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Probing Single-Electron Charging and Dissipation of Au Nanocrystals with Electric Force Microscopy J. ZHU, M. BRINK, P. L. MCEUEN, LASSP, Cornell University, Ithaca, NY 14853 — We synthesize and link Au nanocrystals to carbon nanotube (CNT) field effect transistors through thiol and aromatic ring bi- functionalized molecules. AFM images taken at room temperature using tapping mode and at 77 K using force microscopy both show specific binding of Au nanocrystals onto the CNTs. At 77 K, the small size of the Au nanocrystals (d $\sim$ 12 nm) leads to quantum dot phenomena. A metalized AFM tip perturbs the electrostatic potential of the dot and brings electrons onto the dot one by one. The CNT serves as a charge transfer line and a reservoir. We study the force, frequency shift, and dissipation generated by this single-electron motion using AFM-based electric force microscopies. We observe Coulomb oscillations of the Au nanocrystal and derive its capacitances to the gates, i.e. the backgate, the AFM tip, and the anchoring CNT, through charge addition spectra. The total capacitance of the Au nanocrystals was found to be approximately 1.6 aF, corresponding to a charging energy of 100 meV. Most interestingly, we observe a typical power dissipation of $\sim$ 10 aW, extracted from the decrease of the quality factor Q of the AFM cantilever, for many charging events. We discuss the possible origins of the observed dissipation.

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