Development of a Quarter-wave Plate near Carbon K-edge by Using Graphite

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We present a quarter-wave plate near photon energy 290 eV. A quarter-wave plate is a polarization element that retards the phase between s- and p-components 90 degrees. It changes polarization state, from linear polarization to right or left circular polarization for example. By using the quarter-wave plate, the circularly polarized light is available without a light source specialized for circular polarization, such as helical undulator in the synchrotron ring.

Crystals with low symmetry were calculated to have large phase retardation near its absorption K-edge [1]. These crystals were predicted to work as a quarter-wave plate. We measured polarization properties of graphite crystal, which has K-edge at 284.1 eV. The evaluation was carried out by using linearly polarized synchrotrons radiation at BL27SU of the SPring-8. A versatile apparatus for polarimetry and ellipsometry [2] was attached to the beamline. Rotating analyzer method was performed in the apparatus to obtain the phase retardation and polarizance, normalized difference between the reflectivity of s- and p-components. Figure 1 shows the measured phase retardation and polarizance as a function of glancing angle at 289.1 eV. At the glancing angle of 6.1 degree, the graphite had the phase retardation 90 degrees and worked as a quarter-wave plate.

In the soft x-ray region, a quarter-wave plate is usually designed by transmittion-type multilayer. However, a quarter-wave plate of this type for 290eV is not available. The throughput of graphite was as high as 1%, which is much higher than that of a phase retarder designed by multilayer. Lamellar crystals would be new type of polarization elements in the soft x-ray region.

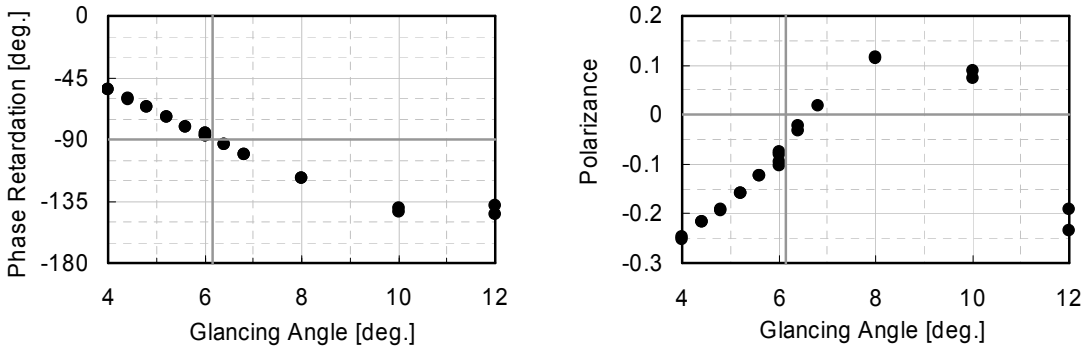

Figure 1. The phase retardation (panel a) and polarizance (panel b) of the graphite at 289.1 eV.

[1] V. Sh. Machavariani, Phy. Rev. Lett. **80** (1998) 1541.
[2] H. Kimura, T. Hirono, T. Miyahara, M. Yamamoto, and T. Ishikawa, Synchrotron Radiation Instrumentation: Eighth International Conference, edited by T. Warwick et al., **AIP CP705** (2004) 537.