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In The News

Constructed Wet Land developed by CSIR-IMMT Inaugurated in Bhubaneswar



DG CRPF inaugurating the constructed wetland designed by CSIR-IMMT inside the CRPF campus in Bhubaneswar

CONSTRUCTED wetlands are a sustainable wastewater treatment process for mildly polluted wastewater like sewage. It is a technology that can be highly appropriate for the Indian situation and has the potential of replacing costly conventional treatment plants. Based on wastewater flow regime, subsurface flow constructed wetlands have

emerged as efficient and suitable choice for sewage treatment.


An experienced research group at the CSIR-Institute of Minerals and Materials Technology (IMMT), Bhubaneswar is active in this field and running a subsurface flow constructed wetland for treating combined municipal and canteen wastewater for their

premises in Bhubaneswar. The constructed wetlands are perfect examples of passive


treatment which does not require any mechanical and electrical machineries and chemical dosing for treatment of wastewater. This characteristic of constructed wetlands makes it very appropriate for wastewater treatment in the Indian context.

CSIR-IMMT has constructed a pilot-scale constructed wetland in the CRPF Bhubaneswar campus. It took more than a month to construct it. On 18th June 2015, DG CRPF inaugurated the constructed wetland facility and agreed to propagate the same in other CRPF campuses. This is the first successful attempt by CSIR-IMMT under the Swachh Bharat Programme.

Constructed Wetland in CSIR-IMMT, Bhubaneswar



% Removal	
• Total solids	- 61-82%
• COD	- 65-92%
• Phosphate	- 52%
• Nitrogen	
- Ammonium	- 67%
- Nitrate	- 81%
• Pathogens	- >99%



This is just a model CW, full scale design CW will improve treatment efficiency further



CSIR-IICT Strives to Mitigate the Fluorosis Problem in Nalgonda District of Telangana

A delegation from CSIR-IICT met the Collector of Nalgonda District, P. Satyanarayana Reddy, to discuss technological interventions for mitigation of the fluorosis problem prevalent in the region. The meeting took place on 22 June 2015. The CSIR-IICT delegation was led by its Director, Dr. S. Chandrasekhar and comprised of Dr. S. Sridhar, Dr. Saibal Das, Dr. Yella Reddy and Mr. Siddhartha Moulik.

CSIR-IICT had earlier installed nine community-based membrane systems of 600-1000 L/h in Telangana, Andhra Pradesh and Tamil Nadu including four plants in Nalgonda and one plant in

Warangal District of Telangana State, which were replicated by NGOs and gram panchayats in other villages.

This time CSIR-IICT has come forward to install its newly designed compact low-cost membrane system of moderate capacity of 100 to 200 L/h in schools, hostels and hospitals. Training would be provided to operators on the two pilot plants installed in IICT's premises. The collector and his team have assured their full cooperation in assisting IICT with its newly planned venture which is expected to commence in a month's time.

DIPP Approves CSIR-CLRI Pilot Biogas Plant at Calcutta Leather Complex (CLC)



Dr. K. Sri Bala Kameswari, Sr. Scientist, Environmental Technology Division of CSIR-CLRI making his presentation on the proposal for a pilot biogas plant to be put-up at CLC

Following up the Programme for Implementing Emerging and Sustainable Technologies (PriEST) held for the Kolkata leather industry from March 2012 to February 2014, the Environmental Technology Division of CSIR-CLRI submitted a project proposal to DIPP (Department of Industrial Policy and Promotion) for a pilot biogas plant based on tannery solid waste for CLC, Kolkata. The DIPP has approved the proposal.

In this connection, a meeting was held at the office of CLE Regional Chairman Shri Ramesh Juneja on 23 June 2015 to discuss the proposal. Shri Juneja, who is also the president of the Calcutta Leather Complex Tanners' Association (CLCTA) convened the meeting and presided over the same.

CLCTA General Secretary Mr. Imran Khan, ILTA President Shri Arnab Kumar Jha, ILTA General Secretary Shri Susanta Mallick, former President of ILPA Shri Sankar Dawn, former CLE Regional Chairman Shri Tapan Nandi and CLRI Kolkata Centre Head Dr. Dipankar Chaudhuri were among those who participated in this meeting. Dr. K. Sri Bala Kameswari, Senior Scientist at Environmental Technology Division of

CSIR-CLRI made a short presentation on the project proposal and sought support from the industry for execution of the project.

Assuring full co-operation and support from the industry, Mr. Imran Khan, Honorary General Secretary, CLCTA suggested sending a formal letter to CLCTA by CSIR-CLRI seeking a plot of land for erecting the plant saying that CLCTA would obtain approval from the Govt. of West Bengal after receiving the formal request from CSIR-CLRI.



From left: Shri Ramesh Juneja, Regional Chairman, CLE and Mr. Imran Khan, Hon. General Secretary, CLCTA watching the presentation

R&D Highlights**Metallic Foam Related R&D Activities at CSIR-AMPRI, Bhopal**

Metallic foams belong to a special category of materials having an interesting combination of engineering properties. These properties are imparted to the material system through the generation of pores in the alloy matrix. Their specific features include high damping capacity, noise and vibration attenuation, thermal insulation characteristics etc.

Accordingly, there lie a lot of potential applications in aerospace, automobile, chemical and other engineering applications in the form of impact energy absorbers, vibration and noise attenuators, heat exchangers and catalyst substrates depending on the nature, content and morphology of the pores. For example, Ti foams have the potential for use in environments encountering corrosion and heat. Ti foams have also emerged as a potential replacement to the conventionally used ferritic stainless steels in biomedical applications. Similarly, Al and Mg alloy foams are relatively cheaper and lighter than that of steel and have the potential for use in automotive and other applications.

Metallic foams can be synthesized by employing liquid metallurgy (L/M) and powder metallurgy (P/M) routes. Foams of low-melting materials like Al and Zn could be produced by L/M as well as P/M routes while the ones having high melting points like steels, Ti alloys, etc. could be processed by P/M route only. In the case of L/M route, a foaming agent and/or cenospheres are used to generate pores in the liquid mass while space holders are used for creating porosity in the matrix in the P/M technique of foam making.

The use of space holder particles in this case has been found to be quite effective in terms of improved pore distribution and superior mechanical

properties. Moreover, the pore morphology and level of porosity can effectively be controlled by varying the morphology and quantity of the space holder material. There are two kinds of space holder materials, namely, (a) the ones which are solid particles and get vaporized leaving behind voids in the due course of further processing, and (b) those which are hollow in nature and are retained by the matrix of the processed material termed syntactic foam. The use of the space holder gives rise to the generation of isolated/close pores.

During recent years, CSIR-AMPRI has been pursuing R&D activities in the area of metallic foams containing Ti-, Al- and Zn-based alloys as the matrix. Both powder and liquid metallurgy routes have been employed to synthesize the foams with isolated as well as open pores as discussed below.

Ti Foam

Ti foam samples have been developed at CSIR-AMPRI, Bhopal by P/M route using space holder technique. Three types of space holders, namely, (i) the one (urea) having the tendency to vaporize during subsequent processing, (ii) the other (NaCl) which could be leached out after sintering, and (iii) the third one (fly ash cenospheres) capable of being retained by the matrix in the finally processed material system, have been used for the purpose of making foam with isolated pores. It may be noted that fly ash is a waste material generated by thermal power plants and its dumping becomes a problem. Cenosphere particles of fly ash are separated by different separation techniques.

The effects of morphology and content of the space holder particles on the pore morphology and volume fraction and resulting mechanical properties of the developed material samples have also been

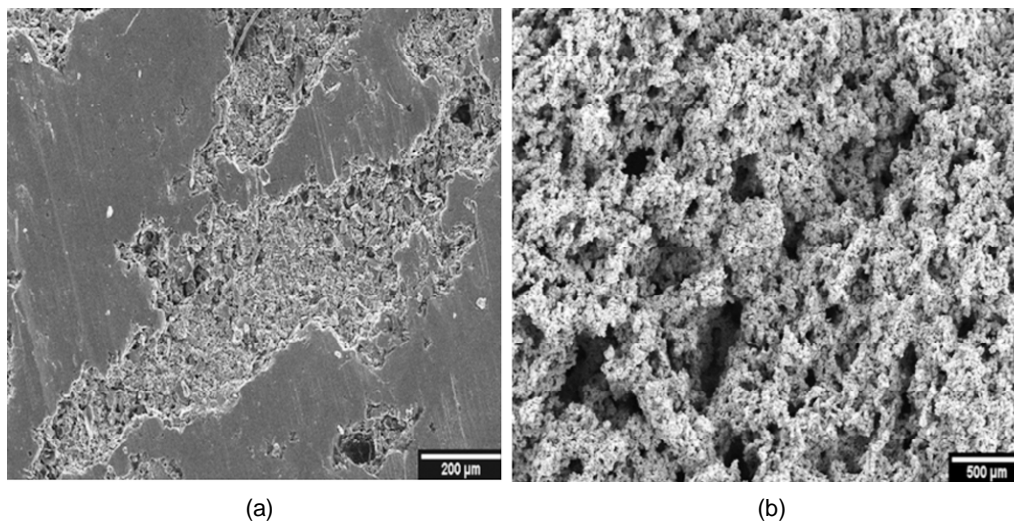


Fig. 1. SEM micrographs of foam samples having (a) 64 vol. % porosity processed using acicular space holder (urea) particles and (b) 62 vol. % porosity processed using fine space holder (urea) particles

investigated. The porosity level generated in the foams was 45-65% with a pore size range of 1-100 μm , density of 1.35-2.40 g/cc, plateau stress of 35-60 MPa, energy absorption capacity of 20-35 MJ/m³ and elastic modulus of 8-24 GPa. These foams have the potential for use in applications requiring blast resistance, damping and energy absorption at high temperatures and in adverse (corrosive) environments.

The foams processed using acicular space holder particles consisted of islands of acicular porous regions of size up to 1200 μm (Fig. 1a). These acicular porous regions revealed a large number of micro-pores which grew in size and shape with increasing content of the space holder.

The foam also delineated a defined plateau region even at a low porosity content of 46 vol. % (Fig. 2). With an increase in porosity to 65 vol. %, the foams revealed higher failure strain and yield strength when compared with macro-porous foams having a similar level of porosity. This could be attributed to the requirement of higher stress to cause yielding of large-sized acicular porous regions containing fine micro-pores within. On the contrary, the foams processed using fine spherical space holder particles delineated the presence of fine pores distributed fairly uniformly in the matrix (Fig. 1b). With an increase in

the porosity to 60 vol. %, the pores began to form an interconnected network which is an associated feature of open cellular foams.

However, distinct plateau region occurred only when the porosity was increased beyond 60 vol. % (Fig. 2). The plateau strength obtained in this case was also higher than that of the foams having acicular porous regions. This was due to the better deforming capability of interconnected pores and an increased aspect ratio of acicular regions at higher porosity

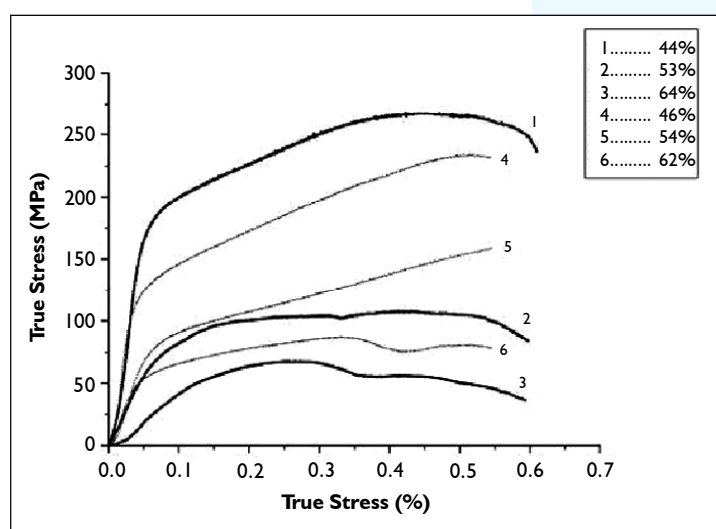


Fig. 2. Stress-strain diagram of the foam samples having acicular porous regions and fine pores (—: acicular porous regions and: uniformly distributed fine pores)

levels (>60%) which ultimately reduced their yield strength. It has also been noted that the morphology of the space holder particles controls the end characteristics of the foam more dominantly than that of their content. Moreover, coarser space holder particles were found to be more beneficial than those of finer ones in terms of end characteristics (flat and longer

plateau region) of the samples while the finer space holder particles proved to be beneficial in terms of achieving higher plateau strength especially when the porosity level increased beyond a limit (60 vol. %), the latter suggesting a greater contribution of the mode of pore distribution rather than its content (Fig. 2).

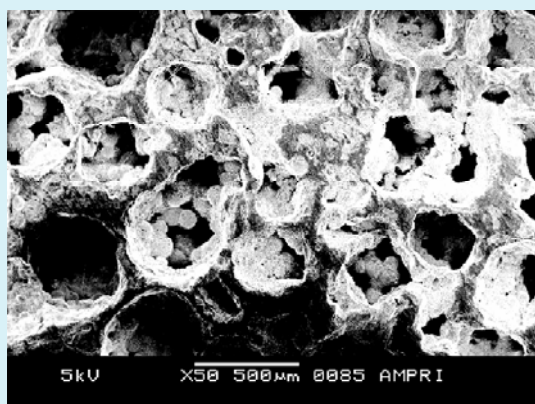
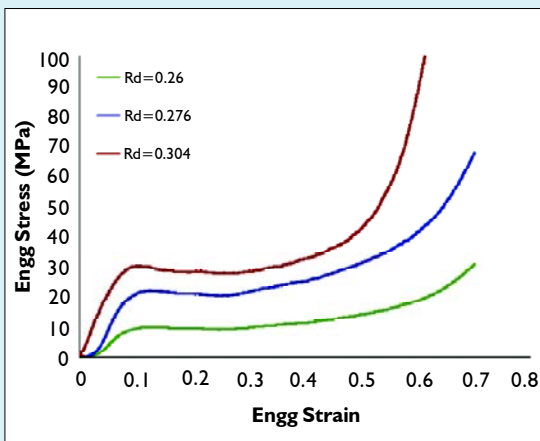
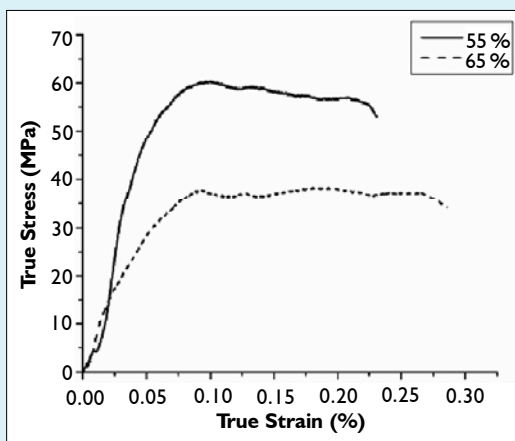
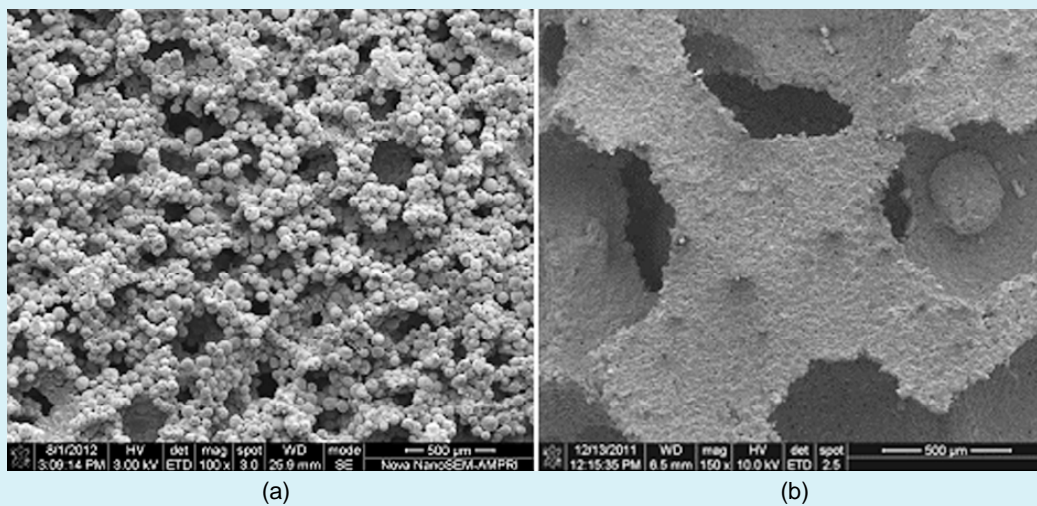


Fig. 3. (a&b) Microstructural features and (c&d) compressive stress-strain plots at different porosity levels in the case of open-cellular Ti foam samples (e) HAP coated Ti foam

Open cell Ti-foams with a porosity range of 55-80% and pore size of up to 700 μm have also been synthesized by the P/M route. Figs. 3a & b show the microstructure of the open cellular foam having cell wall thickness of 200-300 μm and pore size ranging from 500-700 μm . The pores began to form an interconnected network when the porosity level increased beyond 50 vol. %. The plateau strength of the open-cell foam decreased from around 58 to 35 MPa when the porosity level was raised from 55 to 65% (Figs. 3c & d). Moreover, the strain to failure increased with the increasing porosity level. Further work is in progress towards the evaluation of other relevant properties/ characteristics of the foams to assess their application potential. Efforts are underway

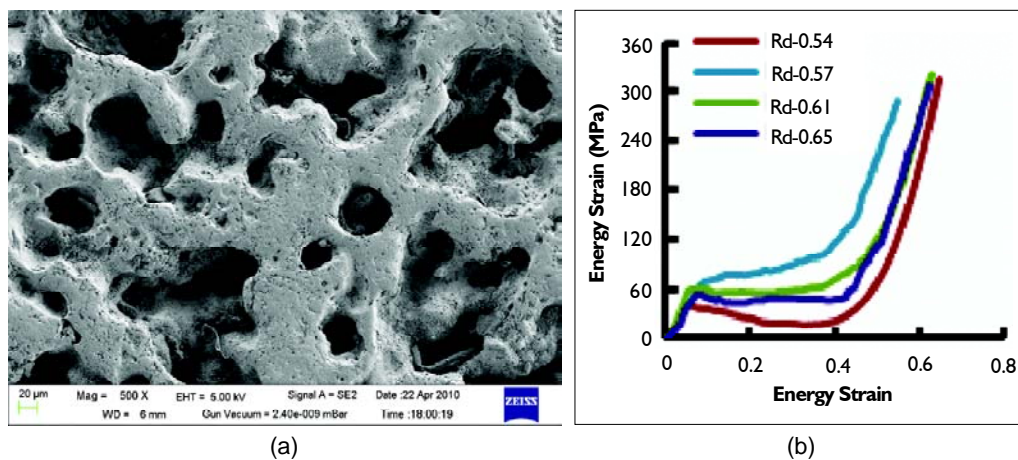


Fig. 4 (a) Microstructure and (b) stress-strain plots for Ti syntactic foam

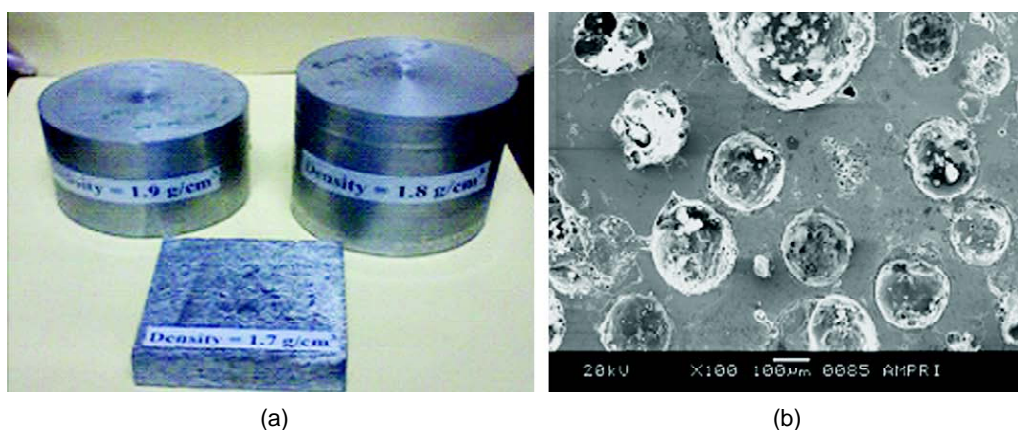


Fig. 5 (a) Al syntactic foam (ACSF) sample and (b) microstructure revealing cenospheres particles distributed in the matrix

to process open cellular foams (pore size: 500-1000 μm) for biomedical applications using the space holder technique. Hydroxy apatite (HAP) – an inorganic constituent of natural bone-coated Ti-foams – have also been synthesized with an aim to explore its use as bone scaffolds/replacements (Fig. 3e).

Ti syntactic foams with 50 to 65% porosity (Fig. 4a) were synthesized employing P/M route. The foams exhibited plateau stress in the range of 40-60 MPa and energy absorption capacity 20-30 MJ/m^3 (Fig. 4b):

Al Syntactic and Hybrid Foams

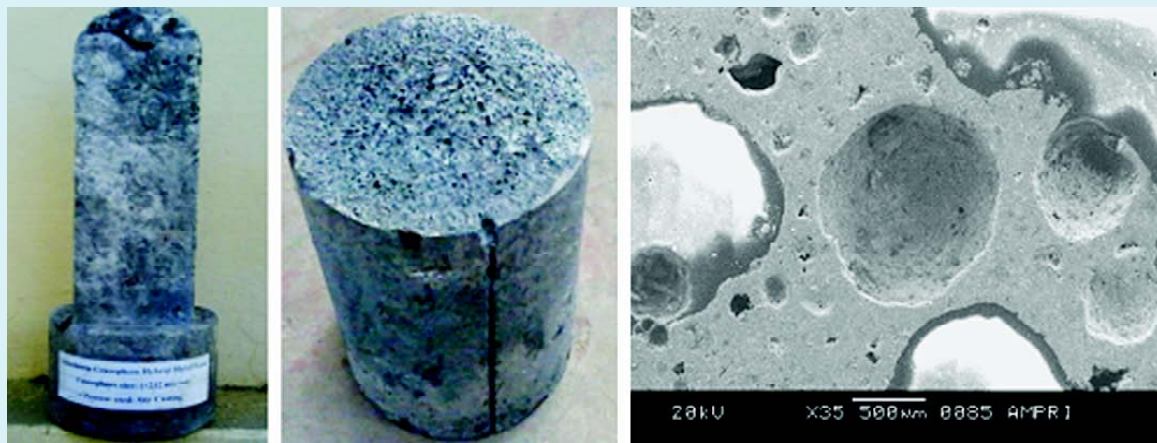
Aluminium syntactic foams (Fig. 5a & b) of varying densities (1.7-2.2 g/cc) have been synthesized through L/M (stir casting) technique using cenospheres

(density: 0.4 to 0.6 g/cc) of flyash. The foam samples attained plateau stress in the range of 50-180 MPa, energy absorption capacity of 25-50 MJ/m^3 , low-cycle fatigue strength of ~ 40 MPa with a degree of deformation to up to 0.01 without any failure.

Aluminium hybrid foams (Fig. 6a) with varying porosity levels (50-95%) have been synthesized employing a mixture of cenospheres and hydride for generating pores. A precise control of the contents of the hydride (CaH_2) and cenospheres and foaming temperature has led the hybrid foams to exhibit mechanical properties comparable to that of the conventional aluminium foam at a 30-40% less cost.

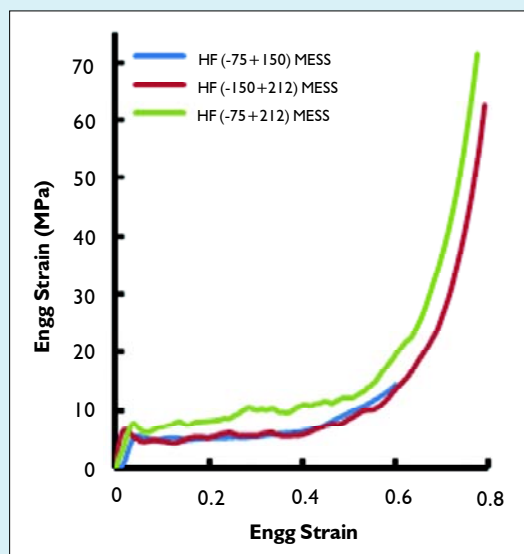
Zinc foam

Zn-based alloy foam (Fig. 7a) containing

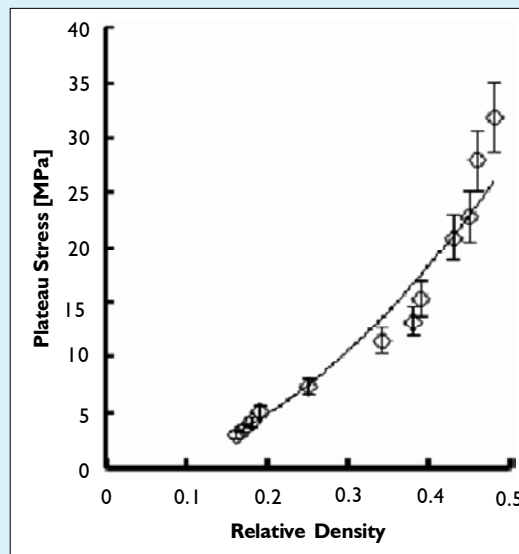


(a)

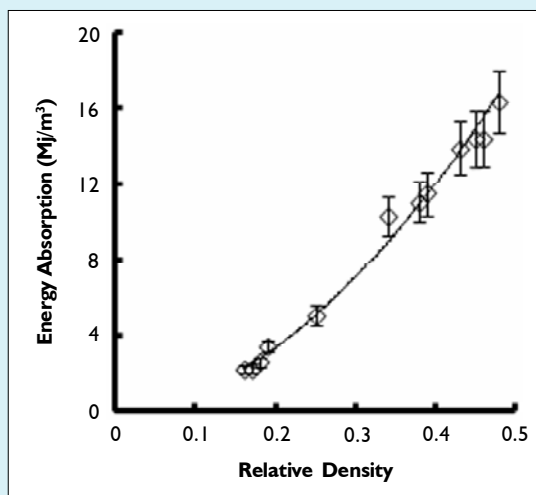
(b)



(c)



(d)



(e)

Fig. 6 (a) Samples (b) microstructure, and (c) stress-strain, (d) plateau stress –density and (e) energy absorption-density plots for the Al hybrid foam

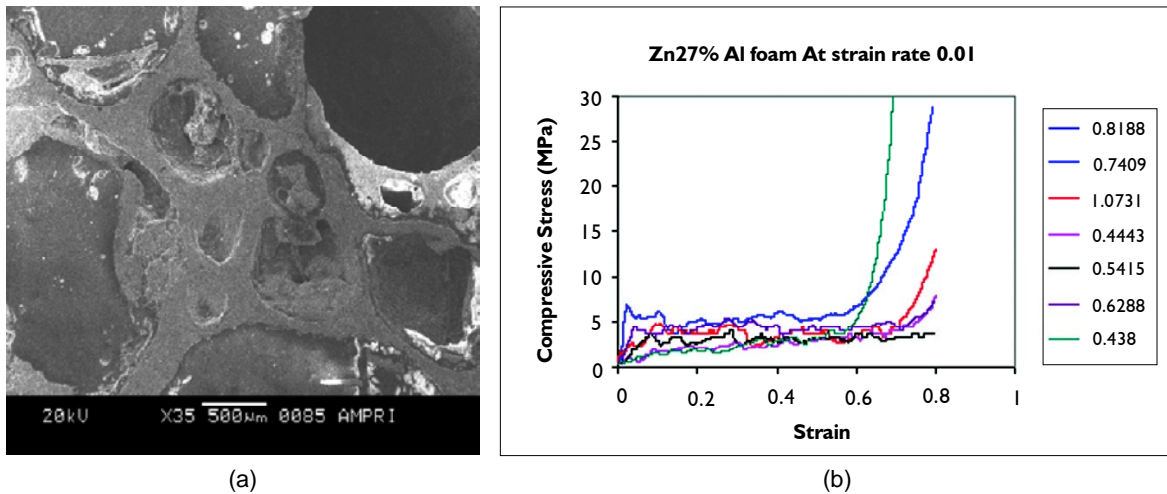


Fig. 7 (a) Microstructure and (b) stress-strain plots for the Zn foam

10 % by W SiC with varying density (0.25-0.85 gm/cc) have been prepared employing L/M route. The plateau stress, energy absorption (Fig. 7b) and density of the foams are comparable to those of Al-SiC foams. Attractive features of Zn foam over that of Al include ease of

processing, less cost of Zn than Al, lower processing temperature leading to less oxidation/burning losses of the foaming agent (hydride) and the metal. The material is sensitive to strain rate and possesses higher damping capacity than that of aluminium.

CSIR-NIO studies implications of sea level rise on coastal zones of Cochin

Scientists from CSIR-National Institute of Oceanography studied the implications of sea level rise scenarios on land use/land cover classes of the coastal zones of Cochin, India. This work was published in the *Journal of Environmental Management*, vol. 148; 124-133.

It was initiated to find out the response of coastal regions under climate change conditions and to demarcate the probable inundation regions with different sea level rise scenarios. Though the sea level rise trend varies as per the regional influence, this study throws light on the importance of mitigation measures need to be considered at this hour.

Cochin has been designated as one of the smart cities along the coast of India for the “Smart City” mission of

Honourable Prime Minister of India Mr. Narendra Modi. It is one of the most populated and fast growing cities of India and millions of dollars are invested in infrastructural projects such as Metro rail, setting up of industries, etc. Certainly, this city will become an urban conglomerate in the near future. This study will help Cochin authorities to demarcate environment and social sustainable regions unaffected by climate change effects.

Physical responses of the coastal zones in the vicinity of Cochin due to sea level rise were investigated based on analysis of inundation scenarios. Quantification of potential habitat loss was made by merging the Land use/Land cover (LU/LC) prepared from the satellite imagery with the digital elevation model.

It was initiated to find out the response of coastal regions under climate change conditions and to demarcate the probable inundation regions with different sea level rise scenarios.

Scenarios were generated for two different rates of sea level rise and responses of changes occurred were made to ascertain the vulnerability and loss in extent.

LU/LC classes overlaid on 1 m and 2 m elevation showed that it was mostly covered by vegetation areas followed by water and urban zones. For the sea level rise scenarios of 1 m and 2 m, the total inundation zones were estimated to be 169 km² and 598 km² respectively using Geographic Information System (GIS). The losses of urban areas were estimated at 43 km² and 187 km² for 1 m and 2 m sea level rise respectively, which is alarming information for the most densely populated state of India.

Quantitative comparison of other LU/LC classes showed significant changes under each of the inundation scenarios. The results obtained conclusively point to

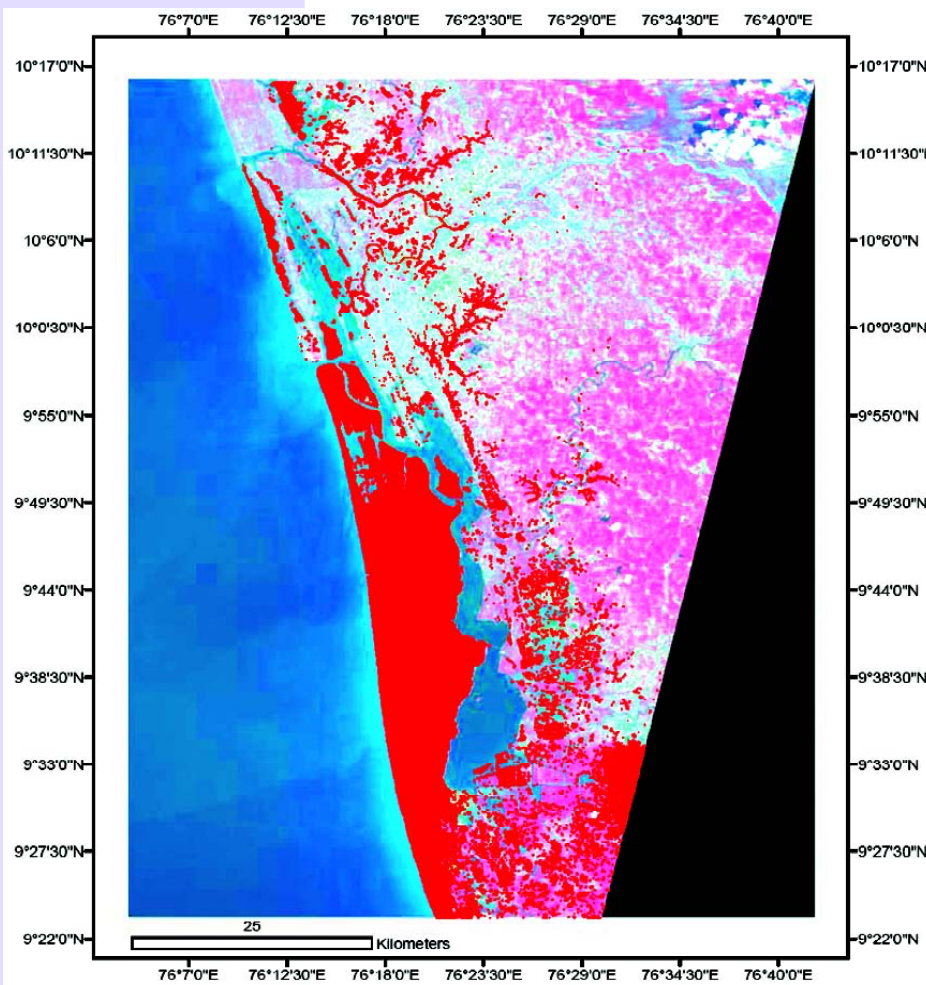
the fact that sea level rise scenarios will bring profound effects on the land use and land cover classes as well as on coastal landforms in Cochin region. Coastal inundation would leave the ocean front and inland properties vulnerable. Increase in these water levels would alter the coastal drainage gradients. Reduction in these gradients would increase flooding attributable to rainstorms which could promote salt water intrusion into coastal aquifers and force water tables to rise.

Changes in the coastal landforms associated with inundation generate concern and the coastal region may continue to remain vulnerable in the coming decades due to population growth and development pressures. Assessments of climate change impacts using the scientific data generate new knowledge. The process of adaptation includes the latest technologies as well as the traditional knowledge.

The overall probable inundation zones, their land use, land cover, the expansion plans of future and the assessment of current situation will help to devise the adaptive management. Preventive planning will reduce lot of hassles in the future. Adaptation to sea level rise situations should go with the improved versions of integrated coastal zone management projects. Mostly, agricultural lands, urban areas and vegetation zones are affected in this region. Alternate or modified agricultural practices, security for the fresh water, and managing the urban and industrial areas should be initiated immediately.

Reference:

Mani Murali R, Dineshkumar P.K: Implications of Sea Level Rise Scenarios on Land use/Land cover classes of the Coastal Zones of Cochin, India. *Journal of Environmental Management* 07/2014, DOI:10.1016/j.jenvman.2014.06.010.



Probable inundation zones for 2 m sea level rise

Seminars

Seminar organised by CSIR-NIIST on Environmental Management in Small and Medium Scale Industries



The Seminar was jointly organized by the CSIR-National Institute for Interdisciplinary Science & Technology (NIIST), Thiruvananthapuram and IChE, Thiruvananthapuram Chapter on 20 June 2015. It was attended by 48 delegates from industry, government, besides internal delegates from IChE and NIIST.

While the Convenor, Dr. V.B. Manilal welcomed the gathering, Dr. Ajit Haridas outlined the objectives of the seminar. NIIST is undertaking a project funded by the Department of Scientific and Industrial Research, Government of India, to establish a Common R&D Hub (CRTDH) for Environmental Interventions in MSMEs. The CRTDH will take up environmental issues and invest in developing solutions for the benefit of MSMEs.

The facilities created under CRTDH are open to MSMEs. The seminar aimed to bring together Government agencies and industries so as to identify issues that can be addressed by CRTDH. Environmental issues are closely related to improving efficiencies of raw material consumption and energy consumption. Thus process interventions can improve both environmental performance and also profitability.

Director, NIIST, Dr. Ajaya Ghosh, inaugurated the seminar.

Shri C.D. Kumar, Senior Environmental Engineer, Karnataka State Pollution Control Board gave an overview of the environmental and regulatory issues affecting MSMEs. MSMEs contribute to the economy. Actions such as closure of MSMEs forced by court orders affect the livelihood and employment of large number of people. Examples are closure of stone crushers, silk dyeing units, metal surface finishing units, granite and stone cutting units.

MSMEs also face space constraints and problems created by change in land use. Many MSMEs operate on job-work basis. Market conditions determine whether they operate, and hence do not want to incur capex. The lack of common facilities and common dumping sites affect MSMEs. They do not get institutional support for technical inputs to improve their environmental performance. Effective enforcement is difficult in the case of MSMEs. The large companies and multinational corporations want to create a green and responsible image by outsourcing polluting processes to MSMEs.

Case studies of Peenya Industrial Area (8 sq km) where surface treatment MSMEs have polluted groundwater (Cr 32 mg/L, limit 0.005 mg/L), Silk Hub in Cubbonpet (25 silk yarn dyeing units), Stone crushers in Karnataka were presented.

MSMEs are not allowed to discharge trade effluents into municipal sewers, whether treated or untreated. Ajit Haridas remarked that this policy has to change. It is economically and environmental better to allow the discharge of trade effluent into municipal sewers where suitable STPs are available. Restrictions need only be placed on effluents that have characteristics which damage sewerage system. The charges for discharge of trade effluents can be based on parameters such a COD load and nutrient load, thereby incentivising MSMEs to reduce waste and adopt recycling and pre-treatment.

Ms Mythili, Member Secretary, Kerala State Pollution Control Board, appreciated the initiative of this Seminar. KSPCB has NIIST scientists in its various technical committees. She stressed the need to develop low-cost technology solutions for MSMEs.

Mr M.P. Dileep, District Environmental Engineer, Kerala State Pollution Control

Environmental issues are closely related to improving efficiencies of raw material consumption and energy consumption. Thus process interventions can improve both environmental performance and also profitability.

The lack of common facilities and common dumping sites affect MSMEs. They do not get institutional support for technical inputs to improve their environmental performance. Effective enforcement is difficult in the case of MSMEs.

Wet scrubbers are provided for control of emissions, on the recommendations of Central Pollution Control Board. There is question mark on whether these are effective. These are not effective for control of smell, although particulate matter emissions can be controlled. But with modernized drum roasters, there is little particulate emissions and hence, the need for wet scrubber is questionable.

Board listed some priority sectors in Thiruvananthapuram District such as: cashew factories (odour, VOC, particulate matter emissions), flour mills (odour, noise), chicken stalls (25% of live weight is waste, some are not easily degradable wastes like feathers, head), pig farms, (odour and discharge of untreated waste), chicken farms (odour, dust, litter waste), brick making units (fugitive emissions, smoke), hollow block units (noise, dust), composting units (odour, leachate, fly nuisance), small-scale slaughterhouses (no waste segregation, failure of single technology such as anaerobic digester for waste treatment, need for resource recovery technology).

Ms Sreekala, Senior Environmental Engineer, Kerala State Pollution Control Board listed MSME issues identified from Idukki, Kozhikode, Kannur. These include 1) Cocoa fermentation – pulp utilization, odour nuisance, runoff; 2) Tea factory – wash water contains colour; 3) Dehydrated coconut – high strength wastewater; 4) Rubber units – reclaiming rubber by mastication – VOC emissions and very pungent odour; 5) Crumb rubber units – odour; 6) Gasifiers – tar, but new type gasifiers that have less tar production do not have this problem; 7) Paving tile manufacture – surface polishing VOC emissions; 8) Spices – vanilla fermentation odour; 9) Laundry units – need to recycle washwater; 10) Service stations – open spray painting VOC emissions; 11) Cuttle fish processing – cuttle fish ink discoloured effluent; 12) fish oil units – odour; 13) Prawn shell – chitin and chitosan units – smell problems; 14) Handloom units – dyeing; 15) Kraft paper units – wastewater; 16) Small Rubber sheet units – ammonia, small quantity of high strength effluent and smell; 17) Petroleum blending unit – smell; 18) Ayurveda – spent herbals; 19) Steel re-rolling units – fugitive emissions, foundry sand disposal, scrubbing is not viable; 20) Rubber and spice smoke houses – sulphur is used in smoke houses and during opening of smoke houses there are emissions.

Mr. Sreenivas of MILMA, Kollam Dairy said 15 tonnes of plastic film are consumed in packaging in Kollam alone. Biodegradable packing needs to be developed for milk.

Ms Maya, Asst. Principal Scientist, Head, MB Division, CEPC Lab, Cashew Export Promotion Council of India, Kollam said that there are 647 units producing 20 lakh tonnes of cashew kernels, graded in 37 varieties. 80% of the small units follow drum roasting technology, since foreign buyers want drum roasted cashew. Technical innovations are required in the drum roasting process. During quenching of the roasted cashewnut with water, “doghouse”, there is emission of smoke and smell. The drum is heated using cashewnut shell initially, but subsequently the nuts burn providing the heat. Wet scrubbers are provided for control of emissions, on the recommendations of Central Pollution Control Board. There is question mark on whether these are effective. These are not effective for control of smell, although particulate matter emissions can be controlled. But with modernized drum roasters, there is little particulate emissions and hence, the need for wet scrubber is questionable.

A small quantity of wastewater containing CNSL is generated during the quenching of roasted nuts. Innovation to avoid the wastewater is required.

Dr. Manoj, MD, Pelican Industries said that industry will always view pollution as an avoidable expenditure. The main problem is that of undue advantage for those do not install pollution control systems. Hence, it is suggested that vendors who are compliant have to be empanelled. Soft loan is required for installation of pollution control devices. Much of the pollution issues are the result of supply chain management. Waste $FeCl_3$, dilute acids and alkalis, herbal spents, etc., are raw materials for other industries but there is no supply chain.

Mr. Radhakrishnan, retired Senior Geologist, Department of Mining and Geology, in his presentation, listed the issues in the mining sector. India is seventh

in the world in mining value production. Mining contributes 1.5% of India's GDP. Mining uses only 0.2% of Kerala's land area. Most of the environmental issues associated with mining are reversible. The major environmental issues are top soil management, surface water pollution, dust suppression. The environmental issues connected with mine closure are long-term water management, post-mining land use, final rehabilitation and re-vegetation. Post mining land-use opens the possibility of restoring mined out area that were agricultural, to its original ecology prior to transformation for agriculture. This could be important for restoring areas such as coastal zones.

Ally Latheef, Director, Marksmen Marine mentioned issues in fishmeal

industry. NIIST-developed biofilters for odour control are very effective. Media life observed is one year. This may be improved to reduce operation costs. The industry needs a design for modern anaerobic reactor for fishmeal effluent.

Mohan Kumar, Industry Extension Officer, DIC, Thiruvananthapuram mentioned environmental concerns from tourism – encroaching on sensitive areas and E-waste – as issues of concern. The DIC provides investment support of Rs. 30 lakh to MSMEs and this includes investment in pollution control systems.

In the concluding session, Ajit Haridas remarked that since CRTDH has limited resources, especially manpower, there was a need to prioritise.



Workshops

Second Indo-US Workshop on Engineered Nanocarbons for Electrochemical Energy Storage organized at CSIR-CECRI

Fifteen years after President Clinton floated the National Nanotechnology Initiative as a key global scientific and societal endeavour, nanoscale science and engineering remains a field in formation. For, according to Prof. Pulickel M. Ajayan of Rice University, USA, the possibilities are exciting and the challenges interesting.

Inaugurating the Second Indo-US Workshop on Engineered Nanocarbons for Electrochemical Energy Storage at the CSIR-Central Electrochemical Research Institute at Karaikudi on 19 June 2015, he said that we had moved into an era of nanomodular systems. Nanotechnology has evolved into a general-purpose technology with attendant benefits in areas as disparate as smart coatings, electronics, photonics, energy storage, catalysis and medicine. From its foundational creative stage of confluence of knowledge and passive components, it has now



entered a stage of system integration and divergence in innovation, opening windows for spin-offs and novel technology platforms.

He said that the transitions are marked by a multi-billion manufacturing sector driven by user industries. R&D in graphene, the wonder two-dimensional carbon, for example, is a flagship program of the

European Union, with a billion dollar investment for lab-to-device programs. The paradigm shift, Prof. Ajayan said, was for all to see. Today, the technologies that are envisioned are never heard of before: carbon nanotube fibers, flexible, paintable and transparent batteries, direct writing of supercapacitors on graphene oxide films, graphene antenna sandwich

photodetectors, seamless engineering of compositionally variant layers, superelastic covalently bonded graphene and self-stiffening nanocomposite with dynamic strain.

Earlier, Dr. Vijayamohan K. Pillai, Director, CSIR-CECRI, and Dr. M. Jayachandran, Chief Scientist, CSIR-CECRI, welcomed the audience and spoke of the workshop as a necessary bilateral enterprise for mutual growth. About twenty experts drawn from India and the US deliberated in this two-day program jointly organized by the Indo-US Science and Technology Forum, CSIR-Central Electrochemical Research Institute, Indian Institute of Science Education and Research (Thiruvananthapuram) and the Society for Advancement of Electrochemical Science and Technology.

Earlier in the day, Prof. Ajayan inaugurated the HR-TEM (High Resolution Transmission Electron Microscopy) Facility at CSIR-CECRI.



Awareness Programmes

Awareness Programme on “Samadhan Kendra” Organised by CSIR-IICT

An awareness program on *Samadhan Kendra* was organised at Kommugudem village, Tadepalligudem Mandal, of West Godavari District, Andhra Pradesh on 11 May 2015. Dr. U.S.N. Murty, HOD Biology, CSIR-IICT, Mr. Venugopal Krishna, Agriculture Officer, Government of A.P., Mr. Sudheer, Horticulture Officer, Government of A.P and Mr. Surapaneni Venkat Rao, progressive farmer and Panchayat President of Kommugudem village were present to address a large gathering of farmers who assembled for the occasion.

After the customary introduction of the dignitaries the programme began with the address of Dr. U.S.N. Murty who highlighted the effectiveness of *Samadhan*

Kendra and its user friendliness and the ease with which it can be operated backed by audio and video facility. He brought to the notice of the farmers present that the portal has useful information about the chief crops grown in the area like Paddy, Sugarcane, Cotton, and Coconut. In addition to these information about the other horticulture crops grown in the area are also included. The *Samadhan Kendra* disseminates information about Pest Disease Information (PDIS), how to tackle the menace by taking necessary precautions, information about the availability of quality fertilizers and insecticides available with the local dealers, physico-chemical properties of soil, etc.

He also stressed that information



about the various Governmental schemes which are in vogue also have been incorporated for the benefit of the farmers, and emphasis has been given in *Samadhan Kendra* to upload information about the banking schemes and loans offered by nationalised banks for the farming community. He also said that information about the Governmental health schemes and comprehensive information about education and career guidance have been ported for the benefit of the local populace.

Dr. Murty told the audience present that Filariasis is a much prevalent disease in East and West Godavari districts and asked the inhabitants of the villages in these districts to visit the local National Filaria Control Program Units (NFCP) operated by the Government and subject themselves to regular blood smear tests to lead a safe and healthy life. He also stressed that without local support no technology can be successful, and urged the farmers to make optimum use of the *Samadhan Kendra* once the centre is inaugurated.

Addressing the gathering, the agriculture officer Mr. Venugopal Krishna spoke at length about the issues plaguing the farming community and shared his breadth of experience with the farmers and urged them to adopt innovative techniques to improve the output of the agriculture produce. He wanted the farmers to introduce new disease-resistant strains of rice and other crops to overcome the over-usage of pesticides and requested them to use neem cake and neem oil for effective pest management.

The Horticulture Officer Mr. Sudheer, urged the farmers to adopt novel and new techniques in agriculture and also make maximum use of bio-fertilisers to increase the fertility of the soil and also get maximum

produce. He stressed that pesticides should be used judiciously. He assured the farmers that he would extend his fullest support for the maximum benefit of the farmers of the region.

Speaking on the occasion, the Kommugudem village, Panchayat President, Mr. Surapaneni Venkat Rao, expressed his heartfelt thanks on his and on behalf of the farming community to



Mr. Surapaneni Venkat Rao Panchayat President and progressive farmer addressing the gathering of farmers during the awareness program on *Samadhan Kendra*

CSIR-IICT for coming up with this novel idea of *Samadhan Kendra* and for organising the awareness camp for the benefit of the farming community. He said that scientific inputs developed in the lab have to be successfully implemented in the field, usage of bio-fertilisers has to be promoted in a big way, and periodic soil testing of the farm lands has to be taken up to assess the fertility of the soil.



A section of farmers during *Samadhan Kendra* awareness programme

Visits

Ambassador of Monaco visits CSIR-NIO

His Excellency Mr. Patrick Medecin, Ambassador of Monaco visited CSIR-NIO on 8 July 2015. During the meeting with Director, CSIR-NIO and Heads of Divisions, he expressed that as Monaco has a long history of oceanographic research, it would be worthwhile to collaborate with CSIR-NIO on issues such as ocean acidification, climate change and sustainable development of marine resources.

Dr. S.W.A. Naqvi, Director, CSIR-NIO made a presentation on the research activities of NIO as well as service to industry and outreach programs in terms

of training and manpower development. Dr. Naqvi also highlighted that the Institute, which was established in 1966 at the culmination of the International Indian Ocean Expedition (1962-65), is celebrating its golden jubilee year (1966-2015) and invited the scientists and officials from Monaco to participate in the forthcoming symposium on *Dynamics of Indian Ocean* to be held at NIO, Goa during 30 November-3 December 2015.

HE Mr. Medecin expressed hope that a joint programme could be worked out between his government and the National Institute of Oceanography.



**Glimpses
of the
visit**



CSIR News is profiling all the CSIR laboratories throwing light on the significant areas they work in and their achievements.



CSIR-Central Electronics Engineering Research Institute, Pilani

Established in 1953, CSIR-Central Electronics Engineering Research Institute (CEERI) has been the leading source of knowledge and technologies in the field of electronics in the country. Located in Pilani, Rajasthan and Chennai, Tamil Nadu CSIR-CEERI has served the country's evolving needs for strategic, societal and industrial technologies.

Since its inception, it has been working for the growth of electronics in the country and has established the required infrastructure and well experienced manpower for undertaking R&D in the following major areas:

1. Electronic Systems
2. Microwave Tubes
3. Semiconductor Devices

The Chennai center focuses on process control instrumentation and automation as well as cutting edge research in machine vision technologies.

In the 1960s, the institute made significant contribution towards import substitution and generation of employment through indigenous industry, including indigenous know-how for Black & White Television Receiver, for which it was awarded the Gold Shield by Invention Promotion Board in 1972.

Its Semiconductor Devices Division is credited with the development of the first Planar Silicon Transistor in India. CEERI also produced a number of technologies for audio systems, different types of microphones, and calibration equipment, scanning components, deflection coil winding machines for TV sets, magnetrons, 5 kW co-axial power triode, 5 kW induction heater

and special purpose electronic flash tubes.

Another notable achievement is of Excitation Control System for Diesel Electric Locomotives for Indian Railways that were started in the late 1960s. The know-how for this system was transferred to M/s Electronics Corporation of India (ECIL) Limited. More than 4000 diesel electric locomotives of Indian Railways fitted with these control systems have been plying the tracks since.

Some of the other achievements of CEERI during the 1970s include Colour TV Receivers, Thick Film Hybrid Microcircuits, Power Triodes (12.5 kW), Multi-channel Electronic TV Tuner, 32-line Electronic Telephone Exchange, Silicon Solar Cells and Panels, Silicon Power Transistors and Synchronised Projection Control System.



During the 1980s, CEERI focused on modernisation of traditional industries through the introduction of electronic instrumentation for monitoring and control of processes in industries such as Sugar, Paper and Pulp and Mining.

The other streams of R&D focused on strategically important electronic devices

In the 1960s, the institute made significant contribution towards import substitution and generation of employment through indigenous industry, including indigenous know-how for Black & White Television Receiver, for which it was awarded the Gold Shield by Invention Promotion Board in 1972.

like Microwave Tubes, Hybrid Micro-circuits, and development of design capabilities and fabrication technologies for Large Scale Integrated Circuits (LSI).

In the 1990s, R&D efforts started in the upcoming area of Micro-Electro-Mechanical Systems (MEMS).

Some other notable R&D achievements of the institute during this period were:

- Digital mapping system (DIGIMAP) for Survey of India
- Transistorised PWM drive for electric vehicles
- A PC-based speed indicating and recording instrument for diesel electric locomotives
- Withering trough automation system for tea industry
- Parametric speech synthesis system (unlimited vocabulary) for converting Hindi text to speech

- Voice/Joystick operated wheel chair
- Integrated optical receiver module
- Alumina bias circuit boards for IR detectors

The New Millennium

During the new millennium, CEERI scaled up its ambitions and took major initiatives in the field of Microwave Tube Technologies and strategic Microwave Tube design and development (particularly High Power Microwave Tubes and High Efficiency & High Reliability microwave Tubes). CEERI also undertook to lead a DST sponsored multi-institutional project for developing the first Gyrotron tube in the country.

R&D groups in Electronic Systems Area of the institute focused on the development of electronic systems for different applications in the areas of horticulture and agro-based industries, national water mission, aquaculture, communication and disaster mitigation in mines, synthetic adulteration detection in milk and specialised high-voltage pulsed and CW power systems required for operating high-power microwave tubes.

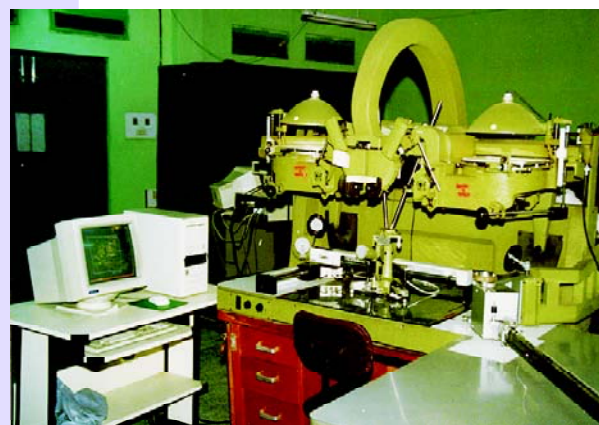
New areas of R&D were also started at the institute, which include reconfigurable computing systems, application specific processors, virtual instrumentation, wireless sensing networks, real-time image processing based systems, NIR-based chemometric systems, electronic tongue, electronic nose, mixed-analog digital circuits and sensor-electronics integration, low temperature co-fired ceramic (LTCC) technology and nano electronic devices.



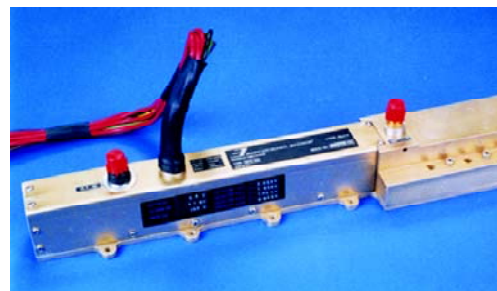
VIBROTONE for Canned Food Industry



Withering Trough Automation System at Gulma Tea Estate



DIGIMAP System Installed at Survey of India, Bhubaneswar



C-band 60 W Space TWT for ISRO

Major accomplishments of the institute in the new millennium include:

Microwave Tubes:

- 5 MW pulsed power S-band klystron for RRCAT, Indore
- 2 MW S-band tunable pulsed magnetron for Department of Atomic Energy
- 3 MW pulsed S-band magnetron for RRCAT, Indore
- Multi-ceramic rectangular RF window for IPR, Gandhi Nagar



S-band Klystron for Centre for Advanced Technology, Indore

- Design and development of 42 GHz, 200 kW CW/long pulsed gyrotron (currently underway as a DST sponsored multi-institutional project led by CEERI)

Semiconductor Devices:

- Silicon MEMS pressure sensors for LPSC, ISRO
- MEMS acoustic sensor for VSSC, ISRO (which was also used in Chandrayaan)
- RF MEMS switches for C, X, Ku-band for SAC, ISRO

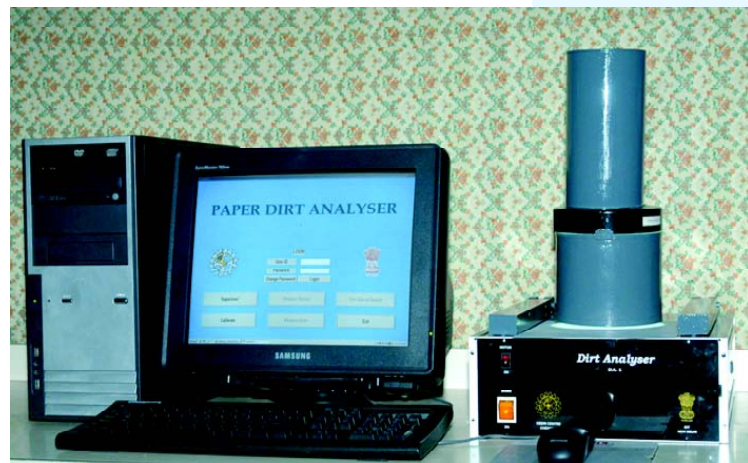
- Microwave circuits using LTCC technology for SAC, ISRO
- Organisation of six training programmes (2-week duration each) on MEMS technology for faculty of academic institutions (IITs, NITs, universities) and scientists of DRDO under NPMASS programme

Electronic Systems:

- Paper formation analyser
- Integrated PLC-based electronic controller for batch-digester in paper industry
- On-line freeness tester for paper and pulp industry
- Electronic process control system for paper converter machine
- Paper dirt speck analyser
- X-ray imaging based automatic sorting machine for mangoes with internal defects (seed weevil and spongy tissue)
- Electronic tongue based synthetic milk detector
- Smart pond management system for fresh water aquaculture



Paper Formation Analyser for Pulp and Paper Industry



Paper Dirt Speck Analyser for Pulp and Paper Industry

- Electronic monitoring and control system for community RO plants
- High-efficiency direct ac-to-ac convertor
- Solid-state versatile pulsar for high-voltage and high-power applications
- A wireless and wired hybrid communication system for miners to tackle emergencies and disasters in mines

Future programmes

CSIR-CEERI has proposed to undertake and coordinate three major CSIR Network R&D programmes in the 12th Five-year Plan. These include:

1. **Very High Power Microwave Tubes:** Design and Development Capability
2. **Advanced Microsensors and Microsystems:** Design Development and Applications.
3. **Nano Devices:** Research and Applications

In addition, CSIR-CEERI is also partnering in several other CSIR Network Research Programmes (being coordinated by other CSIR laboratories) to develop:

- GaN-based High-efficiency, High-Luminosity White LEDs for Lighting Applications
- GaN-based Very

High-efficiency Solar Cells

- High-efficiency Advanced Silicon Photovoltaic Devices Incorporating Nanomaterials and Nanostructures
- Wireless Sensor Networks for Smart Structures and Smart Buildings
- Advanced Electronic Controls for Micromachines
- Advanced Instrumentation Technologies for Water Sector, Agri-processing and Precision Agriculture
- Development of Solar Thermo-acoustic Electric Generators and Refrigerators
- Technological Support to Micro, Small and Medium Enterprises

Human Resource Development

CEERI also makes seminal contribution towards developing human resource through its Post Graduate Engineering education in Microelectronics in the country. CEERI partnered with Birla Institute of Technology and Science (BITS), Pilani to start the M.E. (Microelectronics) degree programme.

The institute also supported IIT-Delhi in their effort to launch an industry sponsored postgraduate engineering degree programme in Microelectronics. CEERI also provided pivotal support to the then Department of Electronics (DoE), Government of India, in the planning and implementation of their major national initiative termed 'Special Manpower Development Programme for VLSI Design and Related Software' that aimed at developing faculty, learning

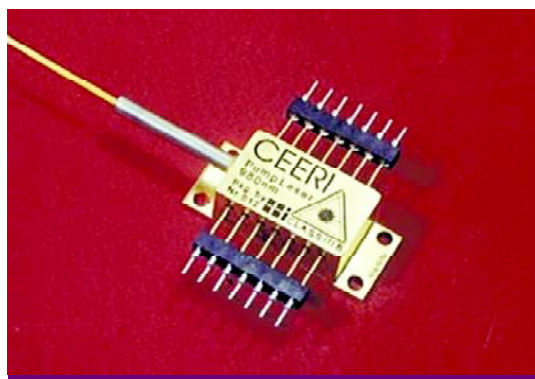
material and laboratory infrastructure at 19 leading academic institutions in the country in a bid to gear them up for the launching of post graduate engineering degree programmes in Microelectronics



Synthetic Milk Detector



X-ray Imaging Based Mango Sorting Machine



980 nm Pump Laser Module for Fibre Amplifier

(silicon chip design and technology).

Under CSIR's initiative of starting Post Graduate Research Programmes in Engineering (PGRPE), CEERI launched two PGRPE programmes namely "High Power Microwave Devices and Systems Engineering" and "Advanced Semiconductor Electronics" in the year 2009. A third PGRPE programme, namely

"Advanced Electronic Systems" was launched in the year 2011.

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Appointments

Dr. Sanjay Kumar joins as Director CSIR-IHBT, Palampur

Dr. Sanjay Kumar joined as Director, CSIR-Institute of Himalayan Bioresource Technology (IHBT), Palampur on 11th June 2015.

With a focus on high altitude biology, his research interests span plant adaptation and climate change studies, metabolic engineering of secondary metabolites and bioprospecting genes and enzymes.

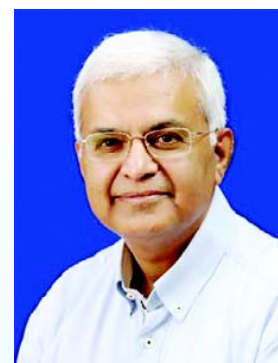
After obtaining Master's degrees in plant physiology from G.B. Pant University of Agriculture and Technology, Pantnagar, he pursued Ph.D. from the Indian Agricultural Research Institute, New Delhi, joined CSIR-IHBT as Scientist B in 1990 and served as Senior Principal Scientist in the same institute prior to his joining as Director.

Early in his career, he received the Young Scientist Award by the Indian National Science Academy, New Delhi. He is recipient of the DST sponsored BOYSCAST Fellowship and DBT Overseas Associateship. Later, he received the International Research Associateship at Kansas State University, USA in the area of Ecological genomics. In 2008, Dr Sanjay was awarded Certificate of Merit in CSIR Leadership Programme. Currently, he is a Fellow of the National Academy of Sciences, National Academy of Agricultural Sciences, and The Crop Improvement Society of India.

For his distinguished service to industry, he was awarded the prestigious VASVIK Industrial Research Award 2013 for Agricultural Science and Technology. His key contributions to industry include production of unique autoclavable superoxide dismutase enzyme which finds application in cosmetic, food and medical industry. The technology was transferred to M/s Phyto Biotech, Kolkata at a premium price. Another technology, the RNA Isolation Kit developed by his group has been commercialized to a Chennai-based company which is presently marketed by Merck.

Other major research contributions of his group are on discovery of a novel carbon fixation pathway; bioprospecting genes, proteins and processes for tolerance under abiotic stresses; deciphering the mechanisms of winter dormancy and drought stress in tea; genetic regulation of catechins, picrosides, steviosides, shikonins and podophyllotoxin biosynthesis.

He has guided 15 Ph.D. and 4 M.Sc. students and has over 100 publications, including in Nature Publishing Group journal. He has several patents to his credit, some of which are commercialized also. He is a member of several professional committees and Task Forces at the national level, and Editorial Board of international journals.



Prof. R.K. Sinha assumes Charge as Director, CSIR-CSIO



Prof. R.K. Sinha assumed the charge as Director, CSIR-Central Scientific Instruments Organisation (CSIO) w.e.f. 2 July 2015.

Prof. R.K. Sinha received M.Sc. degree in Physics from the Indian Institute of Technology (IIT), Kharagpur, in 1984, and Ph.D. degree in the area of Fiber Optics and Optical Communication Technology from IIT-Delhi, in 1990. He has held various research and academic positions at the Indian Institute of Science (IISc), Bangalore during 1991, Birla Institute of Technology and Science (BITS), Pilani during 1992-1994, REC (now NIT), Hamirpur during 1994-1998 and at Delhi College of Engineering-DCE (now Delhi Technological University-DTU), University of Delhi during December 31, 1998 to July 01, 2015.

Prof. Sinha has taken over the charge of Director, CSIR-Central Scientific Instruments Organisation (CSIO), Chandigarh with effect from July 02, 2015 maintaining lien with his position as a Professor of Applied Physics since October 2002 & Chief Coordinator of the Technology Information, Forecasting and Assessment Council (TIFAC)-Centre of Relevance and Excellence (CORE) in Fiber Optics and Optical Communication since its inception in 2005 at Delhi Technological University-DTU (Formerly known as Delhi College of Engineering, University of Delhi).

He has served as (i) Dean (Academic-UG) during January 2015-June 2015 (ii) Dean (Industrial Research and Development) during 2008-2010, (iii) Head, Applied Physics Department during March 2009 to July 2012 and (iv) Chief Warden during 2003-2006 at DCE/DTU Delhi.

He is the author/co-author of 233 research publications in leading national and international journals (95) and referred conference proceedings (138). He also has to his credit 4 book chapters, 2 books and

1 filed patent. He has supervised 14 Ph.D. theses and over 20 R&D projects sponsored from Government and Private Organizations.

Prof. R.K. Sinha has been awarded the Institution of Electronics and Telecommunication Engineers (IETE) Biman-Behari Sen Memorial Award for outstanding research in the area of Telecom Grade Optical Fibers and Optoelectronic Devices Optics in 2012; Emerging Optoelectronics Technology Award [(CEOT-IETE, India)]-2006 for outstanding research work in the area of Nano-photonics; S. K. Mitra Memorial Award for Best Research Paper in IETE Technical Review 2002 on Nanostructure Electron Waveguides and Devices; his co-authored research paper has won several Best Research Paper Awards which include Swarna Jayanti Puraskar (Gold Medal) from the National Academy of Sciences in the area of Nano-scale Optical Devices for the year 2001, Reliance Technology Awards 2010, SPIE 2014 best research presentation award and OSI-2014 second best poster presentation award.

Prof. Sinha is a Fulbright Scholar – recipient of Fulbright-Nehru Fellowship to acquire first-hand knowledge of Higher Education Systems and Practices of USA covering over a dozen US universities and higher educational institutions as an International Educational Administrator in 2013. He was Keynote Speaker in International Conference-NOPT in Singapore in February 2010.

He has also been awarded National Science Council Taiwan Fellowship-2009 to pursue collaborative research and deliver invited talk on Photonic Crystal based Nano Photonic Devices; Indo Swiss Bilateral Research fellowship-2009 to initiate collaborative research in the area of Nano Photonic Devices with EPFL Switzerland and DTU, Delhi; Royal Academy of Engineering (UK) Fellowship-2008 to carry out research on Photonic

Crystal Waveguides and Devices at Glasgow University, UK; the Japan Society for Promotion of Science (JSPS) Invited Fellowship-2007 to carry out research work on Multicore Photonic Crystal Fibers at Hokkaido University, Sapporo, Japan; and UKIERI Fellowship from the British Council of India to initiate collaborative research between leading universities of UK and his organization in the year 2006.

Prof. Sinha was academic visitor of Stanford University in 2002 and academic visitor of MIT, Harvard University and Boston University in 2005, ICTP-Visiting Scientist Fellowship-1991 at ICTP, Trieste, Italy, IROST Fellowship 1992 and Visiting Scientist position at University of Campinas in Brazil in 1995, and recipient of Japanese Govt. Scholarship in 1989-

1991 to work at Osaka University and Kobe University in Japan.

Prof. R.K. Sinha is a Fellow of SPIE-The International Society of Optical Engineering, Fellow of the IETE, and a Fellow of Optical Society of India, a Member of The Optical Society (OSA, USA), a Member of IEEE and a Member of The Photonics Society of IEEE. Prof. Sinha is also Faculty Adviser of SPIE-DCE Chapter and OSA-DCE Chapter at DTU, Delhi. Earlier, Prof. Sinha was actively involved in supervising several innovative projects on the design and development of unmanned and autonomous vehicles and in the establishment of Knowledge and Innovation Park with focus on student-led innovation and product development.



Professor Alok Dhawan takes charge as Director, CSIR-IITR, Lucknow

Professor Alok Dhawan has assumed charge of Director, CSIR-Indian Institute of Toxicology Research, Lucknow in the forenoon of 24 June 2015. He was earlier Director, Institute of Life Sciences, Ahmedabad University, Gujarat.

Professor Dhawan obtained his Ph.D. Biochemistry from the University of Lucknow in 1991. He is an accomplished scientist and started the area of nanomaterial toxicology in India and published a guidance document on the safe use of nanomaterials. As a scientist at CSIR-IITR, he spearheaded the alternate to animal models in toxicology programme in the country. He also developed *in silico* models for toxicity assessment and used them for understanding the mechanism of toxicants and nanomaterials. His work in the area of nanomaterial toxicology brought India on to the global map through Indo-UK collaboration and the flagship European Union programme (NanoValid) under the EU-FP7.

Professor Dhawan has several

honours and awards to his credit including INSA Young Scientist Medal in 1994, CSIR Young Scientist Award in 1999, Shakuntala Amir Chand Prize of ICMR in 2002 and Vigyan Ratna by the Council of Science and Technology, UP in 2011.

He founded the Indian Nanoscience Society in 2007. In recognition of his work he has been elected as Fellow, The National Academy of Sciences, India; Fellow, The Academy of Toxicological Sciences, USA; Fellow, The Academy of Environmental Biology; Fellow, Academy of Science for Animal Welfare; Fellow Society of Toxicology (India), Founder Fellow, Indian Nanoscience Society; Fellow, Gujarat Science Academy; Vice President, Environmental Mutagen Society of India (2006-07), and Member, National Academy of Medical Sciences.

He has to his credit over 100 publications in peer-reviewed international journals, several reviews/book chapters, four patents and one copyright. He has edited two books.



Dr. S. Chandrasekhar appointed CSIR-IICT Director

Dr. Srivari Chandrasekhar has taken charge as Director of the CSIR-Indian Institute of Chemical Technology from 8 June 2015.

Born in 1964 in Hyderabad, Dr. Srivari Chandrasekhar completed all his primary and higher education in Hyderabad. He received his B.Sc. (1982), M.Sc. (1985) and Ph.D. (1991) degrees from Hyderabad-based Osmania University, and pursued post-doctoral research at the UT Southwestern Medical Center, Dallas, USA, with Prof. J. R. Falck. Later, as a Humboldt Fellow at the University of Göttingen, he worked on the synthesis of hybrid natural products with Prof. L. F. Tietze.

Dr. Chandrasekhar joined CSIR-IICT as Scientist C in 1994 and grew upto the level of Chief Scientist in 2010. Since then he has been leading one of the largest groups in CSIR-IICT – the Natural Products Chemistry division.

Dr. Chandrasekhar has made significant contributions in diverse areas of organic chemistry with special emphasis on chiral chemistry, total synthesis of biologically active natural products and pharmaceutical products. He has developed polyethylene glycol (PEG) as a novel, environmentally benign solvent medium. He has also developed technologies for synthesis of anti-tuberculosis drug, bedaquiline (the first drug approved by

FDA in over 40 years for the treatment of multidrug-resistant TB); anti-tumor and abortive drug, mesoprostol; anti-platelet molecule, beroprost; anti-depressive compound, sertraline and drug for treatment of schizophrenia, asenapine. His work in devising innovative, practical approaches to pharmaceuticals has helped the pharmaceuticals industry based in Hyderabad and elsewhere.

Dr. Chandrasekhar was also instrumental in setting up the Molbank facility at CSIR-IICT for the storage and retrieval of chemical samples for HT screening.

He is a Fellow of all the three Indian Science academies, i.e., National Academy of Sciences India, Indian Academy of Sciences and Indian National Science Academy. Dr. Chandrasekhar has more than 250 publications with 5000 citations; 50 students have been awarded Ph.D. degree under his guidance and 20 post-doctoral associates have worked in his group.

He has received several accolades including CNR Rao National Prize for Chemical Research 2012, CSIR Technology Award 2014 and Infosys Prize in Chemical Sciences 2014 for his contributions in process development and applied sciences.



Prof. B.K. Mishra is Temporary Chairperson, RAB

The Prime Minister as President, CSIR has approved the proposal of assigning temporary charge of Chairperson, RAB of CSIR to Prof. B.K. Mishra, for a period of six months or till such time a regular Chairperson is appointed or until further orders, whichever is earlier.

Prof. B.K. Mishra will look after the work of Chairperson, RAB, CSIR in addition to his present assignments.

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