ESRF	**Experiment title:** **Antiferromagnetic order in double layer Fe nanostripe on W(110) by DXRMS**	**Experiment number**: HE-772
Beamline: ID12B	**Date of experiment**: from: 21/06/00 to: 27/06/00	**Date of report**: 22/08/00
Shifts: 18	**Local contact(s)**: S. Dhesi	*Received at ESRF:*

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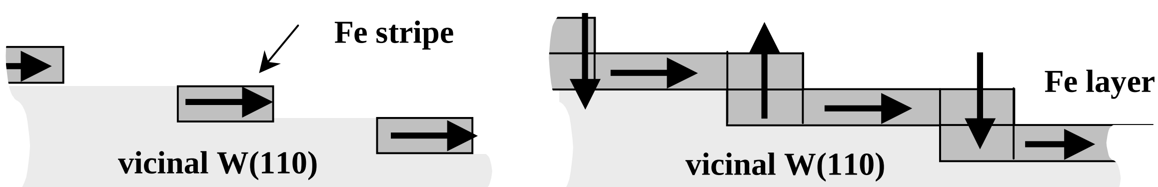
Report:

The aim of this proposal was to find experimental evidence of the model proposed by J. Hauschild *et al.*[1] which explains the magnetic behavior of Fe/W(110)-vicinal in the 1.2 - 1.8 ML thickness range. It was assumed that, in this thickness range, the Fe bi-layers with a perpendicular anisotropy are antiferomagnetically coupled each other while the single-layer stripes still have an in-plane anisotropy (see figure 1). The idea was to use diffuse x-ray resonant magnetic scattering (DXRMS) to look for this antiferromagnetic coupling as this extra, purely magnetic, symmetry should correspond to an extra Bragg condition leading to an otherwise forbidden reflection.



0.5-1 ML **1.2-1.8 ML**

Figure 1. Scheme of the magnetic behavior of Fe/W(110)

Unfortunately the experiment proved to be difficult. We did not manage to obtain a diffraction pattern even from the steps themselves. The experiment was complicated by the fact that the sample preparation (cleaning and evaporation of a new Fe film) was done in a separate preparation chamber leading to a slightly different geometry after each transfer preventing an easy comparison between the clean W and the W with a Fe deposited film. Suspecting a misalignment problem different geometries were tried without any improvement. Actually without any in-situ probe (like a STM) it was difficult to make sure that we indeed managed to form Fe wires. We tried different ways to prepare the Fe films with no improvement. The residual magnetic field from the magnet also could have played a role, as it is known that this antiferromagnetic coupling disappears with very a low applied field.

In the meantime Pietzsch *et al.*[2] published a Spin-Polarized Scanning Tunneling Microscopy study of the same system. They demonstrated, by direct observation, that the dipolar antiferromagnetic coupling actually exists. We still believe that the diffraction experiment is feasible but the detection needs to be improved, perhaps with a 2D detector.

As a backup experiment we studied the **magnetism of clusters of non-magnetic materials deposited on Au(111)**. We managed to obtain interesting preliminary results for the Rh/Au(111) system.

Indeed freestanding Rh clusters are predicted to be magnetic and this was indeed confirmed in a Stern Gerlach experiment on Rh clusters.[3] For Rh epitaxial layers on Au(100), calculations show that Rh should be magnetic.[4] Moreover recent STM studies show that it is possible to fabricate Rh cluster at RT by self-organization on the herringbone reconstruction of the Au(111).[5]

The XMCD measurements were performed at the limit of the energy range of ID12B (470 eV) with low flux. The films are prepared by evaporating Rh at RT on a clean Au(111) surface. The temperature, during the measurement, was chosen as low as possible (6K) to make certain the clusters show some magnetic behavior, provided Rh is magnetic in small clusters. Figure 2 shows the XAS spectra obtained for a coverage of ~0.01 ML of Rh (the M_{III} and M_{IV} edges are indicated). The two curves of figure 2 are obtained for the same Rh film by changing the temperature of the sample during the measurement. The low temperature curve (at 6K) shows big oscillations that actually overcome the signal from the Rh itself. These oscillations correspond certainly to the EXAFS signal coming from the Au N_{IV} N_V edges (353 and 335 eV respectively).

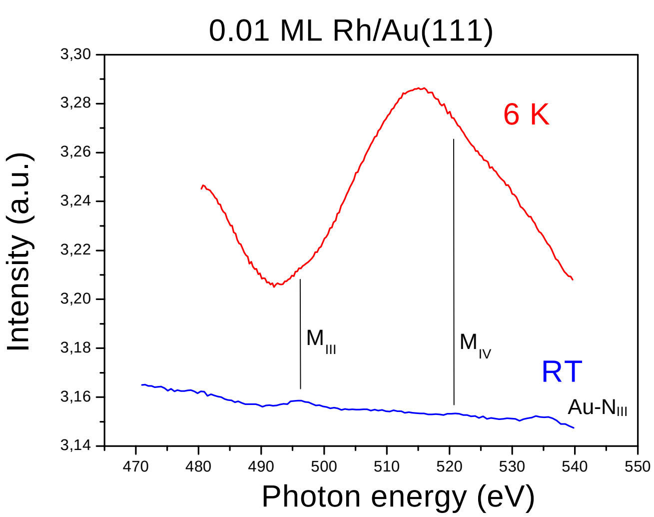


Figure 2. XAS curves for 0.01 ML of Rh on Au(111): top curve measured at 6K, bottom curve measured at RT.

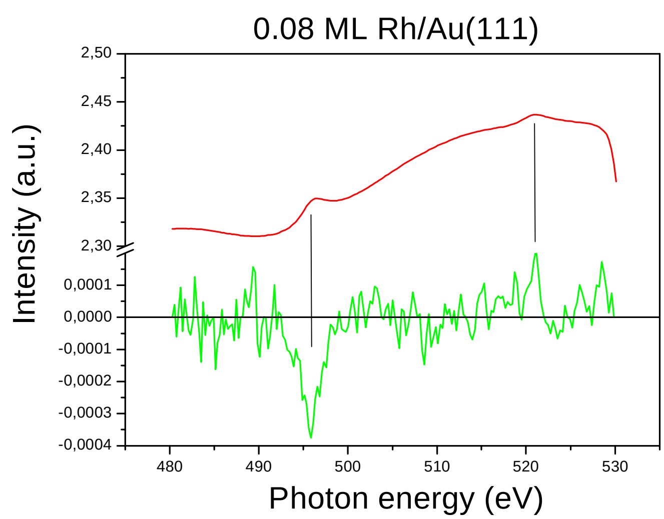


Figure 3. XMCD curves for 0.08 ML of Rh on Au(111) (measured at 6K).

For a higher coverage of 0.08 ML (figure 3) a XMCD signal is observed. These preliminary results are encouraging, and with the higher flux along with the higher polarization rate on ID8 a systematic study of the dependence of the m_{orb}/m_{spin} ratio with the coverage should be possible on this Rh/Au(111) system. If the determination of the integral of the isotropic XAS spectra (by subtracting the Au background for instance) is feasible it could even be possible to obtain quantitative values for the spin and orbital magnetic moments (see proposal on the "**Magnetism of self-assembled Rh clusters**".

References:

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[4] Zhu et al. Phys. Rev. B **43** (1991) 4007
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