Novel Carbon Nanotube-Based Multi-Scale Hybrid Composites: Processing, Characterization and Emerging Applications in Smart Sensing

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Abstract

In the 25 years since they were first observed carbon nanotubes have been the focus of considerable research. Increasingly, there has been broad interest in utilizing carbon nanotubes to tailor the properties of traditional fiber composites. Carbon nanotubes are widely known to have exceptional mechanical and physical properties and because of their small size – three orders of magnitude smaller than traditional advanced fiber reinforcements – the hybridization of the reinforcement scales offers unique potential to selectively reinforce local areas and penetrate regions where there is no fiber reinforcement, such as intra-bundle and interlaminar areas where composite properties are dominated by the properties of the polymer matrix. Often referred to as multi-scale hybrid composites or hierarchical composites, the co-mingling of reinforcement scales enables selective reinforcement where nanotubes can be placed in specific locations. Through hybridizing nanoscale reinforcements with traditional advanced fibers there are opportunities to integrate new functionality into existing composite material systems. This presentation focuses on recent advances in the processing of these composites using an industrially-scalable electrophoretic processing technique. Our novel approach for hybridization provides enabling capabilities towards the integration of adaptive, sensory, active and energy storage capabilities of nanostructures within structural materials. Because carbon nanotubes can form electrically conductive networks around the fibers it is possible to utilize these as *in situ* sensors for detecting deformation and damage. New applications where carbon nanotube-based hybrid composites can be utilized for large-scale damage detection and structural health monitoring will be discussed.

Short Biography

Dr. Thostenson is an internationally-recognized expert in the field of carbon nanotubes and their composites. Thostenson is currently Associate Professor in the Department of Mechanical Engineering at the University of Delaware and holds an affiliated appointment in the Department of Materials Science and Engineering. He heads the Multifunctional Composites Laboratory which focuses on developing a fundamental understanding of the processing-structure-property relations in nanostructured materials and composites. Thostenson has published over 50 refereed journal articles and book chapters and his research has been cited widely in the scientific literature (Google Scholar: >12,000 citations, h-index: 34; i10-index: 44), and he has given invited plenary/keynote addresses in Europe, South America, and Asia. He has received several early-career awards, including the National Science Foundation's Early Career Development Award (CAREER) and a Young Investigator Proposal (YIP) Award from the Air Force Office of Scientific Research. He is the recipient of the Elsevier Young Composites Researcher Award from the American Society for Composites, the Hayashi International Memorial Award from the Japan Society of Composite Materials, the Distinguished Young Alumnus Award from Winona State University and the Alan P. Colburn Prize for outstanding dissertation from the University of Delaware. In recognition of excellence in research mentoring Thostenson also received the University of Delaware's Outstanding McNair Faculty Mentor Award. Thostenson, who holds a Ph.D. in Materials Science and a master's degree in Mechanical Engineering from the University of Delaware, is an affiliated faculty member at the University of Delaware's Center for Composite Materials, an internationally-recognized center of excellences in composites research and education. In addition, Dr. Thostenson has a Bachelor's degree in Composite Materials Engineering (Summa Cum Laude) from Winona State University (Minnesota).