At-wavelength measurement and on-site compensation of wavefront error for hard X-ray nanobeam

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We developed a surface-figuring method to realize 0.1nm (RMS) level figure accuracy over the large area of several 100s mm range, and applied it to fabricate hard X-ray nano-focusing mirrors [1, 2, 3]. A total-reflection mirror fabricated was tested at the 1km-long beamline (BL29-XUL) of SPring-8 and found to realize the nearly diffraction-limited focusing with the spot size of 25 nm at the X-ray energy of 15keV.

We are now trying to form a sub-10nm X-ray beam, the wavefront perfectibility in which should be controlled with an unprecedented accuracy. We proposed novel methods to measure and correct the wavefront shape. The proposal is based on an adaptive compensation concept. An at-wavelength interferometry using a phase retrieval technique was established for the wavefront-shape measurement [4]. The intensity map near the beam waist was precisely measured by a special knife-edge method and processed to recover the phase information of the reflected X-ray beam [4, 5]. To remove the phase-error, an adaptive mirror placed upstream is employed. An on-site phase error compensation system developed was demonstrated at BL29-XUL of Spring-8 and showed good enough performance in a nano-focusing system, the diffraction-limited spot size of which was 12nm [6, 7].

References

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