ONLINE PROGRAMME//

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Manipulation of magnetic domains in thin magnetite films

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The study of static and dynamic properties of magnetic domains in ferromagnetic nanostructures has recently received a lot of attention not only because of the fundamental interest, but also due to the emergence of technological applications based for example on domain walls (DWs) and their dynamics in memory and logic devices. Consequently, their behavior under applied magnetic field or spin-polarized electric currents as a driving force has been studied extensively over the past years. For most spintronic applications, thin films or nanostructures are required, while many materials show unwanted modification of their properties when their dimensionality is reduced to the nanoscale. For example, thin films of transition metal spinel oxides such as magnetite typically suffer from so-called anti-phase boundaries and exhibit disappointing properties with respect to the expectations. Thus, there is a strong motivation to understand and control the growth of functional ferromagnetic films and nanostructures and to study their magnetic properties and their manipulation. During the past few years we have shown that transition metal oxide films grown by high temperature oxygen-assisted MBE on metallic substrates present an extremely high structural quality and thus strongly improved magnetic properties [1,2,3].

In an effort to probe functional properties of such microstructures, we have developed a exchangeable sample holder system [cite manuscript in preparation] which permits in situ surface preparation and growth at high temperature (up to more than 1500 K) and in situ applications of small magnetic fields either in-plane or out-of-plane, all within the ultra-high vacuum system.
In this talk we present first experiments with the new sample holder system. In particular we study microstructures of ferrimagnetic F_3O_4 grown on a Ru(0001) substrate by high temperature oxygen-assisted MBE. The chemical and magnetic characterization is performed by x-ray absorption spectroscopy (XAS) and x-ray magnetic circular dichroism (XMCD) spectromicroscopy. Further the switching characteristics of individual magnetite microstructures under applied field are subsequently imaged by means of XMCD-PEEM at tens of nm resolution. The experimental magnetization distribution will be compared with micromagnetic simulations.

References

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[3] Mandziak A., et al., Tuning the Neel temperature in an antiferromagnet: the case of $Ni_xCo_{1-x}O$ microstructures, Sci. Rep. **9**, 13584 (2019)

Changes in the magnetic domains of hard and soft magnetic materials in bilayer setup

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Strontium ferrite (SFO, $SrFe_{12}O_{19}$) is a ferrite employed commercially for permanent magnets due to its high magnetocrystalline anisotropy, low cost, and low toxicity. However, its magnetization is moderate [1]. A possible avenue for improving such property is combining it with magnetically soft materials. It is well-known that the rigid coupling between a magnetically hard and soft material improved magnetization while avoiding a high cost in coercitivity loss. However, results have been disappointing so far as structural and geometrical limitations make it extremely challenging to fabricate. In fact, it can be found intermediate scenarios as if exchange coupling between both materials is very small, dipolar interactions might couple both layers. Thus, in order to understand the magnetic behavior in the bilayer systems we have carried out two experiments. One of them consisted on platelets of SFO with an out-of-plane magnetization direction with a Co layer deposited on top [2]. In that study, we observed no correlation between the magnetic domains of the metal and those of the SFO platelets. Therefore, in order to avoid the competition of the magnetodipolar field created by the SFO platelet with the shape anisotropy of the metal layer, we devised the second experiment using in-plane magnetized SFO films, again with a cobalt overlayer [3]. We have grown and characterized both bilayer systems using different spectroscopy, diffraction and microscopy techniques and in particular employing element-resolved magnetization maps using x-ray circular dichroism in a photoemission electron microscope.

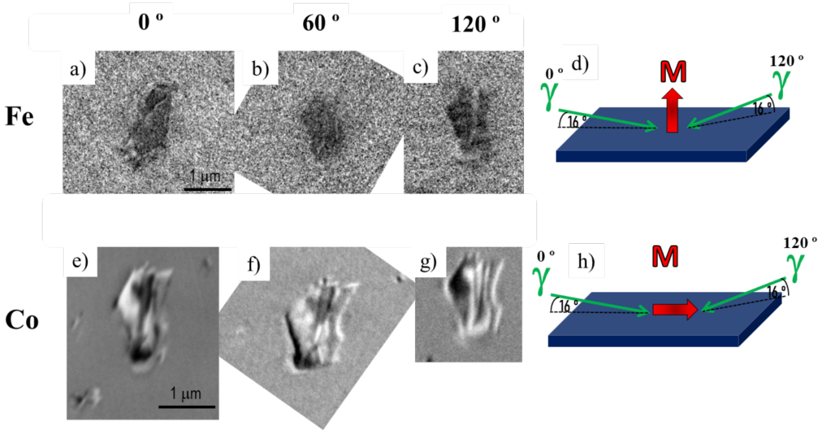

Figure 1. Upper line: XMCD-PEEM images for a) 0º, b) 60º and c) 120º azimuthal angles obtained at the Fe L_3-edge maximum (third dichroic peak). Lower line: XMCD-PEEM images for e) 0º, f) 60º and g) 120º azimuthal angles obtained at the Co L_3-edge maximum. On the right side, schemes of the magnetization of the platelet d) and Co layer h) with two azimuthal angles of incoming photons are sketched.

Acknowledgement

This work is supported by the Spanish Ministry of Science and Innovation and by the European Comission and by the Regional Government of Madrid. Technical support of the technical staff of CIRCE beamline of the ALBA Synchrotron Light Facility is gratefully acknowledged.

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