National Aeronautics and Space Administration

Growing Patterns of Carbon Nanotubes or Nanofibers

NASA has patented a unique innovation for growing carbon nanotubes and nanofibers in a desired pattern. The method utilizes chemical vapor deposition (CVD) on a patterned catalyst supported by a substrate

This method provides separate procedures for generating growth patterns for arrays of Single-Walled Carbon Nanaotubes (SWCTs), Multi-Walled Carbon Nanotubes (MWNTs) and/or Nanofibers (NFs). A substrate is placed in a chamber that could contain both ion-beam sputtering and CVD equipment, or separate chambers could be used. The substrate can be made of any of a variety of materials that include several forms of silicon or carbon, and selected polymers, metals, ceramics and even some natural minerals. The substrate is first coated with a noncatalytic metal layer by ion-beam sputtering. The choice of metal(s) and thickness(es) of the first layer (if any) and its sublayers (if any) depends on the chemical and electrical properties required for subsequent deposition of the catalyst and the subsequent CVD of the carbon nanotubes.

This technology is available for licensing from NASA's space program to benefit U.S. industry.

Patent

This technology is protected by U.S. Patent No. 6,858,197 (Reference No. ARC-14613-1)

Benefits

- High strength, light-weight composites
- Provides mechanical strength and electrical or thermal conductivity
- Controlled deposition of catalysts for growth of CNT
- Separate procedures for generating and controlling patterns of growth of an arrays
- Very simple and inexpensive to construct
- Controlling the diameter and length allows to produce useful nanoprobes

Technology Details

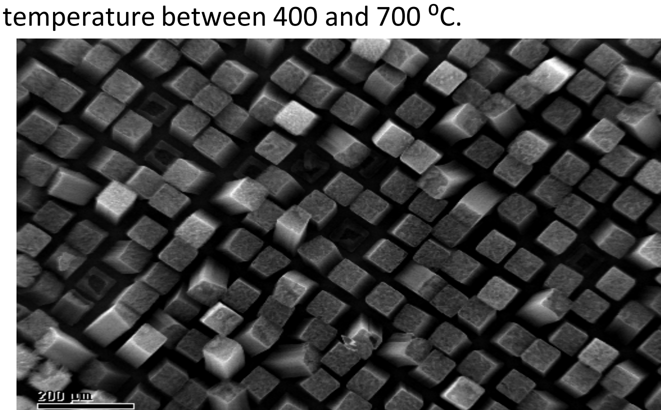
A typical metal for the first-sublayer is P, Pd, Cr, Mo, Ti, W or an alloy of two more of these elements. A typical metal for the second sublayer is Al at a thickness of ≥1 nm, or Ir at a thickness of ≥ 5 nm. A mask having holes in the desired pattern is placed over the coated substrate. The catalyst is then deposited on the coated substrate by ion-beam sputtering through the mask. The catalyst could be deposited by a technique other than sputtering and/or patterned by use of photolithography, electron-beam lithography, electron-beam lithography, or another suitable technique.

Following the deposition of the patterned catalyst, a shutter is moved into place to protect the sputtering equipment against CVD of carbon. To promote growth of carbon nanotubes in a corresponding pattern, a selected heated feed gas is passed over the coated substrate and forms primarily single wall nanotubes or multiple wall nanotubes, depending upon the selected feed gas and its temperature. Nanofiber, as well as single-wall and multi-wall nanotubes, are produced using plasma-aided growth from the second (catalyst) layer. An overcoating of a selected metal or alloy can be deposited, over the second layer, to provide a coating for the carbon nanotubes grown in this manner. For example, for growing SWNTs the preferred gas is CH_4, and temperature is ≈900 ^oC. For growing MWNTs, the preferred gas is C_2H_2 or C_2H_4, and temperature is ≈750 ^oC. For growing NFs, it is preferable to form a plasma discharge in the chamber and to maintain the temperature between 400 and 700 ^oC.

Commercial Applications

- Electronics and computers
- Field emitter devices
- Sensors and electrodes
- Thermal protection/cooling systems
- Semiconductor industry
- Micro-energy storage devices
- Heat exchangers in electrical circuits
- Nanotechnology
- Optics

Grid 10min on Si 50x b1



Contact the Ames Technology Partnerships Office at 1-855-627-2249 or ARC-TechTransfer@mail.nasa.gov