ESRF	**Experiment title: Relation of structure to magnetotransport in Au/Fe epitaxial multilayers**	**Experiment number**: 21-01-111
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Shifts: 18	**Local contact(s)**: Danny Mannix	*Received at ESRF:*

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Report:

Grazing incidence in-plane diffraction, specular and diffuse scattering measurements and high resolution out-of plane diffraction measurements have been undertaken to determine the structure of Fe/Au(001) multilayers, grown by molecular beam epitaxy using a new technique for the preparation of Au buffer layers on MgO (001) substrates. In a previous paper [1] we presented the first experimental evidence for channelling in Fe/Au multilayers. By growing epitaxial Fe/Au(100) multilayers on (100)MgO and Fe/Au(111) multilayers on *a* plane sapphire we demonstrated that much stronger channelling exists in the (100) orientation than in the (111) orientation. As the magnetisation measurements showed only very weak coupling in the (111) samples and a correspondingly low GMR of 6% when compared to the (100) samples (which had a maxiumum GMR of 40% and antiferromagnetic coupling with ~30% remenance), the key comparison was between the saturation conductivity of the two systems. However, despite extremely careful reflection high energy electron diffraction (RHEED) and x-ray scattering measurements, there remained a question as to whether some difference in physical property between layers grown in the two orientations might be interfering with the effect. This was particularly relevant to the (111) system Fe layers where a bcc to fcc phase transition occurs during layer growth. As the thickness at which this phase transition occurs is comparable with the Fe thickness used, we have undertaken new experiments solely on the (001) system, where the Fe layer is deposited pseudomorpically in the bcc phase.

X-ray scattering and diffraction showed that multilayers grown on the new buffers, although having little difference in the crystalline structure, have much smoother interfaces than those grown on previous buffers. Compared with earlier multilayers with rougher interfaces, the giant magnetoresistance is increased by 20% due to more complete antiferromagnetic exchange coupling. Measurement of the saturation conductivity shows that the number of specular reflections occurring during electron channelling remains unchanged even though the interfacial roughness is reduced by a factor of five. Spin dependent scattering at the interface appears therefore to be driven solely by the difference in the band structure, not by diffuse scatter at the interfaces [2].

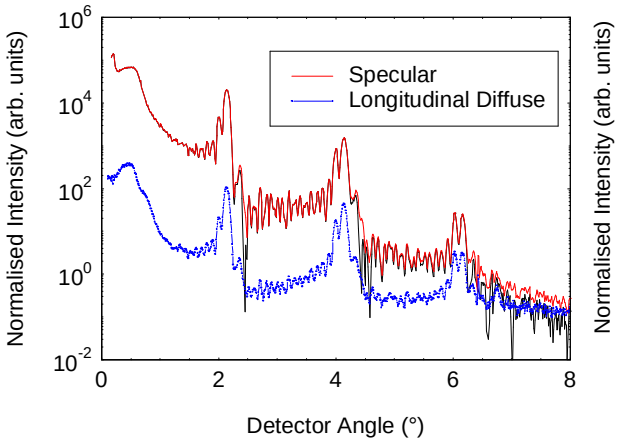

Fig 1. Specular scatter from Au/Fe multilayer grown on new Au buffer

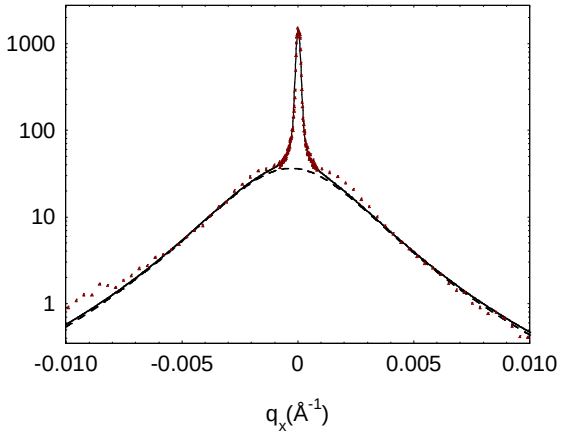

Fig 2. Transverse diffuse scan of multilayer grown on new Au buffer

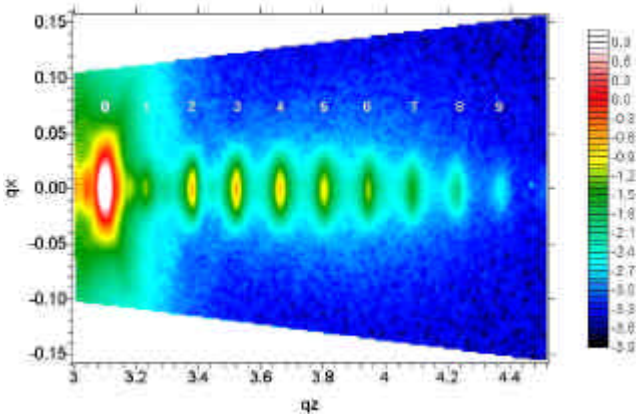

Fig 3. Full high angle reciprocal space map around the 002 reciprocal lattice point of a multilayer

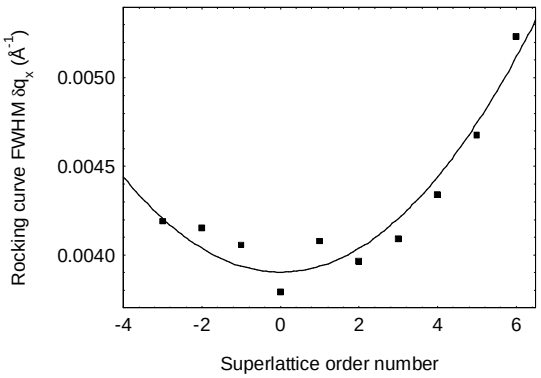

Fig. 4. FWHM of rocking curve through successive high angle diffraction satellites

[1]D T Dekadjevi, PA Ryan, B D Fulthorpe, B K Tanner and B J Hickey. Phys.Rev.Lett **86** (25) 5787 (2001).
[2] A. Cole, B. J. Hickey T. P. A. Hase, J. D. R. Buchanan and B. K. Tanner, J Phys: Condens Matter. **16** 1197 (2004)