AFM current-force spectroscopy of colloidal nanoparticle arrays

H. Diesinger[1], M. Biaye[1], G. Copie[1], C. Krzeminski[1], F: Cleri[1], N. Decorde[2], J. Grisolia[2], N.M. Sangeetha[2], B. Viallet[2], M. Gauvin[2], L. Ressier, T. Melin[1]

1)Institut d'Electronique, Microélectronique et de Nanotechnologie, CNRS UMR 8520, Avenue Poincaré, 59652 Villeneuve d'Ascq, France;

2)Laboratoire de Physique & Chimie des Nano-Objets (UMR 5215, IRSAMC), INSA Toulouse, 135 Avenue de Rangueil, 31077 Toulouse CEDEX 04 - FRANCE

heinrich.diesinger@isen.iemn.univ-lille1.fr

Abstract
Conducting AFM current-force spectroscopy is performed on assemblies of colloidal nanoparticles coated by thiol and phosphine based ligands [1]. Complementary to macroscopic measurements, AFM allows addressing a few junctions and hence working at larger bias such that thermal activation due to possible Coulomb blockade effects [2] is negligible and a sequence of different tunneling regimes can be traversed. Decomposing the assembly into a resistor network (fig.1) furthermore gives access to the characteristics of the individual interparticle junction. Force dependent transition voltage spectroscopy is performed to study the effect of compression on the barrier height or band offset depending on whether tunneling through coherent levels [3] or vacuum barrier tunneling [4] is considered. In addition to the gain of fundamental knowledge about the applicable transport mechanism, different types of nanoparticles and ligands are compared with respect to their suitability for resistive strain gauges used in touch sensible panels on flexible substrates. The experimental work is completed by molecular dynamics simulation (fig.2).

References

[1] H. Moreira, J. Grisolia, N.M. Sangeetha, N. Decorde, C. Farcau, B. Viallet, K. Chen, G. Viau, and L. Ressier, Nanotechnology, **24**(9)(2013), 095701
[2] K. H. Mueller, J. Hermann, G. Wei, B. Raguse, G. Baxter, and T. Reda, Phys. Rev. B, **66** (2002) 075417
[3] E. H. Huisman, C. M. Guedon, B. J. van Wees, S. J. van der Molen, NANO LETTERS **9** (11) (2009), 3909
[4] J.M. Beebe, BongSoo Kim, J. W. Gadzuk, C. Daniel Frisbie, and James G. Kushmerick, PRL, **97 (2006)** 026801

Figures

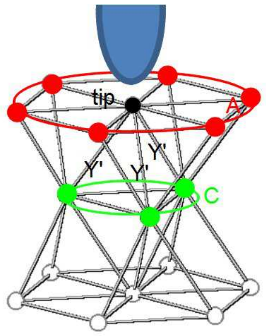

Figure 1: Realistic arrangement of nanoparticlaes into a hcp lattice; lateral current spread with increasing depth; junctions labeled Y' are considered compressible

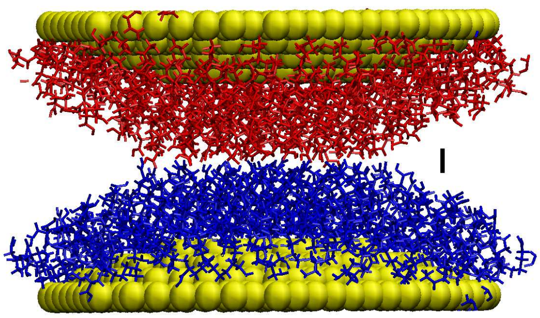

Figure 2: Molecular Dynamics Simulation of a NP/thiol/NP junction.