PROJECT FACTS

UNIVERSITY OF KENTUCKY CENTER FOR APPLIED ENERGY RESEARCH

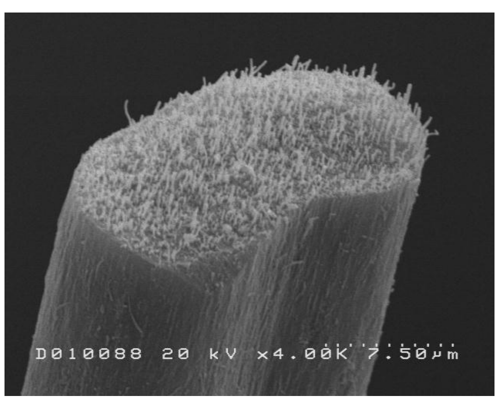
CARBON MATERIALS

Synthesis of Multiwall Carbon Nanotube/Polyacrylonitrile Composite Fibers and Resulting Carbon Fibers

Multiwall carbon nanotubes (MWNTs), tiny concentric tubes of carbon, have attracted significant attention due to their unique physical properties. In particular, their unrivalled mechanical properties, including an elastic modulus of ~1TPa, break strength of ~150 GPa and strain to failure of ~15%, makes them five times stiffer and more than 400 times stronger than SAE 1010 cold-worked steel, while at the same time being nearly four times lighter! The current effort at CAER is to produce usable engineering MWNT composite materials that most effectively inherit the mechanical properties of the MWNT reinforcement.

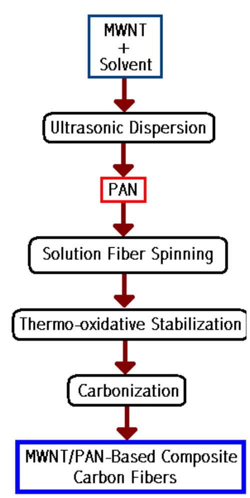
Polyacrylonitrile (PAN)-based carbon fibers are widely used in high-performance composite material applications including the aerospace, sporting equipment, and automotive industries. Selected primarily for their high strength, PAN-based fibers do not possess the ultrahigh moduli attainable with mesophase pitch-based carbon fiber, which in turn are not as strong. The production of MWNT reinforced composite carbon fibers of both high strength and modulus is being investigated. Work has focused on PAN-based composite carbon fibers due to the possibility of intimately incorporating the MWNTs into the matrix as the PAN converts to carbon. Equally, the process of spinning MWNT composite fibers results in alignment of the MWNTs with the fiber axis due to the shear and elongational flow fields involved. Therefore, maximum tensile reinforcement is achievable.

We have observed both stiffening and strengthening for fibers loaded with ~20 vol. % MWNTs that are processed at high drawdown ratios resulting in small diameter fibers. Higher drawdown ratios better align the MWNTs with the fiber axis and reduce the fibers' cross-section allowing for fewer voids and more efficient thermal processing. We are working to optimize processing through enhanced MWNT dispersion to achieve higher loadings in smaller diameter fibers. The ultimate goal is to realize a carbon fiber that is successfully and efficiently reinforced by MWNTs displaying significantly enhanced mechanical properties.



SEM micrograph of the fracture surface of a PAN-based carbon/MWNT composite fiber containing ~ 16 vol. % MWNTs showing axial alignment

The flow chart summarizes the processes involved in the synthesis of these composite fibers



PARTICIPANTS

University of Kentucky
Center for Applied Energy Research
2450 Research Park Drive
Lexington, KY 40511

University of Kentucky
Department of Chemistry
Lexington, KY 40506

CONTACT

Matthew C. Weisenberger
UK CAER
2540 Research Park Dr
Lexington, KY 40511
(859) 257-0322
matt.weisenberger@uky.edu
www.caer.uky.edu