Photon Factory Activity Report 2012 #30 (2013) **B**

BL-3C/2012G643

Development of a simple method of monochromatic X-ray magnetic diffraction for magnetic multilayer films

Hidefumi Shimoyama[1], Hiromi Watanabe[1], Kenta Hiiragi[1], Kosuke Suzuki[1], Hiroshi Ssakurai[1] Keiichi Hirano[2] and Masahisa Ito[1,*]

[1]Graduate School of Eng., Gunma Univ., Kiryu 376-8515, Japan

[2]Photon Factory, Tsukuba 305-0801, Japan

1 Introduction

X-ray magnetic diffraction (XMD) experiments have been performed by using elliptically-polarized white X-rays on PF-BL-3C. In this method diffracted X-rays are apt to be contaminated with fluorescent X-rays. Especially for multilayer samples fluorescent X-rays are occasionally more intense than diffracted X-rays. Therefore we need to develop a monochromatic XMD method which is almost free from fluorescent X-rays.

We had developed a monochromatic XMD method by using a phase plate and a double crystal monochromator [1]. In this study we aim to develop a simpler method of XMD by using only a double crystal monochromator.

2 Experiment

We have utilized the XMD experimental system on PF-BL-3C. Experimental setups of the conventional white X-ray method and a simple monochromatic X-ray method using a Si(111) double crystal monochromator are shown in Fig. 1 (a) and (b). The sample was a single crystal of Fe and we have measured diffraction intensity of 220 reciprocal lattice point in horizontal scattering plane with 90° scattering angle. The X-ray energy for Fe 220 diffraction is 8.65keV, and the Bragg angle of Si (111) plane for this X-ray energy is 13.2°.

3 Results and Discussion

First we have measured the diffraction intensity for various vertical positions of the slit together with the sample. This intensity corresponds to the one of the vertical component of elliptically polarized X-rays. The result is shown in Fig. 2. The intensities of both methods are normalized by their minimum values. The origin of the horizontal axis represents the vertical position of the electron orbital plane of the storage ring. In Fig. 2 both methods provide similar profile. This suggests that the incident X-ray polarization is not altered much by the monochromator in this case.

Next we have measured the magnetic effect (flipping ratio) *R* of the diffraction intensities accompanied by reversing the magnetic field direction. The *R* values have been measured for various vertical positions of the slit and sample. The result is shown in Fig. 3. Though slight asymmetry is seen in the profile of monochromatic X-ray method, which will be discussed elsewhere, the monochromatic XMD method by using only a double crystal monochromator is shown to be essentially possible.

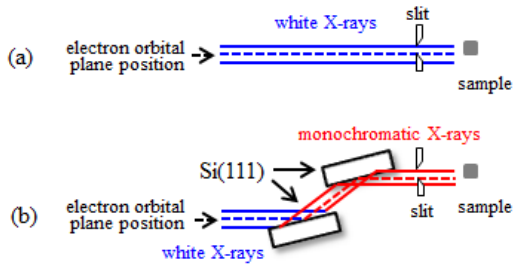

Fig. 1 (a) White X-ray method. (b) monochromatic X-ray method using a double crystal monochromator.

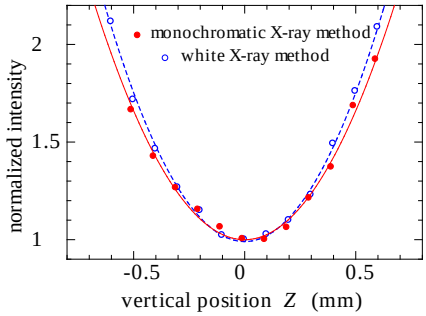

Fig. 2 Fe 220 diffraction intensities measured for various vertical positions of the slit together with the sample.

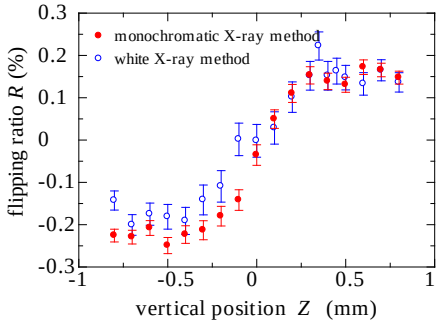

Fig. 3 Flipping ratios values for various vertical positions.

Acknowledgement

The authors thank Prof. X. Zhang for kind help and useful discussion in the experiment at the Photon Factory.

References

[1] M. Ito and K. Hirano, *J. Phys.:Cond. Matter* **9**, L613 (1997).

* itom_phys@gunma-u.ac.jp