Controlling SWNT metallic fraction and (n,m) distribution during the floating catalyst CVD synthesis

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We use ferrocene-CO-CO_2 floating catalyst chemical vapour deposition (FC-CVD) reactor to explore the effect of synthesis temperature, ferrocene and as well as CO_2 concentration on the (n,m) as well as length distributions of the produced tubes. Electron diffraction was used to reliably determine tube (n,m) distributions, At 880 ^oC synthesis temperature tube diameter increases from 1.3 to 1.8 nm when increasing the CO_2 concentration from 1 sccm to 1.3 sccm when the CO flow rate was 300 sccm. The corresponding fraction of metallic tubes increased from 24 to 39 %. Similar results were obtained at 850 ^oC synthesis temperature with the fraction of metallic tubes increasing with the CO_2 concentration. At both temperatures the chiral angle distributions peaked at about 25 degree. When using ethanol as the carbon source with tiophene as the sulphur source and nitrogen-hydrogen mixture as the carrier gas at 1000 ^oC synthesis temperature, the fraction of metallic tubes was 23 % and chiral angle distribution peaked 23 degrees, i.e. the results were quite comparable to those obtained with ferrocene-CO-CO_2 system at lower synthesis temperature. Interestingly, when using ferrocene with C_2H_4 as the carbon source in nitrogen-hydrogen carrier gas at 1050 ^oC synthesis temperature, the chiral angle distributions were quite flat with no maxima close to armchair side of the distribution. The fraction of the metallic tubes was 38 %. These results show that the fraction of metallic tubes as well as the (n,m) distributions can be controlled by the carbon source when using ferrocene-based iron clusters as catalysts in the ambient pressure FC-CVD synthesis.

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