CEA - Saclay 91191 Gif-sur-yvette Cedex

Service de Physique de l'Etat Condensé

SÉMINAIRE

******

Lundi 4 mai 14h00

Orme des Merisiers SPEC Salle Itzykson, Bât.774

Molecular electronics: stable Pt contacts and electron-transparent membrane substrate

Bo. GAO

Kavli Institute of Nanoscience, TU Delft, Lorentzweg 1, 2628 CJ Delft, the Netherlands

In order to measure electronic transport properties of single molecules, two electrodes with a nanometer-scale separation are needed. Electromigration of metal nanowires, with a special breaking technique named "selfbreaking", has been proved to be useful to make such electrodes. However, the most often used gold electrodes are not stable at room temperature due to the high mobility of gold atoms. Aiming at developing molecular devices which are capable to work at ambient temperature, we choose Pt as the material to make electrodes since it has a higher cohesive energy. The nanowires are narrowed by feed-back controlled electromigration to fewatom contacts; at elevated temperature (∼420K), those contacts undergo self-breaking so that gaps are formed. The stability of Pt nanogaps is demonstrated through continuous I-V measurements lasting for 50 hours. Upon cooling down to low temperature, the gaps can be further characterized in details. When performing feed-back controlled electromigration of Pt nanowires, we have found that in the early stage of electromigration, the resistance of Pt nanowires drops instead of increasing, which is contradictory to the general picture of electromigration. To further investigate the nature of electromigration of Pt nanowires, we have fabricated devices on electron transparent silicon nitride membrane and performed the in-situ TEM imaging of electromigration. The measurements are performed at both room and liquid nitrogen temperature. The realtime video shows the growth of Pt grains in the wire, named as "recrystallization", which is responsible for the resistance reduction because of the suppressing of grain boundary scattering. Using electron transparent silicon nitride membrane, we can also combine three-terminal transport measurements with TEM-inspection. We have evaporated a thin Cr/Au layer below the membrane, which serves as the back gate. The electronic transport through gold nanoparticles is investigated with these devices. At liquid helium temperature, Coulomb Blockade features are observed. After removing the Cr/Au back gate, TEM inspection are performed on the sample, demonstrating the presence of gold particles in the gap. The sample topology revealed by TEM agrees qualitatively with the one deduced from transport characterizations.

Contact : fabien.portier@cea.fr - Tel : +33 1 69 08 72 16/74 75

http://iramis.cea.fr/spec/Phocea/Vie_des_labos/Seminaires/index.php