MANIPULATION OF ORGANIC NANOSTRUCTURES BY FIELD GRADIENT DIFFUSION INDUCED WITH STM

Renaud Caillard, Gonzalo Otero, Carlos Sánchez-Sánchez, José Ángel Martín-Gago and Javier Méndez
Instituto de Ciencia de Materiales de Madrid, Spain
Organization, Address, City, Country
jmendez@icmm.csic.es

Nanostructuration of materials is a key issue in many investigations (see for example the review by J. Barth and K. Kern [1]). Among them, nanostructuring organic materials have incremented interest due to the potential applications of these materials in nanotechnological devices. We have successfully investigated the nanostructuring of PTCDA (perylene-tetracarboxylic-dianhydridre) by combination with metals (iron or cobalt) on gold substrates [2]. In this previous work, the self-organization strategy is used in order to obtain organic nanodots (0D) and molecular chains (1D), where the metal-molecule interaction derives in new supramolecular nanostructures [3].

In another approach we pretend to incentive the formation of metalo-organic nanostructes in chosen places. With this purpose and using a STM set-up, we increase the tunnel bias voltage on a desire position over a gold substrate where PTCDA molecules and iron have been previously evaporated. As a result of the increased electrical field between tip and sample, an induced diffusion towards under the tip [4-5], locally provokes the nucleation of PTCDA and iron atoms on the substrate under the tip. The PTCDA molecules provide the organic nature of the nanostruture and the iron atoms give the stability. The obtained nanostructures have a size determined mainly by the applied voltage and the tip radius. Typically a point nanostructure has around 20nm in diameter, as the one in figure 1.

With this method we have written several motives, dots arrays, lines, circles (as in figure 2), crosses, squares and text. In figure 3, over the gold monoatomic steps the “ICMM” logo can be clearly observed.

References:

[1] J.V. Barth, G. Costantini and K. Kern, "Engineering atomic and molecular nanostructures at surfaces", Nature **437**, 671 (2005).
[2] J. Méndez, R. Caillard, G. Otero, N. Nicoara and JA. Martín-Gago, "Nanostructured Organic Material: From Molecular Chains to Organic Nanodots", Adv. Mater. **18** (2005) 2048.
[3] Jean-Marie Lehn, "Review: Supramolecular polymer chemistry", Polym. Int. **51** (2002) 825.
[4] L.J. Whitman, J.A. Stroscio, R.A. Dragoset, R.J. Celotta, Science **251**, 1206 (1991)
[5] J. Méndez, J. Gómez-Herrero, J.I. Pascual, J.J. Sáenz, J.M. Soler, and A.M. Baró, "Diffusion of atoms on Au(111) by the electric field gradient in scanning tunneling microscopy", J. Vac. Sci. and Technol. B **14** (1996) 1145.

Figures:

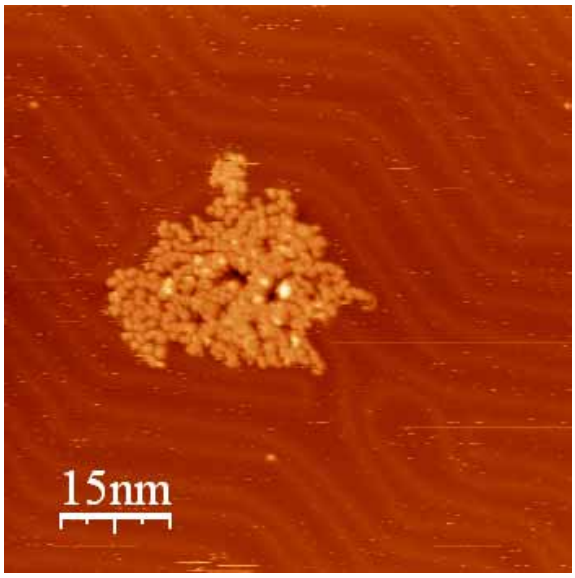

Figure 1. STM image of a nanostructure form by locally increase the tunnel bias. As a result, PTCDA organic molecules and iron atoms nucleate under the tip forming this 20nm nanostructure.

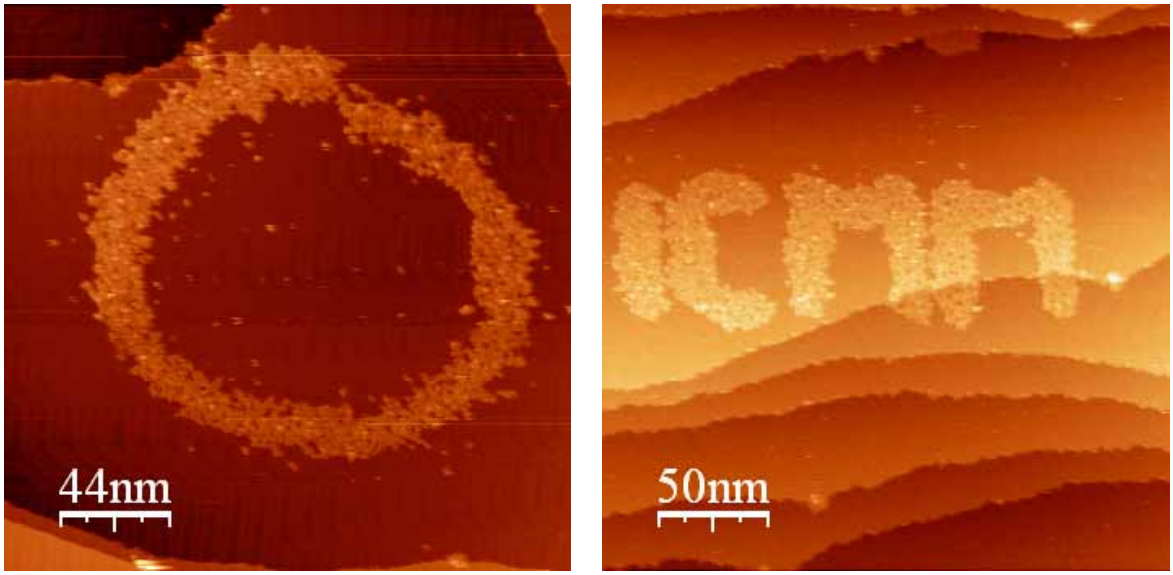

Figure 2-3. STM images of a circle with 100nm in diameter and the "ICMM" logo written on gold by field gradient diffusion induced with the STM.