ESRF	**Experiment title:** X -ray diffuse scattering from interfaces in transition metal multilayers	**Experiment number:** SI-288
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Report:

The aim of this experiment was to perform high angle diffraction at moderately high resolution with good statistics on thin magnetic multilayer systems of Au/Fe and Co/Cu. We also performed preliminary studies on the granular giant magnetoresistive system Ag/Co and completed grazing incidence scattering measurements on the Au/Fe system. High quality data sets were obtained from all systems.

Measurements were taken on the two axis diffractometer using a single 111 germanium crystal as an analyzer. For the Co/Cu multilayers data were taken using wavelengths close to and away from the Cu absorption edge, in order to enhance the scattering from the Co/Cu interfaces by switching in and out a large anomalous dispersion correction to the scattering factors. We successfully exploited this technique on station BMI 6 at much longer wavelengths than had previously been used on the station. No problems were found either in calibration from the absorption edge of a standard sample [l] or in reproducibility in the monochromator setting.

Au/Fe Multilayers grown by Molecular Beam Epitaxy

Grazing incidence X-ray scattering measurements were made on a series of Au/Fe multilayers grown at different temperatures on substrates of (001) MgO and (1120) sapphire. Analysis

of the specular and diffuse scatter shows that the conformal roughness on the interfaces of the multilayers grown on MgO was consistently larger than that of the sapphire samples and that the lateral correlation length was significantly shorter. This is consistent with the initial roughness values of the substrates. Magnetotransport measurements show that the MgO samples consistently show antiferromaguetic coupling and high values of magnetoresistance, while ferromagnetic coupling is the norm for sapphire substrates with corresponding low values of magnetoresistance. Compared with the sapphire samples, the high angle rocking curves (transverse scans) of the MgO samples were narrow and satellites up to third order were measured in the longitudinal scans of the latter. (Fig 1)

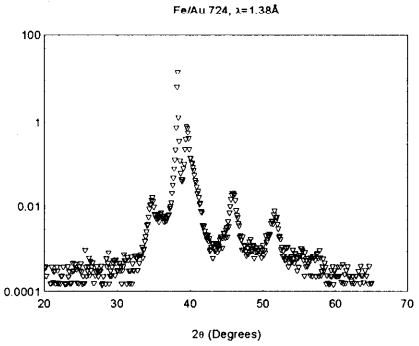

Fig 1

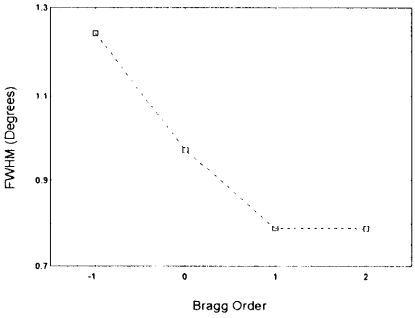

Fig 2

There is however, a presently unexplained asymmetry in the FWHM of the transverse scans as a function of satellite order around the 002 Au/Fe peak (Fig 2). The data show that there is a very small range of mosaic around the 001 direction in the high GMR samples grown on cubic MgO [2]. The samples on sapphire substrates show predominantly 111 orientation with much larger rocking curve widths and absence of clear satellites in the longitudinal scans.

Co/Cu Multilayers grown by Magnetron Sputtering

During this run we completed measurement of the 111 texture of uniquely smooth Co/Cu multilayers. These data show that in addition to having r.m.s. roughness values of the order of 1-2Å, the FWHM of the rocking curves through the 111 peaks is of the order of 7.543". Remarkable levels of antiferromagnetic coupling are found in these materials, together with extremely large room temperature GMR. Through comparison with our previous ESRF studies on MBE grown Co/Cu which indicate that a low spread of orientation about the 111 direction correlates with high GMR values [3], these results suggest that the non-magnetic spacer layer thickness is the key parameter which determines the coupling and hence GMR.

1. T.P.A. Hase, I.Pape, B.K.Tanner and M.Wormington, Physica B (in press)
2. B.D.Fulthorpe, J.Clark, T.P.A.Hase, LPape, B.K.Tanner, P.Ryan and B. J.Hickey, submitted to MML98, Vancouver, June 1998
3. T.P.A. Hase, I.Pape, B.K.Tanner, H.Laidler, P.Ryan and B. J.Hickey, J. Magn. Mag. Mater (in press)