| ESRF | **Experiment title:**<br><br>**Correlation study of magnetic lines or dots using XMRS** | **Experiment number**:<br>HE-762 |
|---|---|---|
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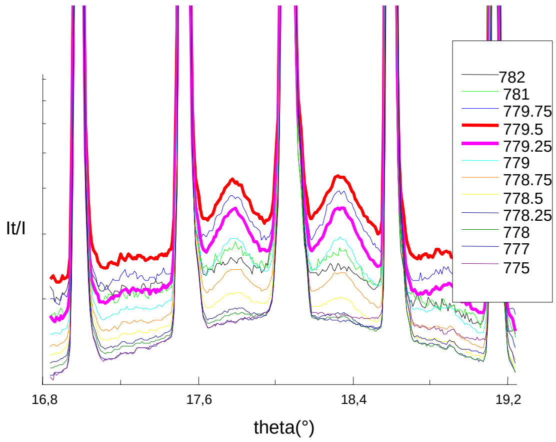
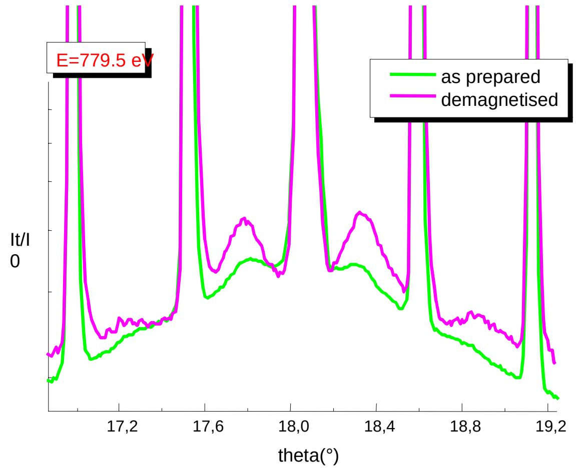
**Report:**

To achieve future ultra-high-density storage, a possible roadmap is to pattern silicon substrates into submicrometric dots and to cover these with a magnetic layer using sputtering [1]. We report here on the first study of such systems using x-ray magnetic resonant scattering (XMRS). The specimen consist of $[Co/Pt]_{13}$ multilayers deposited on arrays of lines 200 nm in width. The central aim of the experiment was to study the magnetic coupling between the lines as a function of their spacing. The XMRS measurements were carried out using circularly polarized light at photon energies around the Co $L_3$ edge (779 eV). Off-resonance, the lateral scattering on the periodic relief gives diffraction spectra that contain information about the asymmetric profile of the sputtered layer. At resonance, magnetic satellites are observed under certain conditions located between the structural peaks, evidencing an antiferromagnetic coupling between the lines with a magnetic periodicity of twice the structural one. The main result is that this coupling occurs only for small (75 nm) and not for large (200 nm) interline spacing (Fig. 1). Moreover, the intensity of the magnetic satellites depends on the specific magnetic state of the sample. From the "as-prepared" to the demagnetized state, the demagnetization process leads to nucleation of a single domain along each line, enhancing the magnetic scattering intensity (Fig. 2). Additionally, rod scans were measured along the magnetic satellites as well as reflectivity scans, showing that the magnetic depth profile in the multilayer differs appreciably from the structural one. We also emphasize the complementarity between XMRS, which is more sensitive to the bulk distribution of the magnetic domains, and MFM which images the magnetic fields at the surface. Summarizing, the results provide a novel method to understand the way that the magnetic dipolar coupling depends on the substrate geometry and the deposited multilayer, and how it evolves with the magnetic history of the multilayer.

This experiments were performed using the SRS Daresbury vacuum diffractometer installed for this purpose on beamline ID12B.




$(Co/Pt)_{N=13}$ sample: 200 nm lines with 75 nm spacing; groove height = 300 nm

Fig. 1 Variation of the antiferromagnetic peak intensities, located between the intense structural peaks, versus photon energy (indicated values in eV) around the Co $L_3$ edge resonance.

Fig. 2 Variation of the antiferromagnetic peaks for the "as prepared" state and a specific demagnetized state.


[1] *Domain structure of magnetic layers deposited on patterned silicon*

S. Landis, B. Rodmacq, B. Dieny, B. Dal'Zotto, S. Tedesco, M. Heitzmann,

Appl. Phys. Lett. **75**, 2473 (1999).