ESRF	**Experiment title: Influence of oblique incidence growth on magnetic anisotropy of amorphous Co-Si films**	**Experiment number**: HS-3500
Beamline: BM05	**Date of experiment**: from: 23/07/2008 to: 28/07/2008	**Date of report**:
Shifts: 15	**Local contact(s)**: Luca Peverini	*Received at ESRF:*

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Report:

The aim of this experiment is to study the relation between oblique incidence growth and magnetic anisotropy in thin films by using diffuse scattering measurements. The experimental approach has consisted in preparing *in-situ* magnetic Co films at different oblique growth angles, measuring reflectivity curves and acquiring diffuse scattering images in grazing incidence geometry. Magnetic characterization of the films has been done by Kerr effect in order to correlate the structural properties with the magnetic anisotropy. The initial idea was to study the Co-Si system which, for certain compositions, is an amorphous material with well defined in-plane uniaxial anisotropy. However, due to problems in the Si sputtering magnetron of the deposition chamber, only the Co magnetron could be used during the experiment, so we focused the study on pure Co polycrystalline films.

After some preliminary growths and tests, carried out to determine deposition rates and to setup the CCD detection, four Co films, about 30 nm thick, were deposited at different oblique angles with respect to the Si(100) substrate normal: 15º, 45º, 60º and 75º. For each growth, two sets of measurements (reflectivity curves + diffuse scattering images) were acquired, one keeping the deposition plane (defined by the normals of the Co magnetron and the Si substrate) perpendicular to the scattering plane (theta = 0º) and the other mantaining the deposition and scattering planes parallely oriented (theta = 90º). The corresponding diffuse scattering images were obtained using 15 keV photons at three incident angles, 0.16º, 0.28º and 0.40º, in order to check the effect of increasing the probing depth on the measurements.

A summary of some of the data collected can be seen in figure 1. Panels (a) to (d) of figure 1 show the reflectivities of the four Co films measured for both orientations. Two main features can be remarked from this data. First, the amplitude of the fringes in the reflectivity curves for each growth is significantly higher for the perpendicular scattering orientation than for the parallel one. Secondly, the oscillations are damped when the oblique angle is increased with respect to normal. Possible explanations related to oblique structures, roughness effects or wedge shaped films will be tested in modelling the curves.

Concerning the diffuse scattering images shown in figure 1(e-h), it should be noted that their horizontal axis is related to the in-plane parallel component of the momentum transfer vector, whereas the vertical axis is related to the out-of-plane component (increasing downwards in the images). Several aspects should be remarked. First, an strong enhancement of the intensity distributed at one side of the specular plane is observed at the Yoneda region, in an intermediate position between the direct beam (stronger spot in the upper part of the images) and the reflected one (white spot in the lower half of the images). This intensity could be related to the inter-island distance of the growing films. In addition, the intensity enhancement is asymmetric, since it is only observed at one side of the specular plane. The asymmetry is clearly seen in figure 1(h) where the specular plane has been centered with respect to the detector. Furthermore, the intensity enhancements and asymmetries are only observed at one azimuthal orientation (the other one, th = 90º, is not shown in figure 1), suggesting that oblique structures in the film could be playing a significant role on the intensity distribution. In order to quantify the sensitivity of the technique to the presence of such oblique structures, the experimental images will be compared with calculated ones were oblique grains will be used to model the films. Finally, all the results will be compared with magnetic Kerr effect measurements in order to obtain correlations between structural features and magnetic anisotropy. The corresponding analysis are currently under way.

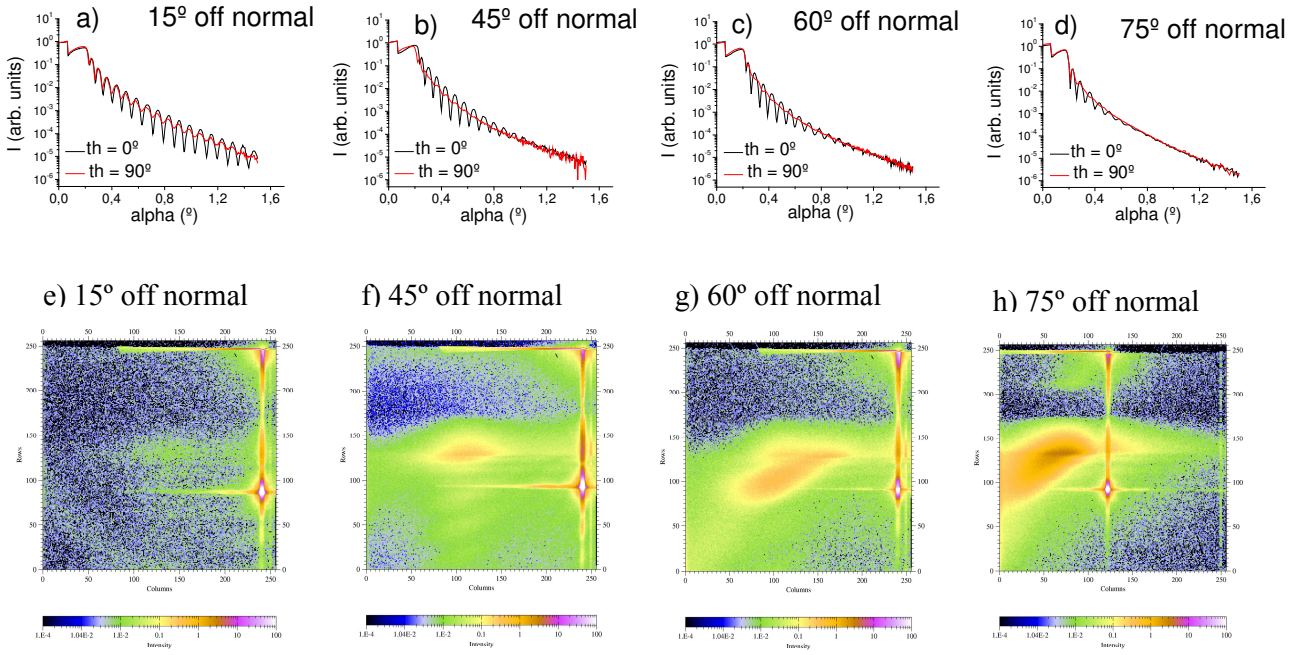

Figure 1. (a-d) Reflectivities from four Co films *in-situ* prepared at different Co incidence oblique angles. They have been measured for two azimuthal orientations: theta = 0º (scattering plane perpendicular to evaporation plane) and theta = 90º (scattering plane parallel to evaporation plane). (e-h) Diffuse scattering images of the same films obtained at an incidence angle of 0.40º with 15 keV photons for th = 0º. Direct beam is in the top of the figure, whereas the reflected beam is the white spot in the lower have of the image (out-of-plane momentum transfer increases downwards in the image). Panel (h), where the specular plane has been centered, shows the strong asymmetries in the scattering.