# Tailored and Tunable Properties of Nanomaterials

.....

## Overview

The design of properties of (nano-) materials is typically achieved by means of nano-/microstructural optimization. This is called tailoring as the properties are strictly related to the details of the microstructure and therefore, cannot be easily changed. In contrast, properties can be tuned by means of external fields, such as interfacial charges, that can be reversibly changed by means of an external electric field, leading to reversible changes of the properties. In addition to introducing the basic concepts of tailoring and tuning, the materials concepts will be discussed. Examples of reversible changes of electronic and magnetic properties for a variety of nanostructures and different gating concepts will be described. Finally, examples for applications based on the concepts developed will be presented.

The course is meant to introduce the students to the concepts and design opportunities for (nano-) materials. Microstructure and gating using external fields are the two overlaying principles used. While the concepts are applicable for all materials, in the course a focus will be on specialties arising from the nanostructuring of the materials. The underlying principles will be described for the students to achieve a basic understanding of tailoring and tuning concepts. Furthermore, the requirements for the nano- and microstructure of the materials and the physics of tuning will be described. Examples will be chosen from the most recent research projects and include the area of metallic nanoglasses (as an example of tailoring) and the tuning of electrical, mechanical and magnetic properties by dielectric, ferroelectric and electrolyte gating. As an example of applications based on the tuning concepts, the course will introduce the principles of printed electronics based on inorganic nanomaterials and electrolyte gating.

| | |
|---|---|
| **Dates for the Course** | **3rd March, 2016 to 17th March, 2016**<br>**($16^{30}$ – $19^{30}$ hrs on weekdays, $09^{00}$ – $13^{00}$ hrs on Saturdays)** |
| **Host Institute** | **IIT Madras** |
| **No. of Credits** | **2** |
| **Maximum No. of Participants** | **60** |
| **You Should Attend If…** | ▪ You are a materials engineer or research scientist interested in designing the electronic and magnetic properties for a variety of nanostructures.<br>▪ You are an electronics engineer or research scientist interested in learning different gating concepts with nanomaterials and nanostructures.<br>▪ You are a student or a faculty from an academic institution interested in research in the area of tuning and tailoring the properties of nanomaterials for a variety of applications. |
| **Course Registration Fees** | The participation fees for taking the course is as follows:<br><br>**Student Participants:** Rs.2000<br>**Faculty Participants:** Rs.6000<br>**Government Research Organization Participants**: Rs.10000<br>**Industry Participants:** Rs.20000<br><br>The above fee is towards participation in the course and for the course material.<br><br>**Mode of payment: Demand draft in favour of "Registrar, IIT Madras" payable at Chennai and may be sent to the course coordinator** |
| **Accommodation** | The participants may be provided with hostel accommodation, depending on the availability, on payment basis. Request for hostel accommodation may be submitted through the link: http://hosteldine.iitm.ac.in/iitmhostel |

# Course Faculty

**Prof. Dr.-Ing Horst Hahn** is the Executive Director of the Institute for Nanotechnology and Head of Programme on Science and Technology of Nanosystems, Karlsruhe Institute of Technology, Karlsruhe, Head of Joint Research Laboratory Nanomaterials at Institute of Materials Science, TU Darmstadt. He is also a professor at the Technische Universität Darmstadt, Darmstadt, a Professor at the Herbert Gleiter Institute of Nanoscience at Nanjing University of Science and Technology, Nanjing, and a Distinguished Professor of IIT Madras. His research interests lie in nanostructured metals and ceramics and general nanostructures, i.e. clusters, nanoparticles thin films, synthesis processes and processing of nanostructured materials, stability and reliability of nanostructured materials, tailored and tunable properties of nanostructures, functional properties of ceramics, i.e. electronic and ionic conductivity, and applications in printable electronics, energy materials, i.e., batteries and fuel cells among other areas.

**Prof. S.S. Bhattacharya** is a professor in the Nano Functional Materials Technology Centre of the Department of Metallurgical and Materials Engineering at Indian Institute of Technology Madras, Chennai. His primary interests lie in the synthesis and processing, consolidation and characterization of nanostructured and nanocrystalline materials, with particular emphasis on oxide ceramics synthesized under gas phase processing routes.

**Prof. B.S. Murty** is a professor and currently the head of the Department of Metallurgical and Materials Engineering, IIT Madras. His research interests include physical metallurgy and phase transformations, structure-property correlations, composites and nano materials, and non-equilibrium processing.

# Course Coordinator

**Name: Prof. S.S. Bhattacharya**
**Department of Metallurgical & Materials Engineering,**
**IIT Madras**
**Chennai - 600036**
Phone: +91 44 2257 4765
E-mail: ssb@iitm.ac.in

.....

URL: http://mme.iitm.ac.in