F K-XAFS Spectrum of NaF powder obtained at the soft X-ray Microscopy Beamline BL-12

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Zone-plate-based soft X-ray full-field transmission X-ray microscopy (XM), installed in BL-12, is a unique tool which can provide 2-D images of light elements, such as carbon and oxygen. The beamline optics at BL-12 covers the photon energy from 280 - 800 eV. The energy resolution, $E/\Delta E$, can be estimated by the outermost zone width of the condenser zone plate and the size of the pinhole. About 300 was expected by using the pinhole of 15 μm diameter [1]. BL-12 was designed for X-ray imaging and we have frequently reported on the spatial resolution evaluated experimentally, but not on the energy resolution. It is a challenge to confirm the energy resolution experimentally and apply to obtain absorption spectra. In the present work, we examined how good we can reproduce absorption spectra by using the image data obtained so far.

Sodium fluoride (NaF) powder was chosen as the sample. The powder was mounted on the X-ray transparent silicon nitride (SiN) membrane. Every image with and without sample was taken with the step of 1 eV from 660 to 710 eV. Exposure time of each image was 60 s.

Figure 1 shows X-ray images with and without sample at 670 eV. F K-edge spectrum was obtained as follows. (1) A region of interest (ROI) was fixed for each image with and without sample, as shown in Fig. 1. (2) The grayscale values of the pixels in the ROI of the image with sample (Fig. 1a) were summed up (I). (3) The grayscale values of the pixels in the ROI of the image without sample (Fig. 1b) were also summed up (I_0). (4) $\log(I_0/I)$ was plotted as a function of the energy. All the images were analyzed in ImageJ (Version 1.52a, NIH, USA).

The spectrum obtained is shown in Fig. 2, compared with the reference by Nakai *et al* [2], where the photon energy was shifted by 6 eV, so as to fit the first main peak. It is a surprise to show a good agreement with the reference spectrum, which was taken with a grazing incidence monochromator in Photon Factory, whose energy resolution $E/\Delta E$ is about 2,000 [3].

These results suggest that the energy resolution of XM achieves 300 in this energy range.

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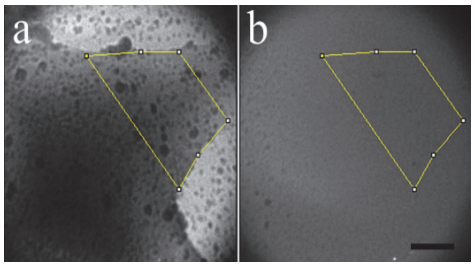

Fig. 1 X-ray images with sample (a) and without sample (b) at 670 eV. Area surrounded by a polygon is the ROI. Scale bar is 5 μm.

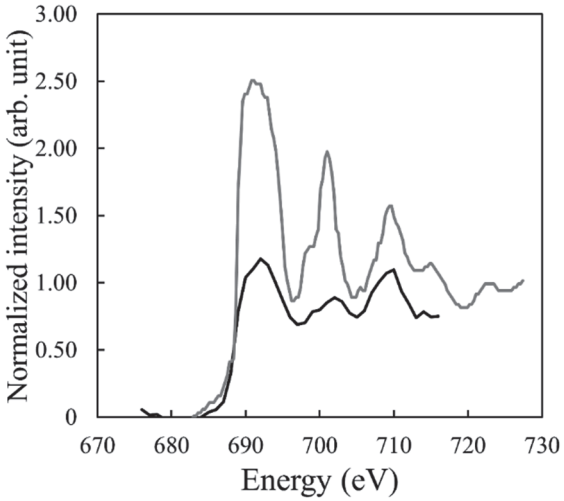

Fig. 2 F K-edge XAFS spectra of NaF powder. Black line: XAFS spectrum extracted from the XM images. Gray line: that obtained with the total electron yield mode [2].

References

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