ESRF	**Experiment title:** Magnetism of $RECo_2$ Laves phases examined by inelastic X-ray scattering	**Experiment number**: HE-1514
Beamline: ID 26	**Date of experiment**: from: 18.06.03 to: 24.06.03	**Date of report**: 27.08.03
Shifts: 18	**Local contact(s)**: Dr. Thomas Neisius	*Received at ESRF:*

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Report:

The aim of this beamtime (18 shifts) was to study the local Co moments in the Laves phase $GdCo_2$ and in reference compounds (Co metal, $SmCo_5$) by means of Kβ-fluorescence spectroscopy. Due to the exchange interactions of 3d magnetic moments with the of 3p hole created during the emission process an additional satellite peak on the low energy side of the Kβ -fluorescence can be observed. The intensity of this satellite peak is related to the 3d moment. While Kβ-fluorescence spectroscopy has successfully been used to study the Fe moment in FeS, Fe and $Fe_{65}Ni_{35}$ Invar under pressure, to our knowledge such measurements on Co compounds are still rare. The experiments were performed at beamline ID26 using the set-up for high-resolution inelastic x-ray scattering. The fluorescence signal was detected by a Rowland circle spectrometer in horizontal scattering geometry. The analyser consists of a Si(620) single crystal operated at Bragg angles corresponding to the Co-Kβ-emission lines. The energy resolution was 3.8 eV. Although the first three shifts of the beamtime were lost due to stability problems of the monochromator and for calibration of the spectrometer the proposed experiments could be successfully performed.

We performed measurements on the Laves phase $GdCo_2$ at several temperatures in the range from T=70°C to T=190°C in steps of 10°C. In $GdCo_2$ the ferrimagnetic ordering disappears at a temperature of T=130°C. At each temperature we recorded five spectra. As result we found that the shape of the Kβ-fluorescence signal remained unchanged over the whole temperature range investigated (Fig. 1). This is, on a first glance, quite surprising since the relatively large band moment at the Co site of ≈1 μ_B is believed to be (at least in part) induced by the Gd-magnetism [1]. The $RECo_2$ Laves phases are known to be spin-fluctuation systems; the magnetism in theses systems is dominated by the ferromagnetically ordered 4f spins, the Co magnetic moments order ferrimagnetically to the 4f spins. The present results indicate that the Co magnetic moments are still present above the ordering temperature and demonstrate that the K_β-method like other core-level spectroscopies should not be used to study magnetic ordering temperatures.

To check the feasibility of Co-K_β fluorescence spectroscopy for future experiments under high pressure we measured the Co-K_β fluorescence from a $GdCo_2$ sample contained in a diamond anvil cell at a pressure of 1.8 GPa. The flourescence radiation was collected through an X-ray transparent beryllium gasket [2]. We recorded nine spectra. The result is shown in Fig. 2 and indicates also no drastic change of the Co moments. This present measurement clearly demonstrates the possibility to perform high resolution fluorescence spectroscopy of Co-magnetism under pressure. Such changes should occur at high pressures around 10 GPa. Experiments in this pressure range are envisaged in the next beamtime.

Another experiment was performed on a $SmCo_5$ magnet at ambient conditions but with different orientation of incident/outgoing beam with respect to the sample magnetisation direction. $SmCo_5$ is a hard permanent magnet with the easy magnetisation axis being parallel to the hexagonal c-axis. These samples are produced industrially by sintering processes which leads to a strong texture of the sample grains. We used a large piece of magnetised $SmCo_5$ with the direction of the magnetisation parallel to the sample surface. Spectra were recorded in two different orientations: In the first case the magnetisation direction was perpendicular to the scattering plane; in the second case the sample was rotated by 90° with the magnetic field in the scattering plane. The angle between incident beam and surface was 45° in both cases. The K_β-spectra show some differences which would imply that the absorption and/or emission process is not isotropic. This question will be subject of further investigations. An evaluation of the fluorescence spectra with emission lines similar to Ref. [3] is underway.

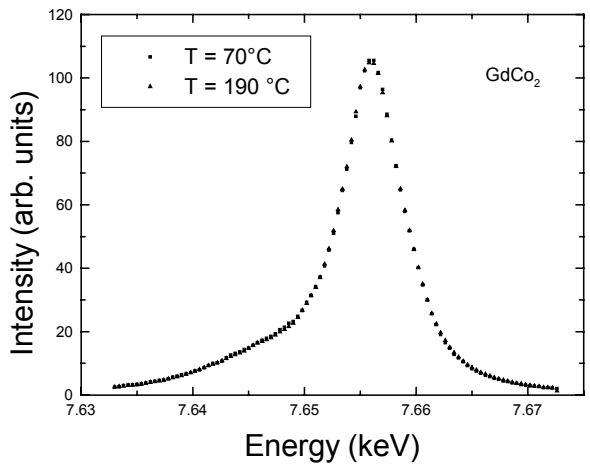

Fig 1. Kβ-fluorescence spectra of $GdCo_2$ at 70°C and 180°C. The spectra remained unchanged in the temperature range investigated.

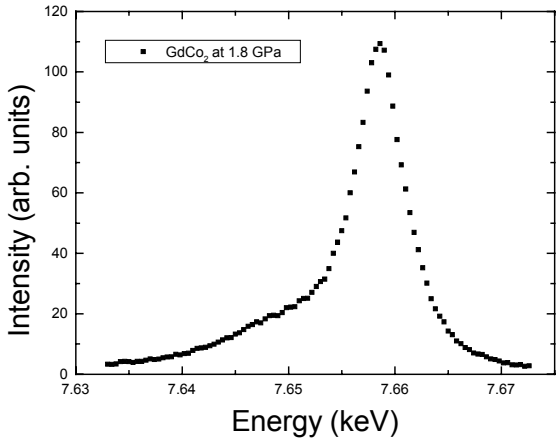

Fig. 2. Kβ-fluorescence spectrum of $GdCo_2$ in a diamond anvil cell at a pressure of 1.8 GPa.

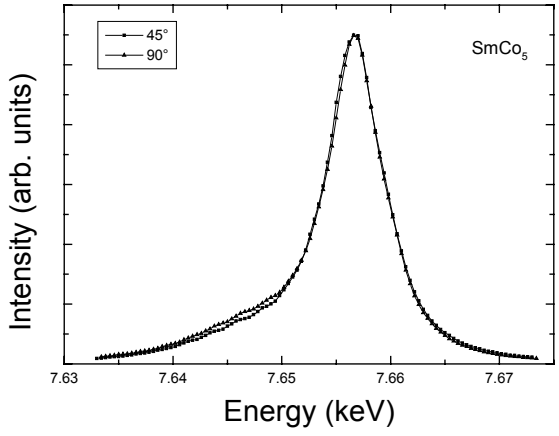

Fig.3. Kβ-fluorescence spectrum of $SmCo_5$ with the sample magnetisation in two different orientation with respect to the X-ray polarisation.

[1] E. Gratz, A. Lindbaum, A.S. Markosyan, H. Mueller, A.Y. Sokolov, J. Phys. Cond. Mat. 6, 6699 (1994)
[2] R. Lübbers et al., Science 287, 1250 (2000), see also ESRF Highlights 2000, p. 48
[3] G. Hölzer et al., Phys. Rev. B 56, 4554 (1997)