

# Magnetic Imaging and Manipulation of Molecular-based Nanoparticles

<sup>1</sup>Instituto de Ciencia Molecular (ICMol). Universidad de Valencia.  
Catedrático José Beltrán Martínez nº 2, 46980, Paterna, Spain.

<sup>2</sup> Institut de Chimie Moléculaire et des Matériaux d'Orsay CNRS, Université Paris Sud 11,  
91405 Orsay, France

A. Forment-Aliaga<sup>1</sup>  
E. Coronado<sup>1</sup>, S. Kumar<sup>1</sup>,  
S. Mañas<sup>1</sup>, E. Pinilla-  
Cienfuegos<sup>1</sup>, L. Catala<sup>2</sup>  
and T. Mallah<sup>2</sup>

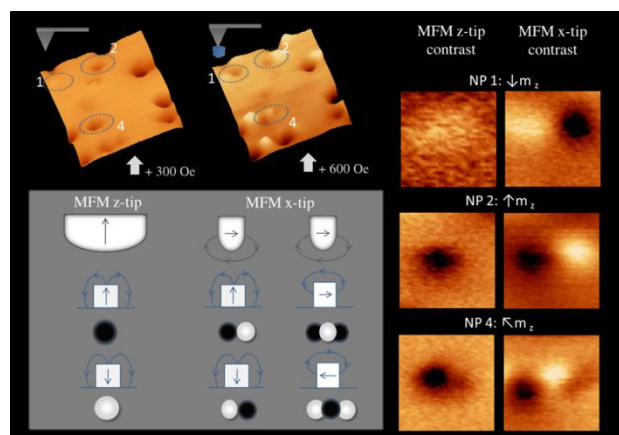
alicia.forment@uv.es

In the race towards the miniaturization in nanoelectronics, magnetic nanoparticles (MNPs) have emerged as potential candidates for their integration in ultra-high density recording media. Molecular-based materials open the possibility to design new tailor-made MNPs with variable composition and sizes, which are benefited by the intrinsic properties of these materials. Among them, bimetallic, cyanide-bridged nanoparticles of the family of Prussian blue analogues (PBA-NPs) have been broadly studied.[1] Before their implementation in real devices is reached, a precise organization on surfaces and a reliable characterization and manipulation of their individual magnetic behavior are required. We will show how molecular-based MNPs are accurately organized on surfaces by soft-lithography and how their individual magnetic properties are detected and tuned by means of low-temperature magnetic force microscopy[2] (LT-MFM) with variable magnetic field. The magnetization reversal on dispersed and organized MNPs is investigated, and the temperature dependence of their magnetic response is evaluated.

Finally we will present the results from magnetic measurements performed with a functionalized-MFM tip by a PBA-NP (Figure 1). The new contrast observed with this PBA-NP-tip is compatible with an in-plane magnetized MFM tip (as opposed to the original out-of-plane MFM tip). Therefore, this functionalization converts the  $\sim 50$  nm tip into a  $\sim 19$  nm tip with an effective magnetic moment in the +x direction, enriching the information that can be extracted from the magnetic images.

## References

- [1] (a) Y. Prado, et al. Chem. Commun. 3 (2011) 1051; (b) D. Brinzei, et al. J. Am. Chem. Soc. 129 (2007) 3778  
[2] U. Hartmann Annu. Rev. Mater. Sci., 29 (1999) 53.



**Figure 1.** 3D magnetic images (520 nm x 520 nm) acquired with the regular MFM tip (left) and the functionalized PBA-NP-tip (right). Three NPs are highlighted and zooms in of 115 nm x 115 nm show the different magnetic contrasts for each case. A schematic of the magnetic contrast for the different situations is shown for clarity.