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EFFECT OF CATALYTIC MATERIALS ON THE SYNTHESIS OF GRAPHITE-CAPPED VERTICALLY ALIGNED CARBON NANOTUBE ARRAYS

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Over the last three decades, various new nano-carbon materials such as fullerene, carbon nanotube (CNT), graphene were discovered, and a wide range of basic and application researches have been conducted. In addition to these materials, Kondo *et al.* reported a novel composite structure consisting of graphene multi-layers (graphite) supported by vertically aligned multi-walled CNTs (referred to as "composite") in 2008. Because of its unique structure, new applications such as via-hole wiring material of electronic circuit are expected. The understanding of the growth mechanism is an urgent issue to realize such applications.

Here we demonstrate the detailed study of the effect of catalyst material to the composite growth. Syntheses were conducted by custom-made chemical vapor deposition (CVD) apparatus using iron and cobalt catalyst film with various thicknesses to study relationship between the catalyst element and the grown film structure. Iron catalyzed aligned CNT arrays at the overall thickness (2.0 ~ 15.8 nm for CNT arrays ~ composite, respectively), while cobalt catalyst lost its activity of synthesis of aligned CNT arrays above 4.6 nm. Crystallinity of the CNTs arrays synthesized from thin iron and cobalt film was estimated by Raman spectroscopy. The cobalt–catalyzed CNTs showed better crystallinity than iron-catalyzed ones (G/D ratio: 1.05 and 0.79 for cobalt and iron, respectively), which is consistent with a previous computational study. Based on these results, defects in the graphitic forms are assumed as paths of the carbon supply to the catalyst. Since the cobalt catalyst precipitates with higher crystallinity than iron on graphit, the cobalt deactivates quickly, because of the suppression of carbon supply, resulting in the graphite film without CNT arrays.

In conclusion, the catalytic element dependence of the growth of graphite-capped, vertically aligned CNT arrays by thermal CVD has been examined. Iron can catalyze composite films on a wide and thick catalyst region, in contrast to the Co catalyst. This difference is discussed in terms of the different quality of graphite precipitated as well as the different way of supplying carbon to grow CNTs. Such surface graphite with high crystallinity is highly necessary to improve the thermal and electrical conductive properties.

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