ESRF	**Experiment title:** Layer Resolved Spin and Orbital magnetic moments in 3*d*/5*d* multilayers	**Experiment number**: HE-1354
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Report

In order to gain insight in the complex behavior of the induced W 5*d* magnetic polarization we performed a complete study on a Fe(30Å)/W(10Å) multilayer. During the allocated beamtime on ID12 we carried out a complete study combining XMCD using the 7 T superconducting magnet and anomalous reflectivity and XRMS using the newly installed UHV reflectometer [1]. Circularly polarized x-rays were diffracted in the vertical plane and a 0.5 T magnetic field, strong enough to saturate the Fe magnetic moments, was applied parallel to both the diffraction plane and sample surface. The beamline quality combined with a high efficiency detection device allowed us to extract the very small asymmetry (~ $2x10^{-4}$) with a good signal-to-noise ratio.

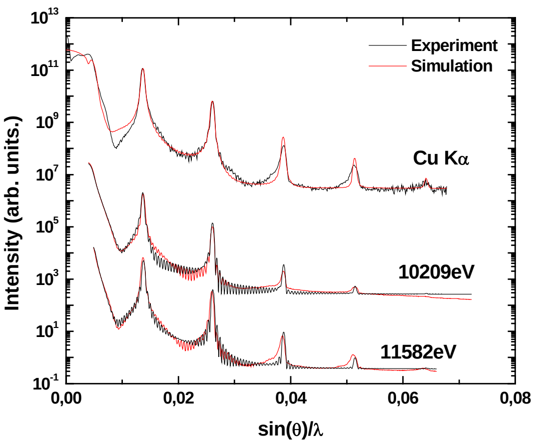

Fig. 1: Resonant x-ray reflectivity (black curve) performed with Cu Kα source and close to the W $L_{2,3}$ edges. Simulation (red curve).

Being aware of the importance of a real structure characterization of the sample and despite the fact that the quality stacking of the superlattice was already properly verified using a laboratory source previous to the experiment, we recorded anomalous reflectivity at the energies of the W $L_{2,3}$ edges. A 40 μm verical slit in front of the sample allowed us to record high-resolution x-ray reflectivity spectra. The experimental curves has been refined using a modified version of the SUPREX package [2]. The good agreement between calculation and experiment gives confidence concerning the resulting thicknesses which were found to be 29.7 Å and 11.4 Å for the Fe and W layer, respectively.

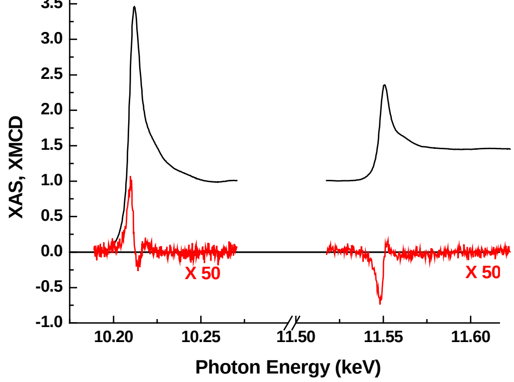

Fig. 2: XAS and XMCD spectra at the W $L_{2,3}$ recorded at 300 K and H = 4T.

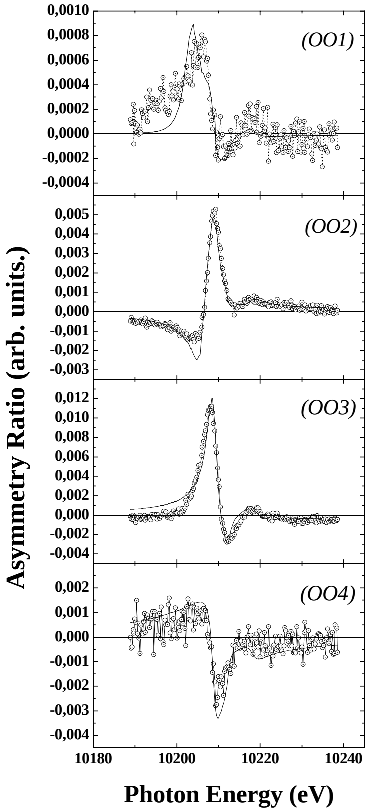

Fig. 3: Energy dependence of the asymmetry ratio R measured at the four first low order Bragg peaks at the W L_3 edge. Experimental results (open circles) and calculation (drawn lines) leading to the magnetic profile.

Figure 2 shows the W $L_{2,3}$ XAS and XMCD spectra of the Fe/W multilayer at T = 300 K and H = 7 T. In order to avoid any experimental artifacts, the XMCD spectra were recorded both by reversing the helicity of the incoming light and by reversing the direction of the external applied magnetic field. The data is corrected for the incomplete degree of polarization and the L_3/L_2 intensity ratio has been set to 2.19. Despite its very small amplitude (multiplied by 50 for clarity in Fig. 2) a clear XMCD signal was detected confirming the existence of a non-zero induced magnetization in the W 5*d* states. The shape and magnitude of the XMCD spectra are similar to those measured previously on a similar sample [3]. Using the magneto-optical sum rules [4] our analysis gives a value of μ_{tot} = -0.038 μ_B/atom for the total magnetic moment of W, whereas the ratio of orbital-to-spin magnetic moment is μ_L/μ_S = 0.085.

Finally, we measured the energy dependence of the asymmetry ratios $R = (I^+ - I^-)/(I^+ + I^-)$, where I^+ and I^- are the diffraction intensities for the two opposite directions of the magnetic field, collected across both the L_2 and L_3 edges for several low angle Bragg peaks. Figure 3 displays these asymmetry ratios. In addition to the XMCD information, the scattering approach allows us to obtain layer resolved information about the magnetization. Using the approach described elsewhere in detail [5,6] the simultaneous refinement of the asymmetry ratio, measured at the L_3 (drawn lines in Fig. 3) allows us to determine the W 5*d* induced magnetization profile across the W layer.

This analysis show that the total magnetic moments are opposite for the first two W atomic planes from the Fe interface. Taking into account the error bars resulting from this analysis, this tendancy is in agreements with results from recent relativistic band-strucutre calculations [7].
A detailed paper will be published [8]. Furthemore, the analysis of the experimental XRMS spectra recorded across the W L_2 edge (not shown here) is expected to allow us to extract the layer-resolved spin and orbital magnetic moments across the W layer.

References

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