Fe particles as catalyst and C_2H_2 as feedstock. Growth is performed at atmospheric pressure. We also record the growth of carbon nanotube forests by high resolution real-time optical imaging. We derive activation energies of < 1 eV.

Carbon nanofibres and large diameter carbon nanotubes in PECVD are known to grow by diffusion limited growth, as their growth rate varies inversely with the catalyst droplet diameter. We also look at the pressure dependence of the growth rate of SWNTs and small diameter MWNTs in the C_2H_2 pressure (p) range of 10^{-5} to 20 mbar. We observe a $\sqrt{p}$ dependence. Thus, we suggest that the rate limiting step for SWNT growth under purely thermal conditions is molecular dissociation at the catalyst surface.

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Quantitative Evaluation and Control of the Diameter of Vertically Aligned SWNTs

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To quantify the diameter change along a vertically aligned single-walled carbon nanotube (SWNT) array grown by alcohol catalytic CVD, we compare three samples that followed almost the same growth curves but grew for different CVD time. By subtracting UV-Vis-NIR absorption spectra from each other, we obtain the local absorption information, which clearly show that the average diameter of SWNTs along a vertically aligned array is around 10-20% larger at the root than at the tip. The increase of diameter begins from a diminishing of signal in small diameter range and then a shift of the entire peak. From this observation, we discuss that catalyst aggregation is the main reason of the diameter increase rather than the catalyst ripening. Higher concentration of Mo is introduced into the original catalyst recipe to prevent from the aggregation of metal particles at high temperatures. As expected, the average diameter of SWNT arrays is significantly reduced. Small-diameter vertically aligned SWNTs (average diameter of 1.2 nm) have less buckling due to higher flexibility, which lowers the resistance of thermal and electric transport.

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Origins of optical absorption components of metallic and semiconducting single-wall carbon nanotubes in ultra-violet region

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