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# Full-field imaging x-ray fluorescence microtomography for quantitative elemental analysis

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## Introduction

X-ray fluorescence analysis has many advantages, such as low detection limit, high sensitivity, low noise and suitable for quantitative analysis. We have been developing this method with a full-field imaging microscope system. One of the advantages of the full-field imaging x-ray fluorescence microscope is relatively short exposure time compared with a scanning system. Then it is easy to be applied to 3-dimensional tomography. We have already reported the 3-dimensional computed tomography [1]. In the previous experiment, absorption effects of the incident beam and x-ray fluorescence of the sample itself were not taken into account reconstruction process so that quantitative distributions of the elements could not be expected. In this report, quantitative distributions of the elements could be evaluated by considering these effects.

## Optical system

The schematic of the experimental setup is shown in Fig.1. A monochromator with double $W/B_4C$ multilayer mirror [2] was used for selective excitation ($\Delta E/E \approx 1.9\times10^{-2}$). X-ray transmission image through a sample were recorded with a CCD camera system (Hamamatsu K.K., C-4880) with a phosphor plate. X-ray fluorescence emitted from a sample was imaged by a Wolter mirror (magnification: 10, average grazing angle: 7 mrad) onto another CCD camera system (Roper Scientific, PI, SCX-TE/CCD-1300 EM/1). The optical axis of the Wolter mirror was set normal to the incident beam. The Wolter mirror chamber was transferred by He and the path of x-ray fluorescence and the monochromator was evacuated to ~$10^{-3}$ Torr.

## Experiment

Distribution of Fe in a synthesized diamond was evaluated in this experiment. It includes Fe and Ni as impurities, which were incorporated through its synthesized process [3]. Energy of incident beam was 8.05 keV. X-ray transmission images of 8.05 keV and 6.40 keV (energy of Fe Kα line) were also acquired. The sample was rotated to obtain 50 projections per 360 degree (x-ray fluorescence images) and 100 projections per 180 degree (x-ray transmission images).

X-ray fluorescence images and x-ray transmission images were acquired at the same time. Then, energy of the incident excitation beam was changed to Fe Kα line and the x-ray transmission images were acquired. Two sets of transmission tomographic images were used for the reconstruction process. The reconstruction was performed with the algebraic reconstruction technique by taking account of absorption effects of incident beam and x-ray fluorescence along their paths.

The reconstructed image of Fe in the cross section of the synthesized diamond was shown in Fig.2.

## References

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[2] T. Ohigashi, N. Watanabe, H. Yokosuka, T. Sairai, S. Maeda, Y. Yoshida and S. Aoki, Photon Factory Activity Report 18, 272 (2001).
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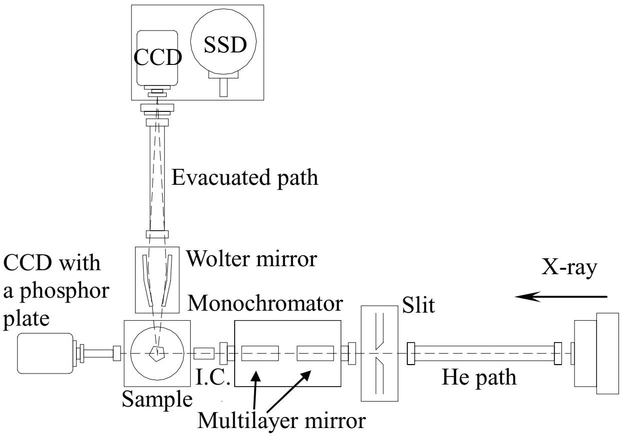


Fig.1 Experimental setup

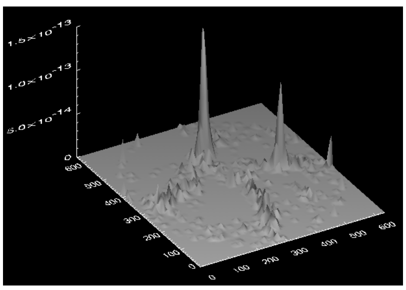

Fig.2 Distribution of Fe in a cross section of the synthesized diamond

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