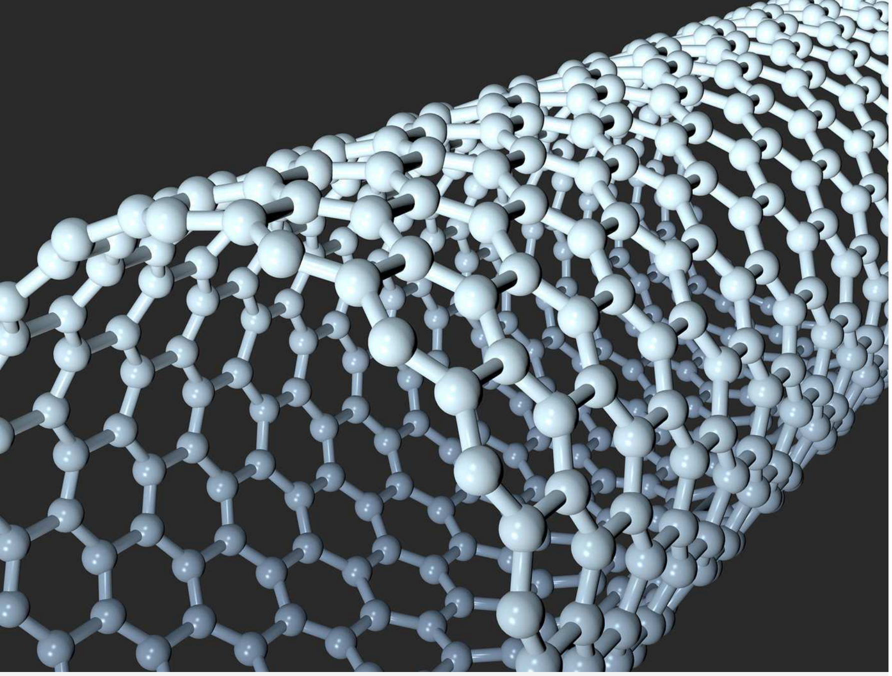

National Aeronautics and Space Administration

Materials and Coatings

Selective Functionalization of Carbon Nanotubes

Method and system for functionalizing a collection of carbon nanotubes

Method and system for functionalizing a collection of carbon nanotubes (CNTs). A selected precursor gas (e.g., H2 or NH3 or NF3 or F2 or CF4 or CnHm) is irradiated to provide a cold plasma of selected target particles, such as atomic H or F, in a first chamber. The target particles are directed toward an array of CNTs located in a second chamber while suppressing transport of ultraviolet radiation to the second chamber. A CNT array is functionalized with the target particles, at or below room temperature, to a point of saturation, in an exposure time interval no longer than about 30 sec. The predominant species that are deposited on the CNT array vary with the distance d measured along a path from the precursor gas to the CNT array; two or three different predominant species can be deposited on a CNT array for distances d=d1 and d=d2>d1 and d=d3>d2.

BENEFITS

- CNT functionalization is dry and requires no wet chemicals
- Little residue for disposal
- May be used for many functional groups
- Reasonably selective
- Scalable
- No complex apparatus or complex processing required

technology solution

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THE TECHNOLOGY

This technology provides a selective, scalable approach, not involving wet chemistry, for functionalization of a collection of CNTs with any of a large class of elements and compounds, including hydrogen, the alkali metals, selected hydrocarbons, selected organic species, and the halogens. 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. When a given target molecule, such as NH3 or CF4, is provided as a source for functionalization, the predominant species present will depend, in part, on the distance of separation, d, between the source and the collection of CNTs that serve as the target. For example, where N2 is the target molecule, at a distance d=1 cm, the predominant molecular components appear to be C===N and C===N; and at a distance d=2.5 cm, the predominant molecular components appear to be C---(NH)2 and/or C===NH2. For a distance d7 cm in certain situations, little or no functionalization is present, in part because the molecular sub-components provided by the breakup of N2 have recombined and are no longer available to react with the CNT target.

One of the applications of the technology is in the fields of body armor and space suits

APPLICATIONS

The technology has several potential applications:

- High Strength/ Low Weight Composites
- Membranes, Mechanical Filters
- Body Armor, Space Suits
- Nano-Electro-Mechanical Systems
- Heat Exchange Systems and Radiators
- Chemical and Physical Sensors
- Actuators
- Data Storage, Computers

PUBLICATIONS

Patent No: 7,767,270

More Information

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NP-2015-02-1442-HQ

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ARC-14661-3