Controlling the magnetization direction with hydrogen

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The ability to control easy-axis of magnetization is an important topic. The magnetic anisotropy is due principally to competition of two interactions: the magnetic dipole contribution which favores an in-plane magnetization in thin films and the magneto-crystaline anisotropy. The latter, despite being usually smaller, is an responsible for the modifications in the magnetic anisotropy. In some cases it can even turn the magnetization out of the plane of the films .

The experiments have been performed in a spin-polarized low-energy electron microscope (SPLEEM) with in-situ grown cobalt films. This technique allows to image the magnetization of surfaces and thin films with sub-micron resolution. The SPLEEM consists of a spin-polarized electron source as illumination source of a low-energy electron microscope. For a given electron spin direction, real-space images of the reflected electrons at low electron energies are acquired. Subtracting images taken with opposite spin-polarization, removes topo-graphic features from the images providing pure magnetic contrast images of the magnetization component in the electron spin direction selected.

The growth of the cobalt thin layers on Ru(0001) is layer-by-layer up to 10 ML[1]. Films thicker than the first monolayer are relaxed to the Co bulk lattice spacing. The first Co layer show an in-plane easy-axis of magnetization. On other hand, the second Co layer presents an out-of-plane magnetization. More than 3 ML of Co on Ru(0001) shows again an in-plane magnetization. This consecutive spin reorientation transition has been atributed to a combination of strain and surface effects. Capping the Co layer with non magnetic metals like Pd, produces aditional spin reorientation transitions[2].

In this work we report the change observed in the magnetic anisotropy of the cobalt bilayer upon hydrogen adsorption. When molecular hydrogen is introduced in the chamber, a gradual change in the domains pattern can be observed. Domains start to breakup into smaller ones. As more hydrogen is dosed, the out of plane magnetization starts to dissappear. When the hydrogen dose is around 0.4 L the out-of-plane magnetic signal vanished. Heating the films to 400 K, presumably desorbing the hydrogen from the surface, restores the magnetization out-of-the plane. To determine the cause of the spin reorientation, low energy electron diffraction intensity vs energy (LEED- IV) and low energy electron reflectivity data were taken. No structural changes were detected within the accuracy of these techniques. The results obtained so far suggest that hydrogen adsorption changes the magnetic anisotropy purely though an electronic effect, without significant changes in the strain of the films.

References:

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