Mechanical & Aerospace Engineering

seminar

Bulk Nanostructured Advanced Materials: Fundamentals and Applications

April 22, 2016 at 1:30pm in SCOB 228

abstract

Bulk nanostructured materials offer tremendous opportunity for re-inventing materials, but also pose many challenges both in terms of characterization, design, processing, and scaling. This presentation will focus on recent work developing nanoengineered hierarchical advanced composites with a focus on enhancing mechanical properties. Such hybrid advanced composites employ aligned nanofibers (in our work, carbon nanotubes, CNTs) in several architectures to enhance laminate-level bulk properties of existing aerospace-grade advanced composites. Intrinsic and scale-dependent characteristics of the nanofibers are used to engineer bulk property improvements including critical mechanical design parameters for composite laminates such as open-hole compression (OHC) and tension bearing strengths. Building multifunctionality concurrent with these mechanical property improvements includes thermal and electrical conductivity tailoring for damage detection and ice protection, among others. Fundamental studies on polymer-nanofiber interactions led to the development of a combined top-down and bottom-up fabrication methodology that addresses several of the key issues (agglomeration, viscosity, scale, alignment) that have frustrated the use of nanomaterials in bulk materials, particularly advanced composites. New research directions, including new 3D nano-scale visualization and contributions in related disciplines such energy storage and transport, will be highlighted if time allows.

biosketch

Brian L. Wardle is Professor of Aeronautics and Astronautics at MIT where his work focuses on materials and structures. He received a B.S. in Aerospace Engineering from Penn State University in 1992 and completed S.M. and Ph.D. work at MIT in the Dept. of Aeronautics and Astronautics in 1995 and 1998, respectively.

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biosketch (cont'd) After four years at the consulting firm McKinsey & Co., Prof. Wardle joined the faculty of MIT in 2003. His research interests are in the areas of nano-engineered advanced composites, bulk nanostructured materials, carbon-based material synthesis, traditional composites, power-MEMS devices (fuel cells and energy harvesters), and other structure and materials topics. Prof. Wardle is founder and Director of the necstlab research group and MIT's Nano-Engineered Composite aerospace STructures (NECST) industry Consortium. Prof. Wardle is active in the Materials Processing Center (MPC), Institute for Soldier Nanotechnologies (ISN), Center for Materials Science and Engineering (CMSE), and Microsystems Technology Laboratory (MTL) communities. His research focuses on bulk nanostructured materials, particularly nanoengineered hierarchical advanced composites with enhanced mechanical properties, with recent contributions in multifunctionality. Highlights from recent work include conception and fabrication of aligned carbon nanotubes (CNT) nanoengineered composite laminate architectures, realization of a nanostructured aerovehicle ice protection system, discovery of a new class of oxide catalysts for carbon nanotube (CNT) synthesis, invention of out-of-oven composite manufacturing, and processing development of novel carbon matrix nanocomposites. Past work includes nonlinear design and operation of thermomechanically stable ultra-thin fuel cells operating in the postbuckling regime, and design and realization of optimal-power MEMS energy harvesters. Prof. Wardle has authored over 100 journal and conference papers, given more than 80 invited talks, holds 5 patents with ~10 other applications pending in the area of nano-engineered materials, and Founded n12 Technologies. Professor Wardle's educational activities cover experimentation and modeling of materials and structures.