ESRF	**Experiment title:** **Resonant x-ray magnetic scattering from anisotropy-constrained magnetic domains**	**Experiment number**: HE-1330
Beamline: ID8	**Date of experiment**: from: 04/12/02 to: 09/12/02	**Date of report**: 15/06/03
Shifts: 18	**Local contact(s)**: S.S. Dhesi	*Received at ESRF:*

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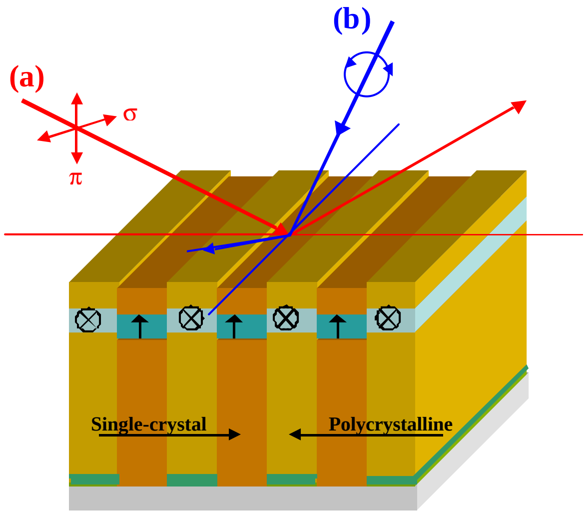
Report:

In the pursuit of ever-increasing ultra-high-density storage capabilities, the size dependence of the spin configurations and reversal processes of magnetic nanostructure produced by lithography patterning of thin magnetic films are of significant scientific and technological interest. While isolated 'island' magnetic structures, such as dots, wires, and other special geometries, have already been studied [1,2], the experimental realisation of patterned magnetic structures in a chemically homogeneous film remains an important goal [3]. In this experiment we used the depth sensitive and element-specific technique of Soft X-ray Resonant Magnetic Scattering (SXRMS), which shows large potential to studies such complicated magnetic systems. [4]

The experiment was performed on beam line ID08 using the new 6-circle UHV diffractometer equipped with in-plane magnetization coils. Measurements were made on a sample of Cu/Ni/Cu/NiO/GaAs with a 2 μm wide wire array with 4 μm separation between the wires. Such a system forms anisotropy-constrained magnetic domains of alternating in-plane and perpendicular easy-directions of magnetisation (see Fig. 1 and Ref. 3).

In order to obtain the magnetic structure of the perpendicular magnetic domains of the sample (see Fig.1) we performed transverse scans at resonant and off-resonant photon energies with the scattering plane perpendicular to the wires (geometry a). Since the measurements were carried out in remanence, no magnetic scattering was observed for that scattering geometry, but information of the sample structure was collected, confirming the existence of an "electron-density grating" and revealing the sample surface topography arising from the NiO seed-layer pattern as well as the density difference between the polycrystalline and single-crystal regions of the sample (Fig. 2).
The use of ingoing circularly polarised x-rays in the scattering plane parallel to the wire domains (geometry b) gives information about the in-plane magnetic moments. Taking advantage of the element sensitivity of SXRMS the photon energy was tuned to the Ni $L_{2,3}$ resonance (Fig.3). Additionally, using longitudinal scans the depth profile was studied (Fig. 4) and hysteresis loops were recorded for different scattering angles. The strong Kiesig fringes (caused by the interference of top and bottom interface) show that the x-rays penetrate much deeper than the Ni layer itself, clearly demonstrating the depth sensitivity of this technique (Fig. 4).

Summarising, all data collected allows to extract valuable information about the chemical and magnetic structure of the sample, making SXRMS a valuable technique to study magnetically modulated systems.



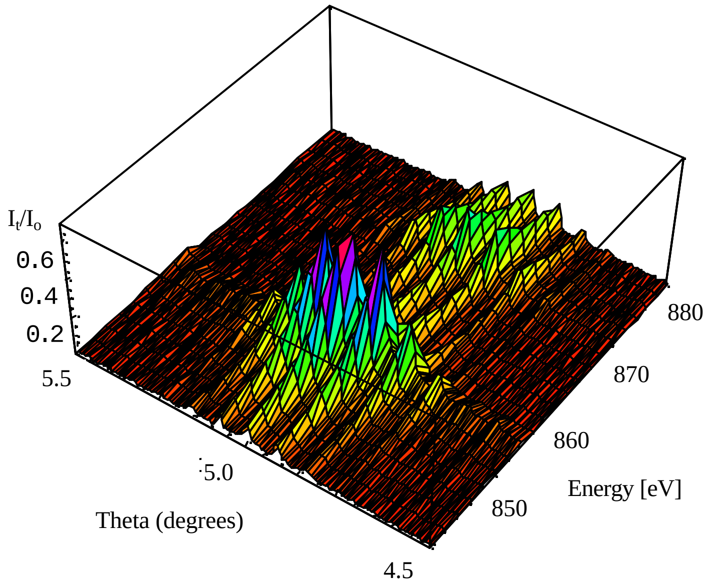
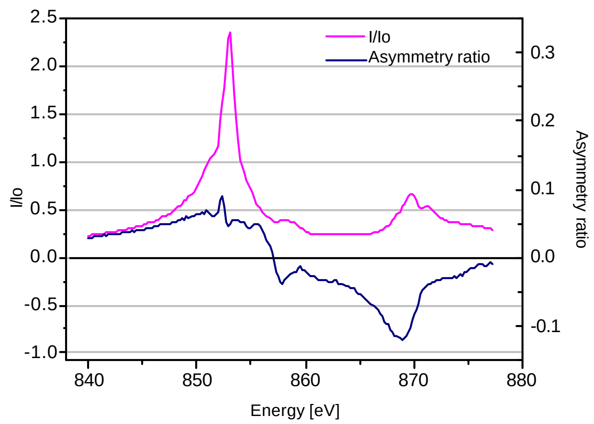


Fig. 1: Schematic picture of the measured sample Cu(5nm)/Ni(5nm)/Cu(70nm)/NiO(1nm)/GaAs(110) illustrating the experimental scattering geometries for (a) linearly polarised x-rays perpendicular to the wires; (b) (left and right) circularly polarised x-rays parallel to the wires.

Fig. 2: Photon energy and theta dependence of the scattered intensity using transverse scans in geometry (a) of Fig.1.



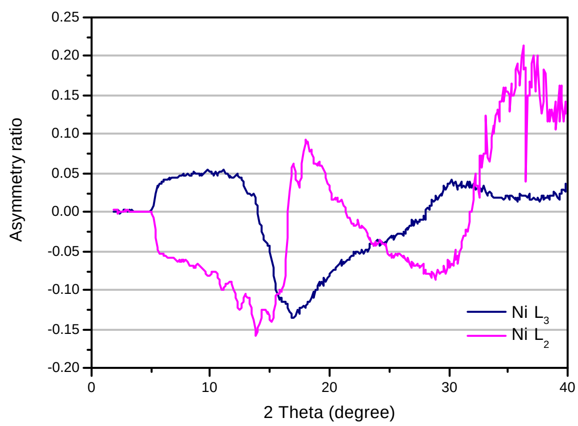


Fig. 3: Photon energy dependence of the specular reflectivity at Q = 5° (¾) and its asymmetry ratio (¾). The L_3 / L_2 ratio of the latter provides information about the spin to orbital magnetic moment ratio of the sampled domains.

Fig. 4: 2Theta dependence of the asymmetry ratio of the specular reflectivity at the photon energies of the Ni L_3 (¾) and Ni L_2 (¾) resonances. Note the strong difference in intensity of the Kiesig fringes for the L_3 and L_2 resonances due to the different absorption lengths at these two photon energies.

References

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