Hard X-ray Interference Microscope with Two Zone Plates

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A hard x-ray interference microscope with two zone plates was designed and tested at SPring-8 BL20XU. This was the first on-axis interference microscope with zone plates on the hard x-ray region.

The optical system is shown in Fig. 1. A zone plate is a circular diffraction grating so that there are various diffraction orders. If parallel x-rays are incident on a zone plate, the first order x-rays are focused at the focal length f downstream the zone plate, the minus first order x-rays diverge as if they emerge from the point f upstream the zone plate, and the zero-th order x-rays are simply transmitted in the forward direction. Then, the two zone plates were placed twice of the focal length apart from each other. The (+1, 0) order x-rays of the beam illuminating the specimen had the same path as the (0, −1) order of the other beam after the two zone plates. Then, the two beams interfered with almost the same phase difference over the image plane.

The two zone plates had the same specifics. The diameter and the outermost zone width were 155 microns and 0.1 microns, respectively. The beam-line BL20XU has an x-ray undulator source. The distance between the source and the experimental hatch is 245 m, so that the full area of the zone plate could be illuminated coherently. The image contrast could be adjusted by a phase shifter shown in Fig. 1 (rotating quartz sheet of 62 microns in thickness). Figure 2 shows the bright and dark contrast images of a diatom at 10 keV.

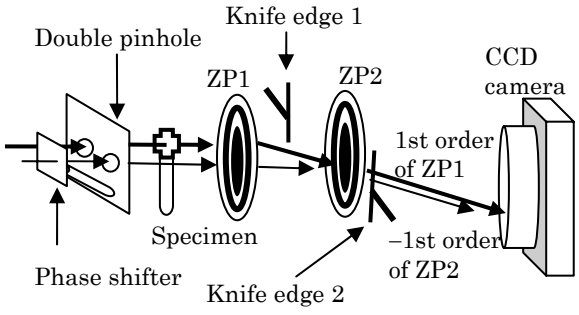

Fig. 1 Optical system.

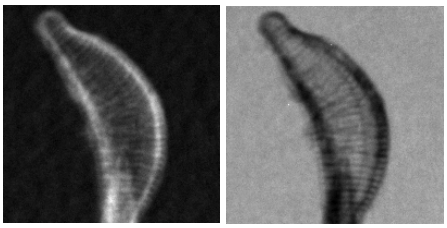

Fig. 2 Bright (left) and dark (right) phase-contrast images of a diatom at 10 keV.