Mist-CVD deposition of SWCNT films for transparent electrodes

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The floating catalyst CVD using ferrocene–ethanol mist [1] has the potential for large-scale production of SWCNTs (single-walled carbon nanotubes) at a low temperature, since it is a continuous process of both catalyst particle formation and nanotube growth occurring in the same reactor. In this work, the ferrocene-ethanol mist CVD under atmospheric pressure was successfully used to deposit web-like SWCNT films from the gaseous phase onto a Si substrate and a membrane filter (⌀: ~50 mm). The home-built vertical mist-CVD system was carried out without the use of H2 or CO gases [2]. The tiny mist of ferrocene-ethanol was generated using a high-frequency ultrasonic vibration (~1.7 MHz). The effects of various parameters including furnace temperature, ferrocene/ethanol ratio, flow rate of carrier gas, and deposition time on the formation of SWCNTs were investigated using SEM, TEM and Raman spectroscopy. The furnace temperature and the flow rate of carrier gas were found to determine the diameter and crystallinity of nanotubes. The ferrocene concentration in ethanol strongly influenced the diameter distribution of nanotubes and the amount of impurity particles in the materials. The collected SWCNT films on a filter were directly transferred to a laminate sheet by using a hot press laminator. The properties of SWCNT films were investigated by UV-Vis spectrophotometer and four-point probe measurement. The high sheet resistance of 22 kΩ sq⁻¹ was observed for the as-transferred films. However, the initial results show that a sheet resistance of 8 kΩ sq⁻¹ could be achieved with a 65% transmittance at the wavelength of 550 nm after nitric acid or hydrochloric acid treatments (the transmittance of a plastic sheet was 80%). Further investigation in improving the electrical properties of the films is under progress and will be presented at the conference.