. Goel : Invited lectures at Department of Civil Engineering, College of Engineering, Pune, India during workshop titled “Blast Resistant Design of Structures” on January 10-12, 2014.

P. Asokan : Fly ash based wood substitute composites & other technologies of CSIR AMPRI and creates opportunities for possible commercial exploitation at Bilaspur, CG. Fly ash user Meet, NTPC Sipat, Bilaspur, Chhattisgarh (CG), Feb 11-12, 2014.

S. Das : Al Foam: Emerging Materials for crashworthiness and thermal management, Inter. Conf. on Emerging Trends in Science & Tech impact on Environment & Society for Inclusive Growth, ICETST 14, AISECT, Bhopal February 14-15, 2014.

S. Das : Synthesis, Properties and Applications of Magnesium Alloys Int. Conf. on Emerging Materials and Processes (ICEMP), Bhubaneswar, February 26-28, 2014.

R.K. Rawlley : talk during National seminar on Recent trends in instrumental techniques for environmental monitoring, University Institute of Technology, Rajiv Gandhi Technical University, Bhopal, March 12-14, 2014.

R.K. Rawlley : talk during `World Water Day’ meet by IWWA, Bhopal chapter, Bhopal, March 22, 2014.

I. B. Singh, : Synthesis of MnOOH/MnO_2 nanowires/nanorods for their application in supercapacitors, National workshop on Fuel Cell Technology – From basic Science to applications, MANIT Bhopal, March 24-25, 2014

P. Asokan : High volume use of NTPC fly ash for the development of advanced cement free geo-polymeric - polymeric green concrete and process optimisation for commercial exploitation, Interactive meeting for possible collaborative research programme NEITRA, NTPC, Noida NEITRA, Noida, March 25, 2014.

Hindi Day Celebration

The Hindi week started from September 7, 2014 concluded on September 13, 2014 as Hindi Divas Samaroh. Noted journalist and Founder, Madhav Rao Sapre Samachar Patra Sangrahalay, Padmashrii Shree Vijay Datt Shridhar was the Chief Guest at the main function. Various competitions, such as Chitra aur Vichar, Prashnottarii and Noting were organized for the staff during the week. Dr. Navin Chand , Chief Scientist welcomed the guests and underlined the importance of working in Hindi.

At the main function, Dr. J.P.Shukla, Principal Scientist introduced the Chief Guest. In his address the Chief Guest expressed pleasure for being amongst the scientists. He said that if you want to reach the masses, you have to communicate in their language. Every language has it's culture and awareness can be brought in their language only, he said.

The Chief Guest gave away the prizes for the winners of the competitions and incentives for working in Hindi. The Controller of Administration, Sh. Ram Sarup proposed the Vote of thanks and the programme was conducted by Dr. Manisha Dubey, Hindi Officer.

Hindi Day Celebration

A view of the dias

Workshop on Records management

The Controller of Administration, Sh. Ram Sarup delivered a lecture on Records Management on July 11, 2013. The staff took keen interest in the presentation.

Rajbhasha cash incentives for the year 2013-14

Smt. Sathi Vijayan	First
Smt. Swagatika Pal	First
Sh. Vijay Nathile	Second
Sh. Atul Kumar Jain	Second
Sh. Vijay Shrivastava	Second
Sh. Anup Kumar Khare	Third
Sh. Arun Saxena	Third
Smt. Sangita Gamad	Third
Sh. N.S.Jadav	Third
Sh. R.D. Kushwah	Third

Awards

- M.P. Govt's award to Dr. Navin Chandra, the then Acting Director for significant contributions in Engineering & Technology on May 18, 2013.

Dr. N. Chandra receiving the award

- Dr. Navin Chand, Chief Scientist received Materials Research Society of India annual prize 2014 (MRSI-ICSC Prize) on Feb 12, 2014 in recognition of his outstanding contribution in the field of Materials Science.
- ISAE Best Paper Award-2012 to Dr. D. P. Mondal for the paper "Effect of peening Intensity and applied load on low stress abrasive wear response of agricultural grade SAE-6050 Steel" Journal of Agricultural Engineering, 2012 Vol. 49. No.2. (Award was given during International Symposium on Bio Energy: Challenges and Opportunities, Held in Hyderabad, Jan 28-30, 2013, by Indian Society of Agricultural Engineers, New Delhi
- Dr. Manmohan Dass Goel, CSIR-Advanced Materials and Processes Research Institute, Bhopal, awarded Innovative Student Project Award 2013 in Civil Engineering discipline by The Indian National Academy of Engineers (INAE), India.

Research Council Meeting

A meeting of research council was held at CSIR-AMPRI Bhopal On July 31, 2013 .

RC Meeting in progress

Press Coverage

समारोह में सम्मानित वैज्ञानिक

AMPRI ready with technology to improve farm implements

Shilpa Saburaj@timesgroup.com

Bhopal: CSIR-AMPRI has developed technologies for improving quality of farm implements that will prove a huge help for farm... aking their work cost-effective and ... AMPRI has the technology that can ... n duct foot cultivator behind a trac... used by farmers for ploughing and ... vities.

...mers in the state are still using ... duct foot cultivators that have a ... und are depending on local man... supply it to them Not only are ... plements of low quality, but are ... w-cost that attracts farmers to ... urers," said scientists from ...

... wishes to impart the tech... of the state so that farmers ... from above techniques in ... ent in their products. Al... ls would lead to efficient functioning and lower down time of machines, tractors and increased productivity.

"Most of beneficial properties of steels are lost while manufacturing during heating, beating and welding of these implements. No attention is being paid to proper ties and performance of these tools. However, there is wide scope for improvement in these tools, if proper care is taken during manufacturing and components are subjected to metallurgical treatment. We have technology of heat treatment that can increase life of these farm implements, they added.

Local manufacturers do not want the technology to come to market because in that condition, farmers won't need to approach manufacturers again and again, which will impact their business. The local duct foot cultivator sustains for 100 hours, but we have technology with which equipment's life will be increased by 50%, said Amol Kumar Jha, scientist, AMPRI.

New device to cut sugar-making cost

Indigenous hammer tip developed by AMPRI will be cheaper than imported one and perform better

ACHIEVEMENT

HIGHLIGHTS

...lops wood substitute

... minimize con... ption of timber in building and house construction along with solving the problem of environmental pollution, Advanced Materials and Processes Research Institute (AMPRI), Bhopal has developed a technology for making wood composite panels using industrial wastes, natural fibre and polymer. This wood composite can be used in variety of applications like partitions, ceilings, flooring, doors, ventilators, instant houses and furniture.

APMRI scientist Dr Asokan P with his team developed wood substitute composite

Furniture made of wood substitute composite at AMPRI

panel from the waste generated in industrial, aluminum waste, agricultural waste, chemicals waste, marble waste after five years of research.

Asokan P said, "This technology has been developed in view of the National Forest Policy of MOEF, Government of India for development of wood substitute for building application so that tress like timber and other can be saved from construction, deforestation and ecological imbalance."

"We have used industrial wastes as filler in making natural fibres, polymer composite," Asokan said, adding during the process, processed industrial wastes, such as fly ash (industrial waste in dust form), red mud, marble waste, polymer were mixed and reinforced with natural fibre. He said 1 billion ton of fly ash is generated from industries and making wood composites is the best way to utilize to avoid pollution and deforestation.

"After testing and examining wood composite is six times better than teak wood, in quality as well as in strength," Asokan said. It is termite and corrosion resistant and various textures and colours can be added. "The indicative cost of the wood composite doors is estimated Rs. 4500-6000, while the teak wood doors costs around Rs. 8900 and above," he added.

AMPRI celebrates 71st CSIR Foundation Day; achievments, goals highlighted

71st CSIR Foundation Day celebrated at AMPRI auditorium on Thursday.

■ Staff Reporter

ADVANCED Materials and Processes Research Institute (AMPRI), Bhopal celebrated 71st CSIR Foundation Day on Thursday at AMPRI auditorium. Director of Indian Institute of technology, Indore Professor Pradeep Mathur was the Chief Guest.

The distinguished guests were welcomed by the Chief Scientist and Head of Publicity and Public Relation, AMPRI Dr S Das.

During the programme, Acting Director of CSIR-AMPRI Dr Navin Chandra highlighted the importance of the occasion and talked about the history and establishment of CSIR. He also underlined the achievements of CSIR and AMPRI. During address, Prof PK M... the com...

working and sharing of resources is important for development and said that networking and sharing of resources is important for development. He further said that m... ple are migrating ... cities th...

should be exclusive and development should be inclusive and there should be synergy between both of them.

Professor Akhilesh K. Pandey underlined the importance of indigenous technology. He further said that with innovative and domestic technologies must be preferred since national pride comes with it. He moreover emphasised the need to collaborate with the private universities.

The Chief Guest also presented the recognitions and awards. Momentoes were given to the staff for completing 25 years of service in CSIR. An open day program was also organised for the students in the afternoon where the entrepreneurs and general public helped the students in getting acquainted with the activities of AMPRI and C...

The guests of ... the Ch...

Workshop on entrepreneurship devpt held

■ Staff Reporter

ONE-DAY 'Entrepreneurship Development Workshop' was held at CSIR-AMPRI, Bhopal, on Friday in the premises of AMPRI Bhopal. The workshop was organised by Council of Scientific and Industrial Research (CSIR), New Delhi and CSIR-AMPRI, Bhopal and was supported by Ministry of Micro, Small and Medium Enterprises (MSME), Government of India.

The aim of the workshop was to provide technical support and technologies to existing industries, budding entrepreneurs and Micro, small and Medium Enterprises (MSME).

Director of MSME ...

A one-day 'Entrepreneurship Development Workshop' was organised at CSIR-AMPRI Bhopal on Friday.

Dr J S Chauhan were the eminent guests who were present on the occasion along with executives of industrial sectors like IDBI and ... pal and budding entrepre... participants.

... of CSIR-AMPRI Bhopal ... Chandra highlighted the ... of research or... industries to work...

er for taking the new technologies to shop floor for benefit of society. This will not only improve industries but also provide employment to the people.

Speaking on the occasion eminent guests emphasised the importance of creating job opportunities through MSMEs and entrepreneurship activ... The programme was held in two sessions covering technical presentation of the products by CSIR-AMPRI scientists followed by the exhibition and demonstration facilities available at CSIR-AMPRI Bhopal under the guidance of Dr Navin Chandra.

Principal Scientist of CSIR-AMPRI Dr Mohd Akram Khan conducted the programme.

City scientists develop cement-free concrete mix

Pallavi Nair | TNN

Bhopal: Council of Scientific and Industrial Research (CSIR) – Advanced Materials Power Research Institute (AMPRI), Bhopal has developed a cement free concrete from fly ash that has a greater strength than cement concrete and requires no water for curing.

Made of industrial waste, this new concrete mix addresses issue of carbon dioxide emission associated with cement production and is environmental friendly.

One ton of cement production emits about one ton of carbon dioxide.

A team of CSIR- AMPRI, Bhopal comprising chief scientist, Dr S S Amritphale, acting director Navin Chandra, Dr Deepti Mishra, R K Chouhan, Manish Mudgal, Mohd Akram Khan and Swati Lahiri developed new material from waste generated from industries after four years of research.

CSIR-AMPRI has signed technology transfer with Jindal Steel and Power Limited (JSPL), Raigarh (Chhattisgarh) for licensing of the process for making this concrete.

He explained, "We have used fly ash (industrial waste) which acts as a binding material on concrete and some new cementitious materials." This cement free concrete is developed by utilizing up to 85% fly ash. "With the use of industrial waste we tried to replace use of conventional cement completely." The process is useful for making concrete mix suitable for road laying, repair and other applications.

"Fly ash binds the concrete at a faster rate and hence concrete sets early cutting down project time and need for water for curing," added Amritphale.

It also takes care of health related issues of labourers as cement factories who inhale cement and develop breathing problems.

ADVANTAGES APLENTY

- Fire resistant
- Solves global warming: One ton cement production generates one ton of carbon dioxide
- Obviates the need for water curing
- Uses conventional machineries
- Energy efficient - can be made at ambient temperature (35-40C approximately)
- Increased productivity as strength is achieved in 7 days compared to 28 days for conventional cement concrete

Increased productivity also saves project cost & time

A structure made of concrete-free cement

Research bodies, industry must work in sync: CSIR dir

TIMES NEWS NETWORK

Bhopal: Day-long 'entrepreneurship developmeht workshop' was held at Council of Scientific and Industrial Research (CSIR) - Advance Material and Process Research Institute (AMPRI), Bhopal, on Friday on the AMPRI premises.

The aim of the workshop was to provide technical support and technologies to existing industries, budding entrepreneurs and micro, small ...dium enterprises (MSME).

...e workshop was organized by ...New Delhi and was supported ...stry of Micro, Small & Medi... ...prises (MSME) Government ...Director, CSIR-AMPRI Bho...

pal, Dr Navin Chandra, highlighted the importance of research organizations and industries to work together for taking the new technologies to shop floor for benefit of society.

Dr S S Amritphale, Dr P. Asokan, Dr S Das, Dr A K Jha;Dr Navin Chand and Dr S A R Hashmii presented their technologies via presentations on areas of construction sector, metallurgy sector and natural fibre & polymer sector. Around 130 persons from different parts of the state and country showed keen interest in products and technologies of CSIR-AMPRI, which are ready for transfer and commercialization. Head PPD, CSIR, New Delhi, Dr. Sudeep Kumar, also spoke to participants via video conferencing.

Press Coverage

'Research, industry should work together'

HT Correspondent
editorbhopal@hindustantimes.com

BHOPAL: The need of research organisations and industries to work together so that new technologies are taken to the shop floor and used for benefit of the society was stressed during a one day entrepreneurship development workshop held at Advanced Materials and Processes Research Institute (AMPRI) on Friday.

The workshop was jointly organised by AMPRI and the Council of Scientific & Industrial Research (CSIR), New Delhi with support of ministry of micro, small & medium enterprises.

The aim of the workshop was to provide technical support and technologies to existing industries, budding entrepreneurs and Micro, Small & Medium Enterprises (MSME).

DS Mandloi, director, MSME-Development Institute, Indore, CP Singh and Rohit Jaiswal from Khurai Agricultural Association, Gyanendra Singh, former Director, Central Institute for Agriculture Engineering (CIAE), JS Chauhan, professor and head of civil engineering, Samrat Ashok Technological Institute (SATI) Vidisha were the eminent guests. Also executives of industries, banking sectors like IDBI and SBI Bhopal and budding entrepreneurs participated.

AK Jha, chief scientist & coordinator of the programme welcomed the guests and Navin Chandra, director, AMPRI Bhopal also spoke.

Speaking on the occasion eminent guests emphasised the importance of creating job opportunities through A... and entrepre... ties.

NewspaperDirect

Technology Transfer

CSIR News JANUARY 2014 17

Transfer of Technology by CSIR-AMPRI

Signing of agreement between CSIR-AMPRI and Jindal Steel and Powers Ltd (JSPL)

...nced Materials and Processes ...IR-AMPRI) has signed ... with Jindal ... the use of cement and also does not require water during the curing process needed in the conventional concrete. The avoidance of cement in the concrete has further ...e of reducing the carbon dioxide ...ironment – each ton of ...the generation

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SATURDAY • MARCH 1 • 2014 • BHOPAL • TheHitavada

Advanced Materials and Processes Research Institute celebrate National Science Day

■ Staff Reporter

NATIONAL Science Day was celebrated on Friday at Advanced Materials and Processes Research Institute, Bhopal. This day is celebrated every year to commemorate the discovery of 'Raman Effect' by eminent scientist CV Raman.

Director of IISER Bhopal Prof. VK Singh was the Chief Guest of the function while Director of MANIT, Bhopal Prof. Appu Kuttan was the guest of honor. At the outset, Acting Director Dr. Navin Chandra welcomed the guests and highlighted the importance of this celebration and commitment of AMPRI to vigorously pursue Science and Technology in the service of the nation. He also informed that in the current financial year two technologies have been licensed by AMPRI for commercial utilisation by industries.

Prof VK Singh delivered the Science Day lecture on 'Organic Synthesis: From creativity to sustainability and human well being' on the occasion. He also highlighted this year's theme of the celebration Fostering scientific Temper.

National science Day was celebrated on Friday at Advanced Materials and Processes Research Institute, Bhopal.

Kuttan delivered a talk on 'Recent trends in manufacturing' during which he underlined the historical resume of manufacturing and said that engineering and science are working very closely on Friday.

Chief scientists Dr SS Amritphale and Dr BK Prasad introduced the guests. In the afternoon, poster presentation session was organised for the research fellows and the best posters were awarded.

...for this ...es Dr. S.S. ..., Dr. Navin ..., Dr. Deepti ...a, Dr. Manish ...am Khan and

Staff News

Retirements

Dr. S.P. Narayan, Principal Scientist, retired on 30.09.2013

Sh. Girish Chand, SO (F&A), retired on 28.02.2014

Joining

Sh. Shikhar Sharma, SO (Gen.), joined on transfer from SERC Chennai on 22.04.2013

Sh. Sanjay Vinodia, SO (F&A) joined on transfer from NEERI, Nagpur on 17.06.2013

Sh. Ravindra Kumar Bharilya, Sr. Scientist joined on transfer from CMERI, Durgapur on 01.07.2013

Transfers

Sh. Anjum Sharma, AO transferred to CSIR HQ. on 25.02.2014

Staff Technically Resigned

Sh. Ganesh Dhakad, Sr. Steno, technically resigned on 20.11.2013

Sh. Shikhar Sharma, SO (Gen.), technically resigned on 26.03.2014

Promotions

Dr. Deepti Mishra from Sr. Scientist to Principal Scientist

Sh. S. Shrimanth from Sr. Scientist to Principal Scientist

Dr. Sanjeev Saxena from Sr. Scientist to Principal Scientist

Dr. J.P. Pandey from Sr. Technical Officer (2) to Sr. Technical Officer (3)

Sh. H.N. Rao from Sr. Technical Officer (2) to Sr. Technical Officer (3)

Sh. Ajay Kulshreshtha from Sr. Technical Officer (2) to Sr. Technical Officer (3)

Dr. E. Peters from Sr. Technical Officer (2) to Sr. Technical Officer (3)

Dr. Sorna Gowri from Sr. Technical Officer (2) to Sr. Technical Officer (3)

Sh. O.P. Chaurasia from Technical Assistant III (2) to Technical Officer III (3)

Sh. A.K. Asati from Technical Assistant II (3) to Technical Assistant II (4)

Financial Upgradation under Modified Assured Career Progression (MACP) Scheme

Sh. Harihar Singh Yadav, Asst. Gr. Gen. (II)

Higher Education

- Dr. Akram Khan was awarded Ph. D. on "SOLIDIFICATION AND STABLIZATION OF WASTE SLUDGE FROM ZINC PROCESSING INDUSTRY FOR ABETMENT OF ITS HAZARDOUS POTENTIAL" from Maulana Azad National Institute of Technology, Bhopal.
- Dr. M. D. Goel was awarded Ph. D. on "BLAST RESPONSE OF STRUCTURES AND ITS MITIGATION USING ADVANCED LIGHTWEIGHT MATERIALS" from Indian Institute of Technology (IIT) Delhi, India

Foreign Visits

- I. B. Singh attended 10th Pacific Rim Conference on Ceramic and Glass Technology, San Diego CA during June 2-7, 2013.
- Dr. Rupa Dasgupta visited China to attend BIT's 2nd annual world congress of advanced materials and to present a paper at Suzhou International Expo Centre during June, 3-10, 2013.
- Dr. Sorna Gowri visited University of Minho, Centre of Science and Textile Technology, Guimaraes, Portugal under the Indo-Portuguese Joint Research Project during Dec. 11-20, 2013.

Manpower (as on March 31, 2014)

Dr. Navin Chandra, Acting Director

Group IV

Dr. Navin Chandra	Chief Scientist
Dr. Navin Chand	Chief Scientist
Sh. P.D. Ekbote	Chief Scientist
Dr. S. Das	Chief Scientist
Dr. A.K. Jha	Chief Scientist
Dr. O.P. Modi	Chief Scientist
Sh. R.S. Solanki	Chief Scientist
Dr. J.P. Barnwal	Chief Scientist
Dr. B.K. Prasad	Chief Scientist
Dr. M.S. Yadav	Chief Scientist
Dr. S.S. Amritphale	Chief Scientist
Dr. (Ms) Rupa Dasgupta	Senior Principal Scientist
Dr. R.K. Morchhale	Senior Principal Scientist
Dr. S.A.R. Hashmi	Senior Principal Scientist
Dr. (Ms.) Swati Lahiri	Senior Principal Scientist
Dr. Murari Prasad	Senior Principal Scientist
Dr. S.K. Sanghi	Senior Principal Scientist
Dr. D.P. Mondal	Senior Principal Scientist
Dr. I. B. Singh	Senior Principal Scientist
Sh. A.K. Singh	Senior Principal Scientist
Dr. P. Asokan	Senior Principal Scientist
Dr. R K Rawlley	Principal Scientist
Sh. R.S. Ahirwar	Principal Scientist
Dr. K. K. Pathak (On lien)	Principal Scientist
Dr. Mohd Akram Khan	Principal Scientist
Dr. Manish Mudgal	Principal Scientist
Dr. J.P. Shukla	Principal Scientist
Dr. Raghuvanshi Ram	Principal Scientist
Sh. H.N. Bhargaw	Principal Scientist
Dr. Sanjeev Saxena	Principal Scientist
Sh. S. Shrimanth	Principal Scientist
Dr. (Ms) Deepti Mishra	Principal Scientist
Dr. S. Murali	Senior Scientist
Dr. J.P. Chaurasia	Senior Scientist
Sh. R.K. Bharilya	Senior Scientist
Dr. Sanjay K. Panthi	Scientist
Sh. Meraj Ahmed	Scientist
Dr. M. D. Goel	Scientist
Sh. Gaurav K. Gupta	Scientist
Sh. Satanand Mishra	Junior Scientist
Sh. Abhishek Pandey	Adhoc Sceintist
Sh. Amulya Bihari Patnaik	Adhoc Sceintist

Group III

Dr. N. Saha	Sr. Tech. Officer (3)
Dr. Ajay Naik	Sr. Tech. Officer (3)
Sh. R.K. Chauhan	Sr. Tech. Officer (3)
Sh. H.N. Rao	Sr. Tech. Officer (3)
Dr. J.P. Pandey	Sr. Tech. Officer (3)
Sh. A. Kulshreshtha	Sr. Tech. Officer (3)
Sh. M. Chandra	Sr. Tech. Officer (3)
Sh. P. Banerjee	Sr. Tech. Officer (3)
Dr. E. Peters	Sr. Tech. Officer (3)
Dr. Sorna Gowri	Sr. Tech. Officer (3)
Dr. Anita Bhushan	RMO
Sh. M.K. Ban	Sr. Tech. Officer (2)
Sh. TSVC. Rao	Sr. Tech. Officer (2)
Dr. R. K. Soni	Sr. Tech. Officer (2)
Dr. (Ms). P. Padmakaran	Sr. Tech. Officer (2)
Sh. A.A. Bakhsh	Executive Engineer
Sh. O. P. Chaurasia	Jr. Engineer
Ms. S. Gamad	Technical Officer
Sh. Deepak Kumar Kashyap	Technical Assistant
Sh. B. Barkhaniya	Technical Assistant
Sh. M. Shafique M	Technical Assistant
Sh. K. K. Naktode	Technical Assistant
Sh. A.K. Khare	Technical Assistant
Sh. Prashant N.	Technical Assistant

Group II

Sh. U.M. Lakra	Sr. Technician (2)
Sh. R.K. Kosthi	Sr. Technician (2)
Sh. R.K. Gurjar	Sr. Technician (2)
Sh. Md. Rafique	Sr. Technician (2)
Sh. A. Yadav	Sr. Technician (2)
Sh. M. L. Gurjar	Sr. Technician (2)
Sh. A. Ullah	Sr. Technician (2)
Sh. B. Patil	Sr. Technician (2)
Sh. D. K. Singh	Sr. Technician (2)
Sh. R.C. Malvi	Sr. Technician (2)
Sh. A. Saxena	Sr. Technician (2)
Ms. S.Pal	Sr. Technician (1)
Sh. S.K. Suryavanshi	Sr. Technician (2)
Sh. A.K. Asati	Sr. Technician (2)
Sh. R. Kishore	Technician (2)

Group I

Sh. S.K. Raikwar	Lab Assistant
Sh. S.K. Batham	Lab Assistant
Sh. R.D. Kushwaha	Lab Assistant
Sh. L.N. Mehra	Lab Assistant
Sh. B.L. Pradhan	Lab Assistant
Sh. N.S. Jadav	Lab Assistant
Sh. L.N. Sahu	Lab Assistant
Sh. Indraj Yadav	Lab Attendant (2)
Sh. Devilal Rathore	Lab Attendant (2)
Sh. Anil Gond	Lab Attendant (2)

Sh. Ram Sarup	COA
Mr. Bhag Singh Shiksharthi	SPO
Mr. Ajay Kumar	FAO
Sh. P. K. Srivastava	Protocol Officer
Sh. S. Majumder	SO(General)
Sh. P. K. Sinha	SO(F&A)
Sh. D.P. Singh (On lien)	SO (S&P)
Sh. A. K. Jain	SO(General)
Dr. (Ms) M. Dubey	Hindi Officer
Ms. S. Soman	Private Secretary
Ms. M. Surendran	Private Secretary
Sh. Sanjay Vinodiya	SO(F&A)
Sh. N. Vishwanathan	Sr. Steno
Ms. S. Vijayan	Sr. Steno
Sh. D.M. Chilbule	Assistant. (S&P) Gr. I
Sh. P.K. Satyanesan	Assistant (G) Gr.I
Sh. J. Kujur	Assistant (G) Gr.I
Ms. A. Vinodia	Assistant (G) Gr.I
Sh. N.K. Pethari	Assistant (G) Gr.I
Sh. N. Jaiswal	Assistant (G) Gr. I
Sh. A. K. Meshram	Assistant (S&P) Gr. I
Sh. V. Nathiley	Assistant (S&P) Gr.I
Sh. V. Shrivastava	Assistant (F&A) Gr.I
Sh. H. Singh	Assistant (G) Gr.II
Sh. S. Bhawsar (On lien)	Sr. Hindi Translator
Ms. A. Daniel	Receptionist
Ms.T. Rangari	Record Keeper
Sh. K.P. Tripathi	Security Guard
Sh. R.N. Pradhan	Security Guard
Sh. G.B. Gurung	Security Guard
Sh. D. Prasad	Tea & Coffee Maker
Sh. Dayaram	Safaiwala
Ms. A. Golait	Peon