DREXEL UNIVERSITY
College of
Engineering

Department of Mechanical Engineering And Mechanics

MEM Invited Seminar for Mechanics of Materials

Monday, February 9th, 1-2pm, MEM Seminar Room

Design and Mechanics of Cellular Materials at the Macro- and Nanoscale

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Abstract

Cellular structures are Nature's solution to the need for efficient, lightweight but strong materials. Natural cellular materials like wood, trabecular bone, and sponge combine low density with superior mechanical properties. Inspired by these naturally evolved cellular structures, human-made lattice structures fabricated from a wide array of solid constituents are desirable for a broad range of applications including components in modern aerospace and naval structures, shock and acoustic absorption, thermal insulation, battery electrodes and biomaterials. This talk will focus on the mechanical properties of metal foams and recent efforts on the design and modeling of DNA nanolattices.

I will present results on the crushing behavior of open-cell metal foams under quasi-static and dynamic loadings. Micromechanically accurate random foam models are developed based on soap froth geometries and are shown to reproduce faithfully the complete quasi-static response including associated deformation patterns. The dynamic behavior of the same foam under impacts (5-160 m/s) is examined by combined experimental and modeling efforts. Specimens impacted at velocities of 60 m/s and above developed nearly planar shocks that propagated at well-defined velocities. Random foam models are used to simulate the formation and evolution of shocks and calculate the force acting at the two ends, the shock front velocity, and the energy absorbed. I will also present recent results on the effect of relative density and the statistical variation of cell sizes on the foam's mechanical properties.

The strong connection between material topology and functionality is the main focus as well on the field of structural DNA nanotechnology which uses DNA strands as a building block for complex nanoscale assembly. These rationally programmed molecular assemblies with precision at the nanoscale offer vast unexploited opportunities for the design of functional materials with applications to nanomedicine and nanoelectronics, due to their ability to act as templates for the precise positioning of inorganic nanoparticles and other biomolecules. In this talk I will discuss ongoing efforts on the design and computational modeling of extended DNA nanostructures including polyhedral nanocages, 2D sheets and nanotubes.

Bio

Stavros Gaitanaros is a Postdoctoral Associate at the Laboratory for Computational Biology and Biophysics in the Massachusetts Institute of Technology. He obtained his PhD in Engineering Mechanics from the University of Texas at Austin working at the Center for Mechanics of Solids, Structures and Materials under the supervision of Prof. Stelios Kyriakides. His work focuses on the integration of physics-based modeling with characterization and experimental data to study the design and mechanics of lightweight cellular materials.

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