

Nanotube 'Sandwiches' Could Lead to Better Composites

Reinforced composite fabrics made from woven ceramic fibers have been used for decades in structural applications, but tend to perform poorly in terms of "through-thickness," or the ability of a material to respond to forces applied perpendicular to the fabric-stacking direction.

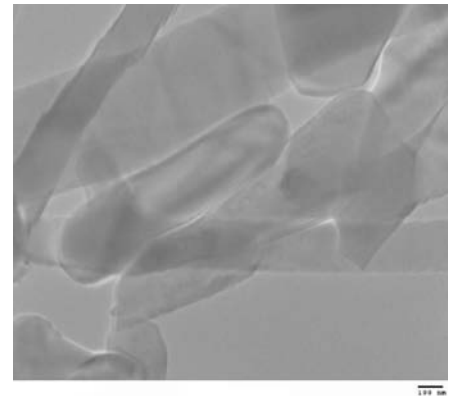
Scientists at Rensselaer Polytechnic Institute (Troy, N.Y.) and the University of Hawaii (Manoa) have pioneered a process to help overcome these difficulties. Recently, they demonstrated that through-thickness properties can be improved by adding nanotube Velcro-like structures between the layers.

To make the composite, they deposit a forest of carbon nanotubes across the

surface of a cloth woven from fibers of silicon carbide. The fabric layers are infiltrated with a high-temperature epoxy matrix, and then several layers of cloth are stacked on top of each other to form a 3-D composite "sandwich," with interlocking nanotubes acting to fasten the layers together.

Experiments showed that the interlocking nanotubes provided remarkable improvements in strength and toughness under various loading conditions. The materials performed well in fracture tests, and they demonstrated a five-fold increase in damping over the original ceramic composites without nanotubes. Tests also showed that both the thermal and electrical conductivity were significantly improved.

The team has made cloths up to $\sim 5 \times 2$ in. (12.5×5 cm), and the process is easily scalable to make larger materials, they say. (Contact: Pulickel Ajayan, E-mail ajayan@rpi.edu)



TEM image of the electrospun fibers fired at 1500°C/1h. (Bar = 100 nm)

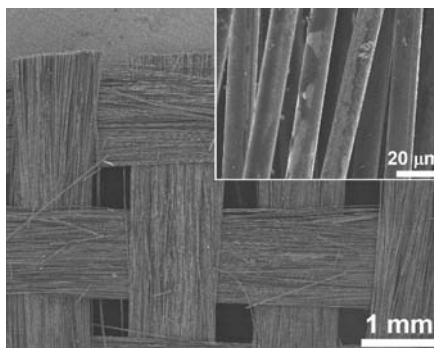
sive spectroscopy, and transmission electron microscopy coupled with energy dispersive spectroscopy and selected area electron diffraction techniques. (Contact: Abdul-Majeed Azad, E-mail aazad@eng.utoledo.edu)

New Insight into Mechanism of HTS

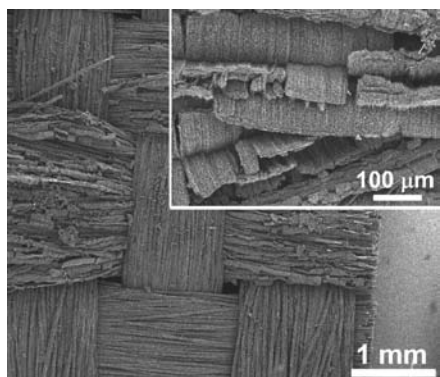
Results from studies at the University of Aberdeen (Scotland) of a crystal structure of a new chemical compound containing copper and ruthenium have provided valuable insight into the mechanism of high-temperature superconductivity (HTS). The results show that the mechanism of HTS actually is coupled to the crystal lattice. This discovery could lead to a breakthrough in the theory of HTS.

Leading the research team, Abbie McLaughlin explains, "We are interested in the chemistry of materials that show fascinating physical properties that may be important in the technologies of the future. We are particularly interested in synthesizing new layered materials that have an interesting property, such as magnetism, in one layer and another property, such as superconductivity, in another layer. It is then possible to observe how the two phenomena compete with one another which can in itself lead to the observation of novel physics."

This new chemical compound



A piece of ceramic cloth woven from silicon carbide fibers.



The same ceramic cloth with nanotubes grown perpendicular to the surface of the fibers.

Electrospinning Transparent Alumina Nanofibers

Researchers at The University of Toledo (Ohio) have successfully conducted the fabrication, processing and characterization of transparent one-dimensional alumina nanofibers.

The target composition was achieved by electrospinning polymer-ceramic (polycer) composite fibers from a 1:1 mixture of aluminum precursor in acetone and polyvinylpyrrolidone (PVP) in ethanol. Using a high-voltage dc source, 7-9 kV was applied between the needle of a syringe containing the mixture and a collector to initiate the electrospinning.

The transformation of polycer to ceramic was followed by a series of heat-treatments and the systematic phase evolution.

Morphological features of the product subsequent to each heat treatment were verified by laser Raman spectroscopy, X-ray diffraction, scanning electron microscopy coupled with energy disper-