

Hybrid and nanomaterials – 2009*

The city of Tours is situated in the heart of a European communication network, nearly 200 km from Paris. The region around Tours is known as the Touraine, spread around a radius of 80 km, also called 'the garden of France'. This territory has many chateaux and famous residences such as: Chenonceau, Azay-Le-Rideau, Chambord, Loches, Chinon and Amboise. This land has been blessed with many great historical figures, like François Rabelais (satirist and humorist), Honoré de Balzac (Novelist), Pierre de Ronsard (poet), René Descartes (philosopher and mathematician) and Leonardo da Vinci (painter, sculptor, architect, engineer and scientist) at Amboise. It became part of the Roman Empire during the first century AD and name of the city evolved in the 4th century first as 'Civitas Turo-norum' then as 'Tours'.

Hybrid materials

Most of the materials we use in our routine life are either in the form of alloys, composites, multi-components mixture or hybrid materials. Hybrid materials have unique properties, different from their parent constituents. With the development in research in nanotechnology, a new class of materials with one dimension in 1–100 nm range with/without bio or organic additives has evolved termed as nano-hybrids. This field has attracted a keen interest among scientists from multidisciplinary fields. In the synthesis of nano-hybrid materials, we often adopt nature's bottom-up approach for controlling size and shape of particles. The details of synthesis and applications of hybrid materials were covered in tutorial lectures by Clément Sanchez (France) and Michael Popall (Germany).

Nearly 1400 delegates from all over the world attended the conference. In the delegate list, it was very encouraging to see the names of twelve Indian researchers.

*A report on the First International Conference on Multifunctional, 'Hybrid and Nanomaterials – 2009' at Tours, France during 15–19 March 2009. The conference took place at the 'Vinci Convention Centre' in Tours.

Among them, three scientists were from CSIR family – P. Thanikaivelan (CLRI, Chennai), S. Nayar and A. K. Pramanick (NML, Jamshedpur) and another one is D. Chakraborty from B.N. College, Dhubri. Three Ph D students also participated in this conference, two from Pune and one from Delhi. All participants had presented their papers in the poster sessions. In this conference, five plenary talks, three tutorials, 33 invited talks, nearly 155 oral presentations and several hundred posters were presented in three poster sessions. A wide range of topics were covered ranging from design, synthesis, processing, storage, catalysis, sensors, optics, microelectronics, smart materials and coatings, biotechnology and medicine.

The conference was arranged in three parallel sessions: Symposium A: Biohybrids and Biomaterials; Symposium B: Bottom-up approaches to functional nanomaterials and nanocomposites; Symposium C: Functional porous materials.

Biohybrids and biomaterials

This session included topics such as bio-inspired, bio-mimetic materials, biomineralization, synthetic and biopolymer conjugates. The symposium highlighted recent advances in the design of functional materials/biomimetics. Materials prepared using biological systems, including living organisms and renewable sources were also covered.

Three papers were presented on biomimetics from India. Thanikaivelan presented a paper on 'Structural and thermal investigations of biomimetically grown casein-soy composite protein fibers'. The casein – a type of protein extracted from milk and from soya milk, are different from each other. The former has a feel of silk and the latter has feeling of wool. A composite of two different proteins was studied using different weight ratios by solution spinning techniques. He demonstrated that composites with ≥ 50 wt% casein exhibits better morphology and thermal stability. S. Nayar presented a paper on 'Drug delivery using *in situ* functionalized ferrofluids'. Magnetic nanofluids containing maghemite

and magnetite are attractive biomedical materials with applications in MRI, cancer therapy and targeted drug delivery. Nayar demonstrated biomimetically synthesized magnetic particles using bovine serum albumin (BSA), poly vinyl alcohol (PVA), amino acid glycine and hydroxyapatite. The results showed good control over not only size and dispersion of the nano particles in aqueous medium but also good stability of the fluid. These nano particles functionalized with BSA/PVA provide easy attachment of ceftriaxone – a chemotherapeutic drug. The binding and release profiles of the drug were also depicted. Pramanick presented a paper on 'Synthesis of biomimetic silver nanoparticles for drug delivery'. He showed the atom data at various stages of hybrid nano silver synthesis with BSA, ceftriaxone-drug attachment with nano silver and its release profile, authenticated by transmission electron microscopy (TEM) and atomic force microscope (AFM) results. Colloidal silver has well-known antibacterial properties which may also be used in combination with hydroxyapatite for tissue engineering which is an ongoing activity of the laboratory.

Bottom-up approaches to functional nanomaterials and nanocomposites

This session included research papers on sol-gel, functional nanoparticles and nanotubes, polymer-matrix nanocomposites. The main focus was on nanochemistry and nanotectonic-based approaches to hybrid materials.

Functional porous materials

This session included zeolites, mesoporous materials, foams and hierarchically structured materials. The ability to tailor material properties over broad length scales has attracted research on hybrids with significant impact in diverse fields, such as nanophotonics, filter, catalysis and smart coatings.

Chakraborty presented a paper on 'Zirconium incorporated aluminophosphate metal oxide framework (MOF)'.

He discussed the importance of catalytic effect aluminophosphate molecular sieve and enhancement of catalytic effect by addition of zirconium to it. The confirmation was done by phenol hydroxylation reaction in comparison to Zr-aluminophosphate and aluminophosphate.

Tutorial sessions

Three tutorial lectures were delivered. The first lecture was delivered by Sanchez on 'Synthesis and preparation of hybrid materials'. The second was on 'Applications of hybrids', by Popall and the third was on 'From biogenic silica biotechnology' by L. Livage (France).

In his lecture, Sanchez summarized about hybrid materials, their synthesis and classifications. Since 1980, explosive growth of hybrid nanocomposite research has taken place. It was possible because of expansion of soft inorganic chemistry (avoids excessive energy inputs during reaction and preferably water-based synthesis) and sol-gel process. These synthesis routes provide enough opportunities for controlling the composition and structure of the materials in the nano range. Therefore, a good structure-property relationship is maintained with enough opportunities for tailoring/fine tuning properties such as, mechanical,

optical, electronic thermal properties of the materials. He showed how hybrid materials can be processed as gels, monoliths, thin films, fibre, particles and powders.

Sanchez also mentioned the classification of hybrid materials. Based on the nature of linking and interactions existing at the interface of organic and inorganic materials, hybrid materials can be classified mainly into two classes: (i) Class-I hybrid, deals with systems where there are no covalent or ionic-covalent bond. Therefore, this class dominantly has van-der Waals, hydrogen bonding or electrostatic forces; (ii) Class-II hybrid, where organic-inorganic components are linked through strong covalent or ionic-covalent bonds. Sanchez also mentioned the following routes for tailor-made synthesis of hybrid organic-inorganic materials: (i) Route A: Combination of sol-gel techniques and polymerization; (ii) Route B: Using separators or polymerization of nano building blocks; (iii) Route C: Combination of sol-gel and self-assembly techniques; (iv) Route D: Integrative pathway, i.e. combination of control in phase segregation, interactions and morphosynthesis to sol-gel/self-assembly.

Popall stressed upon new approaches that allow hierarchical well-organized, low cost technologies for complex hybrid

structures. He also showed promising applications of nano hybrid materials in many areas such as, optics, electronics, mechanics, energy, environment, biology, medicine, functional smart coatings, solar cells, catalysts, sensors. His material research includes organic-inorganic hybrids – ORMOCER® (registered trademark of Fraunhofer, Germany) for optical, dielectric and electrochemical applications.

Livage delivered a lecture with thrust on application of silica in biotechnology. He showed the example of porous silica outer shell of algae, where only a small amount of silica gel is dissolved. He stressed upon silica research in the field of biotechnology and medicine.

In addition to these lectures, invited speakers elucidated the latest developments in the nanohybrid field excellently.

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MEETING REPORT

Environment and disasters: resources, systems and management*

Disasters based in geo-hydro-climatic systems and associated human environment are on the rise in frequency, intensity and level of impact to human life, resources and economies. These are mainly flood (flash, urban, riverine), slope erosion/landslide/debris-mud flow/waste-dump failure, drought, desertification, forest-fire, extreme weather events, cyclone, thunderstorms, dust-storms, etc.

*A report on the one week national workshop on 'Environmental Resources, Systems and Disaster Management' organised at the National Institute of Disaster Management, New Delhi, during 12-16 January 2006, under its mandate under the Disaster Management Act 2005.

Environmental provisions of the constitution of India along with the National Environment Policy 2006, Natural Resources Data Management System and Policy Statements on Water, Agriculture, Climate Change and Land Use give way to manage the disasters by adopting environmental strategies and programmes at various levels. A workshop on disaster management was organized to analyse the implications of natural resource management, system tools and environmental information and eco-technologies in disaster risk management, and also the response for these disasters that rise in the environment. Senior functionaries from sectors like forests, geology, agriculture, livestock, water and land, envi-

ronment, meteorology, information and district administration, from across the nation attended the workshop.

Inaugurating the programme, K. J. Ramesh (Advisor, Ministry of Earth Sciences) emphasized the relevance of earth-environmental resources in disaster mitigation by curbing the alteration of geo-morphological processes that may otherwise result in hazards causing environmental disasters like flooding, landslide, drought, etc. Environmental engineering and restoration science has adequate potential in managing all types of disasters for which the models of application have to be developed by the scientific community. Ramesh mentioned that prevention is possible only with the