X-ray photoemission electron microscopy studies in ultrathin film magnetism

Tevfik Onur Menteş[1]
[1]*Elettra – Sincrotrone Trieste, Basovizza, Trieste 34149, Italy*

Magnetic properties of ultrathin films show significant variations in comparison to their bulk counterparts [1]. Such variations may derive from the electronic and elastic effects at the surface and interface, broken crystalline order, the presence of confined electronic states, etc. With the technological aspect in mind, part of the effort in ferromagnetic ultrathin film research is directed towards the manipulation of magnetic anisotropy (MA). Along these lines, we show the effect of surface and interface on the MA of Co films on Re(0001). In particular, perpendicular MA can be induced in a controlled manner by beam-stimulated deposition of carbon species on the surface as seen in Figure 1 [2]. Moreover, the carbon layer can be patterned using focused electron or x-ray beams, and can be transformed into graphene by annealing to moderate temperatures. The chiral domain walls observed in such stacks point to the possibility to form skyrmions, which have already been seen in similar systems [3].

The experimental methods used in this work can be described as surface microscopy with low-energy electrons [4]. Through the study on Co/Re(0001), we demonstrate that x-ray photoemission electron microscopy (XPEEM) using a synchrotron source with variable photon energy and polarization as well as high flux density gives chemical, magnetic and electronic sensitivity, which complements the structural information obtained by low-energy electron microscopy (LEEM), and provides a complete picture of the surface under study at high lateral resolution [5, 6].

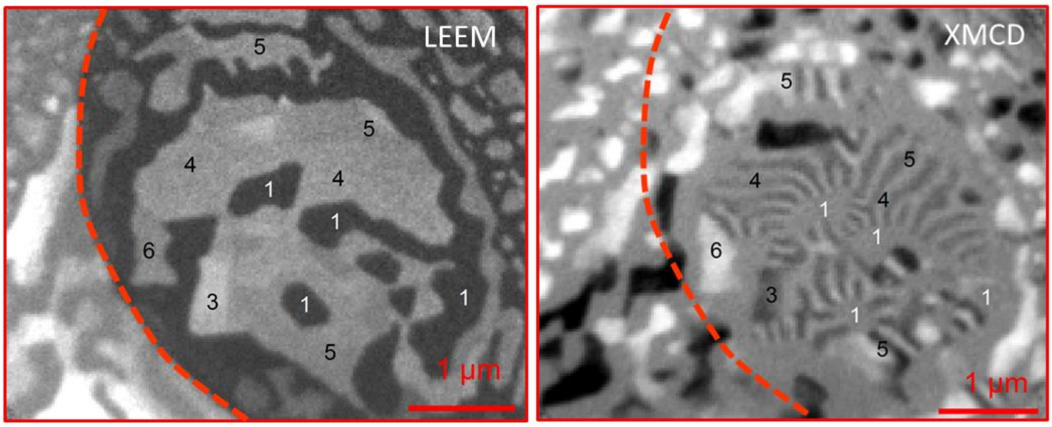

Figure 1. LEEM and XMCD-PEEM images of ultrathin Co/Re(0001) partially covered with carbon. The circular region covered by carbidic and graphitic species is traced by the red dashed line. The Co thickness in atomic layers is marked on the images. The XMCD image is acquired at the Co L-edge, and it shows the magnetic stripe domains typical of out-of-plane magnetization within the carbon-covered region.

References

1. C. A. F. Vaz *et al.*, Rep. Prog. Phys. **71**, 056501 (2008).
2. Genoni, P. et al., ACS App. Mat. Interfaces doi:10.1021/acsami.8b07485 (2018).
3. Boulle, O. et al., Nature Nanotech. **11**, 449 (2016).
4. Bauer, E., “Surface Microscopy with Low Energy Electrons”, *Springer-Verlag New York* (2014).
5. Locatelli A., Bauer, E., *J. Phys. Condens. Matter* **20**, 093002 (2008).
6. Menteş, T. O. et al., Beilstein J. Nanotechnol. 5, 1873 (2014).