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

Permalink
https://escholarship.org/uc/item/0z8946h9

Author
Yashchuk, Valeriy V.

Publication Date
2010-08-25
Development of at-wavelength metrology for x-ray optics at the ALS*

Valeriy V. Yashchuk1, Kenneth A. Goldberg2, Sheng Yuan1, Richard Celestre1, Wayne R. McKinney1, Gregory Morrison3, Tony Warwick1, Howard A. Padmore1

1Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA
2Center for X-ray Optics, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA
3Engineering Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

* The Advanced Light Source is supported by the Director, Office of Science, Office of Basic Energy Sciences, Material Science Division, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231 at Lawrence Berkeley National Laboratory.

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: