MAGNETIC COUPLING BETWEEN ANTIFERROMAGNETIC AND A FERROMAGNETIC MATERIAL STUDIED BY MEANS OF SPIN-POLARIZED SCANNING TUNNELING MICROSCOPY

[1]Josefa M.Rodríguez, [1]Bogdana Borca, [1]Juan José Hinarejos, [1,2]Amadeo L. Vázquez de Parga and [1,2]Rodolfo Miranda
[1]Departamento de Física de la Materia Condensada
Universidad Autónoma de Madrid, Cantoblanco, 28049, Madrid
and
[2]InstitutoMadrileño de Estudios Avanzados en Nanociencia (IMDEA-Nanociencia)
Cantoblanco 28049, Madrid, Spain

Josefa.rodriguez@uam.es

Spin Polarized Scanning Tunnelling Microscope (SP-STM) uses a tungsten tip covered with magnetic material to study the dependence of the tunnelling current on the relative orientation of the tip and surface magnetization. This dependence makes possible to study magnetic properties of surfaces detecting magnetic contrast [1] and the capability of the STM to get atomic resolved images of the surfaces allow us to correlate the structural and magnetic properties.

Exchange bias is one of the phenomena associated exchange anisotropy created at the interface between an antiferromagnetic (AF) material and a ferromagnetic (FM) one. Exchange-bias is widely used in different electronic devices [2]. The most relevant unkown element in the development of a satisfactory understanding and a comprehensive theory of exchange bias phenomenon, are the atomic features at the interface between the ferromegnetic and antiferromagnetic materials.

In this work we studied by means of SP-STM the atomic and magnetic structure of Mn films deposited on Fe(001) surface. Mn deposited on Fe(001) crystalizes in a bct structure. The Mn atoms are coupled ferromagnetically within an atomic plane and the coupling between atomic planes is antiferromagnetic as can be seen in the model show in Figure 1 [3]. The right panel in Figure 2 shows a topographic image of 4ML of Mn deposited on Fe(001) at RT. The magnetic contrast between layers can be seen in the left panel of Figure 2. We will show results also on the magnetic frustration that takes place when the antiferromagnetic layer is deposited over an atomic step of the Fe(001) substrate. Due to the localized nature of the frustrations, it has not been possible to resolve the spin-configurations until the introduction on the SP-STM.

On the Mn surface we deposited several amounts of Fe at room temperature and low temperature and by means of SP-STM and we studied the degree of intermixing and the magnetic structure depending on the deposition temperature. Figure 3 shows the topography (right panel) and the magnetic contrast (right panel) after depositing on the surface 3.7ML of Fe deposited at room temperature.

References:

[1] M. Bode, Rep. Prog. Phys. **66**, 523 (2003)

[2] D. T. Pierce, Phys Scr, **38**, (1988) 291

[3] T.K. Yamada et al. Phys. Rev. Lett. **90**, 056803 (2003)

Figures:

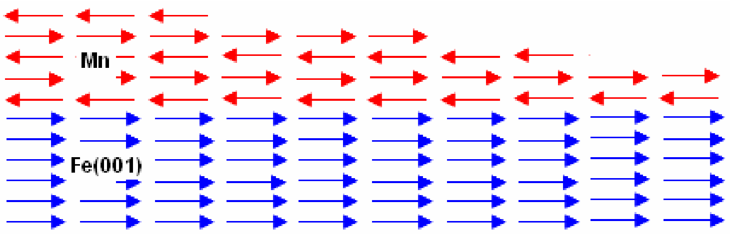

Fig. 1 Atomic magnetizations diagram of different layers in Mn deposited on Fe(001)

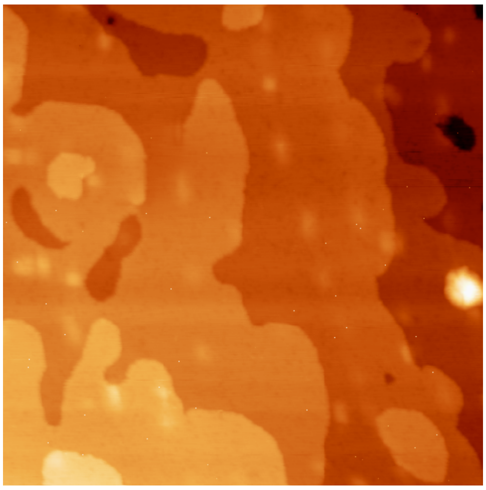

Fig. 2 (a) STM topography of Mn deposited onto Fe(001) at RT.
100nm x 100nm.
Setpoint: -0.53 V, 1nA

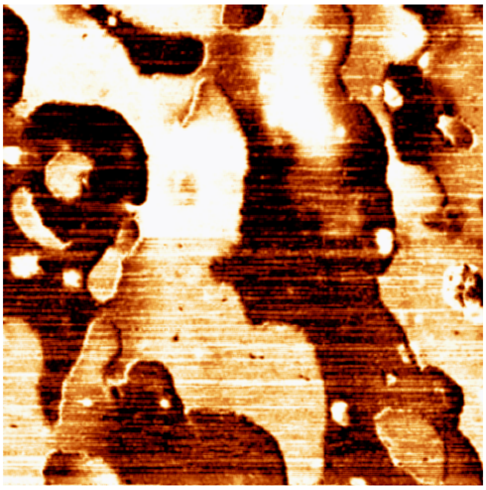

Fig. 2(b) STS magnetic spectroscopy .
100nm x 100nm. 0.2 V.
Magnetic contrast between layers due to the layered antiferromagentic structure of the Mn(001) films.

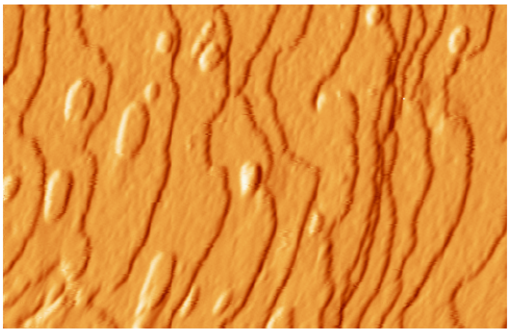

Fig. 3(a) STM topography (<u>I const</u>) of Fe deposited onto Mn/Fe(001).
80nm x 52nm.
Setpoint: -0.53 V, 1nA

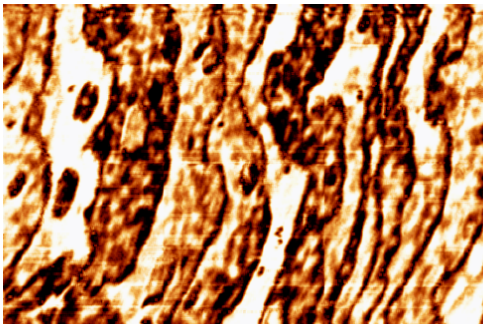

Fig. 3(b) STS magnetic spectroscopy (<u>z const</u>).
80nm x 52nm. 0.2 V.
Magnetic contrast between alternaned layer in the antiferromagnetic deposition.