Hierarchical Reinforcing and Sensing in Next Generation Multifunctional Nanocomposites

by

Andrew M. Proper

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Approved:

Nikhil A. Koratkar, Thesis Adviser

Rensselaer Polytechnic Institute
Troy, New York

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ABSTRACT

Traditional fiber reinforced composites have been replacing conventional structural materials for some time now due to their high strength, stiffness, significant weight savings and directional reinforcing capabilities. More recently, a new type of fiber reinforced composite has been receiving much attention with the addition of nanoscale reinforcing particles such as carbon nanotubes.

Carbon nanotubes are known to have very high strength, stiffness, electrical and thermal properties. They have also been shown to enhance damping properties and slow down fatigue in bulk polymers. Here, it is shown that the hierarchical reinforcing of both the micro and nanoscale with the addition of Kevlar fibers and carbon nanotubes leads to enhanced material properties. The microscale Kevlar fibers still carry the bulk of the load in the material, but the nanoscale reinforcements allow dissipation of energy from the initiation of loading, which may have otherwise lead to failure without their presence. Beyond the mechanical benefit that the nanotubes play, they can serve a dual purpose as sensors within the material. Adding nanotubes to an otherwise electrically insulating composite provides a percolating network for electrons to flow through. By passing a voltage through the material and monitoring its potential difference at points throughout the material, incipient damage can be detected before catastrophic failure occurs.