XMaS the UK-CRG	**Experiment title:** Magnetic X-ray Scattering at Interfaces in Fe/Au Multilayers	**Experiment number**: 28-01-24
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Shifts: 17	**Local contact(s)**: Simon Brown	*Received at XMaS:*

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Report:

Our principle objective during this run was to examine the x-ray scattering in the vicinity of the Au L edge in an to attempt to determine whether a significant moment existed in the Au spacer layers of Fe/Au multilayers. We were concerned to determine whether the presence of a magnetisation density gradient could be related to the magnetotransport differences in Fe/Au multilayers grown on sapphire and MgO substrates. The work was particularly timely, as between proposal submission and award of beamtime a theoretical paper appeared suggesting that a small moment should indeed exist at the Au interface [1]. In addition we aimed to determine whether any antiferromagnetic coupling existed in the Au/Fe multilayers grown on sapphire. This involved a search at the Fe K edge for the existence of an antiferromagnetic Bragg peak at a wavevector value of half that corresponding to the superlattice itself.

Grazing incidence x-ray scattering measurements were undertaken at the Au L edge using polarisation analysis to detect the σ-π scattering associated with the presence of a magnetic moment within the Au layers. No evidence of a moment in the Au layers was found.

In order to set an upper limit on the measurement precision, we undertook similar measurements on small repeat number multilayers of Co/Pt, as evidence for a moment existing in the Pt layer has been obtained from magnetic circular dichroism experiments. All of our experiments were bedeviled by the parasitic σ-σ charge scattering which entered the

detector due to the inability to select a polarisation analyser with exactly 90° scattering geometry corresponding to the edges in question. All data are of the form of small differences in large numbers. Analysers available to us were Al 222 ($2\theta = 98°$ at the Fe K edge), Al 220 ($2\theta = 91°$ at the Au L edge and $2\theta = 94.5°$ at the Pt L edge). Close to the Pt L absorption edge, we did observe changes in the (nominally) σ-π scatter at the position of the structural Bragg peak on switching of a magnetic field in the Co/Pt samples (Fig 1). This change was significantly above that measured at x-ray energy further from the absorption edge (Fig 2). However, the changes in intensity were comparable to the changes in the Keissig fringes due to the varying anomalous dispersion correction in the parasitic charge scattering. Despite considerable effort, we have not been able to find a way of deconvolving these effects.

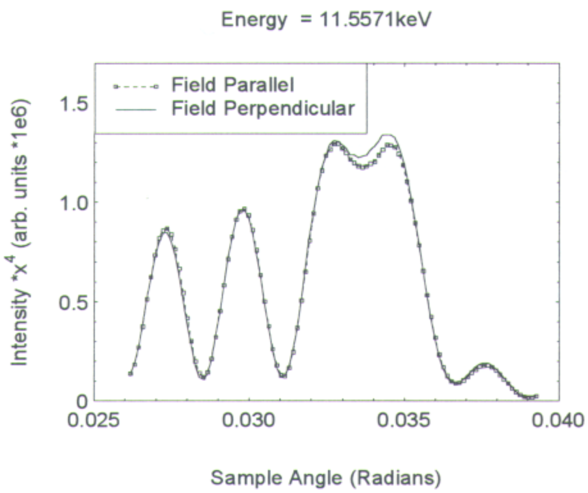

Fig 1

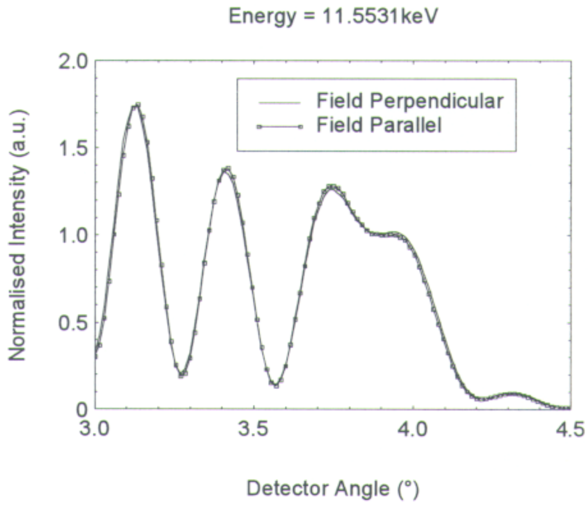

Fig 2

Our conclusion from all of these experiments was that we were not able to achieve sufficient sensitivity to test the validity of the theoretical prediction of a moment of $0.01\mu_B$ at the Au interface.

Attempts to observe a pure magnetic Bragg peak at the *q/2* position at the Fe K edge in the Au/Fe multilayers were also unsuccessful. Not only were we unsuccessful in observing antiferromagnetic order in the Au/Fe layers grown on sapphire, but we also failed to observe such a peak in layers grown on MgO. These latter layers show strong oscillations in both GMR and magnetic remanence as a function of Au thickness. The samples examined had been chosen to be at a GMR maximum. [Subsequent measurements at the Fe L_3 edge have also failed to reveal an antiferromagnetic Bragg peak and the reason for this totally unexpected result is not at all clear.] We found that at these low incidence angles, even with polarisation analysis, the residual charge scattering from the reciprocal space surface streak imposed such a high background as to make K edge experiments of transition metals effectively impossible with the present analysers.

[1] M Bohm and U Krey, J Magn. Mag. Mater. 192 (1999) 27