ESRF	**Experiment title:** **Magnetism in self-organized Rh and Cr clusters grown on Au(111)**	**Experiment number**: HE-772 In-house
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Report:

Small magnetic particles, supported on surfaces or embedded in a matrix, have attracted a great deal of interest and clusters of bulk ferromagnetic materials like Fe, Co or Ni are extensively studied nowadays. However, several non-magnetic metals (like e.g. V, Pd, Rh, Ru, Cr) are supposed to be magnetic from theoretical electronic band calculations, either at the surface, in free standing and epitaxial ultrathin layers, or in small clusters. This was the driving force behind these measurements done on ID12B using in-house time: can non-magnetic bulk metals show a magnetic signal (XMCD) once they form low-dimensional systems.

Freestanding Cr and Rh clusters are predicted to be magnetic and this was confirmed experimentally.[1],[2] For Rh epitaxial layers on Au(100), calculations show that Rh should be magnetic.[3] 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).[4] The case of Cr was more complex and the self-organization of Cr clusters on the Au(111) reconstructed surface was demonstrated only recently by us using STM.[5]

Due to the lack of time, the aim of this project was more likely to perform some test measurements to demonstrate the feasibility of an experiment rather than to do a complete study on such systems.

Rh/Au(111)

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 1 shows the XAS spectra obtained for a coverage of ~0.08 ML of Rh (the M_{II} and M_{III} edges are indicated) with the accompanying dichroism being clearly visible. However, the low temperature curves (at 6K) shows oscillations that arise from the EXAFS signal of the Au $N_{IV},_{V}$ edges (353 and 335 eV respectively). To diminish the fraction of electron coming from the substrate we will apply a positive bias voltage. For a higher coverage of 0.08 ML (figure 2) a XMCD signal is observed.

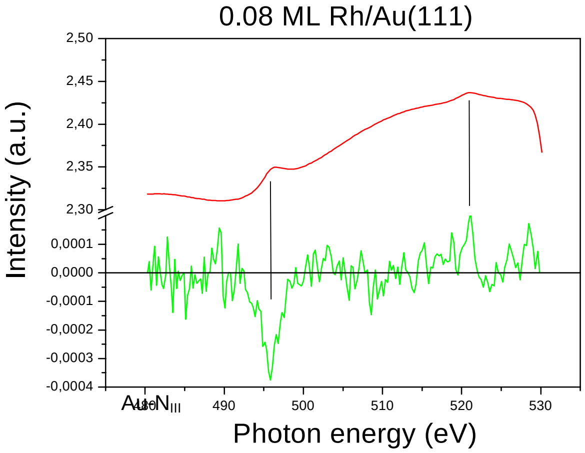

Figure 1. XMCD curves for 0.08 ML of Rh on Au(111) (measured at 6K).

Cr/Au(111)

For the Cr we also observe a dichroic signal for different coverages (see figure 2). A rough analysis demonstrates that the signal is not proportional to the amount of Cr deposited. Moreover the Cr layer deposited at 6K (fig. 2b.) has a XMCD signal higher than a film of similar thickness done at RT (not shown here). This could be correlated to the higher nucleation rate at 6K resulting in smaller islands, as compared to RT films, and consequently to a higher fraction of edge atoms (atoms which contribute most to the magnetism in a model of antiferromagnetic frustrated Cr in nano-clusters).

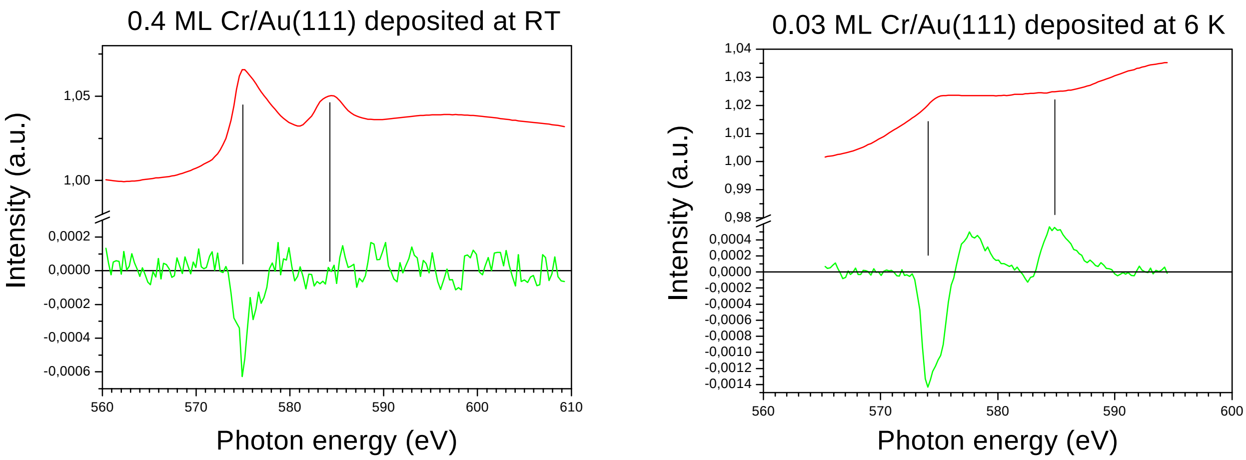

Figure 2. XMCD signal obtained for two different coverage: a) 0.4 ML of Cr deposited at RT and analyzed at 6 K, b) 0.03 ML of Cr deposited and analyzed at 6 K. The difference in the signal to noise ration originate only from the different accumulation time: a) is obtained after few scans and b) needed approximately several tens of scans.

These preliminary results are encouraging, and with the higher flux together with the higher polarization rate on ID8 a systematic study of the dependence of the magnetic moments with the coverage should be possible. The Cr/Au(111) system promises to be a complex and interesting system as many effects are expected A systematic thickness dependent XMCD and XMLD study should extend our understanding of these materials in low dimensions. (see the related proposal the "Nanoscale magnetism in non-magnetic elements").

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[1] Reddy et al. Phys. Rev. Lett. **70** (1993) 3323; Cox et al. Phys. Rev. Lett. **71** (1993) 923
[2] D.C. Douglass, J.P. Bucher, and L.A. Bllomfield, Phys. Rev. B **45**, 6341 (1992)
[3] Zhu et al. Phys. Rev. B **43** (1991) 4007
[4] I. Chado *et al.*, submitted to Phys. Rev. B
[5] P. Ohresser *et al.*, to be submitted.