ESRF	**Experiment title:** XMRS study of patterned $(Co/Pt)_n$ layers.	**Experiment number**: HE 864
Beamline: ID12 B	**Date of experiment**: from: 08-11-2000 to:14-11-2000	**Date of report**: 21-02-2001
Shifts: 18	**Local contact(s)**: Dr. Sarnjeet DHESI (e-mail: dhesi@esrf.fr)	*Received at ESRF:*

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Report:

This experiment was a continuation of first XRMS studies performed on Co/Pt lines (HE 762). Let's recall the context. Arrays of submicronic magnetic objects with perpendicular magnetisation are interesting systems for applications in ultrahigh density storage. This work is centred on arrays of magnetic lines, produced using a novel technique [1]. The conventional method to prepare such systems is to etch the sample after the deposition of the magnetic film. In our case, the magnetic material, a $[Co/Pt]_{13}$ multilayer, is deposited on a pre-etched patterned substrate. The aim of this study was to understand the magnetic correlation between the lines, using the technique of soft X-ray Resonant Magnetic Scattering (XRMS).

In this experiment, we studied the evolution of the magnetic coupling between the lines for different substrate geometries, and its evolution with an external field. The geometrical parameters considered were the spacing between the lines d (200 or 75 nm), and the depth of the grooves h (35 or 300 nm), the lines width being 200 nm. In all cases the structural diffraction spectrum from the pattern exhibits a series of superlattice peaks characteristic of the grating periodicity. At the Co L_3 edge, purely magnetic satellites appear in between the structural peaks, revealing a tendency to antiferromagnetic (AF) order between the lines, which gives a magnetic period twice the structural one (fig.1). It appeared that small spacing (d=75nm) and deep grooves (h=300nm) promote the tendency to this AF order.

The second aspect is the evolution of the magnetic signal with the magnetic history and the application of an external field. This study was performed on the geometry (d=75nm, h=300nm) which optimise AF order. First, we have demagnetised the sample with a perpendicular field by saturating the sample and decreasing very slowly the field to the coercive value in order to favour nucleation processes and AF order between the lines. The XRMS result is reported on fig.2, showing that in the final demagnetised state, each line on the MFM image is single domain and that the magnetic satellites are very strongly enhanced. Finally, we have applied an in situ magnetic field in the diffraction chamber, and followed step by step the evolution of the first magnetic peak intensity through the whole hysteresis loop. The resulting measurement shows the apparition of the magnetic satellite, characteristic of the AF order, around the coercive value, and his disappearance at the saturated state. The analysis of this result with a statistical model of the magnetisation in the lines should provide information about the reversal and nucleation processes in these systems.
This experiment gave new results concerning magnetic coupling in Co/Pt lines, and the tendency to AF order, depending on the geometry and the magnetic state[2]. The XRMS technique gives an interesting way to investigate magnetic profile at the submicronic scale, complementary to MFM, which is sensitive to the surface stray fields only. It provides in addition the possibility to follow the evolution of the magnetic state under an in situ magnetic field.

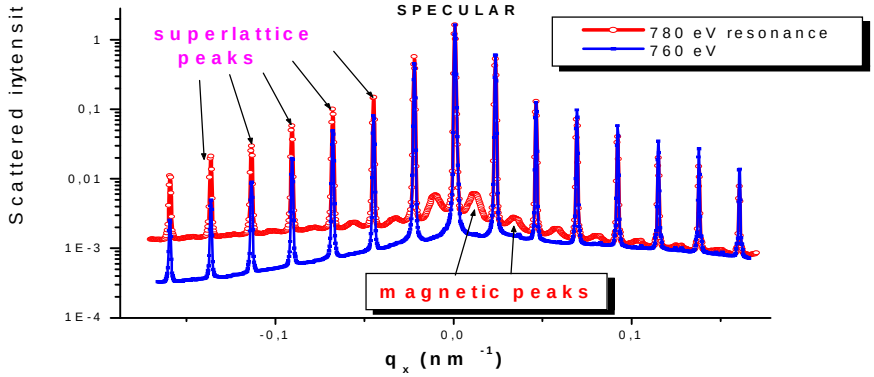

Fig.1 Diffraction spectrum at the Co L_3 edge (780 eV) and out.

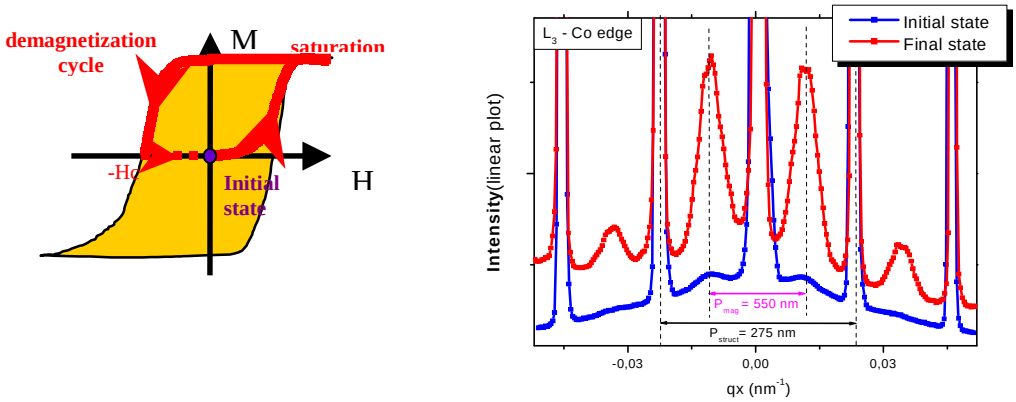

Fig.2 Evolution of the magnetic satellites with the demagnetisation process

References:

[1] S. Landis, B. Rodmacq, B. Dieny. *PRB*, vol. 62, pp.12271-12281 , Nov.2000

[2] K. Chesnel, M. Belkhovsky, S. Landis, B. Rodmacq, E. Dudzik, S. P. Collins, S.S. Dhesi and G. an der Laan, IEEE Trans. Magn., *in press*