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Abstract Details

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Abstract

TITLE: Roles of bimetallic catalysts for controlled CVD growth of single-walled carbon nanotubes
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ABSTRACT BODY:
Abstract Body: Bimetallic catalysts such as Co-Mo have been used for efficient growth of bulk single-walled carbon nanotube (SWNTs) [1] and vertically aligned SWNTs [2, 3]. Recently, bimetallic catalysts such as Co-W [4] or Co-Cu [5] are employed for structure controlled growth of SWNTs. Roles of bimetallic catalysts are explored by newly proposed in-plane transmission electron microscopy (TEM) technique, which enables a direct TEM characterization of catalysts and CVD grown nanotubes on SiO_2 TEM grid. Sputtered and dip-coated cobalt-based catalysts, i.e., Co, Co-Mo, Co-Cu, Co-W, are studied in alcohol catalytic CVD (ACCVD).
The in-plane TEM result of the traditional Co-Mo bimetallic catalysts was consist with our previous report [3]; Co nanoparticle embedded in Co-Mo oxide which adhered to the substrate is the responsible to the nucleation of carbon nanotubes. By using Co-Cu catalysts, we can synthesize vertically aligned SWNTs with subnanometer diameters on quartz (and SiO_2/Si) substrates [5]. Scanning transmission electron microscopic energy-dispersive X-ray spectroscopy (EDS-STEM) and high angle annular dark field (HAADF-STEM) imaging of the Co/Cu bimetallic catalyst system showed that Co catalysts were captured and anchored by adjacent Cu nanoparticles, and thus were prevented from coalescing into larger size, which contributed to the small diameter of SWNTs. High-melting point W_6Co_7 alloy is reported to grow a single chirality (12,6) with over 90 % abundance through high-temperature (1030 deg. C) reduction and growth [3]. Here, we show that a sputtered Co-W catalyst can selectively grow (12,6) SWNTs by CVD at lower reduction and growth temperatures [6]. Statistical Raman mapping analysis and optical absorption spectrum of the as-grown SWNTs reveal that the abundance of (12,6) is over 60 %. The morphology and structure of catalyst is investigated by the in-plane TEM before and after CVD growth. The catalyst alloy we produced was W_6Co_6C and the only metallic Co was left after the CVD of 5 min.

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