Performance test of the Monochromator Crystal KTP

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The soft X-ray region, 1000 eV ～4000 eV contains a number of absorption edges; K edges of Na～Ca and L edges of Zn～Sn. To get monochromatized soft X-rays above 1800 eV, we generally use crystals such as InSb(111), Ge(111) and Si(111), but in the low energy region (1000 eV ～1800 eV), there are few crystals tolerant of radiation and heating for monochromators [1]. KTP ($KTiOPO_4$ potassium titanyl phosphate) is one of the candidates of a monochromatizing crystal, covering the energy range of 1.3 keV～1.8 keV. Al and Mg K-edges and As, Se, Br L-edges are included in this energy region. Takata et al. have ever tested the feasibility of KTP crystal and reported that the crystals were easily deteriorated by SR irradiation [2].

We examined the feasibility of KTP crystals in the double crystal soft X-ray monochromator beamline, BL-10 of the SR center. KTP crystal pair in a size of 25 x 25 x 2 mm^3 were purchased from Crystal Base Ltd. and used for the test.

Figure 1 shows a continuous measurement of the Al K-edge XANES spectra of aluminum foil for 3 hours. Ring current decayed from 259 mA to 161 mA and the peak shifts to the lower energy by 0.2 eV and the relative intensity I/I_0 increased with the decrease of the ring current. This clearly shows that the crystal detuning by the thermal expansion of the 1st crystal was gradually mitigated with the decrease of beam intensity.

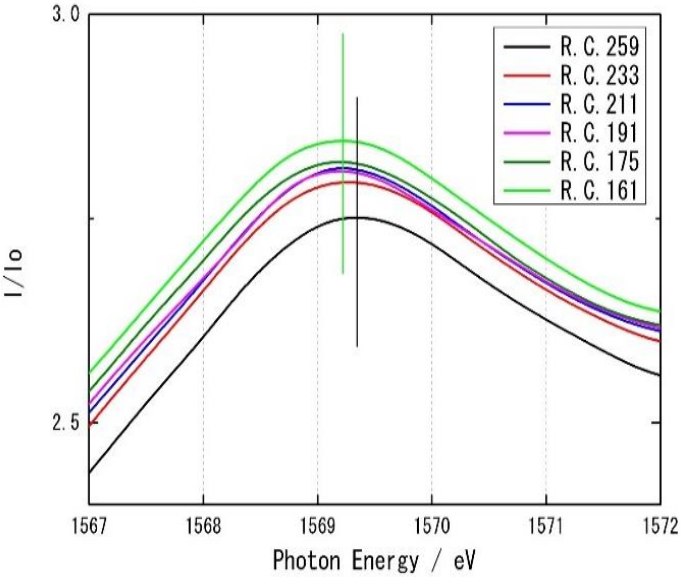

Fig.1 Al K-edge XAFS spectra of aluminum foil. R.C. denotes the synchrotron ring current.

P K-edge XANES spectra from SR

innradiated and non-irradiated KTP are shown in Fig. 2. The spectra of the bulk sensitive PFY mode are almost same to each other, while those of the surface sensitive TEY mode are siginificantly differenct from each other: SR irradiation causes the enhancement of the white line. This result suggests that the surface structure of the KTP cryastal has been somewhat changed by the SR irradiation.

To overcome the deterioration of the KTP crystal by SR irradiation, we coated a gold thin film on the crystal surface and examined how it works.

Figure 3 shows the I_0 intensities from gold coated and non-coated KTP crystals as functions of the elapsed time. I0 intensity from a bare polished KTP crystal decays rapidly with time, while the gold coated one stays almost constant, taking the beam current decay into account.

This dramatic improvement by gold coating is very promising as the monochromatizing crystal of KTP for Mg and Al K-edge XANES spectra.

Gold coating on the crystal causes decrease of the diffracted intensity to some extent. Thus, we have to find an optimum tchikness of the gold film. Further studies for the KTP crystals are now in progress.

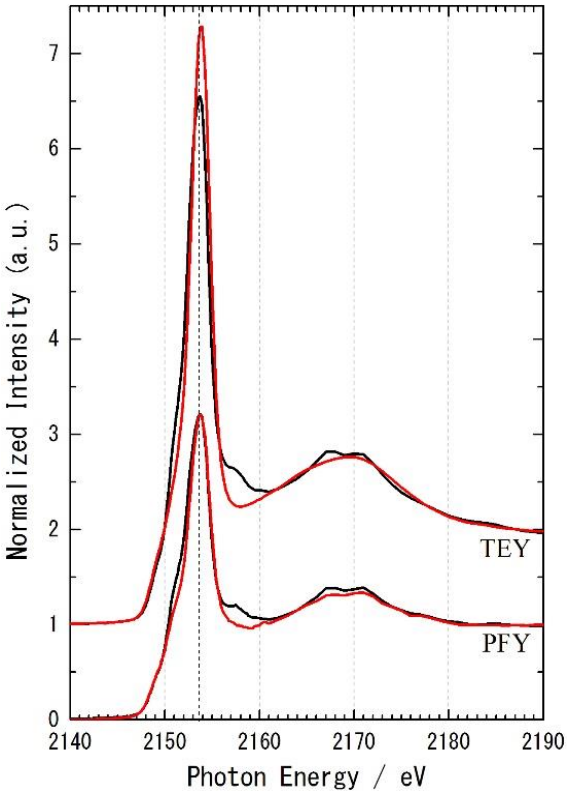

Fig.2 P K-XANES spectra of SR irradiated (red) and non-irradiated (black) KTP crystal. Upper spectra are taken with the total electron yield mode (TEY) and lower are with the partial fluorescence yield mode (PFY).

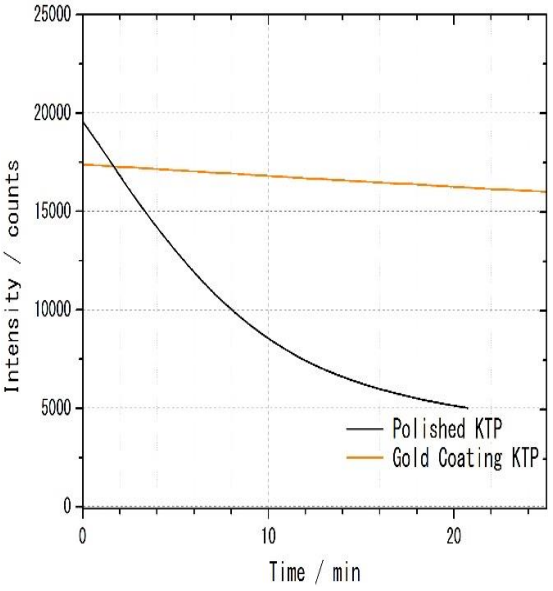

Fig.3 I_0 intensity of monochromatized beam from a bare KTP pair and a gold coated KTP pair as a function of the elapsed time. Ring current decay curve is also shown.

References

(1) K.Nakanishi and T. Ohta, *Surf. Interface Anal*., **44** (2012) 784 - 788.

(2) Y. Takata and E. Shigemasa and N. Kosugi, J. Synchrotron Rad., **8**(2001) 351 – 353.