Mechanical & Aerospace Engineering

seminar

Bioinspired Hierarchical and Cellular Structures: Design, Modeling and 3D Printing

March 25, 2016 at 1:30pm in SCOB 228

abstract

Bioinspired design is a useful method for developing novel materials and structures. This seminar presents some works on designing and modeling hierarchical materials and cellular structures inspired by biological materials. The goals are to provide insight into the mechanisms underlying their remarkable mechanical performance and devise new theories to model their mechanical behaviors. The design and modeling take advantage of structural hierarchy, anisotropy, and symmetry. In addition, most of the designed materials and structures are realized by 3D printing and verified by testing.

The first key objective is to explore the energy dissipation mechanisms in bioinspired hierarchical materials. Two distinct mechanisms have been discovered regarding the wave scattering and damping figure of merit in hierarchical materials. The first mechanism is called multilevel Bragg scattering, which originates from the multiple periodicity of hierarchical materials so phononic bandgaps can be formed in a broad range of frequencies. The second mechanism is the damping enhancement in staggered composites, which arises from the large shear deformation of the viscous soft matrix. A total of three kinds of staggered composites are fabricated by 3D printing and tested to verify the theory.

The second key objective aims at modeling cellular structures with material anisotropy either inherent in the material or induced by the processing. The anisotropic inelastic deformation and failure of 3D printed cellular structures are studied by developing a hyperelastic-viscoplastic constitutive

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abstract cont'd law for glassy photopolymers, which considers material anisotropy, pressure-sensitivity, and rate-dependence. Both experimental and simulation results indicate that the mechanical behavior of 3D printed cellular structures depends on both structural orientation and printing direction.

biosketch

Dr. Albert To is currently Associate Professor & CNG faculty fellow in Mechanical Engineering and Materials Science at University of Pittsburgh. He received his doctoral degree from the University of California at Berkeley in 2005 and was a postdoctoral fellow at Northwestern University from 2005-2008. He joined University of Pittsburgh as an Assistant Professor in 2008 and was promoted to Associate Professor with tenure in 2014. His current research interest lies in the interdisciplinary area of solid mechanics, materials design, and additive manufacturing. He is currently an editorial board member of the International Journal of Rapid Manufacturing and Journal of Micromechanics and Molecular Physics. He is also guest editing a special issue on 'Modeling and Simulation' for Additive Manufacturing. He is a recipient of the 2009 NSF BRIGE award. He has received research funding in additive manufacturing from NSF, America Makes, Army and State of Pennsylvania.