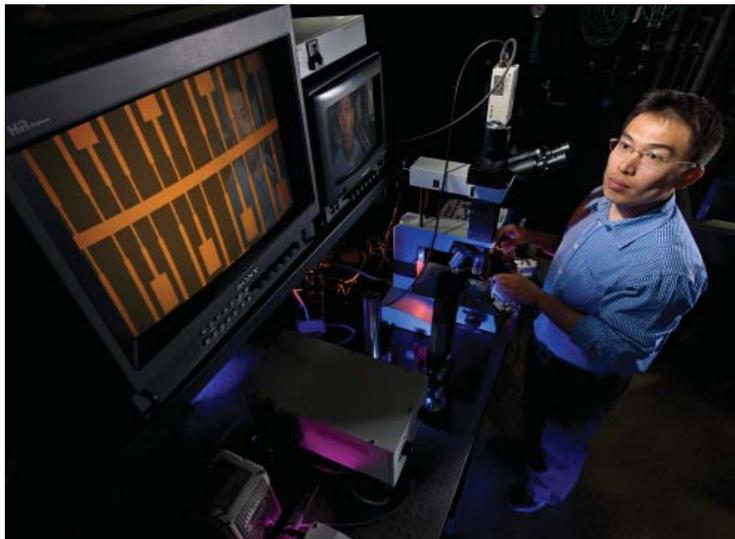


**technology opportunity**

Selective Functionalization of Carbon Nanotubes Based Upon Distance Traveled

Method and System for Functionalizing a Collection of Carbon Nanotubes



A CNT is topologically equivalent to a two-dimensional graphite sheet rolled into a cylinder, with a cylinder diameter as small as 0.7 nanometers (nm) and with a cylinder length up to several microns (μm).

Carbon nanotubes (CNTs) have attracted much attention, due to their extraordinary mechanical properties and their unique electronic properties. A CNT is topologically equivalent to a two-dimensional graphite sheet rolled into a cylinder, with a cylinder diameter as small as 0.7 nanometers (nm) and with a cylinder length up to several microns (μm). A CNT can be single walled (SW) or multiple walled (MW) and can also be fabricated as a nanofiber or other CNT structure. A CNT can be characterized by its chiral vector components (n,m) , which helps determine tube diameter, electronic properties and other properties. CNTs are being studied for applications in high strength/low weight composites, membranes, mechanical filters, body armor, space suits, electronics, nano-electro-mechanical systems, heat exchange systems, radiators, chemical sensors, physical sensors, actuators, data storage, computers and other applications. In some of these applications, chemical functionalization (addition of one or more specified chemical groups to a basic structure) may be necessary to alter the CNT properties for particular applications. For example, functionalization of the CNT tip or the side walls with suitable probe molecules can provide chemical sensors that recognize certain target species and ignore all others. Development of functional composites may require functionalization of a collection of CNTs to allow the tubes to be dispersed more easily in a host matrix.

Benefits

- Produces relatively little residue
- Scalable to large scale production
- Does not require use of complex apparatus to produce target species
- Uses wet chemical procedures and works with liquids or vapors

Applications

- High strength, low weight composites
- Radiators
- Mechanical filters
- Body armor
- Space suits
- Electronics
- Chemical sensors
- Actuators
- Data storage
- Computers

Technology in Detail

An ideal functionalization process should be clean, produce relatively little residue for disposal, efficient, selective, and reasonably fast. It should also be scalable to large scale production, not require the use of complex apparatus to produce the target species, and should not require complex chemical processing. This CNT functionalization process uses wet chemical procedures and works with liquids or vapors to which the CNTs are exposed. An example is use of hot flowing fluorine to attach fluorine atoms to CNTs, as reported by E.T. Michelson et al Chem. Phys. Lett. vol 296 (1998) 188. Large quantities of wet chemicals are often required, with most of the chemicals becoming residues that must be disposed of under hazardous substance guidelines. Taking hydrogen as an example of a target species, atomic hydrogen is produced by applying a glow discharge to a molecular hydrogen source to provide a cold plasma, and using a strong pressure differential to direct the atomic hydrogen thus produced toward the CNTs. Atomic hydrogen that is not received by the CNTs can be allowed to recombine and can be recovered for another glow discharge cycle. Recycling of the chemicals used is seldom an option.

Patents

This technology has been patented (U.S. Patent 7,767,270).

Licensing and Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Office, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about licensing possibilities for this technology for commercial applications.

For More Information

If you would like more information about this technology, please contact:

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