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Abstract for an Invited Paper
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Physical Adsorption on an Individual Carbon Nanotube[1]

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I will present results from physical adsorption experiments on individual carbon nanotubes. A suspended closed-end single-wall nanotube driven at its resonance frequency, f_{res}, can be used as a pristine substrate and an ultrasensitive mass balance. Adsorption changes the suspended mass and $f_{res} \propto [M_{nt} + M_{ads}]^{-1/2}$, where M_{nt} and M_{ads} are respectively the masses of the bare nanotube and the adsorbates. For each yocto-balance (10^{-24}kg sensitivity) the nanotube, suspended across a μm-wide trench on a substrate with evaporated Pt conducting pads, is grown by CVD as the last step in the fabrication. The current through, and charge and tension on the nanotube are controlled via three electrodes (source, drain and gate). The nanotube is driven to vibrate using a modulated (1 kHz) AC current in the 1 MHz to 1 GHz range. Usually several resonances are detected and tracked as a function of gate voltage. To measure an isotherm, a chosen resonance is followed at constant temperature as a function of pressure of gas in equilibrium with the adsorbate. Simultaneous conductance measurements can be performed. With these devices we have studied the adsorption of Ar above 46K, Kr above 68 K, and ^{4}He between 4K and 6K. We observe two-dimensional vapor (V), fluid, commensurate solid (CS) and incommensurate solid phases, and the transitions between them. We observe a change in the conductivity of the nanotube at a V-CS transition. I will compare briefly the adsorption on individual nanotubes with adsorption on nanotube bundles and exfoliated graphite. This work is carried out currently in collaboration with D. Cobden, Z. Wang, H.-C Lee, E. Frederickson and R. Roy.

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