Efficient Filters Produced from Carbon Nanotubes

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Filters remove nano-scale germs from water, heavy hydrocarbons from petroleum

Researchers at Rensselaer Polytechnic Institute and Banaras Hindu University (India) have devised a simple method to produce carbon nanotube filters that efficiently remove micro- to nano-scale contaminants from water and heavy hydrocarbons from petroleum. Made entirely of carbon nanotubes, the filters are easily manufactured using a novel method for controlling the cylindrical geometry of the structure.

"The research demonstrates how to spray well-ordered nanotube structures directly onto a substrate," said Pulickel M. Ajayan, professor of materials engineering at Rensselaer and one of the authors of "Carbon Nanotube Filters," which describes the manufacture and application of the filters in the September issue of Nature Materials. The work was supported in part by the Center for the Directed Assembly of Nanostructures at Rensselaer and the Ministry of Education in India.

The filters are hollow carbon cylinders several centimeters long and one or two centimeters wide with walls just one-third to one-half a millimeter thick. They are produced by spraying benzene into a tube-shaped quartz mold and heating the mold to 900° C. The nanotube composition makes the filters strong, reusable, and heat resistant, and they can be cleaned easily for reuse.

"In the future, we hope to be able to spray, or print, a great variety of

nanotube structures directly onto substrates," Ajayan said. "This method provides a better way of creating more interesting shapes and structures from nanotubes. By adjusting the size and flow of the nozzle, we can define the geometric structure of the nanotube form."

Rensselaer researchers involved in the project are Saikat Talapatra, a post-doctoral research associate at the Rensselaer Nanotechnology Center; Robert Vajtai, a research scientist at the center; and Ajayan. Researchers from Banaras Hindu University in Varanasi, India, are O.N. Srivastava, professor of physics; and Anchal Srivastava, lecturer.

The carbon nanotube filters offer a level of precision suitable for different applications. The experiments demonstrated the filters may be useful in producing high-octane gasoline. They also can remove 25-nanometer-sized polio viruses from water, as well as larger pathogens, such as E. coli and Staphylococcus aureus bacteria. Moreover, the nanotube surfaces of the filters may be chemically modified to create highly ordered and chemically selective pore spaces for high-quality separation of specific chemical mixtures. The researchers believe this could make the filters adaptable to microfluidics applications that separate chemicals in drug discovery.

Ajayan and colleagues plan to continue the development of various macrostructure architectures from carbon nanotubes. Their work is part of the ongoing research at the Rensselaer Nanotechnology Center. The mission of the center is to integrate research, education, and technology dissemination, and serve as a national resource for fundamental knowledge and applications, in directed assembly of nanostructures.

Source: Rensselaer Polytechnic Institute