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X-ray absorption study by using CCD camera

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Introduction

We have examined the local structure of nuclear materials by using the X-ray absorption fine structure (XAFS) technique [1]. The normal XAFS measurement gives the 'averaged' structural information on the sample area corresponding to X-ray beam size (for example 2mm×2mm). Recently, Sakurai et al. constructed the quick atomic scale XAFS system based on X-ray fluorescence imaging recorded by CCD camera [2]. The atomic scale structure can be analyzed in a short time. In the present work, the similar XAFS measurement based on a transmission-type X-ray absorption imaging by CCD camera was tried to obtain the element distribution in various regions and microscopic scale XAFS spectra.

Experimental

The CCD camera measurement was performed at BL-27B station in the KEK-PF. The measurement system is almost the same as the normal transmission-type XAFS system. Only the ion chamber at the downstream of the sample, which usually provide intensity of transmission X-ray, is replaced by the CCD camera. The CCD camera used in the measurement is C6086-03, Hamamatsu Photonics K.K. It has an 8.8mm×6.5mm size as an effective field of view.

A mixture of $RbNO_3$, $Sr(NO_3)_2$ and Y_2O_3 was used for trial measurement of the CCD system. The control program that has already been used in the normal XAFS measurement was used also in the present work. Energetic range from 15.1 to 18.1keV was scanned to cover Rb, Sr and Y K-edge. Images of the CCD camera during the measurement were recorded as a movie (AVI format) file. The element distribution analysis and X-ray absorption analysis were performed by using self-made program codes.

Results and discussion

Element distribution

Fig.1 shows the element distribution of the sample derived from the absorption edge jump of Rb, Sr and Y K-edges. The three output windows in the figure correspond to the three elements. They were obtained by visualizing the absorption edge jump. It can be seen that the test sample consists of three elements and their predominant area. For example, around upper of the sample, the strontium compound is predominant.

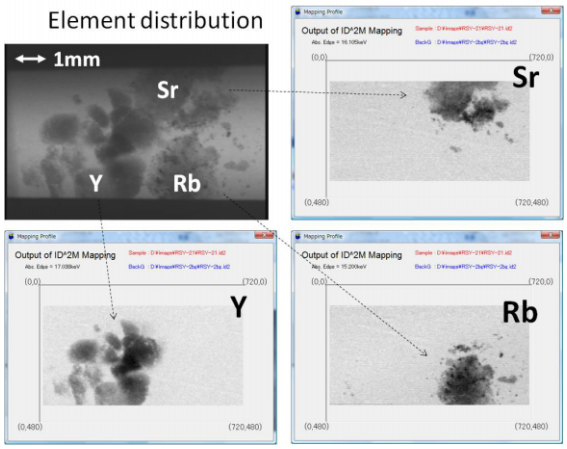

Fig.1 Element distribution of the $RbNO_3$-$Sr(NO_3)_2$-Y_2O_3 sample.

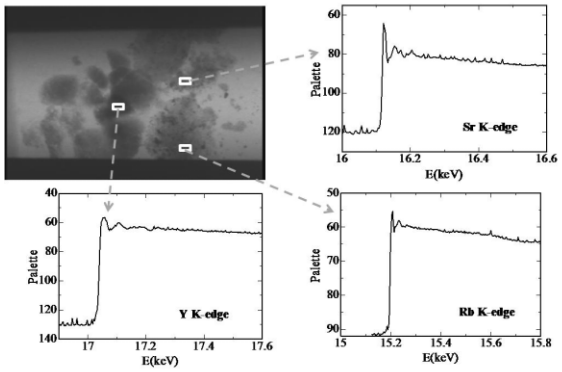

Fig.2 Microscopic XAFS spectra from CCD images. Each spectrum corresponds to the rectangle in the CCD photo.

X-ray absorption spectra for microscopic area

X-ray absorption spectrum for each edge was calculated by analyzing contrast of the image. They are plotted in Fig.2. Each spectrum is assigned to a small area marked as the rectangle in the CCD photo. The microscopic scale XAFS spectra were successfully obtained from the CCD camera measurement.

References

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[2] K.Sakurai and M.Mizusawa, Nanotechnology, 15, S428 (2004).

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