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Introduction and Characterization of Defects in Single Wall Carbon Nanotubes by Ozone Treatment

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Controllable introduction and characterization of defects in single wall carbon nanotubes (SWNT) is the first step toward chemical functionalization of SWNTs for strong bonding and controllable properties in SWNT-polymer composites, and for other applications of SWNTs. The defects or imperfections were introduced using various techniques, including ozone treatment, Ar-ion beam irradiation (E=5kV), alpha-particle irradiation (E=5.3 MeV, Po^{210} source), and electron beam irradiation of purified and raw SWNTs synthesized by laser evaporation. The defects were studied using the D-band (~1320 cm^{-1} for $\lambda_{ext.}$= 633 nm) in Raman spectra of SWNTs and high resolution TEM. The D/G-band intensity ratio in Raman spectra of SWNTs was approximately correlated with the surface density of defects in SWNTs using Ar-ion beam irradiation of SWNTs at different well defined irradiation doses, 10^{12}-10^{15} $1/cm^2$, and a Monte Carlo simulation of this process. It was shown that even a very small ozone concentration (~5 ppm) could produce remarkable number of defects in SWNT that have clear signatures in their Raman spectra, i.e., the increase of D/G-band ratio and the decrease of the intensity of the metallic tangential mode. It was also demonstrated that the ozone treatment considerably changes the chemical properties of SWNTs which could be useful for their chemical functionalization for different applications in SWNT-polymer composites.

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