

UNIVERSITY OF TEXAS AT DALLAS - DEPARTMENT OF PHYSICS
PHYSICS COLLOQUIUM

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Thursday, March 3, 2005; 4:00-5:00 PM
in Kusch Auditorium, FN 2.102

**Fabrication and electron transport properties of
nanodevices containing individual chemical
nanostructures**

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Nanostructures made by chemical synthesis such as nanocrystals and molecules have attracted tremendous attention as they constitute promising building blocks for future generation of electronic devices and model systems to investigate novel quantum transport phenomena in confined geometries. Probing the electronic properties of individual nanostructures is challenging because it requires (i) nanometer spaced electrodes, and (ii) placement of the nanostructures between the electrodes. We pioneered a remarkably simple and highly reproducible method for the fabrication of metallic electrodes with sub-5 nm separation in ambient environment on Si/SiO₂ substrate. Commercially available bare gold colloidal nanoparticles are first trapped between prefabricated large-separation electrodes to form a low-resistance bridge (or “nanoscale fuse”) by an AC electric field. A DC bias voltage is then applied to break the bridge via current induced electromigration to produce nanometer spaced electrodes. In this talk, I will present the fabrication technique of the nanospaced electrodes and present electrical transport characteristics of two sets of devices made with individual nanoparticles and individual molecular wires.

In the first experiment individual thiol coated gold nanoparticles were electrostatically trapped in the nanogap to form a single electron transistor. Current – voltage (*I-V*) characteristic measured at 4.2 K show clear Coulomb blockade and Coulomb staircase phenomenon that can be modulated by tuning the number of electrons in the nanoparticle by applying a gate voltage. In the second experiment, individual phenylene-ethynylene molecular wires with or without NO₂ side group were self assembled onto the nanospaced electrodes. The low- bias *I-V* characteristics measured at 4.2 K could be switched between different stable configurations, some of which show negative differential resistance, and has been observed in molecules irrespective of their NO₂ functionalization. We explain this as a possible demonstration of either conformational changes in the molecules or a change in coupling of the molecular junction.