NJIT chemists cook up new strain of carbon nanotubes

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Kitchen chemistry is alive and well at New Jersey Institute of Technology (NJIT) as chemical researchers report cooking up a new and more water- soluble strain of carbon nanotubes. An article about this work, "Rapidly Functionalized, Water-Dispersed Carbon Nanotubes at High Concentration," appeared Jan. 11, 2006, in the *Journal of the American Chemical Society*.

The team led by Somenath Mitra, PhD, acting chair and professor, department of chemistry and environmental sciences, and Iqbal Zafar, PhD, research professor in the same department, along with graduate student Yubing Wang, have developed a quick and simple method to produce water-soluble carbon nanotubes. This is something that has never been done before. They report that the new nanotubes are 125 times more water soluble than existing ones. In addition, the new nanotubes, following a short heat treatment, can conduct electricity as well as the non-soluble ones.

To achieve results the researchers added carbon nanotubes to a mixture of nitric acid and sulfuric acid. The mixture was heated in a closed vessel microwave reactor for only three minutes. In addition, upon closer examination, the NJIT researchers found that the new solution contained concentrations of soluble nanotubes that were as high as 10mg/mL, compared with only around 0.08mg/m, reported before. The new or transformed tubes, had turned into something with salt-like characteristics. It now contained carboxylated and acid-sulfonated groups, similar to those present in acetic acid or vinegar and salts of

sulfuric acid, respectively. "

"These nanotubes therefore behave as poly-electrolytes or salts of polymers," said Iqbal. "These poly-electrolytes can be dissolved in solvents such as water or even more easily in acidic water and alcohols. They will also even dissolve partially in acetone."

Why does the world need highly soluble carbon nanotubes? "There are many benefits," said Mitra. "The most obvious ones are their value in electronic coatings and films or plastic or polymer composites. The former are used in electronic manufacturing to create lead-free, less toxic, conductive and soldering materials. The computer industry uses these coatings and films to remove heat, because they do that well.

"The polymer-based products are attractive to the auto and pharmaceutical industries," Mitra added. "Car makers prefer them because they make the paints and bumpers more durable, plus they remove static electricity. The latter increases flammability and corrodes parts. "

Future applications include the creation of faster computer chips and improved applications for the pharmaceutical industry, particularly in the area of drug delivery. "We expect the pharmaceutical industry to welcome these water soluble carbon nanotubes," said Iqbal. "Not only will the body be more easily able to ingest and integrate them, but manufacturers will also be able to use them to target specific cells biological cells."

Mitra has published more than 55 refereed articles in scholarly publications. He is the author of Environmental Chemical Analysis (CRC Press, New York, 1998) and the editor of Sample Preparation Techniques in Analytical Chemistry (John Wiley, New York, 2003). Mitra holds four patents and has made more than 100 presentations to

academic peers at scholarly conferences. He received his doctorate in analytical chemistry from Southern Illinois University.

Mitra's other research interests include finding analytical techniques and sensors to discover low level trace elements in air, water and soil. His projects include the development of instrumentation and methods for continuous, on-line analysis of trace levels of organic pollutants in air and water. These methods range from using gas chromatography or mass spectrometry to micro scale, lab-on-a-chip devices. His funders include the Environmental Protection Agency, Department of Defense, the National Science Foundation and others.

Source: New Jersey Institute of Technology