Scanning hard-X-ray microscope with spatial resolution better than 50nm using K-B mirror optics

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Intensive nanofocused X-ray beams are necessary for enhancing performances in various types of X-ray microscope. X-ray focusing techniques using K-B mirrors are promising in terms of highly efficient and energy-tunable focusing. We have been developing a hard-X-ray focusing system in which the obtainable focus size is less than 100nm. In this presentation, we will report the development of a mirror manipulator and demonstrations of the scanning X-ray microscope. Not only figure accuracy of mirrors but also precise mirror alignments are required for ideal focusing. Alignment tolerances in mirror adjustments such as glancing angles and the perpendicularity between two mirrors were estimated using two types of simulator[1]: a geometrical-optical simulator and a wave-optical simulator. The mirror manipulator was designed and constructed on the basis of the simulation results that the glancing angle and the perpendicularity should be set with ±0.9μrad and ±40μrad accuracies, respectively. In the manipulator, the perpendicularity between two mirrors can be adjusted without X-ray beams by the tilt monitor system using two autocollimators before measuring intensity beam profiles. The glancing angles can be adjusted with an angular resolution of 0.2μrad and no backlash while measuring intensity beam profiles simultaneously. At the 1-km-long beamline (BL29XUL) of SPring-8 the focal size, defined as the full width at half maximum in the intensity profile, was achieved to be 48 x 36nm^2 (V x H) by this manipulator with K-B mirrors having a figure accuracy of 2nm peak-to-valley height[2]. As a result of spatial resolution tests using tantalum test patterns, the scanning X-ray microscope with the focus system could resolve the line-and-space patterns of 80nm line width in a high visibility of 60%. We are planning trace element mapping in cell organelles with a high resolution and a high sensitivity using X-ray fluorescent analysis.

1 S. Matsuyama et al., Proc. SPIE 5533, 181 (2004).
2 H. Mimura et al., Jpn. J. Appl. Phys. submitted.