3D magnetometry in ultrathin magnetite using XMCD-PEEM

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One of the main trends in the magnetism roadmap is the study of the magnetic configuration and magnetization dynamics of magnetic nanoelements [1]. Nanomagnets have indeed many potential applications including data storage systems, magnetic logic devices or biomedical applications. Size reduction has considerable advantages in terms of increasing the device density, but also there are new magnetic phenomena linked to the nanoscale. In most of the new devices and applications, the magnetic configuration of the nanoobjects plays a key role in the properties and the performance of the device. Different microscopy techniques like magnetic force microscopy can be used to explore the magnetic configuration of these nanoobjects. However, these techniques normally do not provide us with information about the 3D configuration of the magnetic moments, which could be crucial in many cases. In this work we use XMCD-PEEM for 3D magnetometry in micrometer wide and tens of nanometers thick in-situ grown single crystal islands of magnetite.

The experiments have been performed at the CIRCE beamline of the Alba synchrotron. The station comprises a preparation chamber and the main chamber that houses the low-energy electron microscope (LEEM) with energy analysis capabilities. The instrument, an Elmitec III microscope, can be used in low-energy electron mode to provide real-space observations of the growth front during molecular beam epitaxy. It can also provide low-energy electron diffraction (LEED) patterns of selected areas of the sample as small as a fraction of a micrometer. In photoemission mode (PEEM) and coupled to the Alba synchrotron, it provides selected area x-ray absorption spectroscopy without the need to transfer the sample after growth.

In this work we show how XMCD-PEEM, combined with imaging and data analysis, is a very powerful tool for the study of magnetic configurations of nanometer sized objects [2]. This technique allows 3D mapping of the magnetic moment together with the estimate of the orbital and spin contribution to the local magnetic moment as can be seen in figure 1.

References

[1] D Sander et all.J. Phys. D: Appl. Phys. 50 363001.
[2] S. Ruiz-Gómez et al. Nanoscale. DOI:10.1039/c7nr07143d. *In press.*

Figures

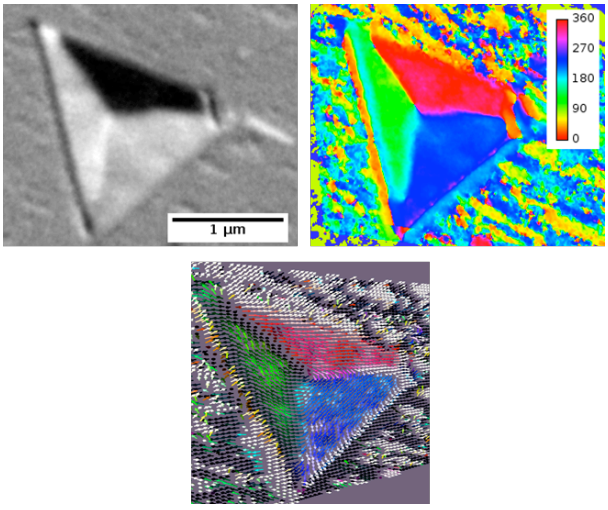

Figure 1: a) LEEM image of magnetite island. b) Magnetic domains measured by XMCD-PEEM. The color scale indicates the azimuthal angle of the magnetization vector. c) 3D magnetic image.