

Efficiency Test of Diamond Phase Retarder and Polarization Analysis

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X-ray transmission phase plate has opened out wide application for magnetic scattering and absorption experiments [1]. The phase plate functions both as a $\lambda/4$ -phase plate to convert linear polarization to circular one and as a $\lambda/2$ -phase plate to generate vertical linear polarization. In this work, to estimate the efficiency of a diamond phase plate, the polarization state of the converted X-rays is characterized by polarization analysis.

A synthetic diamond (111) crystal slab 0.73 mm in thickness was operated around the 220 reflection in transmission Laue geometry. A Si(331) channel-cut crystal was mounted on the χ -axis of 4-circle goniometer together with a scintillation counter.

Degree of polarization was estimated from the angle dependence of intensity expressed as follows:

$$I(\chi) = S_0 + S_1 \cos 2\chi + S_2 \sin 2\chi, \quad (1)$$

where S_0 is an angle-independent term, S_1 and S_2 correspond to the components of Stokes parameter P_3 . In linear polarization, degrees of π and σ polarizations can be estimated by S_1/S_0 and S_2/S_0 , and degree of circular one was derived from $\sqrt{[1 - (S_1/S_0)^2 - (S_2/S_0)^2]}$ on the assumption of no-unpolarized term.

On this beamline the linearly polarized X-rays (π polarization) emitted from a linear undulator are originally available. Degree of linear polarization at 7.1195 keV was evaluated to be 0.998 by a logarithmic fitting to eq.(1). Such a high rate is suitable for not only the magnetic scattering but also a conversion to other polarization states. Indeed, the linearly polarized incident X-ray can be converted to

the circular polarization by adjusting an offset angle from the Bragg condition so as to produce a $\pi/4$ phase shift. Degree of circular polarization was also estimated to be 0.997. Another conversion is to generate a vertical linear (σ) polarization as a $\lambda/2$ -phase plate. Degree of linear polarization was evaluated to be 0.82. This deterioration is possibly due to the contamination of simultaneous reflections and/or higher harmonics of the undulator light. Figure 1 shows the angle dependence of intensity for each of the polarization state.

The present test clearly demonstrates that the phase retarder functions as both a $\lambda/4$ - and a $\lambda/2$ -phase plate, and that the converted X-ray has a high-rate of degree of polarization.

References

- [1] K.Hirano and H.Maruyama; Jpn.J.Appl. Phys., **36** (1997) L1272.

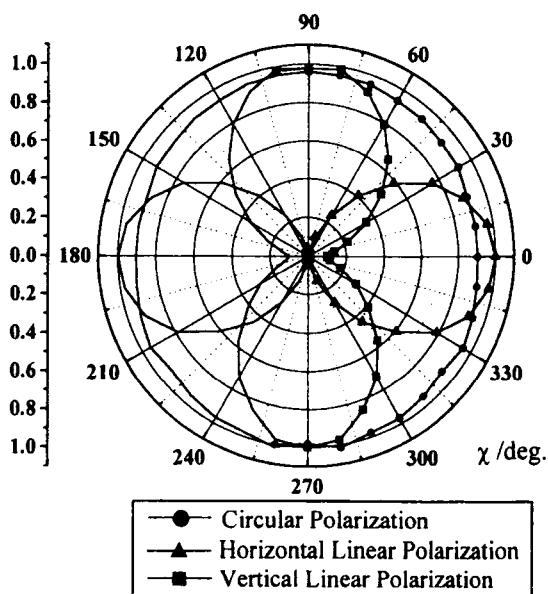


Fig.1. Angle dependence of X-ray intensity.