



Title: Fabrication of Gold Nano-Crystal Arrays for Molecular Electronics: High Frequency Molecular Rectifiers and π - π Inter Molecular Interaction Energy.

When: Monday, September 18, (2017), 12:00.

Place: Departamento de Física Teórica de la Materia Condensada, Facultad Ciencias, Module 5, Seminar Room (5th Floor).

Speaker: Dr. Jorge Trasobares, National University of Singapore, Singapore.

E-beam lithography was used for versatile fabrication of sub-15 nm single-crystal gold nanoarrays at wafer-scale by the so-called dot on the fly (DOTF) technique [1]. Here DOTF and other methods are compared evidencing the limiting factors for the writing speed. Wafer-scale fabrication of such arrays with 50 nm pitch allowed XPS analysis of a ferrocenylalkyl thiol self-assembled monolayer coated gold nanoarray. We exploit these arrays as a suitable test bed for Molecular Electronics (ME) [2] and propose two studies on high frequency molecular rectifiers [3] and inter molecular Interactions [4].

In a first study, we demonstrate molecular diodes operating up to 17.8 GHz. Direct current and radio frequency (RF) properties were simultaneously measured with the tip of an interferometric scanning microwave microscope and S11 parameters show a diode rectification ratio of 12 dB. In a second investigation, we explore the π - π intermolecular interactions. This factor is one of the most important to optimize the transport and optical properties of organic transistors, light-emitting diodes or (bio-) molecular devices. Electrochemical measurements indicate two different phases localized on top and facets of the nanocrystals with clear intermolecular interactions and electrical current statistics on \sim 3000 molecular junctions confirm the theoretical

prediction [5] of asymmetrical histograms due to cooperative effects.

References

- J. Trasobares, F. Vaurette, M. François, H. Romijn, J-L. Codron, D. Vuillaume, D. Théron and N. Clément. High speed e-beam lithography for gold nanoarray fabrication and use in nanotechnology. *Beilstein J. Nanotechnol.* 5, 1918-1925 (2014).
- N. Clement, G. Patriarche, K. Smaali, F. Vaurette, K. Nishiguchi, D. Troadec, A. Fujiwara, D. Vuillaume. Large array of sub-10-nm single-grain Au nanodots for use in nanotechnology. *Small*, 7, 2607 (2011).
- J. Trasobares, D. Vuillaume, D. Théron, N. Clement, A 17 GHz Molecular Rectifier, *Nat. Commun.* 7, 12850 (2016).
- J. Trasobares, J. Rech, T. Jonckere, T. Martin, O. Aleveque, E. Levillain, V. Diez-Cabanes, Y. Olivier, J. Cornil, J.P. Nys, R. Sivakumarasamy, K. Smaali, Ph. Leclère, A. Fujiwara, D. Théron, D. Vuillaume, N. Clément. Estimation of π - π Electronic Couplings from Current Measurements. *Nano Letters*, 17, 3215-3224 (2017).
- M.G. Reuter, M.C. Hersam, T. Seideman, M.A. Ratner. Signatures of cooperative effects and transport mechanisms in conductance histograms. *Nano Letters*, 12, 2243-2248 (2012).