Development of adaptive mirror for wavefront correction of hard X-ray nanobeam

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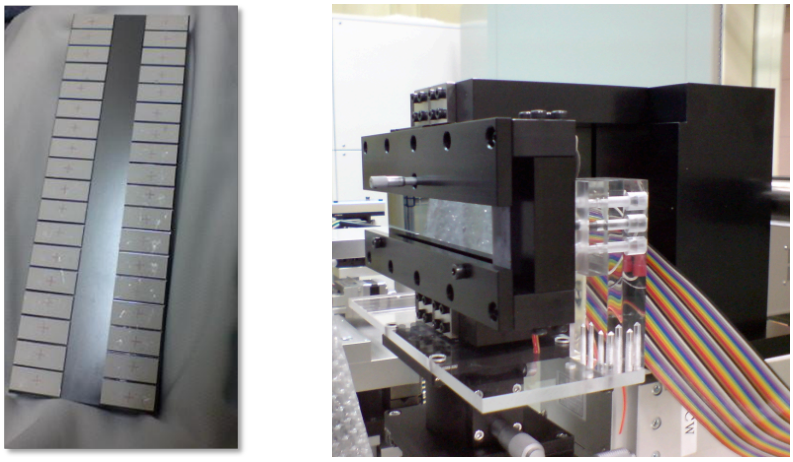
Extremely high surface figure accuracy is required for hard X-ray nanofocusing mirrors, which demands an ideal spherical wavefront in a reflected X-ray beam. For example, in the case of the realization of sub-10-nm focused beam at 20 keV, a PV figure error height of lower than 1 nm is necessary. An effective way to overcome these obstacles is to analyze and compensate wavefront errors during experiments. In the hard x-ray region, adaptive mirror is currently used to add flexibility to beamline systems [1-3]. Piezoelectric bimorph mirrors are employed to enable the adjustment of its optical properties to different beamline geometries or to variations in the grazing angle.

In this study, we developed a new adaptive mirror having unprecedented accuracy in the control of the wavefront of X-rays. The developed adaptive mirror is shown in Figure 1. Taking such high deformability and stability into account, we monitored the surface profile of the mirror continuously using a Fizeau interferometer. In the system, the degree of curvature can be adjusted at each

position on the mirror at a sub-nanometer level, and maintained for a long time by feedback control. Figure 2 shows the results of the deformation test of arbitrary shape.

The intensity profiles of X-rays reflected on the mirror with several curved profiles were measured and compared at the 1-km-long beamline at SPring-8, and the measurement results of intensity profiles of reflected X-rays were shown to be in good agreement with the wave-optically simulated profiles. This indicates that ideal wavefront correction was performed and the wavefront modulation ability for the mirror is better than wavelength order. These results will contribute to the development of hard X-ray coherent science.



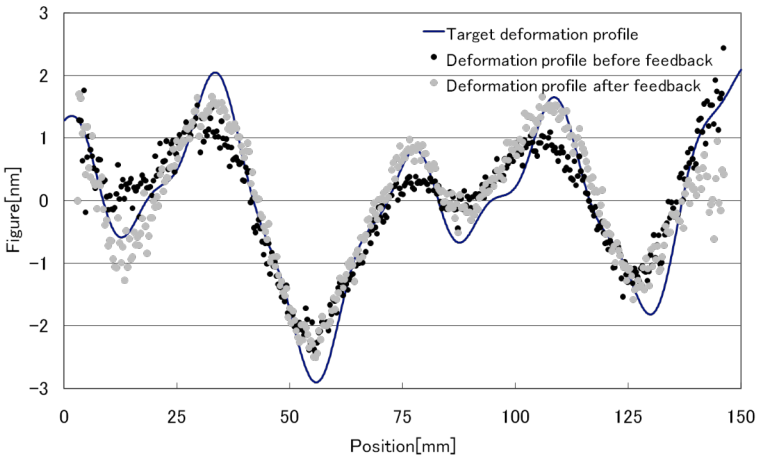


Figure 1 Adaptive mirror and wavefront correction unit.

Figure 2 Results of the deformation test of arbitrary shape.

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