4A/2002S2003

Projection-type XRF imaging with white X-rays from a bending magnet source (2) Color imaging based on single photon counting

Mari MIZUSAWA and Kenji SAKURAI*
National Institute for Materials Science, Sengen, Tsukuba, Ibaraki 305-0047, Japan

Introduction

A projection-type X-ray fluorescence (XRF) microscope can perform element mapping with large pixel numbers in an extremely short measuring time, when combined with a multilayer monochromator and a multi-pole wiggler source [1]. Another possibility is the use of white X-rays from a bending magnet source [2]. This report describes a way of distinguishing elements by single photon counting.

Experimental

The instrumental details of a projection-type X-ray fluorescence (XRF) microscope and experimental conditions for a white beam are described elsewhere [1,2]. Figure 1 shows the experimentally obtained X-ray energy dependence of the charge amount created in a CCD chip (TC281, Texas Instruments). The measurement was done with monochromatic X-rays from a rotating anode source [3]. This relation was used to distinguish the energy of X-ray photons entering the CCD camera. Typical exposure time for one image was 5~30 msec. The exposure was repeated 4096 times, and each time, all the pixels were read and set as 1 or 0, depending on whether the ADC level was within the region of interest or not. The sum of those images produced a map of the specific element. Since several such images were obtained by using different regions of interest, the method can be used for energy-dispersive, or so-called color imaging.

Results and Discussion

Figure 2(a) shows an X-ray image of a gabbroic rock collected at Mt. Tsukuba. Although white X-rays are used, the single photon counting procedure enables energy-dispersive imaging. In this case, the region of interest was set as 400-450, corresponding to 6~7.6 keV X-rays (mainly Fe Kα and Kβ). In Fig.2(b), one can see several grain colors; white (feldspar), black (amphibole) and brown (olivine). It is known that the iron concentration of amphibole and olivine is quite high, while that of feldspar is very low [4]. One can confirm that the X-ray image interprets this well. The present experiment requires the repetition of very short exposures. Since the rate for transferring the image is 30 frames/sec, ca. 2 min is necessary for imaging at the 12 bit (4096) level. This is almost the same as that for normal imaging with monochromatic X-rays. However, the capability of simultaneous multi-element imaging is a great advantage.

The authors wish to thank Dr. M. Shoji for his help in analysing images by the single photon counting method.

References

[1] K.Sakurai and M.Mizusawa, *AIP Conference Proceedings* (SRI- 2003, San Francisco, USA) in press.
[2] M.Mizusawa and K.Sakurai, *Photon Factory Activity Report*, this issue.
[3] K.Sakurai, N.Osaka, H.Sakurai and H.Izawa, *Adv. in X-Ray Anal.* **39,** 149 (1997).
[4] M.Mizusawa and K.Sakurai, *J. Synchrotron Rad.* **11,** 209 (2004).

*sakurai@yuhgiri.nims.go.jp

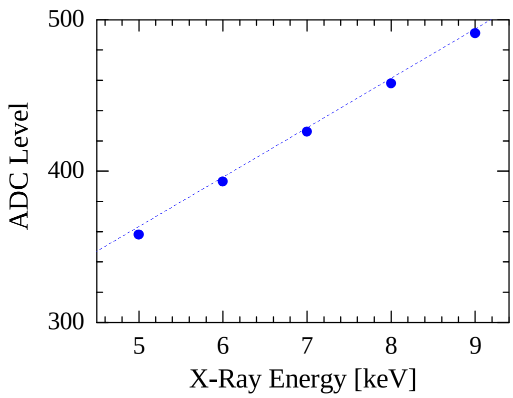

Figure 1 X-ray energy dependence of charge amount (ADC level) created in the TC281 CCD device.

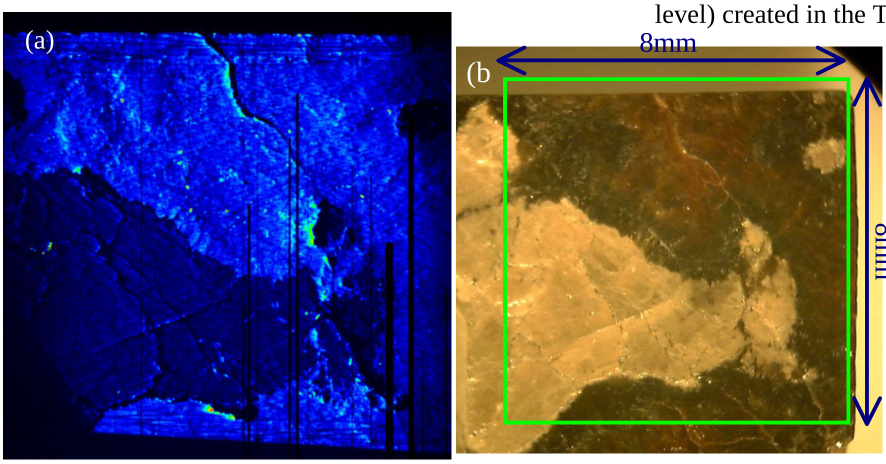

Figure 2
(a).X-ray image of a gabbroic rock measured by the single photon counting method with white X-rays. The image mainly represents Fe Kα and Kβ X-rays. Exposure time was 5 msec. Repetition performed 4096 times.
(b) Optical microscope photo. The square indicates the observed area corresponding to (a). Black grains are amphiboles containing iron.