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Magnetic Anisotropy of Ferrite Nanostructures: towards RIXS-MCD measurements

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Ferrites are of particular interest due to their wide variety of applications in electronics, spintronics and magnetic storage technology. Probing in operando magnetic behavior of nanodevices require quick and responsive experimental methods. RIXS-MCD technique was successfully used for measurements of micro magnetic properties of iron oxides [1-3] and we propose the same approach for complex nanostructures.

At first we studied heterostuctures of 15-40 nm thick magnetite films with different metallic layers deposited on MgO substrate in order to investigate magnetic anisotropy of oxide layer. We present comparison of angular dependence of hysteresis loops probed with bulk sensitive VSM, element specific RIXS-MCD magnetometry (Fig.1), and layer sensitive theoretical modelling using OOMMF software.

In the next stage we aim to probe if magnetic anisotropy can be controlled by shape of nanostructures. We have prepared ladder type nanostructures (1 µm, 500nm and 100nm thick and 100 µm long stripes) from selected magnetite heterostructures using electron beam lithography and argon ion-beam etching. Micromagnetic simulations reveal that in plane magnetic properties are anisotropic and depends strongly on shape of nanostructures (Fig.2).

Probing magnetic properties of such small structures is challenging using conventional methods (e.g. VSM, SQUID) due to negligible amount of magnetic material. Other methods such us MOKE, SXMCD, and MFM provide information only about surface properties. Therefore, they are insensitive to buried and thick layers, that could be probed with 1s2p RIXS-MCD.

Based on results of preliminary 1s2p RIXS measurements of nanostructures we discuss the feasibility of application of RIXS-MCD method as a selective probe of magnetization lurking inside oxide spintronic nanodevices.

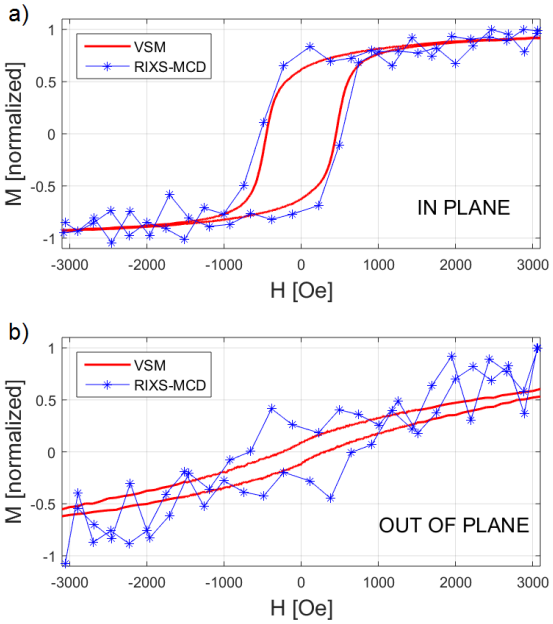

Figure 1. Comparison between hysteresis loops measured using VSM and RIXS-MCD technique for magnetic field applied a) in plane and b) perpendicular to 15nm thick Fe_3O_4 film covered with 2nm of Co and 10 nm of Pt.

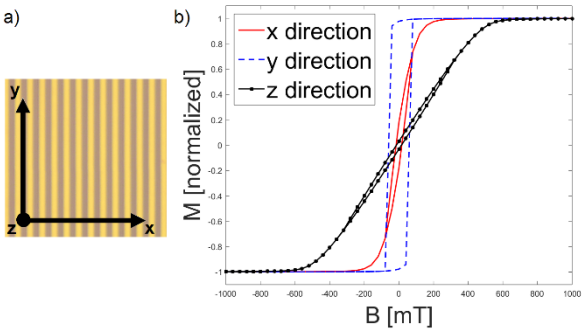

Figure 2. a) Optical microscope image of magnetite ladder type nanostructure with 1 µm tick stripes b) simulations of hysteresis loop for ladder type nanostructure.

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