8C2,15B1,15C/2004G261

XMLD study at the L_2 edge of Gd in transmission with polarization switching method

Toru KURIYAMA*[1], Yoshinori UEJI[1], Yuki BISAIJI[1], Takafumi SHIMIZU[1], Kohei OKITSU[2], Yoshiyuki AMEMIYA[1],
[1] Department of Advanced Material Science, The University of Tokyo, Kashiwanoha, Kashiwa, Chiba 277-8561, Japan
[2] Engineering Research Institute, The University of Tokyo, Yayoi, Bunkyo, Tokyo 113-8656, Japan

Introduction

X-ray magnetic linear dichroism (XMLD) is the absorption difference for linearly polarized light (parallel or perpendicular to the magnetization), while X-ray magnetic circular dichroism (XMCD) is absorption difference for circularly polarized light (right-handed or left handed). XMCD is known to be odd for magnetization **M,** i.e., it reverses its sign when **M** is reversed, therefore XMCD cannot be applied to anti-ferromagnetic materials. On the other hand, XMLD does not change its sign when **M** is reversed, so it can be applied to not only ferromagnetic but also anti-ferromagnetic materials.

The research on XMCD has been actively performed because of its particular aspects (e.g., element selective, capable of separating orbital and spin magnetic moment), and XMCD has become a useful tool for investigating magnetic feature of materials. However, few XMLD studies have been reported as yet [1], especially XMLD spectra in transmission method[2,3]. One of the reasons might be that XMLD signal is expected to be much small compared to XMCD signal[1].

In our experiment, we attempted to detect XMLD spectra at the L_2 edge of Gadolinium (7930 eV). Gd is lanthanoid, 4f shell of which is filled with 7 electrons. It forms a hcp crystal structure, and is a simple ferromagnet below the critical temperature T_c=297 K. We performed this experiment using a universal X-ray ellipsometer, with polarization switching mode. In addition to XMLD, XMCD is also measured because it is predicted that in the particular situation (e.g. spherical symmetry for 3d transition metals) XMLD spectra are proportional to the energy derivative of XMCD spectra[1].

Experimental

The experiment was performed at BL-8C. The sample was Gd polycrystal sheet, the thickness of which was estimated to be about 3 µm. It was chilled to 4°C, and its magnetization axis was controlled by permanent magnet. At a fixed magnetization direction, X-ray beam is switched between horizontal and vertical polarization for XMLD, and between right- and left-handed circular polarization for XMCD in turn, so as to detect the dichroic signals. The same experiments are made with saturated magnetization axis changed to reverse the dichroic signals. The magnetic dichroism signals was extracted by removing XNCD and XNLD. Measurements was repeated 5 times at a fixed magnetization direction.

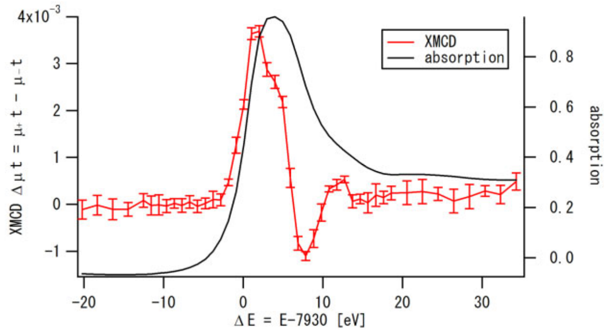

Fig. 1 XMCD spectrum

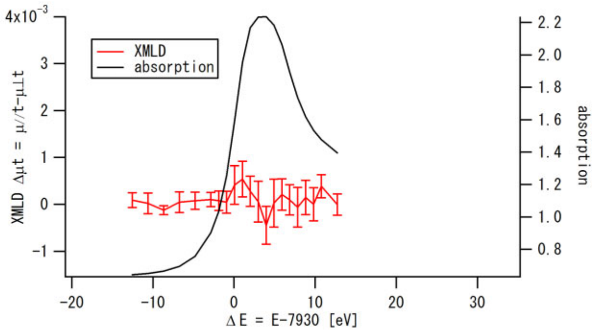

Fig. 2 XMLD spectrum

Results and Discussion

Figures 1 & 2 show XMCD and XMLD spectra. At the maximum XMCD shows about 0.2% of the edge jump, and its spectrum coincides with previous result[4]. However, XMLD signal is buried in error bars and not so large enough to make quantitative discussion.

In order to make quantitative discussion, the following points should be considered in the next experiments.

Using a bragg reflection of smaller indices of monochromator in order to obtain more photon flux

Using thinner and larger samples in order to obtain stronger transmission light

Using more brilliant light source

References

[1] J. Kunes et al., Phys. Rev. B 67, 024431 (2003).
[2] J.B. Kortright et al., Phys. Rev. B 62, 12216 (2000).
[3]H.-Ch. Mertins et al., Phys Rev. Lett 87, 047401 (2001).
[4]G. Schütz et al, Z. Phys. B 73, 67 (1988).
* kuriyama@x-ray.k.u-tokyo.ac.jp