未来社会創造機構 マテリアルイノベーション研究所 エネルギーマテリアル研究部門主催

Esko I. Kauppinen 先生講演会

(Aalto University, Finland)

日時：2022年11月11日（金）10：30−12：00
場所：NIC館１階 Idea Stoa

Can we tune the SWNT atomic structure during the floating catalyst chemical vapor deposition (FC-CVD) synthesis ?

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Floating-catalyst CVD (FC-CVD) is a highly promising technique for the scalable synthesis of single-walled carbon nanotubes (SWNTs). We have been studying FC-CVD systems with several carbon precursor molecules, including CO, C_2H_4, CH_4, ethanol, methanol, isopropanol, and toluene, using mainly iron catalyst nanoparticles, either generated in-situ via ferrocene vapor thermal decomposition or pre-made via the spark discharge aerosol generator. We have determined the SWNT atomic structure i.e. (n,m) distributions directly via the electron diffraction of individual tubes supported by the optical absorption spectroscopy studies. Using ferrocene as the catalyst precursor, CO as the carbon source and CO_2 as the growth promoter, we show that the SWNT atomic structure i.e. (n,m) distribution and the related thin film color can be directly tuned by adjusting the CO_2 concentration. Also, the fraction of metallic tubes can be tuned via adding carbon dioxide. When using CO as the carbon source, the chiral angle distributions are biased towards the armchair side, while with hydrocarbons as the carbon sources, the chiral angle distributions are flat.

We will present results on the synthesis of over 90% semiconducting tubes with 1.2 nm diameter from ethanol via adding methanol with ferrocene as catalyst precursor and thiophene as the growth promoter (Fig. 1). Finally, we will introduce preliminary results on producing 1 nm diameter SWNTs with around 90% semiconducting tube fraction using isopropanol as the carbon source when using nitrogen carrier gas with minor fraction of hydrogen as the carrier gas as well as the tiophene as the growth promoter.

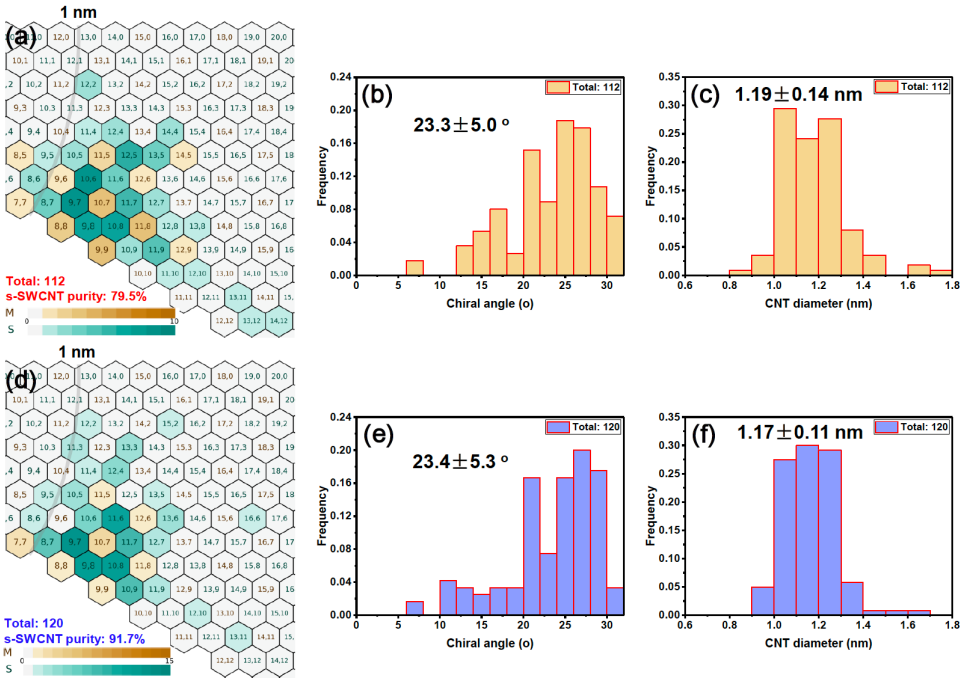

Figure 1. TEM/ED (n,m) distributions when using ethanol alone (a, b, c) and ethanol with methanol (d, e, f) as the carbon source.

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