The AAE Spring 2016 Colloquium Series Presents

“Mechanics as an Enabling Tool in Bioinspired Materials and Biological Interactions of Nanomaterials”

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Abstract

Low-dimensional nanomaterials, including various types of nanoparticles, nanowires, nanofibers, nanotubes, and atomically thin plates and sheets have emerged as candidates as building blocks for the next generation electronics, microchips, composites, barrier coatings, biosensors, drug delivery, and energy harvesting and conversion systems. There is now an urgent societal need to understand the biological and environmental interactions of low-dimensional nanomaterials which are being produced and released into the environment by thousands of tons per year. This talk aims to discuss mechanics as an enabling tool in this emerging field of study. The discussions will touch on some of the recent experimental, modelling and simulation studies on the mechanisms of cellular uptake of low-dimensional nanomaterials and their effects on cell behaviors.

In parallel, rapid technological developments such as 3D printing are making it possible to fabricate many interesting materials and structures that can closely mimic load-bearing biological materials including various shells, nacre, bone, mineralized tendon and wood which have achieved superior mechanical properties through their hierarchical composite structures consisting of hard and soft structural components. While most existing studies in the literature have focused on the role of soft materials in enhancing toughness of biomaterials, here we show that the hard structural components may play even more important roles. For example, a natural biocomposite, Strombus gigas, commonly known as the giant pink queen conch shell, exhibits outstanding mechanical properties, including high toughness. The basic build block of conch shell contains a high density of nanoscale twin boundaries. We show that the twin boundaries allow Conch shell to resist crack propagation more effectively than Nacre, a commonly studied biological material in the community.

Bio

Huajian Gao received his B.S. degree from Xian Jiaotong University of China in 1982, and his M.S. and Ph.D. degrees in Engineering Science from Harvard University in 1984 and 1988, respectively. He served on the faculty of Stanford University between 1988 and 2002, where he was promoted to Associate Professor with tenure in 1994 and to Full Professor in 2000. He served as a Director at the Max Planck Institute for Metals Research between 2001 and 2006 before joining the Faculty of Brown University in 2006. At present, he is the Walter H. Annenberg Professor of Engineering at Brown.

Professor Gao’s research is focused on the understanding of basic principles that control mechanical properties and behaviors of materials in both engineering and biological systems. He is a Member of the National Academy of Engineering, a Foreign Member of the Chinese Academy of Sciences and the Editor-in-Chief of Journal of the Mechanics and Physics of Solids, the flagship journal of his field. He is also the recipient of numerous academic honors, from a John Simon Guggenheim Fellowship in 1995 to recent honors including Rodney Hill Prize in Solid Mechanics from the International Union of Theoretical and Applied Mechanics in 2012, and Prager Medal from Society of Engineering Science and Nadai Medal from American Society of Mechanical Engineers in 2015.