Structure and Phase Transition inside Single-Wall Carbon Nanotubes

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Single-wall carbon nanotubes (SWNTs) are able to encapsulate many kinds of molecules in their one-dimensional cavities. These molecules are expected to show novel properties which cannot be observed in the bulk materials. Particularly, if the encapsulated molecules have magnetic moment, a new kind of magnetic materials can be developed. In the present studies, we investigated structural and magnetic properties of SWNTs encapsulating oxygen molecules with S=1. Here, we report the results of the structural properties studied by powder X-ray diffraction (XRD) experiments, which were performed at BL02B2 of Spring-8.

Figure 1 shows the temperature dependence of XRD pattern of O_2–SWNT samples. The temperature dependence of 10 peak intensity is shown in Fig. 2. From these data, we found that oxygen molecules can be adsorbed inside SWNT in a temperature range between 150K and 300 K. However, in all the temperature range measured, the XRD profiles did not show any change suggesting structural transformation of oxygen inside SWNTs, such as liquid-solid transition.

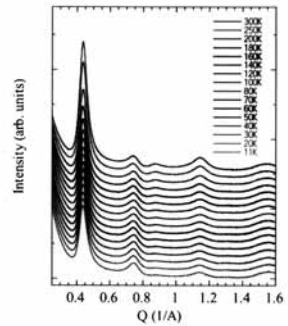

Figure 1. Temperature dependence of the XRD profile of O_2–SWNTs.

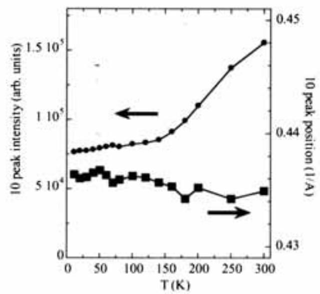

Figure 2. Temperature dependence of the 10 peak intensity and peak position around Q=0.42 (1/A)

Effect of Heat Treatment on Fe Nano-Particles Produced by Chemical Reduction

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Homogenous production of Fe and Fe oxide particles is important for industrial aspect. In this studies, those particles are prepared from chemical reduction of Fe compounds by $NaBH_4$ in aqueous solution in order to produce the homogenous particle.

$(CH_3COO)_2Co \cdot 4H_2O + FeNH_4(SO_4)_2 \cdot 12H_2O$ were chosen as starting materials. The $NaBH_4$ solution was added and reaction mixture was kept at 303K to complete the reduction. Then, the reaction mixture was cooled to room temperature, and diluted with distilled water with stirring. The product was washed many times, and finally, the suspension was filtered through a fine glass filter, and the residue was dried.

The powder diffraction beam line, BL02B2, was utilized for measuring the diffraction patterns of the sample. In order to observe growth of Fe particles, observations at several temperatures were performed. Utilized wavelength was 0.5Å.

Figure 1 shows diffraction patterns at 400K, 500K, 600K, 650K and 900K. Intensities of bcc Fe were increased above 600K, which means growth of Fe particles. On the other hand, the oxide reflections did not grow by the heat treatment up to 600K. However, diffraction pattern of 900K shows complex feature. Strongest peak at 11° seems to be Fe_3O_4. Nucleation and growth of Fe particles are going to be discussed through detailed analyses.

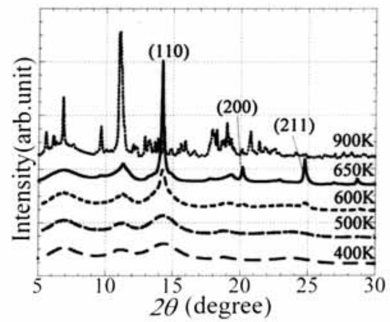

Fig. 1. Diffraction patterns at several temperatures