XMaS the UK-CRG	**Experiment title:** Structural and Magnetic Interface Morphology of Co/Gd Multilayers	**Experiment number**: 28-01-103
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Report:

The prime objective of this experiment was to undertake resonant magnetic scattering using circularly polarized x-rays generated by the new diamond phase plate. A secondary goal was to provide scattering evidence for a complex magnetisation distribution across the Co/Gd interface. This could be a magnetic dead layer as proposed by Hashizume *et al.*[1] to explain the data in the Fe/Gd system, or related to the interdiffusion processes which are significant in Co/Gd [2]. Specular and diffuse scattering experiments were undertaken with the x-rays tuned to the Gd L_3 edge (E=7.79keV) for both positive and negative helicity. A difference in intensity was observed on reversal of the helicity of the incident beam at each of the specular Bragg peaks.

Magnetometry studies show that below the curie temperature of the Gd, the sample behaves as a ferrimagnet with the moments in the layers adopting different configurations as a function of temperature. As the Gd moment orders, it aligns itself in an anti-parallel configuration along the direction defined by the Co moment in an applied field. As the temperature is lowered and the Gd moment increases, there exists a compensation temperature when the moments in the adjacent layers are equal.

Grazing incidence scattering experiments were conducted as a function of temperature and field on a sputter deposited Co/Gd multilayer grown on silicon. Figure 1 shows the specular data recorded from a nominal $[Gd(50Å)/Co(50Å)]_{*20}$ sample. In agreement with our previous studies we find that a significant portion of the Co layer has interdiffused resulting in the formation of a Gd rich alloy layer [2]. The reduced slightly Curie temperature confirms this hypothesis.

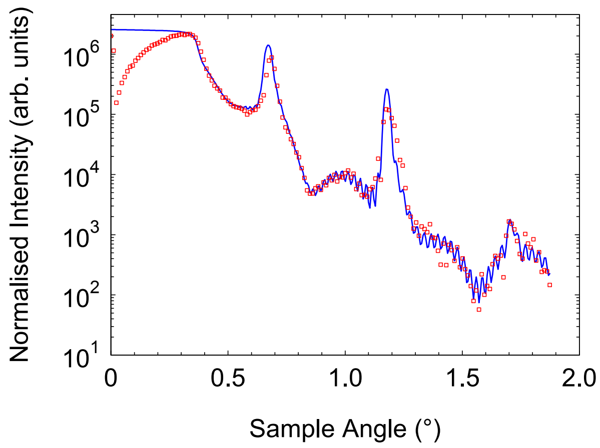

Figure 1: Specular reflectivity (points) and simulation (line) of the Co/Gd multilayer examined

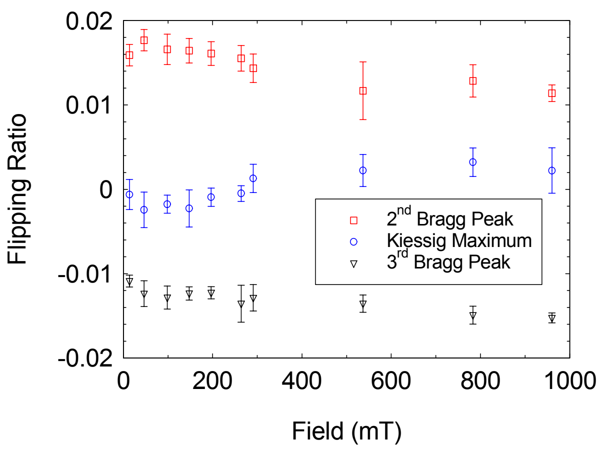

Figure 2: The variation of the flipping ratio with applied field at 19.5K for the 2nd and 3rd Bragg peaks.

Due to instability issues we were unable to measure the flipping ratio, defined as the difference over the sum in the signal measured under opposing field or helicity directions, as a function of sample angle reproducibly. However, we were successful in monitoring resonant magnetic scattering by maintaining a fixed scattering geometry and conducting experiments as a function of applied field and temperature.

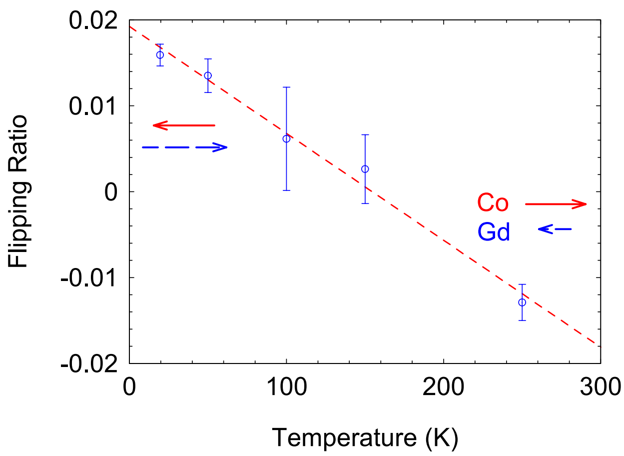

Figure 3: The variation of the flipping ratio as a function of temperature. The layer moment directions are as inset.

Figure 2 shows the flipping ratio, using a fixed helicity, at 19.5K. As expected, a signal is only observed at the Bragg peak positions. (The flipping ratio is equal in magnitude, but opposite in sign for the reversed helicity). The reversal of sign of the flipping ratio between the second and third Bragg peaks shows that the magnetisation distribution within the Gd layer is complex, and is similar to that observed previously in the Fe/Gd system [1]. No variation in the magnitude of the flipping ratio could be observed as a function of applied field at 19.5K. However, a weak field dependence was observed for data recorded around the compensation temperature.

As the temperature was increased from 19.5K, a steady reduction in the flipping ratio was observed (figure 3), until at compensation, it was no longer measurable. On increasing the temperature to 250K, a signal was again observed, but with opposite sign. These data can be explained assuming the spin configurations shown as insets in figure 3. However, the exact position of the layer moments around compensation remain unclear. We have successfully conducted magnetic scattering on the Co/Gd system as a function of temperature and field.

[1] H. Hashizume *et al.* Phil. Trans. Roy. Soc. **A357** (1999) 2817 and H. Sano *et al.* Jpn. J. Appl. Phys. **1 41** (2002) 103

[2] J.A. González *et al.* J. Phys: Condens. Matt. and J.A. González *et al.* J. Magn. Mag. Mat. **242-245** (2002) 547