X-ray Fluorescence Scanning Microscope and Micro-Tomography with a Zone Plate

Norio Watanabe[1)], Mariko Sato[1)], Masato Hoshino[1)], Yoshihiro Takeda[1)], Sadao Aoki[1)], Akihisa Takeuchi[2)], Yoshio Suzuki[2)]

[1)] *Institute of Applied Physics, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan*
[2)] *SPring-8, JASRI, Mikazuki, Hyogo 679-5198, Japan*

X-ray fluorescence micro-tomography is one of the promising applications of an x-ray fluorescence scanning microscope. For micro-tomography, a specimen must be rotated and raster scanned to an incident x-ray beam, which is difficult because a precision rotary stage is usually large and heavy. Then, a scanning microscope by scanning a microprobe instead of a specimen was developed.

Figure 1 shows the optical system. The x-ray beam-line BL20XU of SPring-8 was used. This beam-line has an x-ray undulator and a double-crystal monochromator cooled by liquid nitrogen. X-rays at 9.8 keV were focused by a zone plate. The diameter and the outermost zone width were 155 microns and 0.1 microns, respectively. The zone plate was placed about 250 m downstream from the undulator. This long distance enabled us to obtain the focused spot size of about 0.2 microns. The first order focus was used and the other order x-rays were eliminated by an order sorting aperture (OSA). The zone plate and the OSA were raster scanned synchronously to obtain a 2D image. Transmission and fluorescence x-rays were recorded by an ionization chamber and silicon drift detector (SDD) respectively.

A test sample of iron, zinc, and copper layers evaporated on a tungsten wire (Fig. 2(a)) was used for evaluation of the micro-tomography system. Figure 2(b) shows the section image of iron and copper x-ray fluorescence. The zinc layer (120 nm) could be distinguished, which can be seen as a gap of the two lines.

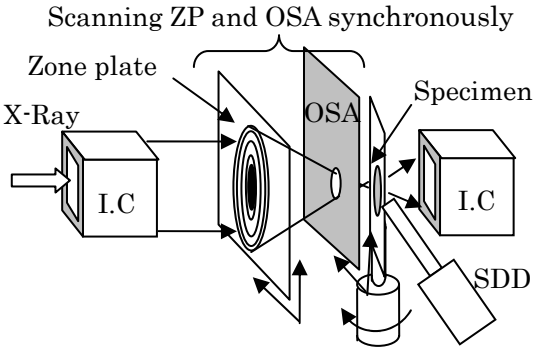

Fig. 1 Optical system of the microscope

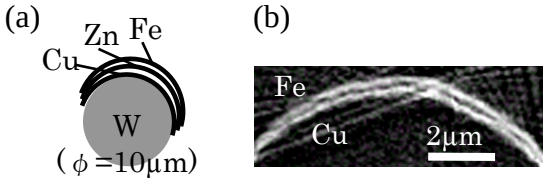

Fig. 2 (a) Test sample, (b) X-ray fluorescence section image of iron and copper of the test sample.