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Growth of Multi-Wall Carbon Nanorod by thermal CVD on Gas/Solid Interface Method using Fe or Co catalyst.

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Abstract: We have grown carbon nanorods (CNRs) and measured thermal characteristic of CNTs forming condition were grown by discharge pyrolysis at gas/solid interface. Typical diameter and length grown CNRs were at about 0.5 μm and 10 μm . And G-peak was 1600 cm^{-1} , D-peak was 1350 cm^{-1} . Grown CNRs had a ratio of a G-band peak and D-band peak of Raman spectrum is 5.78. We observed grown CNRs by scanning electron microscopy, scanning ion microscope images, using focused ion beam, and Raman spectroscopy.

1. Introduction

CNTs have attracted interests because of their novel electronic properties and mechanical properties. Among them have higher crystalline and smaller size than the results so far that is something preferable for electron device applications. Recently cone-shaped boron nitride are aligned toward the incident laser light irradiated during film growth by plasma assisted chemical vapor deposition^[1]. Therefore, we have attempted to grow the oriented CNRs by pyrolysis at gas/solid interface. In order to observe CNRs, we used focused ion beam (FIB) techniques. FIB has the following advantages Ga ion FIB could impact Ga as acceptors impurity in carbon. We have grown CNRs by thermal chemical vapor deposition (CVD), and observed these by FIB. About this time we focused on grown CNRs orientation and crystalline.

2. Experimental Method

Fig. 1 shows experimental system of thermal CVD on gas/solid interface method. Iron particles were deposited on *n*-type silicon (100) substrates (resistivity: 1-10 $\Omega\text{ cm}$, size: 10 \times 40 \times 0.63 mm) as catalysts for CNTs growth by magnetron sputtering method. SUS electrodes were attached on the substrate. These substrate set in the vacuum chamber. Ethanol gas was flowed (gas flow rate: 300 sccm) in to the vacuum chamber as a carbon source. When direct current (current: 5-15 A, growth time: 10 min) applied the electrode, current pathway was observed on the substrate.

CNRs were grown on the current pathway. A focused laser beam (wave length: 808 nm, power: 0.1W) was irradiated to the current pathway. Grown CNRs were observed by scanning ion microscope (SIM) images, using focused ion beam (FIB: Seiko Instruments Inc, SMI2200) techniques, and scanning electron microscopy (SEM: HITACHI)

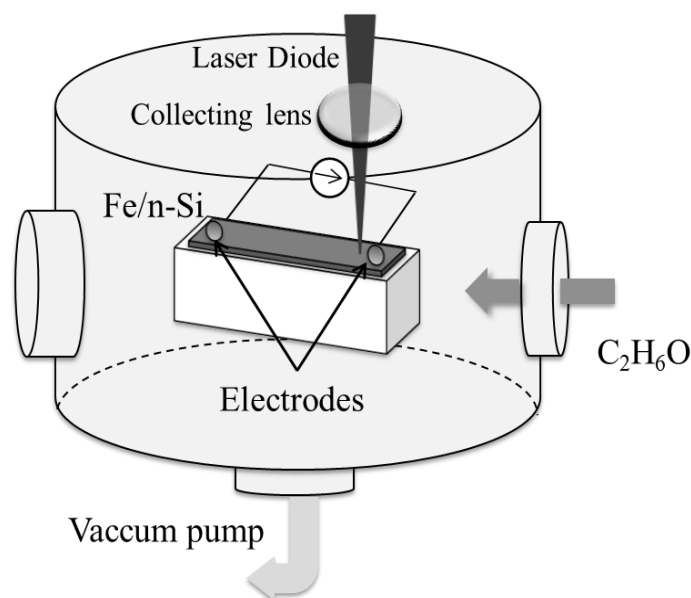


Fig.1 Thermal CVD on gas/solid interface method of grown CNTs

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3. Experimental results and discussion.

Fig. 2 shows temperature characteristic of silicon substrate surface, which applied direct current with Joule heat. The peripheral end of the cathode was observed as this graphs measurement point. We examined been in proportion of current to temperature. Fig.3 show SIM images of CNRs. These images were grown CNRs on iron sputtering silicon substrate surface (15[A] 1100[K] 10[min]). The CNRs were consistent with orientation, and these diameter were at about 0.5 μm . Fig.4 show SIM images of CNRs grown on cobalt sputtering silicon substrate(6[A] 950[K] 10[min]). Grown CNRs had examined by Raman spectroscopy. Fig. 5 shows Raman spectroscopy characteristics of CNRs grown on cobalt sputtering silicon substrate.

Raman spectroscopy is one of the observation method CNRs. Especially important wavelength were 100-300 cm^{-1} sections called RBM. RBM have evidence showing the existence of the CNRs . In the next important wavelength were were around 1590 cm^{-1} called G-band that a case two piace housing wavelength proving CNRs, and at around 1350 cm^{-1} called D-band that proving suffered aloss of CNTs. So CNRs crystalline dicide ratio of G-peak to D-peak. G-peak was 1600 cm^{-1} . In order to grow up CNRs. Because G-peak one of the G-bands could prove of the peak caused by graphite. And D-peak was 1350 cm^{-1} . D-peak one of the D-bands were the peak shift caused by graphite had a financial disadvantage. The CNRs had a ratio of a G-band peak and D-band peak of Raman spectrum is 5.78.

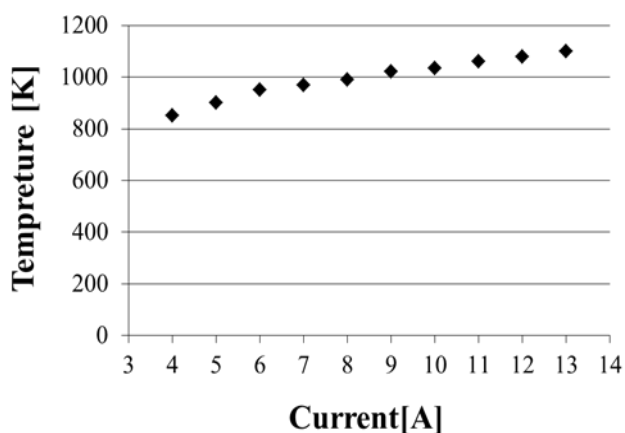


Fig.2 Temperature characteristic

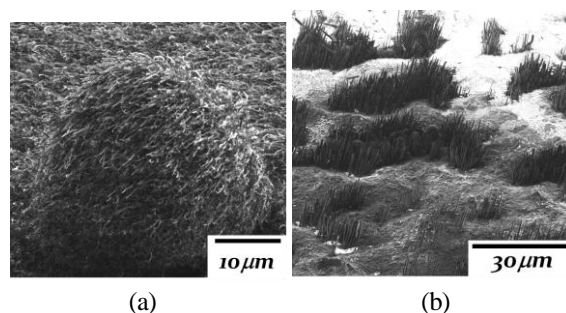


Fig.3 SIM images of CNRs(Fe sputtering)

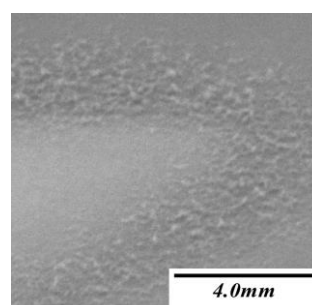


Fig.4 SIM images of CNRs(cobalt sputtering)

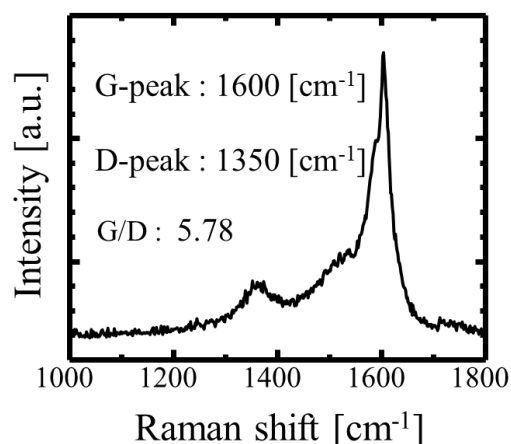


Fig.5 Raman spectroscopy characteristics of CNRs grown on cobalt sputtering silicon substrate

Reference

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