XMaS the UK-CRG	**Experiment title:** Surface Diffraction and Grazing Incidence Magnetic X-ray Scattering of Epitaxial Cobalt Films	**Experiment number**: 29-01-050
Beamline: **BM 28**	**Date of experiment**: from: 19.01.00 to: 25.01.00	**Date of report**: 21.06.00 *Received at XMaS:*
Shifts: 18	**Local contact(s)**: Dr Simon Brown	

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Report:

The focus of this experiment changed for two critical reasons. The first part of the proposal was to use grazing incidence surface diffraction to determine the structure of epitaxial Co films grown on (001) GaAs. From the *in-situ* RHEED studies, we believed that under certain conditions the Co could switch from the bcc to the fcc phase. Unfortunately, prior to the beamtime, it was discovered that there was an error in the interpretation of the RHEED data and that all films were in the bcc phase.

The second part of the proposal was to use grazing incidence reflectivity with a crystal analyser to distinguish the $\sigma \rightarrow \pi$ scatter and thereby measure the magnetisation. However, we find in practice that the size of the resonant enhancement at the K absorption edges of the transition metals is so small that we were unable to measure the magnetic scattering above the parasitic $\sigma \rightarrow \sigma$ scattering transmitted through the analyser. (We were unable to find analyser reflections sufficiently close to 90° scattering for the wavelength of the CoK edge to reduce this scatter sufficiently.) Measurements at the Pt L edge in Co/Pt multilayers during beamtime preceding the present experiments showed that even at the L edges, the data are difficult to reduce and interpret unambiguously.

As a result most of our time was spent on grazing incidence surface diffraction studies of the in-plane strain in Cu-capped Ni layers grown epitaxially on Cu buffered Si (001) substrates. Polarised neutron reflectivity measurements had previously indicated that the magnetic moment on the Ni fell with increasing Cu cap thickness, a result postulated to be the effect of **increasing** in-plane strain in the Ni layer. Our grazing incidence surface diffraction experiments showed unambiguously that this is indeed happening [1]. An example of the data is shown in Fig 1 where we see the changing relative peak heights of the Cu and Ni 220 diffraction peaks as a function of depth probed in the film. As a function of cap thickness the strain in the Ni increased linearly (Fig 2). Contrary to measurements made on Cu/Ni multilayers by Thomas' group in Marseille, the Cu cap was always found to have the bulk, unstrained Cu lattice constant. No significant variation of lattice constant was found as a function of depth in either the Ni or Cu layers (Fig 3), the thick Cu buffer layer being almost fully relaxed.

The data also explain the changes in the hysteresis loop [1] as the magnetisation reversal process in Ni/Cu(001) films takes place by domain wall motion and the coercive field for this reversal mechanism has been shown to increase linearly with strain.

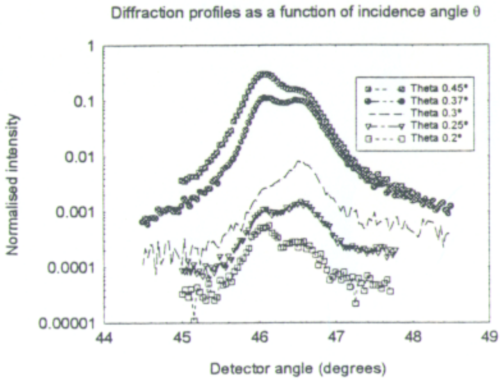

Fig 1

Reference

[1] Effect of the Cu capping thickness on the magnetic properties of thin Ni/Cu(001) films, C.A.F.Vaz, G. Lauhoff, J.A.C.Bland, B.D.Fulthorpe, T.P.A.Hase, B.K.Tanner, S. Langridge and J. Penfold, paper to be presented at International Conference on Magnetism, Brazil, August 2000; submitted to J. Magn. Mag. Mater.

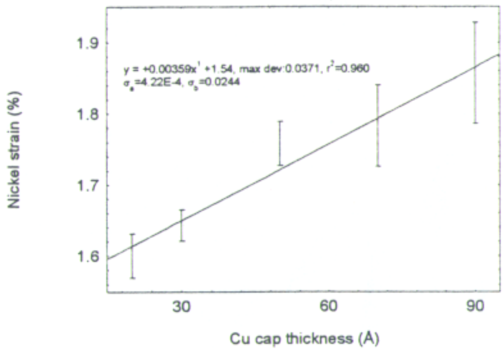

Fig 2

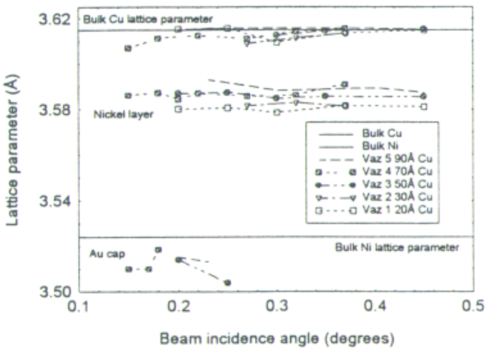

Fig 3