ELECTRONIC TRANSPORT IN GOLD ELECTROMIGRATED NANOGAPS

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Contacting nanometric objects between two metallic electrodes separated by a nanometric distance is the technological challenge at the basis of single molecular electronics. Among the different methods to realize single molecule device, such as scanning tunnel microscopy, mechanical controllable break junction, one of the most used is electromigration [1-3]. Electromigration takes place by applying a current ramp to a continuous nanowire; above a critical current density, the wind force resulting from momentum transfer from the electrons starts to displace gold atoms. A controlled electromigration technique can produce a nanogap, i.e. two electrodes separated by a distance even smaller than a nanometer.

A large number of phenomena have been observed in electromigrated single molecule quantum dot, like single electron effects such as Coulomb blockade and Kondo effect [4–6]. Anyway very often metallic clusters can remain in between the electrodes simulating a molecular behaviour [7]. This point raises the question of characterizing the nanogap even before inserting a molecule. An appropriate description of electron transport through the small space electrode separation, even in absence of molecules, can give a better control of the quality of the future device.

I will present a careful analysis of the current voltage characteristics (I/V) of fresh electromigrated nanogaps at low temperature. The I/V curves exhibit two transport regimes, direct tunneling with a linear dependence at low voltage and field emission with an exponential growth at higher voltage. We describe transport properties in the framework of electron tunneling through a trapezoidal barrier, showing that a 1D as well as a planar junction tunneling model can describe the whole curves for samples with very different tunnel resistances. We find that it is possible to quantitatively extract geometrical and physical parameters characteristics of these structures.

Knowing the size of fresh electromigrated nanogap is an essential precondition to obtain good quality single molecule devices. The quantitative description we propose could infer such properties more exactly.

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