Efficiency Test of Diamond Phase Retarder and Polarization Analysis

H. Maruyama*[1] (1280), M. Suzuki[2] (1173), N. Kawamura[1] (1205), M. Ito[3] (1220), K. Hirano[4] (3392), M. Kuribayashi[5] (3371), A. Kokubun[5] (3372), and S. Goto[6] (724)

(1) *Fac. of Sci., Okayama Univ., 3-1-1 Tsushima-Naka, Okayama 700-8530.*
(2) *Physical and Chemical Institute, 323-3 Mihara, Mikazuki, Sayou 679-5143.*
(3) *Fac. of Sci., Himeji Inst. Technology, 1475-2Kanaji, Kamigouri, Akoh 678-1297.*
(4) *Institute of Material Structure Science, KEK, 1-1 Oho, Tsukuba, Ibaraki 305-0801.*
(5) *Fac. of Sci. and Tech., Science University of Tokyo, 2641 Yamazaki, Noda 278-8510.*
(6) *Japan Synchrotron Radiation Research Institute, 323-3 Mihara, Mikazuki, Sayou 679-5143.*

X-ray transmission phase plate has opened out wide application for magnetic scattering and absorption experiments [1]. The phase plate functions both as a λ/4-phase plate to convert linear polarization to circular one and as a λ/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:

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

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 7.1195keV 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 π/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 λ/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 λ/4- and a λ/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.

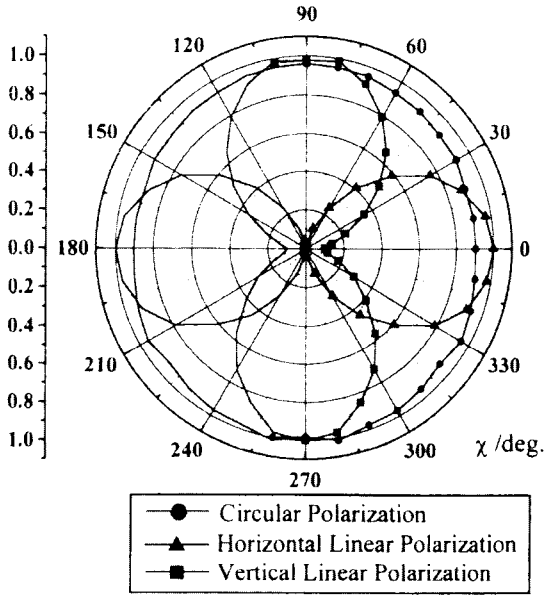

Fig.1. Angle dependence of X-ray intensity.