Nanotechnology with nanotubes: From thermal motors to manipulations of electrons

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Carbon nanotubes have attracted a lot of attentions as high-frequency mechanical resonators. For instance, nanotube resonator devices hold promise for ultralow mass detection or quantum electromechanical experiments. However, the detection of the mechanical vibrations remains very challenging. In this talk, I will present a novel detection method of the vibrations of nanotubes [1], which is based on atomic force microscopy. This method enables the detection of the resonances up to 3.1 GHz with sub-nanometer resolution in vibration amplitude. Importantly, it allows the imaging of the mode-shape for the first eigenmodes.
Another important issue in nanoelectromechanical systems (NEMS) is developing small electrically driven motors. We have developed a new artificial nanofabricated motor in which one short nanotube moves relative to another coaxial nanotube [2]. The motion is shown to be controlled by how the atoms are arranged within the two nanotubes. The motion is actuated by imposing a thermal gradient along the device, allowing for sub-nanometer displacements. This is, to our knowledge, the first experimental demonstration of displacive actuation at the nanoscale by means of a thermal gradient.
I will also report on a radically new approach to probe the spectrum properties of highly resistive molecular systems. This technique, which we call electron counting spectroscopy, consists of counting electrons tunneling into the studied molecular system using a nanotube field-effect transistor [3]. We have recently measured the energy gap of an individual semiconducting CdSe quantum dot, and we have been able to fill (or empty) the dot with about 200 electrons

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References:

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