Synthesis of ultralong carbon nanotubes and subnanometer single shells

Technology #m07-020

The unique electrical and mechanical properties of carbon nanotubes (CNTs) enable them to be used as building blocks in nanoscale electronic devices as well as for strengthening materials. But the difficulty of precise manufacturing of CNTs has restricted some applications. Current methods limit the length of multiwalled nanotubes (MWNTs), while the length of single walled nanotubes (SWNTs) is unpredictable. Since the electrical properties of SWNTs depend on their diameter and chirality, in order to implement them in electronic devices, it is essential that consistent geometries be made. This technology is a method of creating ultralong carbon nanotubes by controlling the gaseous flow during growth. This technology also provides a simple but powerful method for engineering MWNTs using mechanical manipulation of atomic-force microscope through a successive shell-by-shell extraction process on ultralong MWNTs.

Laminar gas flow stabilizes catalysts for uniform nanotube growth

By placing a secondary small tube within a chemical vapor deposition configuration, this technology provides laminar gas flow, with low Reynolds numbers, across the substrate. This stabilizes the catalysts at the growth ends and the synthesis of ultralong, aligned carbon nanotubes can be achieved. Both SWNTs and MWNTs can be formed based on the provided concentration of catalytic precursors.

This technology has been used to grow carbon nanotubes exceeding 10 cm in length.

Lead Inventor:
Philip Kim, Ph.D.

Applications:
- Quasi-continuous growth of ultralong multiwalled and single walled CNTs
- Selective preparation of metallic CNTs to be used as electrodes for molecular electronics
Electrodes or templates for molecule-based chemical/biological sensors
- Multifunctional electronic devices
- Positive-negative junction diode, Schottky diode, FET, bipolar junction transistor, photodetector, memory cell, voltage controlled oscillator, or heterodyne circuit
- Light weight fire retardant fabrics e.g. pajama, firefighting equipment, fire shelter, etc.

Advantages:
- Synthesis of ultralong CNTs with well aligned geometries
- Selective preparation of metallic dominant SWNTs which is not possible by the prior methods
- Ability to construct complicated patterns of MWNTs to provide specified conduction characteristics
- Permits large-scale interconnects with neighboring nanotubes

Patent Information:
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Related Publications:

Inventors
Philip Kim