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CONTACT (NAME ONLY): Kazunori Kakehi

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Abstract

TITLE: Synthesis of Carbon Nanotubes from Ethanol Using Fe, Co, and Ni Catalysts.

AUTHORS (FIRST NAME, LAST NAME): Kazunori Kakehi[1], Suguru Noda[1], Shigeo Maruyama[2], Yukio Yamaguchi[1]

INSTITUTIONS (ALL): 1. Department of Chemical System Engineering, the University of Tokyo, Tokyo, Japan.
2. Department of Mechanical Engineering, the University of Tokyo, Tokyo, Japan.

ABSTRACT BODY: Single-walled carbon nanotubes (SWNTs) have attracted much attention as promising materials for application in nanodevices due to their unique properties. To realize such applications, their controlled growth on various substrates is crucial. SWNT growth is largely dependent on both catalyst conditions (element of catalyst, diameter, etc.) and reaction conditions (source of carbon, temperature, pressure, etc.). Effects of these conditions interact with each other complicatedly.
Previously, we prepared a thickness profile of Co on a SiO_2/Si substrate [1] and that of Ni on quartz glass substrate [2] by our 'combinatorial masked deposition (CMD)' method [3], carried out alcohol catalytic CVD (ACCVD) [4], and grew SWNTs by metal nanoparticle catalysts spontaneously forming from nominal submonolayers of metal. The thickness profiles formed by this method enable preparation of a series of nanoparticles of various sizes and areal densities on one substrate. Thus we can investigate influence of reaction and catalyst conditions.
We prepared thickness profile (about 0.06-3.5 nm) of Fe, Co, and Ni by using CMD method and ACCVD was carried out at 873-1123K. Fe nanoparticles hardly catalyzed the growth of CNTs, however, Co and Ni nanoparticles did. In the case of Co, two active regions appeared with a inactive region in between. Thinner CNTs including SWNTs grew at a thin Co region (~ 0.1 nm), few CNTs grew at a medium region (~ 0.4 nm), and multi-walled carbon nanotubes grew at a thick region (~ 1.5 nm). On the other hand, only one active region appeared for the case of Ni. Ni mainly grew SWNTs at a thin Ni region (~ 0.2 nm), while Ni grew few CNTs at the thicker region. In both Co and Ni catalyst, the active regions shifted to larger metal thickness as increasing growth temperature. We will discuss the underlying mechanisms for these phenomena.

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