ESRF I

Experiment title MAGNETIC FORM FACTOR OF COBALT DETERMINED BY WHITE BEAM DIFFRACTION

Experiment number: HC496

Beamline:

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Shifts:

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Report:

The objective of this experiment was to use the technique of white beam diffraction with circularly polarised radiation and a dispersive detector to measure the magnetic form factor of cobalt. The method has been used successfully by ourselves and others on cubic ferromagnets at the SRS Daresbury (see for example Collins et al Phil Mag B65 371992, and J. Phys Cond Mat 51637 1993; Zukowski et al J X-ray Sci & Tech 3300 1992). As well as using circularly polarised light, obtained by moving off orbit, the magnetisation of the sample needs to be reversed frequently in order to separate the magnetically modulated signal. With the magnetic field parallel/antiparallel to the scattered beam and a 90° angle of scattering, which is necessary to maximise the ratio of magnetic to charge scattering, the magnetic form factor $m(K) = 2S(K) + L(K)$ is measured directly.

The experiment on cobalt failed for reasons that are clear with the benefit of hindsight. In the first place the choice of the high energy beamline (ID15A) was based on experience of its use for magnetic Compton scattering, which employs similar modulation techniques, in the study of spin density in ferromagnets. However there is virtually no flux below 30keV and this made it very difficult to align the crystal and find reflections, since there were no intense low order reflections to detect. Even the use of polaroid film to search for the appropriate reflection was rendered difficult because of its transparency at high energies. The second problem is that the rapidly rotating magnet, which produces the field reversal, exerts a significant torque of the crystal, which may alter its Bragg setting. This arises from the large magnetic anisotropy: the c-axis being much softer than the basal plane directions. This is not a problem for incoherent Compton scattering where small variations in the setting can be tolerated, but is is problematical for diffraction, which is sensitive to strain in the sample and sample movements. It may be necessary to slow the magnet down further and make the crystal mount more robust. Electromagnets, although limited to lower fields, largely avoid this difficulty. Finally a problem which was recognised at the outset, is inherent in hexagonal materials, namely the fact that there are no natural 45° angles. We identified an appropriate reflection in the basal plane which is the hard direction magnetically but were unable to obtain a consistent magnetic effect in the reflections measured before the beamtime was exhausted.

It is clear that future white beam studies of ferromagnetic diffraction should use a beamline where low order reflections can be observed at 90° angles.