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Development of a new X-ray magnetic diffraction method using a long period of magnetic field reversal

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Introduction

X-ray magnetic diffraction (XMD) experiments on BL3C have been performed by using a short period, typically 10s, of magnetic field reversal to measure magnetic effect (flipping ratio) of diffraction intensities. This was because we have needed to compensate monotonic decrease of synchrotron radiation intensity. Recently the Photon Factory storage ring started top-up operation (April 2009), and the incident X-ray intensity has come to be almost constant. In this study we try a longer period of magnetic field reversal. This study will lead to the XMD experiment using a superconducting magnet that produces magnetic field of the order of ten tesla but needs long magnetic-field reversing time.

Experiments

First we modified the XMD measurement program that controls the experimental sequence for accepting various periods of magnetic field reversal. We made the XMD experiment of two samples. One was a pure Fe crystal and the other was a Fe_3Pt crystal. We measured the flipping ratio of diffraction intensities of (110) and (221) reflection plane for Fe and Fe_3Pt, respectively. The period of magnetic field reversal was 10s, 50s, 250s and 1000s.

Results and Discussion

The observed flipping ratios of Fe and Fe_3Pt are shown in Fig. 1 and Fig. 2, respectively. In these figures the flipping ratios of fluorescence intensities are also shown, which are expected to be much smaller in magnitude and much closer to zero than those of diffraction intensities. Miller indices of the diffracted X-rays are 220, 330, 440 and 550 for Fe, and 221 and 442 for Fe_3Pt. Fluorescence X-rays are FeK_α and FeK_β for Fe sample and FeK_α, FeK_β, PtL_α and PtL_β for Fe_3Pt sample. In Figs. 1 and 2 it is noted that the data points of 1000s deviate largely from the others. Especially the fluorescence data are shifted from zero, which infers variation of the incident X-ray intensity.

We tried to correct the spectrum data so as that the flipping ratio of fluorescence X-rays of $FeK_\alpha+K_\beta$ for Fe and PtL_α for Fe_3Pt is zero. The corrected flipping ratios of the diffraction data for Fe and Fe_3Pt are shown in Figs. 3 and 4, respectively. In Figs. 3 and 4 it is noted that the flipping ratios for 10s, 50s, 250s and 1000s agree within the statistical errors.

In conclusion, we have successfully performed the XMD experiment using a long period, 1000s, of magnetic field reversal by correcting the spectrum data so as that the flipping ratio of the fluorescence X-rays is zero. This result will lead to a new XMD experiment using a superconducting magnet.

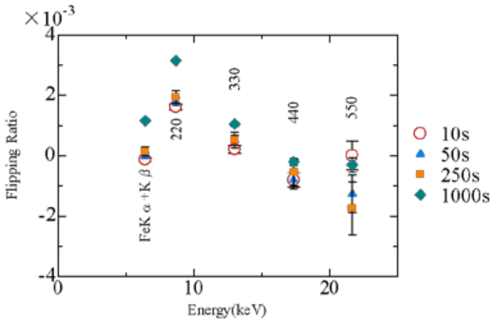

Fig. 1 Observed flipping ratio of Fe.

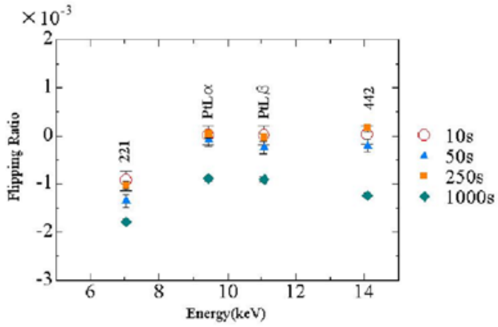

Fig. 2 Observed flipping ratio of Fe_3Pt.

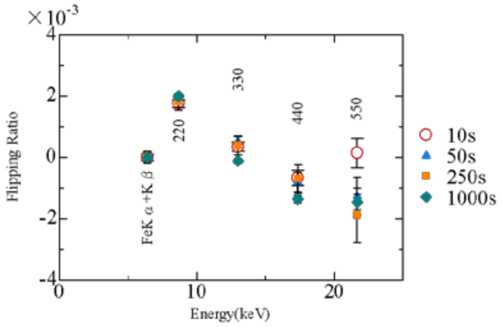

Fig. 3 Corrected flipping Ratio of Fe.

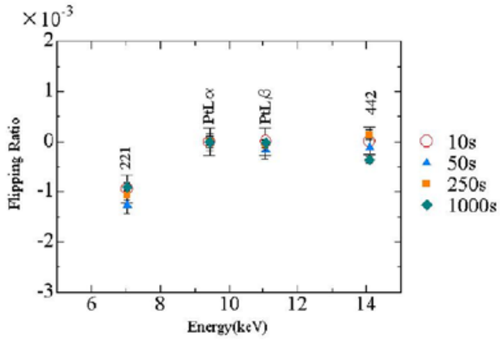

Fig. 4 Corrected flipping ratio of Fe_3Pt.