FT-IR Analysis in Alcohol Catalytic Chemical Vapor Deposition (2)

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Abstract:

Alcohol catalytic chemical vapor deposition (ACCVD) has become a popular CVD method for growth of high-purity single walled carbon nanotube (SWNT) films due to the low cost and easy handling of a non-hazardous CVD gas source [1]. Ethanol mainly decomposes into ethylene and water at CVD temperatures [2]. These thermally generated molecules could affect SWNT growth as is shown in ACCVD study [3]. We have investigated decomposed molecules behavior on the catalyst during ACCVD using Fourier Transfer infrared spectroscopy (FT-IR: Otsuka electronics IG-1000). FT-IR cell was inserted between a reactor tube and a vacuum pump (Fig.1). SWNT synthesis was performed using ethanol as a carbon source and Co/Mo bimetal as a catalyst. The behaviors of ethanol as a carbon source and ethylene, water, and carbon monoxide as the decomposed molecules on the catalyst have been reported by Shimazu *et.al*[4]. Water intensities show unusual behavior as is presented in Fig. 2. In the early stage of the reaction, water was generated by a catalytic reaction. After a few minutes, the behavior of water was changed from generation mode to consumption mode, which mode was continued during growth period. Finally, water was changed again to a generation mode.

We analyzed this behavior using three reaction models. (ⅰ)Generation of water at low active catalysts, (ⅱ) Consumption of water by oxidation of amorphous carbons, and (ⅲ)Generation of water by thermal decomposition of EtOH on the surface of SWNTs. Adjusting parameters of each mode to experimental data, the behavior of water is calculated as shown in Fig. 2. Good agreement was achieved and this result indicates validity of our reaction models.

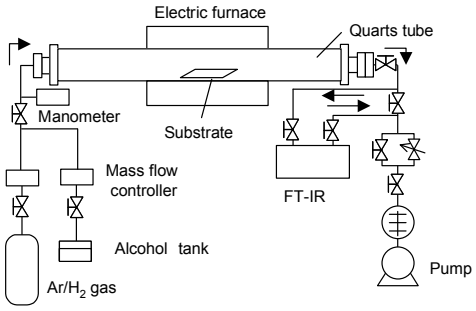

Fig.1 Schematic diagram of experimental apparatus for SWNT growth and ACCVD gas analysis.

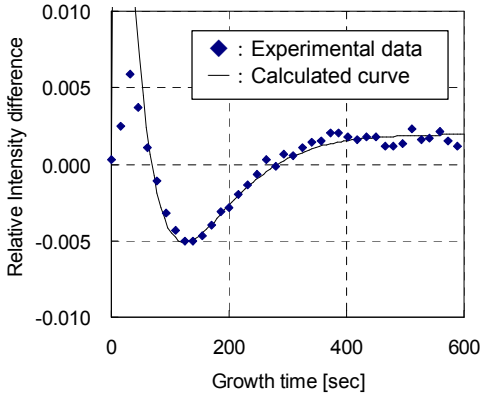

Fig. 2 Square points represent FT-IR water intensity difference measured with and without catalysts presence as function of growth time. The intensity is normalized by the intensity of ethanol at 2.7 kPa at RT. Solid line is the calculated data.

References:

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