SYOE 7: Single Molecule Contacts

Time: Tuesday 16:30–18:00 Location: H32

Invited Talk SYOE 7.1 Tue 16:30 H32

Electronic spectrum and spin states of a single organic molecule — •Herre van der Zant — Kavli Institute of Nanoscience, Delft, The Netherlands

With electromigration nanogaps on an aluminum gate electrode have been made and single molecules have been trapped between the electrode pairs. Three-terminal measurements on samples with the same molecule (OPV-5, Co4L4 grid molecule, Mn-12, single-metal atom complexes) share common features showing Coulomb blockade and Kondo physics at low temperature. Of crucial importance is the observation of molecule-specific properties as deduced for example from the interaction between electronic transport and vibrational modes or spin states in the molecule. Transport through an individual thiol end-capped oligophenylenevinylene molecule with five benzene rings (OPV-5) has been studied in great detail and displays more than fifteen excitations in the differential low-temperature conductance map. Their energies agree with the ones from optical measurements and are attributed to vibrational modes of the molecule. A consistent set of measurements shows that the spin states, the charging energies and the electronic spectrum are completely renormalized by the presence of the gold electrodes. In case of the doubly charged molecule the data indicate delocalized orbitals with an antiferromagnetic ground state and an exchange of 1.7 meV.

Molecules are provided by Thomas Bjørnholm (OPV-5, single-metal atom complexes), M. Ruben and J.-M. Lehn (Co4L4 grid molecules) and A. Cornia (Mn-12).

SYOE 7.2 Tue 17:15 H32

Ultrathin contacts for single molecules: Ag nanostructures on Si(100) — •Gernot Gardinowski, Jendrzej Schmeidel, Herbert Pfnür, Jörg Meyer, and Christoph Tegenkamp — Institut für Festkörperphysik, Leibniz-Universität Hannover, 30167 Hannover, Germany

The fabrication and characterization of metallic nanometer–sized(nm) gaps suitable for conductivity measurements of single molecules has been investigated systematically. First results of conductivity measurements of single molecules and of their direct observation by STM are presented. Epitaxially grown Ag structures with a thickness down to 10 monolayers on Si(100) were used for a controlled gap formation by electromigration (EM). The gaps obtained range from several nm down to sub–nm, as revealed by lateral conductivity measurements and by scanning tunneling microscopy done under ultra high vacuum conditions. Annealing to 300 K closes the gap by surface diffusion of Ag and a new cycle of opening by EM at low temperature(77K) can be performed. The functionality of the contacts is demonstrated by adsorption of single ferrocenedithiol molecules. The zero bias resistance is around 40kOhm. In addition, the dI/dV curve shows clearly molecular contributions in the range of 50meV and 150meV, which can be attributed to ferrocene induced states near the Fermi edge, as revealed by DFT calculations.

SYOE 7.3 Tue 17:30 H32

High-Aspect Ratio Nanogap Electrodes for Averaging Molecular Conductance Measurements — Sebastian Markus Luber[1], Fan Zhang[1], Simone Lingitz[1], Allan Glargaard Hansen[1], Felix Scheliga[2], Emma Thorn-Csányi[2], Max Bichler[1], and •Marc Tornow[3,1] — [1]Walter Schottky Institut, TU München, Germany — [2]Technische und Makromolekulare Chemie, Universität Hamburg, Germany — [3]Institut für Halbleitertechnik, TU Braunschweig, Germany

We present a method to fabricate a pair of closely spaced metal electrodes on the cleaved plane of a GaAs/AlGaAs heterostructure grown by Molecular Beam Epitaxy (MBE). These smooth, co-planar electrodes oppose each other in a predetermined distance of a few nanometers, continuously over their entire width of tens of microns. We propose this structure for the determination of the average electrical conductance of molecules. As test system, we measured the current-voltage characteristics of 8.5 nm long Oligo-(p-phenylenevinylene) molecules assembled across electrode pairs of separation 8 +/- 2 nm and width 30 μm. The observed non-linear I-V characteristics are in good qualitative agreement with model calculations.

SYOE 7.4 Tue 17:45 H32

Kondo effect by controlled cleavage of a single molecule contact — •Ruslan Temirov and Stefan Tautz — International University Bremen, Bremen, Germany (Jacobs University Bremen as of spring 2007)

Contact properties are one of the unresolved challenges in the rapidly growing field of molecular electronics. Here we present a single molecule transport experiment with optimum control over contacts, carried out in an STM in a symmetric configuration, i.e. with a molecule between two chemical contacts. We start with a geometrically and spectroscopically well-characterized chemical bond between a π-conjugated molecule and a single crystalline metal surface and vary this contact by a controllable and gradual structural modification, until the metal-molecule bond is cleaved. In this way, the molecular wire is tuned smoothly from the mixed-valence strong-coupling to the intermediate-coupling Kondo regime, in which electron transport is highly correlated, and beyond, up to the point when the contact is cleaved. This tuning is achieved by a gradual de-hybridisation of a molecular orbital from the metallic states due to mechanical stress [1].

[1] R. Temirov and S. Tautz. cond-mat/0612036.