NIMS NOW
National Institute Materials Science
Vol.1 No.3 August,2003 English Edition

RESEARCH FRONTLINE

Fabrication of Carbon Nanowires without External Carbon Source

—Self-regenerating material with electrical conduction and oxidation resistance—

Daisuke Fujita
Nano-Device Group
Nanomaterials Laboratory

Carbon nanowires are synthesized by various conventional methods, including mainly arc vaporization, laser vaporization, and chemical vapor deposition. However, all of these synthesis techniques require an extrinsic carbon source to supply carbon atoms to the substrate surface. As drawbacks, it is difficult to achieve uniform coating on materials with a complex surface configuration using growth methods that depend on an external carbon source, and if exfoliation occurs, no simple repair method is available.

In this research, we developed a new synthesis method and succeeded in fabricating the world's first carbon nanowires in the class of diameter: 1nm~100nm and length: 100nm to several μm, which are capable of self-regeneration and possess electrical conduction and oxidation resistance. In contrast to the conventional methods, the new method uses high-temperature bulk-to-surface precipitation of carbon atoms dissolved in the material itself, and thus does not require an external carbon source. This means that the growth of the carbon nanowires does not depend on the macro surface configuration, and if exfoliation from the surface occurs, it is possible to re-precipitate and grow the nanowires any number of times by performing heat treatment in a vacuum.

Observation with a scanning tunneling microscope (STM) showed that it is possible to fabricate carbon nanowires coexistent with the bottom surface of a single crystal graphite radical by preparing the (111) plane of a single crystal of nickel containing carbon atoms in solid solution, and precipitating the solute carbon to the surface by controlled heat treatment in an ultra-high vacuum (see figure). The surface shown in the figure is composed entirely of carbon atoms.

These carbon nanowires have electrical conductivity and are extremely stable, resisting oxidation when exposed to the atmosphere. In addition to single nanowires, a bundle structure of carbon nanowires was also observed. Similar nanowires were also found when carbon atoms were doped in polycrystalline nickel. At present, we are studying application to a variety of practical materials and hope to expand the uses of these nanomaterials to STM probes with oxidation resistance and a self-regenerating function, oxidation-resistant battery electrode materials, and ultra-high vacuum materials with a self-regenerating surface which resists gas adsorption.

(Previously reported in Jpn. J. Appl. Phys. Part 1 and the Japanese-language press including Nikkan Kogyo Shimbun, Japan Industrial Journal, Nikkei Sangyo Shimbun, and Kogyo Zairyo)

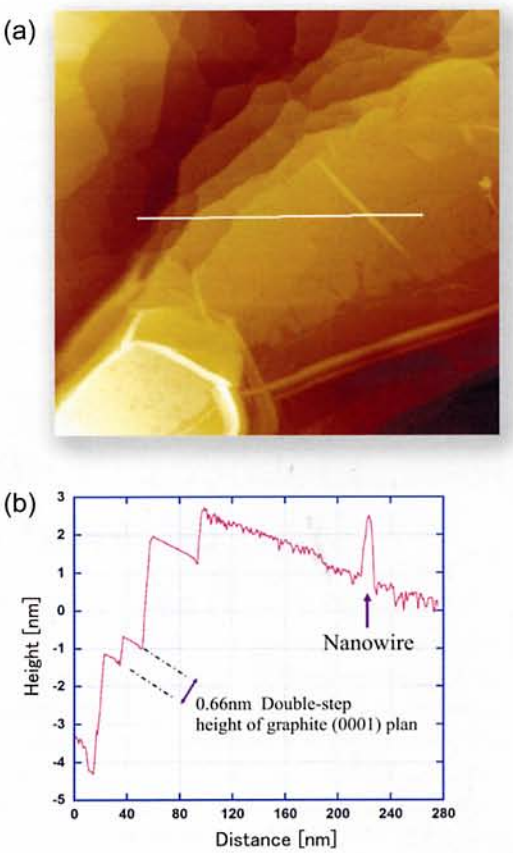

Fig.(a) STM image of bottom surface of graphite radical and carbon nanowires precipitated and grown on (111) plane surface of Ni doped with approximately 0.3at.% solid solution carbon by heat treatment under ultra-high vacuum, and (b) cross-sectional profile of area marked by white line in the preceding STM image.

In this issue

Fabrication of Carbon Nanowires without External Carbon Source	p.1
Creating Nanofibers from Fullerenes	p.2
New Advances in High Strength Steel with Delayed Fracture Resistance	p.2
Elucidation of High-Temperature Ferromagnetism in Boron Compound	p.3
First Successful Synthesis of Co Oxide Superconductor	p.4
NIMS NEWS	p.4
Development of Novel Tissue Adhesive	p.5
NIMS NEWS	p.5