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Upgrade of X-ray Magnetic Diffraction Experimental System

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Introduction

We have performed X-ray magnetic diffraction (XMD) experiment of ferromagnets on the BL3C3. We have upgraded the XMD experimental system in order to apply this method to as many samples as possible and to perform the experiment more effectively. The upgrade was made for the X-ray counting system, the electromagnet and the refrigerator.

Details of upgrade

1. X-ray counting system: We use a high count-rate type Ge-SSD, a DSP module (digital signal processor, CANBERRA Model 9660), and software-type MCA (CANBERRA Genie 2000). In order to control the MCA in the XMD experiment we made the measurement program by using Visual Basic.
2. Electromagnet: The upgraded electromagnet (Tamagawa Ltd) can be operated at 60A and is designed to produce magnetic field over 2T. Precise magnetic field measurement showed that the maximum field was 2.15T.
3. Refrigerator: In the upgraded system, we use a more powerful refrigerator (Iwatani Ltd. HE05) in which the sample temperature is as low as 5K.

Experiments and results

Preliminary experiment was made to check the count-rate performance of the upgraded system. We measured intensities of 220, 330, 440 diffraction of Fe. The X-ray intensity incident on SSD was changed by inserting aluminum foils of various thicknesses between the sample and the SSD. The obtained data was fitted with the following conventional equation (1),

$$I = I_0 e^{-\mu t}, \qquad (1)$$

where I_0 is the incident X-ray intensity on the Al foils, and I is the transmitted X-ray intensity through the Al foils, μ is the absorption coefficient of Al and t is the thickness of Al foils.

The results are shown in Fig. 1. In Fig. 1 the obtained data were plotted against thickness of Al foils. The data of solid circles, open squares, and crosses are corresponding to the diffraction of 220, 330, and 440, respectively. These observed data were expressed well by the lines that were calculated with the equation (1). Without Al foils, the total diffracted X-rays intensity amounted to 2.1×10^5cps. It was confirmed that upgraded X-ray counting system is able to measure the X-ray intensity up to at least 2.1×10^5cps which is ten times higher than the maximum count rate of the previous system.

We examined count rate dependence of the flipping ratio (magnetic effect) of Fe 220 diffraction intensity. The diffraction intensity was changed by changing the size of the incident X-ray beam on the sample from 90μm×90μm to 200μm×200μm. Then, the X-ray intensity was varied from 2.0×10^4cps to 1.1×10^5cps and the flipping ratio of Fe 220 diffraction was measured.

The result is shown in Fig. 2. In Fig. 2, the flipping ratio is plotted against the total intensity of diffracted X-rays. Because of limited measurement time we have fairly large error bars. The observed flipping ratio keeps constant within the estimated error bars in the observed count rate. Therefore, it is concluded that the upgraded system is able to measure flipping ratio up to the count rate of 10^5 cps. Details are presented in the literature[1].

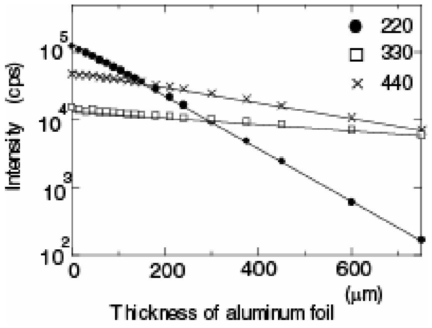

Fig. 1 Measured X-rays intensity of 220, 330 and 440 diffraction of Fe for various thicknesses of Al foils.

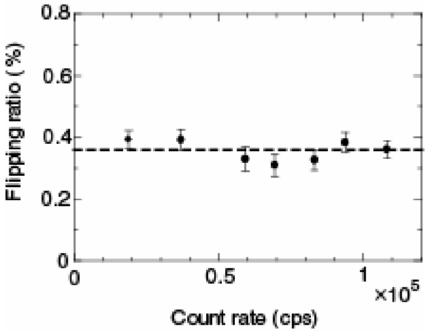

Fig. 2 Count rate dependence of the flipping ratio of Fe220 diffraction.

References

[1] K. Suzuki et al., AIP Conference Proceedings, Synchrotron Radiation Instrumentation, Vol. 879, 1691 (2007).

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