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# Colored SWNT thin films via tuning (n,m) distributions during the FC-CVD synthesis

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**Venue: Faculty of Engineering Bldg. 2, 3F, 31A**

### Abstract:

We have explored floating catalyst chemical vapor deposition (FC-CVD) synthesis of single walled carbon nanotubes (SWNT) for tuning (n,m) distributions. Ferrocene has been used as the catalyst nanoparticle precursor and CO, C<sub>2</sub>H<sub>4</sub>, ethanol and toluene as the carbon precursors and CO<sub>2</sub>, H<sub>2</sub>O, H<sub>2</sub>S and thiophene as the respective additives. By introducing various amount of CO<sub>2</sub> in FC-CVD with CO as the carbon source and in-situ ferrocene decomposition generated Fe catalyst nanoparticles, we directly synthesized SWNT films with tunable (n,m) i.e. helicity distribution as well as tunable colors [1]. When operating the FC-CVD reactor at the ambient pressure and at 850°C temperature with 0.25 and 0.37 volume percent of added CO<sub>2</sub>, the directly deposited SWNT films display green and brown colors, respectively. We ascribed various colors to suitable diameter and narrow (n,m) distributions, which were determined in detail using the electron diffraction.

We will present recent results on using ethylene as the carbon source in N<sub>2</sub> carrier gas with the addition of H<sub>2</sub>O vapor to synthesize SWNTs with extremely narrow (n,m) distribution and accordingly directly deposit colorful films. In addition, we discuss the SWNT diameter as well semiconducting fraction tuning with the ethanol and toluene carbon precursors and with ferrocene-thiophene in the H<sub>2</sub>-H<sub>2</sub> carrier gas. Also, we will present recent results on SWNT synthesis when using spark discharge generated single and bimetallic nanoparticles as premade catalysts with C<sub>2</sub>H<sub>4</sub> and H<sub>2</sub>S in H<sub>2</sub>-H<sub>2</sub> carrier gas.



Figure 1. (n,m) distribution of the green SWNTs and photos of the SWNT thin films synthesized at 850 °C. with 0 %, 0.25 % (green), 0.37 % (brown) and 0.5 % of added CO<sub>2</sub>.

### References:

[1] Y. Liao et al. "Direct Synthesis of Colorful Single-Walled Carbon Nanotube Thin Films". J. Am. Chem. Soc. 140, 31, 9797- 9800 (2018).

主催:

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