Present Status of Hard X-ray Micro-Imaging at BL24XU of SPring-8

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In Hyogo beamline (BL24XU) of SPring-8, we are developing research programs using a hard x-ray microscope for applications to the wide range of science.

MICROSCOPE [1]: The apparatus mainly consists of three parts; one is an X-ray microscope unit, another is an optical microscope unit and the other is a sample stage unit. The two microscope units are interchangeable each other onto the beam axis with the high position repeatability better than 1.0 micron in the three-axis directions. In an X-ray microscope, we can select one of two zone plates (ZP1 or ZP2) for the proper purpose of experiments. The ZP1 has the outermost zone width of 250 nm and the tantalum thickness of 2.4 microns. The ZP2 has the outermost zone width of 50 nm and the tantalum thickness of 800 nm. The ZP1 is used mainly for high-energy experiments, while the ZP2 is used for experiments requiring higher spatial resolution in spite of less intensity. The sample stage unit consists of eight high precision stepping -motor-driven stages including θ-2θ goniometers. The θ goniometer has the very high eccentricity within ±0.25 micron/360°, and a high angular resolution of 0.72 arcsec/pulse can be achieved. The apparatus is also equipped with a SDD for X-ray fluorescence analysis.

PERFOREMANCE: The ZP1 provides the beam size of ~1 μm (10 keV) and ~2 μm (20 keV). The ZP2 provides ~300 nm (15 keV). By adopting a narrow slit in front of the ZP2, a microbeam with a relatively small horizontal angular divergence (~70 μsec) can be also available. This beam is used for strain analysis of various semiconductor devices. Because the diamond crystals used in the two upstream monochromators reduces the beam coherence, the diffraction limited beam size can not be obtained. By putting the ZP2 in BL20XU, where the ZP2 was put 200 m apart from a 20 μm pinhole, the almost diffraction limited beam size of 70 nm can be certainly achieved.

MICROBEAM APPLICATIONS: The microscope is used, for example, for measurements of strain distribution in laser diodes with a θ-2θ diffractometer and structural analysis of polymers with a diffractometer using imaging plate detectors. Scanning differential phase contrast microscope using a wedge absorber detector has been demonstrated [2].

MICRO-INTERFEROMETER [3]: Using the twin zone plate, the micro-interferometer has been successfully demonstrated. Three dimensional phase measurement has been done with the spatial resolution of about 250 nm.

References

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[2] Y. Kagoshima *et al.*, Jpn. J. Appl. Phys. **43** (2004) L1449-L1451.
[3] T. Koyama *et al.*, Jpn. J. Appl. Phys. **43** (2004) L421-L423 and also presented in this conference.