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Bending Modulus of CVD Grown Multi-walled Carbon Nanotubes (MWNTs) JAY GAILLARD, RAZVAN CIOCAN, MALCOM SKOVE, APPARAO RAO, Department of Physics and Astronomy, Clemson University, Clemson, SC, 29634 — We have measured the bending modulus of several different CVD grown MWNTs using a vibrating reed technique. The MWNTs are produced from a thermal decomposition of three different precursors: (i) xylene/ferrocene, (ii) xylene/ferrocene/melamine (nitrogen-doped), and (iii) trimethylamine (TMA)/ferrocene. The first two precursors are used to compare the mechanical properties of typical CVD-grown to bamboo-type MWNTs. Nanotubes prepared using the third precursor shows relatively fewer walls ($\sim$ 4-20 compared to $\sim$15-40) and defects compared to those prepared from the xylene/ferrocene mixture. The resonant frequencies of these nanotubes were measured optically and electronically in air using a dark field light microscope. The diameters of these nanotubes range from 50 – 160 nm as determined from TEM and the average length is $\sim$ 10 microns. For the xylene/ferrocene and trimethylamine/ferrocene tubes, the average bending modulus is estimated to be 0.1 and 0.3 TPa, respectively. However, the bending modulus for the nitrogen-doped tubes is $\sim$9 GPa which is significantly lower compared to regular MWNTs implying that the bending modulus decreases with an increase in wall defects.

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