Floating catalyst CVD synthesis of single walled carbon nanotubes using ethylene as carbon precursor for transparent electrode

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Transparent conducting films (TCFs) are critical components of many optoelectronic devices that pervade modern technology. Due to their excellent optoelectronic properties and flexibility, single-walled carbon nanotube (SWNT) films are regarded as an important alternative to the conventional transparent conducting material, i.e the brittle indium tin oxide. Herein, we have developed aerosol synthesis of SWCNTs using C_2H_4-H_2-N_2 system for high performance thin SWNT film fabrication. For the first time, ethylene has been used as the only carbon source for high-quality SWNT synthesis in FCCVD with N_2 as the main carrier gas, which makes the growth process economical, safe and environmental friendly. The electron diffraction (ED) analysis indicates that chirality of the SWNT randomly distributes between armchair and zigzag structures and the proportion of metallic SWNTs is around 38%. High-performance TCFs of SWNTs are directly fabricated with deposition of SWCNT aerosol on the filters at room temperature. Specifically, CNT TCFs exhibit improved performance up to 51 Ω/sq. at 90 % transmittance after HNO_3 doping with the optimized synthesis process. The excellent conductivity of the SWNT TCFs is attributed to long tubes (mean length 13 um) and low bundling with 29 % of individual tubes. This high-performance SWCNT TCFs have great potential in flexible electronics, photovoltaic [1] and electrochemistry [2]. Moreover, the addition of water vapors produced very small diameter SWCNTs.

[1] Aitola, K, et al. *Energy & Environmental Science* 9.2 (2016): 461-466.
[2] Tavakkoli, M, et al. *Angewandte Chemie* 127.15 (2015): 4618-4621