Scientists modify carbon nanotubes using microwaves

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Researchers at New Jersey Institute of Technology have discovered a novel method of changing the chemical characteristics of carbon nanotubes by heating them in a closed vessel microwave oven. Somenath Mitra, PhD, professor of chemistry and environmental sciences, and Zafar Iqbal, PhD, also a professor of chemistry and environmental sciences, will discuss their findings at the 229th national meeting of the American Chemical Society (ACS).

The pair, aided by doctoral student Yubing Wang, have written "Microwave-Induced, Green and Rapid Chemical Functionalization of Single-Walled Carbon Nanotubes" to be published in a forthcoming issue of the journal Carbon.

Carbon nanotubes, which were only discovered in 1991, are molecular-scale nano materials made from carbon atoms connected single-file in a tube. The tubes are closed at either end by hemispherical structures and typically exhibit lengths ranging from tens of micrometers to a few millimeters.

"We understand ourselves to be the first in the world to have discovered this method," said Mitra. "The beauty is that our method is green and clean. We use no toxic material and reduce the reaction times from hours--on occasion even days--to three minutes."

Iqbal noted that the method costs much less than others currently used. "Plus, the solubility of our carbon nanotubes are several times higher

than any other researcher has yet reported in this short amount of time." Solubility is the most essential characteristic of carbon nanotubes since researchers must be able to dissolve them to see them work their magic.

With a microwave oven hitting temperatures of 250 degrees Celsius, the researchers can chemically modify the tubes. Such a temperature is closer to radiation treatment than the output of a kitchen microwave oven. Since the reactions are fast, the nanotubes are not damaged or structurally modified.

"A carbon nanotube is just carbon," said Mitra. "The surprise for us is that it's difficult to make nanotubes react with anything. They are like diamonds--very, very inert. They don't react and they don't dissolve in water. But, if you can change their chemical characteristics as we have done using our method, we see them transform right before our eyes."

Once the tiny, microscopic tubes are chemically altered, they become soluble in common solvents like water and alcohol, and new kinds of films or coatings can be produced. The tubes can also be formulated into paints and plastic nanocomposites. The functionalized nanotubes become more useful than the pristine ones because the functionalized groups can be tailored for specific applications.

"Nanotubes are opening new vistas for products and design," added Mitra. "For example, the space shuttle includes components of lightweight carbon or carbon-polymer composites. The military especially likes these materials because ultimately they will allow for the development of lightweight equipment."

They will discuss their findings Thursday, March 17 from 8:30 a.m.-12:15 p.m. at the Hyatt Regency Hotel, San Diego.

Source: New Jersey Institute of Technology