

Chemical state imaging using X-ray fluorescence measured by a CCD camera

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Introduction

Chemical shifts of absorption edges can be measured by X-ray fluorescence (XRF), and this technique is widely used for chemical state analysis. The technique is enhanced by extending it to 2D-imaging [1]. This report describes chemical state imaging by a non-scanning XRF microscope [2] equipped with a CCD camera.

Experimental

A Si(111) double crystal monochromator was employed for the energy scan across the absorption edge of the elements of interest. A Rh coated bent mirror was also used for focusing and to reject higher-order harmonics. The experiment consists of repeated exposures of the XRF image (1000 × 1000 pixels) during the monochromator scans. The exposure time was 1 sec for each energy step. The typical number of images is 180~400.

Results and Discussion

The sample measured here is a copper plate, part of which is of a different color due to some corrosion, as indicated in Fig.1. Obviously, the XRF images change when the incident energy goes across the Cu-K absorption edge (8979 eV). In addition, above the K edge, one can see that the image has a different contrast even

for slightly different energy levels, for example, at 8986 and 8998 eV.

Roughly speaking, the present technique provides 1000 × 1000 XAFS spectra simultaneously [3]. As shown in Fig.1, near-edge absorption spectra for a specific area can be obtained by integrating intensities over the pixels corresponding to the area of interest. It was confirmed that the profile for area 1 (green, corrosion) is shifted to the higher energy side compared with that for area 2 (brown metallic, pure copper). This is due to the chemical shifts of absorption edges. At 8986 eV, the intensity ratio (the contrast due to chemical effect) is about 1.6, but almost identical for 8998 eV or higher. Additional image processing can give several images corresponding to different chemical states. The authors would like to thank Drs. H. Sawa, Y. Wakabayashi and Y. Uchida for their assistance during the experiment.

References

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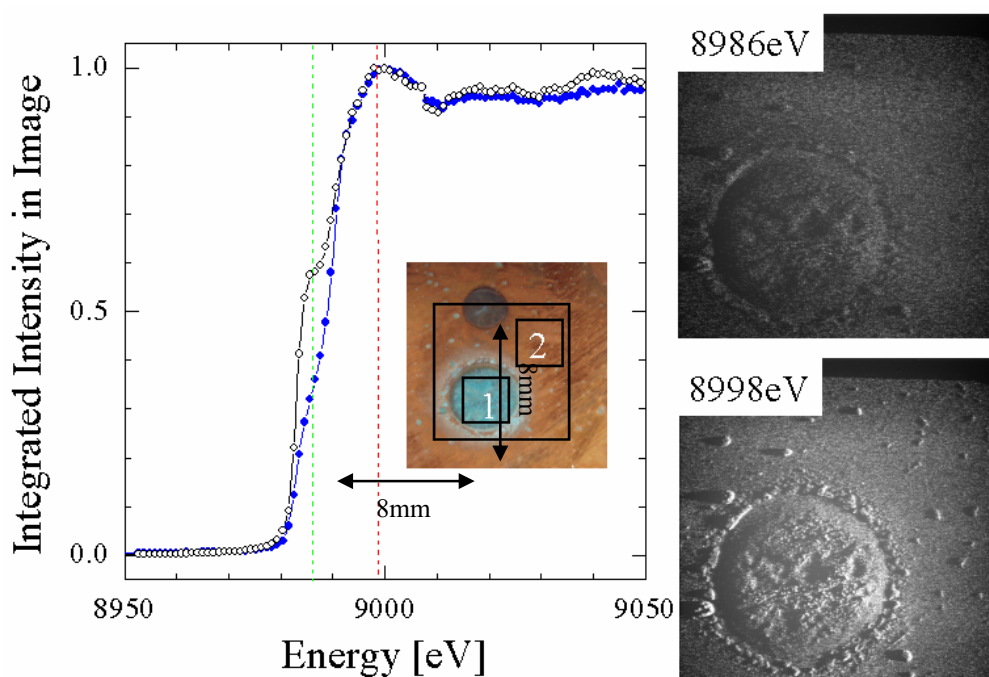


Figure 1. Chemical state imaging for copper corrosion (an optical microscope image is given as an inset). (Right) XRF images obtained at different incident X-ray energy, 8986 eV and 8998 eV. (Left) Near-edge absorption spectra obtained from the integration of intensities for areas 1 (blue closed circle) and 2 (black open circle). The area size was ca. 200×200 pixels.