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A DOUBLE CRYSTAL MONOCHROMATOR FOR SOFT X-RAY BEAM LINE OF UVSOR


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Abstract A simple, constant offset, high vacuum compatible double crystal monochromator has been constructed for the soft x-ray beam line of UVSOR storage ring. Na K-edge XANES and EXAFS spectra are presented as examples of the performances of the monochromator.

1. Introduction

The UVSOR is a 600MeV (750MeV max.) dedicated electron storage ring in the Institute for Molecular Science at Okazaki, Japan, constructed mainly for the use of VUV photons\(^{(1)}\). The calculated intensity distribution of the radiation is shown in Fig. 1. As shown in the figure, the intensity of the soft x-ray around 10Å are not negligible especially in 750MeV operation. Moreover, a 4T superconducting three-pole horizontal wiggler is installed in the straight section.

![fig1.png](http://dx.doi.org/10.1051/jphyscol:1986824)

Fig. 1 Calculated intensity distribution of the radiation from ordinary bending section and the superconducting wiggler of the UVSOR storage ring.

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In order to utilize the soft x-ray and normal x-ray photons from the UVSOR ring, we designed and constructed a double crystal monochromator (DXM) with following characteristics; (a) constant offset, (b) monochromator crystals with small size, (c) simple mechanism, (d) high vacuum compatible. In this paper, the mechanism and several performances of the DXM are presented.

2. Mechanism of DXM

In order to realize the constant offset, i.e. constant output beam position during the rotation of the crystals, we chose a simple mechanism of linear movements of the two crystals, perpendicular with each other. The principle of the mechanism is shown in Fig. 2. The two crystals are placed on the each side of a L-shaped base. The center of rotation (point O in the figure) is placed at the position whose distances to both input and output beam level are the same. The positions of the each crystal are controlled by two linear guides placed on both levels to be at the input and the output beam positions. The mechanical movement was found to be very smooth through a full rotation of 60° (between 15° and 75° of Bragg angle), and a constant offset was successfully achieved. The principle of the mechanism is that discovered by Golovchenko et al. The mechanism is similar to that of Cowan et al. Light beam irradiates the fixed small area of each crystal in any incident angle. Therefore it is not necessary to use monochromator crystals with large area. The actual area of the crystal surface is 20mm×20mm. For fine adjustments of the crystal plane, two piezo-electric transducers (Berley Inchworm, vacuum compatible version) are used for the second crystal.

3. Performances

The monochromator crystals such as beryl(1010), mica(001) and KAP(100) whose 2d value are 15.98Å, 19.80Å, and 26.64Å, respectively were tested. In Figs. 3(a) and (b) are shown the throughput transmission spectrum of the DXM for beryl crystal at the operating condition of the ring of 750MeV and about 30 mA. No radiation damage was observed for both beryl and mica crystals. The KAP crystal, however, suffered a serious damage on the surface even in the 600MeV operation.

Figs. 4(a) and (b) show the Na K-edge XANES and EXAFS spectrum of a thin film of NaCl which was evaporated in situ on a collodion film in a sample chamber. Despite the presence of many structures due to impurities and constituent atoms in the monochromator crystal in the throughput transmission spectrum, no structure appears in the absorption spectrum of NaCl. All the structures were eliminated by the division of signals without and with a sample. From the doublet separation of the spectrum in Fig. 4(a) we can estimate the resolution of about 1 eV which is practically sufficient for this energy range.
A monochromator chamber is evacuated with an ion pump for the use of the soft x-ray. To avoid the influence to the ultra high vacuum in the storage ring, a light tight Be foil with a thickness of 10μm is placed in the upstream of the monochromator in the beam line. As a result, the long wavelength limit is 18Å.

Fig. 3 Throughput transmission spectra of DXM for monochromator crystal of (a) beryl and (b) mica.

Fig. 4 K-edge (a)XANES and (b)EXAFS spectra of evaporated NaCl film on collodion at room temperature.

Other crystals such as InSb (111) and Quartz (1010) are also prepared. They are planned to be used along with a superconducting horizontal wiggler.

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