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Growth and Characterization of Vertically Well Aligned Carbon Nanotubes on Glass Substrate by Plasma Enhanced Hot Filament Chemical Vapor Deposition

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Vertically well aligned multi-wall carbon nanotubes (CNT) were grown on nickel coated glass substrates by plasma enhanced hot filament chemical vapor deposition at low temperatures below 600°C. Acetylene and ammonia gas were used as the carbon source and a catalyst. Effects of growth parameters such as pre-treatment of substrate, plasma intensity, filament current, input gas flow rate, gas composition, substrate temperature and different substrates on the growth characteristics of CNT were systematically investigated. Figure 1 shows SEM image of CNT grown on Ni coated glass substrate. Diameter of nanotube was 30 to 100nm depending on the growth condition. The diameter of CNT decreased and density of CNT increased as NH₃ etching time increased. Plasma intensity was found to be the most critical parameter to determine the growth of CNT. CNT was not grown at the plasma intensity lower than 500V. Growth of CNT without filament current was observed. Raman spectroscopy showed the C-C tangential stretching mode at 1592 cm⁻¹ as well as D line at 1366 cm⁻¹. From the microanalysis using HRTEM, nickel cap was observed on the top of the grown CNT and very thin carbon amorphous layer of 5nm was found on the nickel cap. Current-voltage characteristics using STM showed about 34nA of current at the applied voltage of 1 volt. Electron emission from the vertically well aligned CNT was obtained using phosphor anode with onset electric field of 1.5V/μm. (Figure 2.)

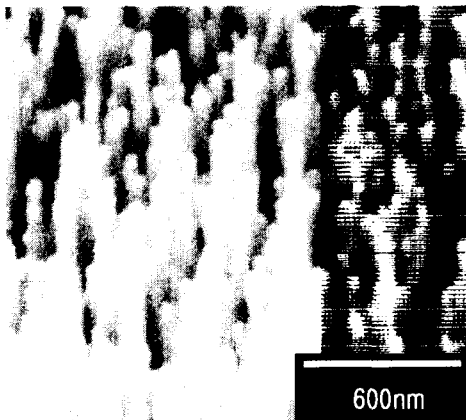


Fig. 1.

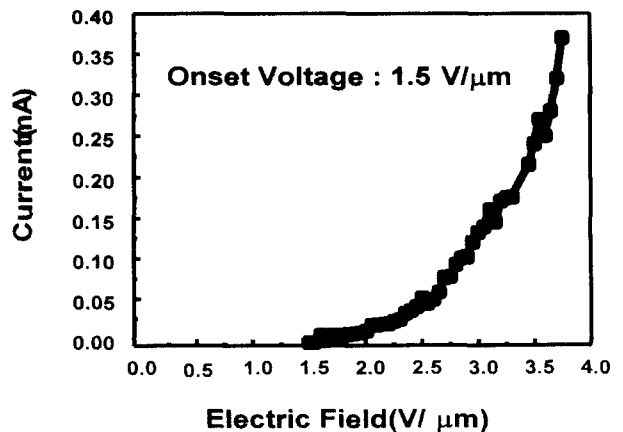


Fig. 2.