

PHYSICS DEPARTMENT COLLOQUIUM

“Electronic conducting states in nano- and mesoscale molecular devices”

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Organic materials can offer new electronic functionality not available in the inorganic devices. However, the integration of organics within nanoscale electronic circuitry poses new challenges for material physics, chemistry and nanofabrication. I will discuss two very different approaches to design useful electronic properties in small molecular devices. In the first case, the electronic functionality is to be provided by the backbones of short molecules. We have developed a set of fabrication techniques allowing us to build devices with self-assembled monolayers from nearly single-molecule size up to ~300 nm on a side. For the first time, the systematic experimenting with the topography, the chemical bonding at metal-molecule interface and the defect generation is performed. Surprisingly, the results consistently demonstrate that the tunneling conductance of common short molecules is 4-6 orders of magnitude smaller than is commonly believed. In the second approach, we build devices with monolayers of macromolecules. The electronic properties are engineered by the composition and by the chemical conversions of the side groups. Voltage-induced reversible switching between low- and high-conductive states is observed in devices fabricated with polyelectrolyte monolayers. In this case multiple chemical modifications can be performed within completed devices significantly affecting the electrical behavior. We suggest that the switching is caused by ionization of the polymer creating a conducting channel of electronic levels aligned with the contact Fermi level.

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