PROJECT FACTS

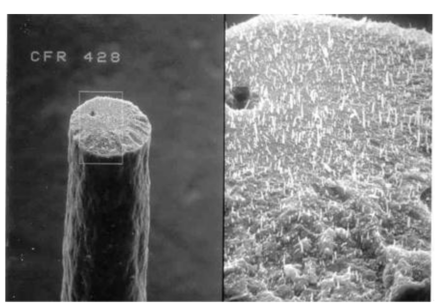
UNIVERSITY OF KENTUCKY CENTER FOR APPLIED ENERGY RESEARCH

CARBON MATERIALS

Carbon Nanotube Composite Materials

The ability to produce high purity aligned carbon multiwall nanotubes (MWNTs) at relatively low cost and in increasingly greater quantities has been considerably advanced by recent developments at these laboratories. This has allowed significant developments to be made in the field of carbon nanotube (CNT) composite materials. Their remarkable properties offer the potential for fabricating composites with substantially enhanced physical properties including conductivity, strength, elasticity, toughness and durability at low nanotube concentrations. However, the effective utilization of carbon nanotubes in composite applications strongly depends on the ability to disperse the CNTs homogeneously throughout the matrix and to achieve good interfacial bonding for load transfer across the CNT-matrix interface.

MWCNTs have been dispersed into a range of matrices including polymers, resins and pitch materials to produce composites with unique properties ranging from high performance engineering materials to additives for accelerating chemical reactions. High quality dispersion has been achieved by either shear mixing using a Haake Polylab unit, 3-roll milling or by the use of a high-energy ultrasonic probe (when dispersion into a low viscosity liquid is required). From these materials, a range of artifacts have been fabricated with enhanced properties. These have included conducting polymer composite films with substantially reduced electrical surface resistivity. In polypropylene the inclusion of MWCNTs at the percolation threshold of 0.05vol%, produced a reduction in resistivity from $\geq 10^{12}$ Ω/square to a value of ~10^5 Ω/square and higher concentrations produced further reductions to <100 Ω/square. This is particularly important for devices used by the electronics industry where charge accumulation and sudden discharge can easily damage sensitive components. Carbon black is the most widely used filler material although as much as 15 to 20 wt% needs to be added to attain the required electrical properties, which adversely affects the physical properties of the host matrix. In contrast, low concentrations of MWCNT in polymer matrices generally result in an increase in Young's modulus and a small reduction in the tensile strength. At higher concentrations, both stiffness and strength are significantly improved. MWCNT/polymer and MWCNT/carbon composite fibers have also been produced with aligned structure and with significantly improved physical properties. The inclusion of MWCNTs in PAN-based carbon fiber has produced fibers with improved toughness. Surface treatment of the nanotubes has been used to improve interfacial bonding and increase tensile strength. When interfacial adhesion is poor, the nanotubes pull out of the matrix. Good adhesion results in nanotube crack bridging and ultimate failure of the nanotube. Controlling this failure mechanism is imperative in achieving high strength materials based on carbon nanotubes.



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