Magnetic Circular Dichroism of 4d-4f Resonant X-Ray Emission for Gd

Yasuhiro TAKAYAMA*[1], Motoki SHINODA[1], Kenji OBU[1], Chol LEE[1], Hidetsugu SHIOZAWA[1]
Hiroyoshi ISHII[1], Tsuneaki MIYAHARA[1], Jun OKAMOTO[2]
[1]Tokyo Metropolitan University, Hachioji, Tokyo 192-0397, Japan
[2]Japan Atomic Energy Research Institute, Sayo, Hyogo 679-5148, Japan

Introduction

Magnetic circular dichroism (MCD) for x-ray emission is expected to be an important technique to study magnetism, since it gives the information on many about a magnetic state rather than x-ray absorption gives. In order to develop the technique to measure the MCD for x-ray emission in the 4d-4f excitation region, we have chosen a Gd bulk sample which was expected to show large MCD signals and multiplet effect.

Experimental

The experiment was performed at an undulator beamline, BL-28A. The x-ray emitted from the sample was analyzed by a spectrometer. The resolution of the spectrometer was better than 0.5 eV at 120 eV. We also measure the MCD for x-ray absorption by the total photoelectron yield (TEY) method.

Results and Discussion

Fig.1 shows the TEY and its MCD spectra for the Gd sample in the 4d-4f excitation region.

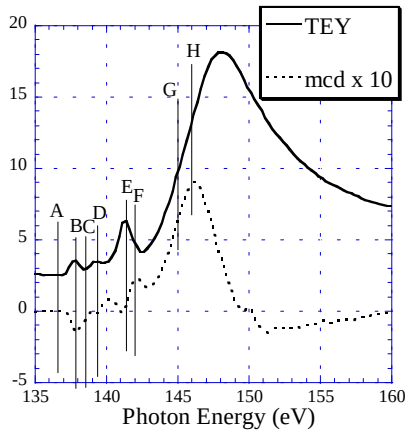

Fig. 1 TEY and MCD spectra for Gd.

Figs 2 and 3 show XES and their MCD, respectively. The letters in the figure indicate the excitation energy in Fig. 1. Some spectra are multiplied by a factor indicated following the letters. The energy shift in these figures was obtained by subtracting the excitation energy from the emission energy. At the energy loss of –22 eV, a clear Raman scattering was observed. This peak is assigned as $5p^5 4f^8$ final state. The Raman scattering extremely enhanced when the excitation energy was set at B in Fig. 1, and the large MCD signal was also observed.

The magnetic moments estimated by TEY and XES

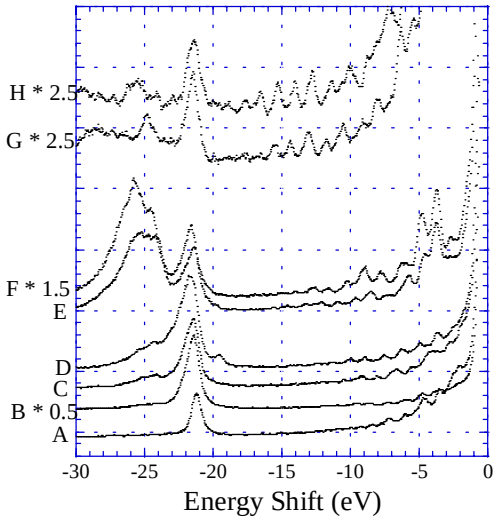

Fig. 2 X-ray emission spectra for Gd.

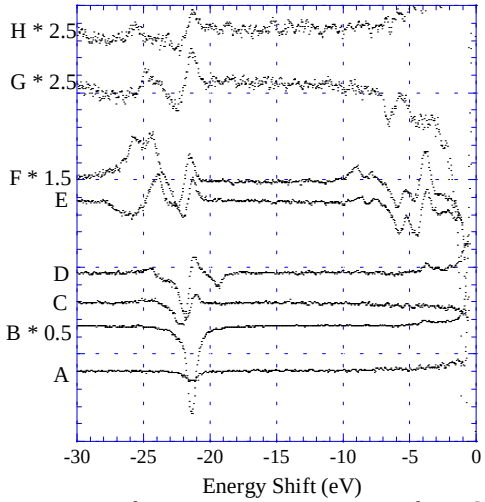

Fig. 3 MCD for x-ray emission spectra for Gd.

were 0.42 μ_B and 1.8 μ_B, respectively. This discrepancy shows that the x-ray emission is bulk-sensitive and the magnetic moment estimated by the x-ray emission is that in the bulk. On the other hands, the TEY is surface-sensitive and the contamination on the surface reduces the magnetic moment. Therefore, we conclude that the magnetic state in the bulk and on the surface can be investigated by measuring the XES and TEY.

* takayama@phys.metro-u.ac.jp