	Experiment title: Resonant Magnetic X-ray Scattering from Co/Gd Multilayers	**Experiment number**: 28-01-708
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Shifts: 18	**Local contact(s)**: L. Bouchenoire and S. Brown	

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Report:

We have continued our study of the interesting rare-earth/transition-metal Gd/Co system. The exchange interaction between the Gd and Co causes the layers to adopt an anti-parallel alignment, and as a function of applied field and temperature, the competition between the layer moments results in a range of complex magnetic states. To date, we have concentrated our resonant scattering experiments on elucidating the Gd moment configurations as a function of temperature, and in particular we have been investigating the moment configuration of the Gd when the system undergoes a spin-flop transition. This magnetic state occurs at the compensation temperature when the Gd and Co layer moments are equal. In our current experiment we have concentrated on two samples in which a spin flop transition can be induced, at room temperature, on application of a magnetic field. Figure 2 shows the magnetization loops of the samples studied.

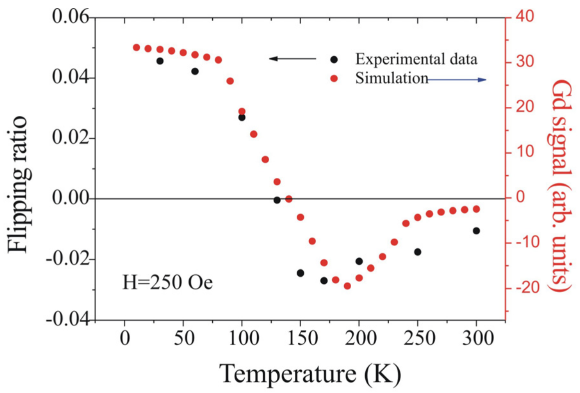

Figure 1. Black: Flipping ratio of the sample $[Gd_{50}/Co_{50}]_{20}$ as a function of temperature at fixed field. Red: simulation following Camley's model.

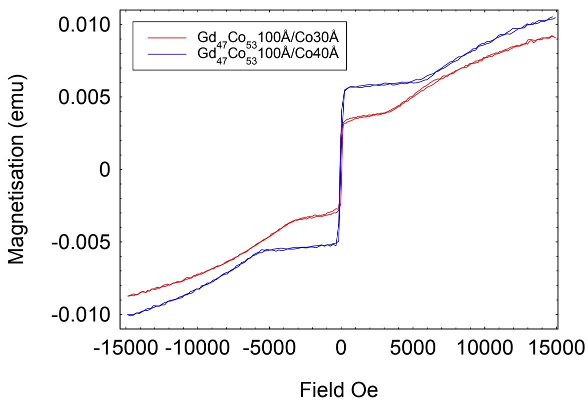

Figure 2. Magnetisation loops for the samples studied. The spin flop transition occurs at 3000Oe (red) and 5000Oe (blue)

We have attempted to fit the magnetization as a function of temperature and simultaneously fit the flipping ratio. Whilst we have had initial success (figure 1), we have not been able to reproduce the field dependence of either the M vs T data, or fit the field dependence of the flipping ratio.
Based on our previous extensive studies, we have deposited a CoGd alloy instead of a pure Gd layer. This results in a smoother, sharper interfaces with little inter-diffusion as can be seen in the full reciprocal space map of the diffuse scatter shown in figure 3. Detailed analysis of reflectivity data obtained during this experiment is being conducted (figure 4)

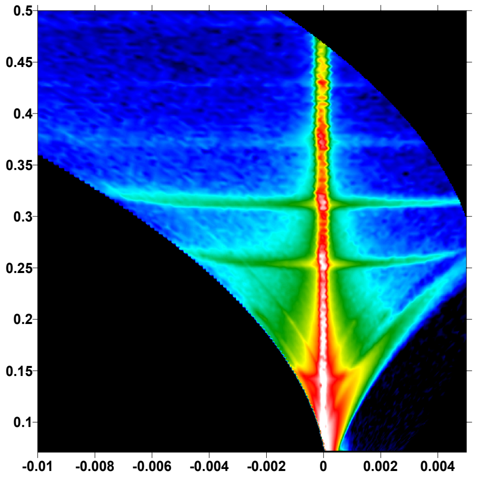

Figure 3. Full reciprocal space map of the diffuse scatter showing the correlated nature of the roughness

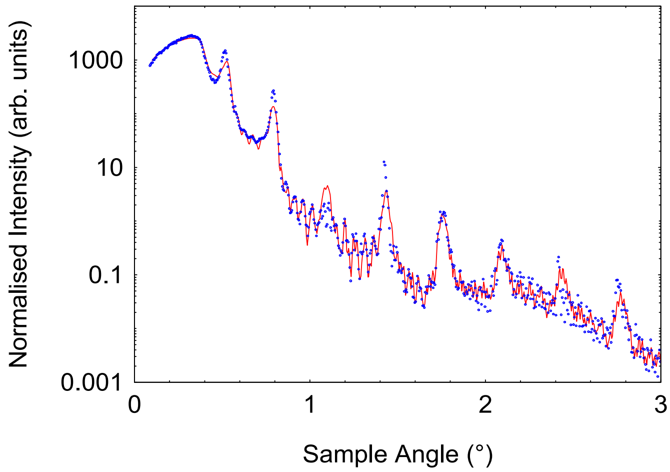

Figure 4. Specular reflectivity (blue points) and simulation (red line). The flipping ratio was determined at the 3rd Bragg peak.

Due to a problem with the electromagnet, we were not able to apply large fields and the maximum field was limited to 800mT. The flipping ratio was recorded at each specular Bragg peak shown in figure 4. The flipping ratio was maximum at the 3rd Bragg peak where the charge scattering was low. We have followed the flipping ratio as a function of applied field when the field is applied parallel (figure 5) and perpendicular (figure 6) to the scattering plane. As can be seen below, the magnitude of the flipping ratio changes in applied fields which are greater than the onset of the spin flop. When the field is applied in the scattering plane, the steady reduction in the flipping ratio is mirrored by the magnetisation data. In contrast, when the field is applied perpendicular to the scattering plane, the changes in the flipping ratio show a correlation with the magnetoresistance and not the magnetisation.

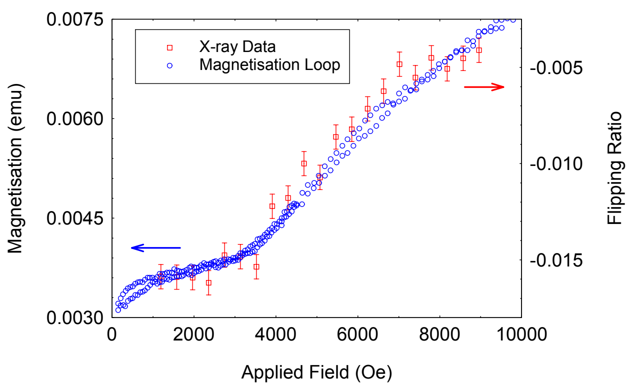

Figure 5. A comparison of the bulk magnetisation as a function of field (blue) and the flipping ratio determined with the field applied in the scattering plane (red)

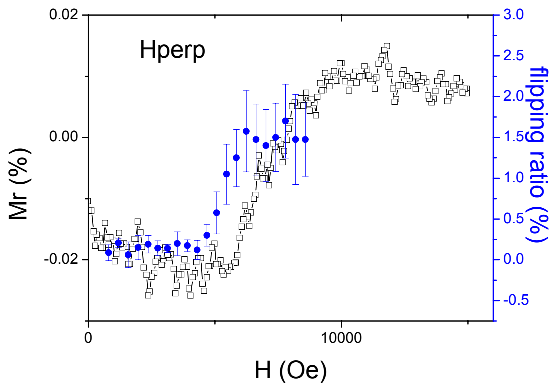

Figure 6. A comparison of the magneto-resistance (black) and the flipping ratio determined with the field applied perpendicular to the scattering plane (blue)