Development of X-ray depolarizer based on phase retarder
– Generation of depolarized X-rays from polarized X-rays –

Yoshinori UEJI [1] , Kohei OKITSU[2], and Yoshiyuki AMEMIYA*[1, 3]
[1]Department of Applied Physics, Univ. of Tokyo, Bunkyo-ku, Tokyo 113-8656 Japan
[2]Engineering Research Institute, Univ. of Tokyo, Bunkyo-ku, Tokyo 113-8656 Japan

Introduction

Recently polarization property of synchrotron radiation has been utilized in some experiments such as X-ray magnetic circular dichroism and ATS scattering. Incidentally most of samples of interest are more or less sensitive to X-ray polarization. Therefore, strictly speaking, it is necessary to characterize the polarization of incident X-ray beam to a sample regardless of the intention whether or not to utilize the polarization property, though it is not practical. It is also not easy to calculate the polarization of incident X-ray beam, because the polarization property depends on optical elements such as mirrors and monochromator. Therefore, it would be beneficial to utilize non-polarized X-ray in stead of not-well-defined polarized X-ray for the experiments in which the use of polarized X-rays is not intended and/or complicates the data analysis. For an example, multi-wavelength anomalous dispersion (MAD) method widely used in protein structure analysis assumes no polarization dependence of anomalous scattering factors. Here, we will propose an idea to use a transmission-type X-ray phase retarder [1] as a depolarizer in order to generate non-polarized X-ray from the polarized synchrotron X-ray radiation.

An X-ray phase retarder is an optical component to utilize double refraction taking place in the vicinity of Bragg condition in perfect crystals like silicon and diamond. The phase shift between σ- and π- component is approximately proportional to the inverse of deviation angle from Bragg condition. Therefore, it rapidly changes at the most vicinity of Bragg condition, whereas it slowly changes in a region further from Bragg condition where it is usually used as phase retarder. If the phase retarder is set just at Bragg condition, random phase shift is given to the incident beam on average and results in generating pseudo non-polarized X-ray whose polarization states are uniformly distributed along a great circle which passes through the north and south pole on the Poincaré sphere. We will report on the performance of a pseudo depolarizer based on a phase retarder.

Experimental

The depolarizer has been evaluated by using a sample which shows linear dichroism (LD). We have compared the magnitude of LD with two different incident beams: one with (a) only polarizer and the other with (b) polarizer+depolarizer (Fig.1).

The energy of the incident X-ray is set at the cobalt *K* absorption edge (7709 eV). The energy spread is about 1 eV, and the horizontal beam divergence is 20 arcsec. The phase retarder is a (100)-oriented diamond (about 300 m thickness) crystal giving 111 reflection in an asymmetric Laue geometry. The sample used is an *h.c.p.* cobalt single crystal.

Results and Discussion

The absorption coefficient (μt) of (b) was normalized to that of (a) at the absorption edge. The magnitude of linear polarization has been decreased to less than 5% by the use of the depolarizer (Fig. 1). It means that the degree of the linear polarization is decreased to 5%. The loss of the X-ray intensity with the depolarizer is 50%. The obtained non-polarized X-ray beam will be useful to XAFS, MAD experiment for protein crystallography.

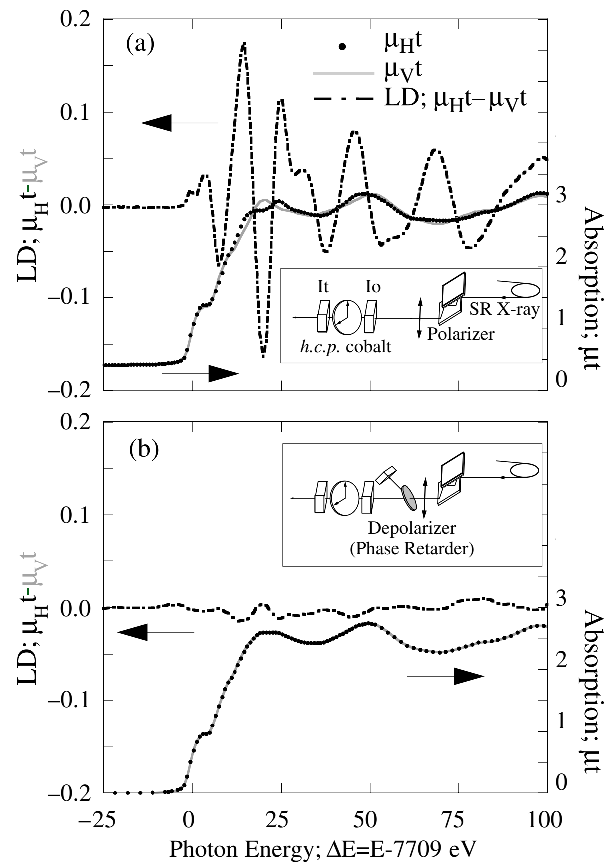

Figure 1: Evaluation of the depolarizer

References

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Present address: Department of Advanced Materials Science, Univ. of Tokyo, Kashiwa, Chiba 277-8581, Japan

* amemiya@k.t.u-tokyo.ac.jp