ESRF	**Experiment title: Correlation between structure and magnetism in CoSi / Si multilayers**	**Experiment number**: MA-114
Beamline: BM25-B	**Date of experiment**: from: 8/03/06 to: 12/03/06	**Date of report**: 16/02/07
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Report:

Three different sets of samples, all of them related to the Co-Si system, have been prepared on top of amorphous fused silica substrates and have been measured with the BM25B six-circle verticle diffractometer using 19.7 KeV photons: (a) Si / Co / Si sandwiches with varying Co thickness, (b) Si / Co_xSi_{1-x} / Si sandwiches with different x atomic Co concentrations, and (c) (Si / Co_xSi_{1-x} $)_{x10}$ / Si multilayers. Most of the measurements have focused on sets (a) and (b). The main results obtained are sumarized in the following. The reciprocal basis vectors used are: $a_1^* = a_2^* = 2.895$ Å^{-1} (parallel to H and K axis, respectively) and $a_3^* = 1.023$ Å^{-1} (parallel to L axis) with angles $\alpha_1^* = \alpha_2^* = 90º$, $\alpha_3^* = 60º$, which correspond to the (111) orientation of the Co fcc lattice, following the usual surface diffraction convention of keeping the L axis perpendicular to the sample surface.

a) Si / Co / Si sandwiches.

Co thickness has been varied between 50 and 2 nm and the corresponding (0 0 3) specular peak position has been shown to vary as the film thickness is decreased from around 3.01 reciprocal lattice units (r.l.u.) for the thickest films to about 3.03 for the thinner ones. The reason of this change, appart from broadening peak effetcts, is most likely related with diffusion processes at Co/Si interfaces leading to a modification of the effective composition of the magnetic layer which is more pronounced in the thinner films. Also, the non-specular (1 0 1) peak has been measured and the corresponding (1 0 L) rod has been followed, indicating that the stacking is mainly of fcc type, although the high background suggests that hcp and disordered stacking may also be present in these polycrystalline films. Azimuthal scans around the (1 0 1) peak confirm that there is no preferential in-plane orientation in these Co films. The corresponding

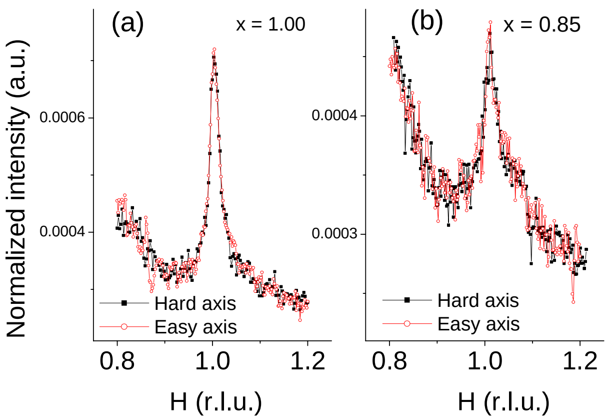
magnetic hysteresis loops, measured by Kerr, not shown, indicate that the coercive field (Hc) and Kerr signal are also decreasing with decreasing thickness.

b) Si / Co_xSi_{1-x} / Si sandwiches with different x atomic Co concentrations.

The magnetic film thickness has been fixed at 50 nm and the results show that both out-of-plane and in–plane peaks shift to higher values as Si is incorporated to the network This trend is indicating that the unit cell is contracting when Si is introduced in the lattice. If Si concentration is further increased, the polycrystalline / amorphous threshold is approached and peaks become weaker and broader. The Si induced contraction has been estimated to be around 0.9 % in-plane and 0.2 % out-of-plane. Interestingly, the out-of-plane (003) FWHM decreases before the amorphization is completed, suggesting an elongation of the grains in the normal direction as the amorphization process proceeds. Table 1 summarizes these results.

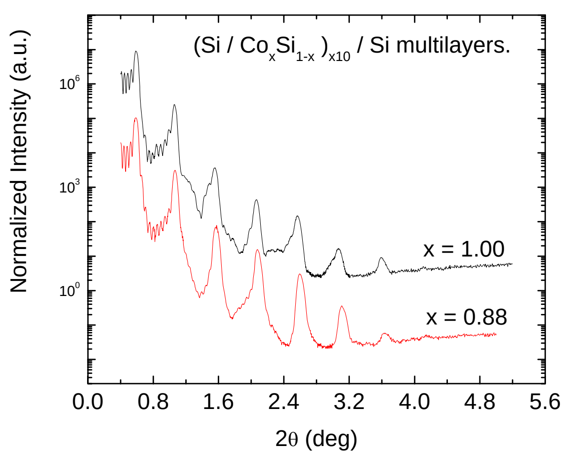
Composition x	(003) peak position (r.l.u.)	(101) H peak position (r.l.u.)	(003) FWHM (r.l.u.)	(101) FWHM (r.l.u.)
1.00	3.008	1.004	0.047	0.026
0.92	3.012	1.008	0.051	0.036
0.85	3.015	1.013	0.027	0.036

Table 1. Peak position and FWHM of (003) and (101) peaks of Si / Co_xSi_{1-x} / Si sandwiches.



Also, couples of in-plane (H 0 1) scans, taken with the H axis either parallel or perpendicular to the magnetic easy axis, have been measured. As it can be seen in Figure 1, they do not show significant differences, indicating that the origin of the magnetic anisotropy observed in these films (not shown) is not related to asymmetries in the grain size.

Figure 1. In-plane measurements for two different compositions acquired with the H axis either parallel or perpendicular to magnetic easy axis of Si / Co_xSi_{1-x} / Si sandwiches.



c) (Si / Co_xSi_{1-x})$_{x10}$ / Si multilayers.

Finally, reflectivities corresponding to different compositions of the magnetic layer, including pure Co, polycrystalline Co_xSi_{1-x}, and amorphous Co_xSi_{1-x}, have also been measured. All of them show total thickness Kiesseg fringes at low angles and up to seven orders of the multilayer periodicity, confirming that the stacking is well defined and the quality of the interfaces is good enough to build up constructive interference (see Figure 2 for the case of two polycrystalline multilayers).

Figure 2. Reflectivities of (Si / Co_xSi_{1-x})$_{x10}$ / Si multilayers.

These results, combined with other magnetic and structural complementary characterizations carried out on the samples, are included in an article which is currently in preparation