INDIAN ACADEMY OF SCIENCES
BENGALURU

Lectures in Chemistry, Engineering and Mathematics

(Convened by Professor K L Sebastian, Indian Academy of Sciences, Bengaluru)
Faculty Hall, Indian Institute of Science

30 JUNE 2016 (THURSDAY)
(1000-1310 hrs)

1000: Nanotechnology and the Chemistry Connection: A Materials Perspective
Professor T P Radhakrishnan
School of Chemistry, University of Hyderabad, Hyderabad

1100 Tea Break

1110: Grasping Cells
Professor G K Ananthasuresh
Dept. of Mechanical Engineering, Indian Institute of Science, Bengaluru

1210: Deterministic Averaging in Complex Systems
Professor M Vanninathan
TIFR-Centre for Applicable Mathematics, Bengaluru

Abstracts

ABSTRACTS

Nanotechnology and the Chemistry Connection: A Materials Perspective

Professor T P Radhakrishnan, *School of Chemistry, University of Hyderabad, Hyderabad*

The nature of materials in vogue has served as the signature of the evolution of human civilization, from the ancient *stone* and *copper*ages to the contemporary *silicon* and *carbon* age. The profound impactof nanoscience and nanotechnology on the society and the world today, owes largely to the development of nanomaterials; the central theme is the emergence of 'size' as a tunable parameter that modulates and controls the attributes and functions of materials. The unifying paradigm of chemistry, namely *molecules*, shares a common space with nano structures, not only in following parallel fabrication strategies, but also manifesting similar underlying physical principles. This highlights the chemistry connection of nanomaterials, and hence nanoscience and technology. The talk will dwell on these ideas, consolidating the centrality of chemistry as a science and illustrating some of its societal impact. Detours will include reflections on chemical reactions within a polymer film as an illustrative case of harmonizing fundamental and application aspects of nanochemistry.

Grasping Cells

Professor G K Ananthasuresh

Deptment of Mechanical Engineering, Indian Institute of Science, Bengaluru

Understanding the mechanical response of biological cells with an aim to use it in diagnostics and therapeutics is vigorously pursued today. In this presentation, we consider a purely mechanical means of characterizing the mechanical response of biological cells. We discuss how a trypsinized single cell suspended in liquid medium can be grasped. Grasping is achieved in our lab with specially designed and built miniature compliant grippers. The stiffness of the grippers is designed to be sufficiently low to match the extremely low stiffness of the cells so that minimal mechanical trauma is caused to the cells. There is also provision within the grippers to measure the applied forces [1,2]. It is based on visually meaured displacements of the elastically deformable, joint-free compliant grippers. An inverse problem, known as the Cauchy's problem in elasticity, is solved for accurate estimation of forces in the presence of noise in the measured displacements [3]. By knowing the force and deformation of the cell, we compute the bulk stiffness, measured in N/m, of isolated cells. Miniature compliant grippers also help manipulate a suspended cell. Squeezing (compression), stretching (tension), shearing, rolling, twisting, piercing (injection), etc., comprise manipulation maneuvers for a cell. Subjecting a cell to such mechanical manipulation helps quantify the inhomogeneous “material properties” of the interior of the cell while keeping it alive and well. It is akin to palpating an object in multiple ways to assess the nature of the material inside. By assuming a simplified material model for the interior continuum of a cell, we present an inverse problem in elasticity known as constructing the Dirichlet-to-Neuman map. Here, we use multiple sets of measured force-displacement data only on the boundary of a suspended cell and use that data to compute the material property distribution of the interior [4]. This “elastic mapping” technique helps establish the specific cause for the change in the effective or bulk stiffness of the cell. The two techniques of measuring the bulk stiffness and interior material property distribution are minimally intrusive. No other field, electrical, thermal, magnetic, radiation, etc., are used here and thus enabling probing mechanical response in the natural living state of the cells. We discuss the details of the inverse problems, the solution algorithms, the design and fabrication methods, simulation and experimental test results for two cell lines, namely, MCF-7 and HuH-7. The measured mechanical responses are also discussed in terms of changes in the cytoskeletal arrangements of the cells, and the effects of mechanical (e.g., flow in perfusion culture) and biochemical (drug-induced) stimuli.

Deterministic Averaging in Complex Systems

Professor M Vanninathan *TIFR-Centre for Applicable Mathematics, Bengaluru*

This talk is about certain types of complex systems modeled by PDE in highly in-homogeneous media. Typical examples are provided by Composite Materials. We seek approximation to them via macro models without involving any probabilistic assumption on the nature of variation of media. After surveying the literature on the topic,the talk presents somerecent results and application to Optimal Design Problems. Among other things, we discuss the so-called G-closure problem and its extension.

All are welcome