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Carbon Nanotube Arrays: Synthesis of Dense Arrays of Well-Aligned Carbon Nanotubes Completely Filled with Titanium Carbide on Titanium Substrates

SUMMARY

Dense arrays of well-aligned carbon nanotubes over large areas were synthesized on titanium substrates by thermal chemical vapor deposition using catalyst iron particles. The carbon nanotubes are aligned perpendicular to the substrate surface, and are densely packed with uniform diameters and lengths. All carbon tubes are simultaneously and completely filled with titanium carbide during nanotube growth through a novel one step solid state reaction.

The dense arrays of the carbon nanowires were produced by the thermal decomposition of ethylene gas at 700°C. A thin layer of iron was first deposited on pure titanium disks by electron beam evaporation at room temperature. Typical growth periods ranged from 2.5 to 3 hours, resulting in tubes ~1.4 microns in length. Tubes of diameters from 50-400 nm with corresponding core diameters of 10-100 nm have been fabricated.

Transmission electron microscopy revealed the titanium carbide cores to be single crystals, surrounded by partially crystalline carbon nanotube walls. The deposited iron catalyst particles were only observed near the substrate, indicating a base-growth mechanism for the nanotubes. This work suggests that oriented carbon nanotubes can be grown on almost any substrate using conventional chemical deposition methods, with minimum surface preparation. The well-aligned and densely packed uniform carbon nanotubes, completely filled with nanowires on conducting substrates, may lead to novel nanoscale devices for electronic and other applications.

Details have been published: Y. Gao, J. Liu, M. Shi, S. H. Elder, and J. W. Virden, "Dense Arrays of Well-Aligned Carbon Nanotubes Completely Filled with Crystalline Titanium Carbide Wires on Titanium Substrates," Applied Physics Letters 1999, 74(24), 3642-3644.

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http://www.emsl.pnl.gov/docs/annual_reports/ice/annual_report1999/1615b_contents.html

U.S. DEPARTMENT OF ENERGY

Patents & Intellectual Property

» Patent #: 7,011,771

» Patent #: 6,361,861

Technology Portfolio(s)

» Materials Synthesis and Functionalization

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Eric C. Lund
Pacific Northwest National Laboratory
(509) 375-3764
eric.lund@pnnl.gov
http://availabletechnologies.pnnl.gov

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