Experiment Report Form

This report form is to be filled in by all users or groups of users who have had access to beam time for measurements at the XMaS Beamline.

Reports accompanying requests for additional beam time

An experimental report on previous measurements - if necessary, a preliminary report - must be attached to all subsequent requests for beam time. The Peer Review Panel reserves the right to refuse to examine new proposals from groups who have not reported on the use of beam time allocated previously.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details
- bear in mind that the report will be reduced to 71% of its original size. A type-face such as “Times”, 14 points, with a 1.5 line spacing between lines for the text, produces a report which can be read easily.

Deadlines for submission of Experimental Reports

- Within 6 months of the experiment and normally before any subsequent submission

Should you wish to make more general comments on the experiment, please enclose these on a separate sheet, and send both the Report and comments to the XMaS Administrator at the address below.

Published papers

All users must give proper credit to XMaS staff members and proper mention to XMaS facilities which were essential for the results described in any ensuing publication. This should take the following form:

“This work was performed on the EPSRC-funded XMaS beam line at the ESRF, directed by W.G. Stirling and M.J. Cooper. We are grateful to the beam line team of S.D. Brown, D.F. Paul, A. Stunault and P. Thompson for their invaluable assistance, and to S. Beaufoy and J. Kervin for additional support.”

Further, they are obliged to send to the XMaS Administrator the complete reference and the abstract of all papers appearing in print, and resulting from the use of the XMaS beamline.

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XMaS the UK-CRG	Experiment title: Grazing Incidence Diffuse Scatter Anomalous Fine Structure Spectroscopy of Interfaces in Magnetic Multilayers	**Experiment number**: 28-01-076
Beamline: BM 28	**Date of experiment**: from: 22.11.00 to: 28.11.00	**Date of report**: 2.11.01
Shifts: 18	**Local contact(s)**: Simon Brown	*Received at XMaS:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

We have continued experiments, begun at the Daresbury SRS, to measure reflection anomalous fine structure (RAFS) and thereby study changes in the layer density and local environment on annealing sputtered permalloy/copper multilayers. The technique is based on diffraction anomalous fine structure spectroscopy (DAFS) which involves the analysis of the variation in the intensity of high angle Bragg peaks from crystalline materials as the x-ray energy is tuned through the absorption edges of the constituent atoms in the material. It is essentially the scattering equivalent of the commonly used XAFS spectroscopy. By fitting the smoothly varying component of the plot of specular Bragg peak intensity versus incident x-ray energy, we have determined that the density difference between copper and permalloy layers increases on annealing [1,2]. From the oscillatory component we have shown that it is the nearest neighbour distance around the Ni atoms which decreases and this happens in both doped and undoped materials. Detailed analysis of the smooth component of the RAFS spectra indicates that at high annealing temperature the Co at one interface only diffuses in the NiFe.

The principal objective of the present proposal was to perform RAFS spectroscopy on the diffuse scatter from the first order Bragg peak. This scatter originates from conformal roughness at the multilayer interfaces. Extremely high quality specular data were obtained [2] at the XMaS beamline (Fig 1), significantly improved on those from the SRS The oscillations in the diffuse scatter had excellent signal to noise (Fig 2). However, the oscillations were identical in amplitude and phase in both specular and diffuse channels. (Fig. 3). Subsequent analysis has revealed that although the diffuse scatter arises from the interface roughness and goes to zero when roughness is absent, the absorption process responsible for the oscillations takes place in the body of the layer, not at the interfaces.

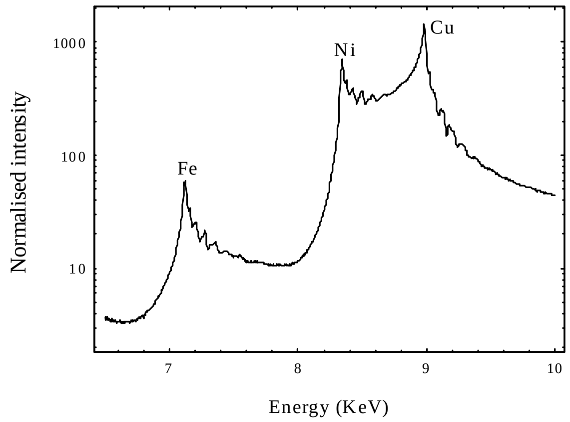

Fig 1

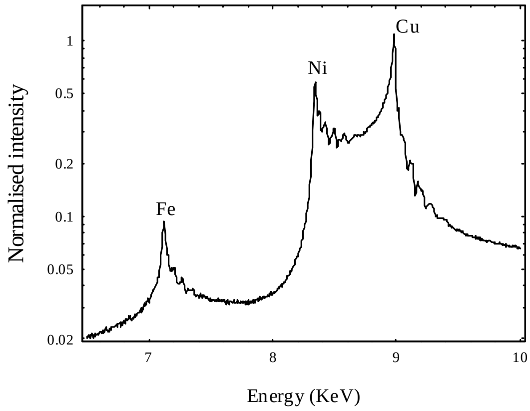

Fig 2

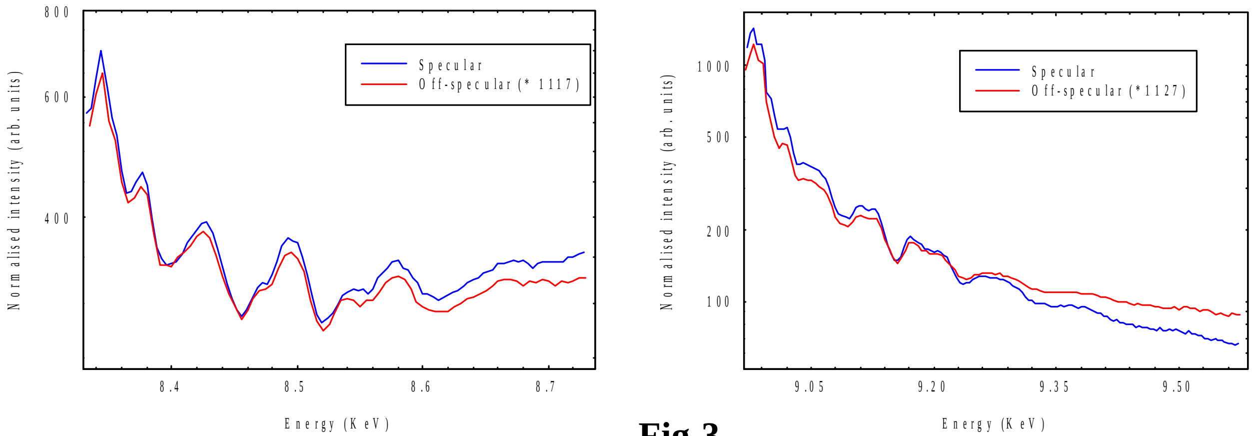

Fig 3

Above the Ni edge

Above the Cu edge

Oscillations arise from the interference of the back-scattered photoelectrons produced during the absorption process and, irrespective of whether detection takes place in the specular or diffuse scatter channel, the local order information derived relates to the body of the layer, not the interface region.

References

[1] X-ray reflection anomalous fine structure analysis of the stability of permalloy/copper multilayers, G.M.Luo, Z.H.Mai, T.P.A.Hase, B.D.Fulthorpe, B.K.Tanner, C.H.Marrows and B.J.Hickey, J. Magn. Mag. Mater. **226-230** (2001) 1728-1729

[2] Variable wavelength grazing incidence x-ray reflectivity measurements of structural changes on annealing Cu/NiFe multilayers, G M Luo. Z H Mai, T P A Hase, B D Fulthorpe, B K Tanner, C H Marrows and B J Hickey, Phys Rev B **64** (2001) in press