Development of at-wavelength metrology for x-ray optics at the ALS*

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Abstract:

The comprehensive realization of the exciting advantages of new third- and forth-generation synchrotron radiation light sources requires concomitant development of reflecting and diffractive x-ray optics capable of micro- and nano-focusing, brightness preservation, and super high resolution. The fabrication, tuning, and alignment of the optics are impossible without adequate metrology instrumentation, methods, and techniques [1]. While the accuracy of ex situ optical metrology at the Advanced Light Source (ALS) has reached a state-of-the-art level [2-4], wavefront control on beamlines is often limited by environmental and systematic alignment factors, and inadequate in situ feedback.

At ALS beamline 5.3.1, we are developing broadly applicable, high-accuracy, in situ, at-wavelength wavefront measurement techniques to surpass 100-nrad slope measurement accuracy for Kirkpatrick-Baez (KB) mirrors [5]. The at-wavelength methodology we are developing relies on a series of tests with increasing accuracy and sensitivity. Geometric Hartmann tests, performed with a scanning illuminated sub-aperture determine the wavefront slope across the full mirror aperture [6]. Shearing interferometry techniques use coherent illumination and provide higher sensitivity wavefront measurements [7]. Combining these techniques with high precision optical metrology and experimental methods will enable us to provide in situ setting and alignment of bendable x-ray optics to realize diffraction-limited, sub-50-nm focusing at beamlines.

We describe here details of the metrology beamline endstation, the x-ray beam diagnostic system, and original experimental techniques that have already allowed us to precisely set a bendable KB mirror to achieve a focused spot size of 150 nm.

References:

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