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Elemental analysis using an x-ray fluorescence full-field microscope and a multilayer monochromator

Takuji OHIGASHI*, Norio WATANABE, Hiroki YOKOSUKA, Takuya SAIRAI,
Shun-ichi MAEDA, Yasutoshi YOSHIDA and Sadao AOKI
Institute of Applied Physics, Univ. of Tsukuba, 1-1-1 Tennoudai, Tsukuba, Ibaraki 305-3578, Japan

Introduction

We have been developing an x-ray fluorescence microscope with a full-field imaging system instead of a scanning one. A Wolter mirror is a proper device for x-ray fluorescence imaging because it has no chromatic aberration, low coma and relatively large acceptance angle.

Using a CCD camera as an energy-dispersive detector under a photon-counting mode, an elemental analysis was achieved last year. For another approach for elemental mapping, scanning of excitation x-ray energies can be applicable. By changing energies of the incident x-rays, elements in a specimen can be excited selectively. Then elemental distributions of a specimen can be investigated. However, photon flux of a monochromatic beam from a double crystals monochromator is not sufficient for x-ray fluorescence full-field imaging at the Photon Factory and a double multilayer monochromator was designed to obtain high photon flux. Using this monochromator, element-specific imaging of metallic wires was tested.

Optical system

The optical arrangement is shown in Fig.1. A white beam was monochromatized through the multilayer monochromator. Two multilayer mirrors were set parallel to maintain the stable exit beam. The mirror had 50 layer pairs and the d-spacing of 25Å (manufactured by Osmic Inc.). The energy width of transmitted x-rays through the monochromator was 0.2keV (FWHM) at 9.2keV. An optical path of the Wolter mirror was set normal to the incident beam to reduce scattering x-rays from a sample. The magnification of the mirror was 10 and the resolution was about 10µm[1]. It had Pt-coated surface to gain the reflectivity. X-ray fluorescence from the sample was imaged on a CCD camera (HAMAMATSU, TI, TC-215). The optical path from the sample to the detector was evacuated below several mTorr to reduce scattering or absorption by air.

Experiment

Wire samples were used for evaluation. It consisted of 6 metal wires of Cu (diameter: 50µm), Ni (50µm), Co (50µm), Fe (100µm), Ti (50µm) and Cu (50µm). Changing the energy of excitation x-rays by the monochromator, the images and energy profiles of x-ray fluorescence of the samples were obtained.

Results

Figures 2 (a) and (b) show the x-ray fluorescence images of the samples. The energy of excitation x-rays were 8.9keV and 8.6keV at the peaks, respectively.

The Cu wires can be seen in Fig. 2 (a). However, the Cu wires cannot be seen in Fig. 2 (b) because of the low energy of excitation x-rays. The results show that this system can be used for the elemental analysis.

References

[1] S. Aoki et al, J. synchrotron Rad., 5 (1998) 1117.

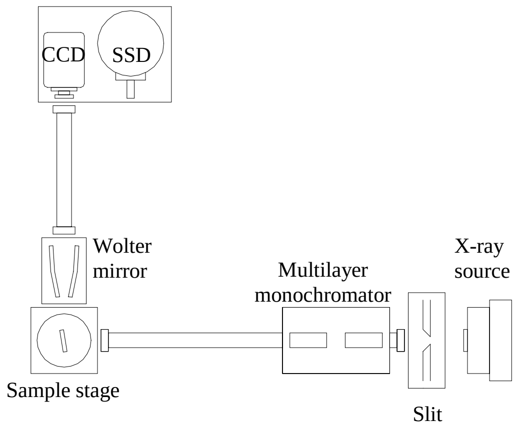
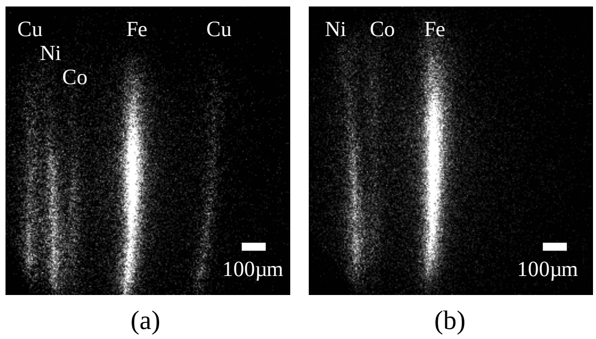


Figure 1 Schematic diagram of the experimental arrangement.



Figures 2 X-ray fluorescence images of the samples. Excitation energies were 8.9keV (a) and 8.6keV (b). Exposure times were 3min and 4min, respectively.

*ohigashi@aokilab.bk.tsukuba.ac.jp