Lawrence Berkeley National Laboratory

Recent research highlights from the ALS OML

V. V. Yashchuk, E. D. Anderson, N. A. Artemiev, R. Celestre, E. E. Domning,
P. Fischer, K. A. Goldberg, W. R. McKinney, D. J. Merthe, G. Y. Morrison, B. V. Smith,
D. L. Voronov, H. A. Padmore

Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA
Email: vvyashchuk@lbl.gov

The main mission of the Optical Metrology Laboratory (OML) at the Advanced Light Source (ALS) is to ensure state-of-the-art performance of beamline optics. New beamlines and instruments laid out in the ALS strategic plan as well as the plan for New Generation Light Source (NGLS) facility all involve increasingly complex optical systems that need ultra-high precision optics to achieve the specifications and goals of their state-of-the art research programs. In order to manufacture, measure, tune, and properly use these optics, we need measuring precision on the level of sub-100-nrad surface slope and sub-nm surface height precision. In the present work, we report recent developments at the ALS OML, bringing the OML measurement capabilities to a completely new level of accuracy and reliability.

In order to increase the accuracy of slope measurements, we have developed and integrated into the updated ALS LTP-II an automated rotating, flipping, and aligning (ARFA) system [1] that is designed to provide fully controlled flipping, tilting, and shifting of a surface under test. The ARFA system allows us to completely realize the advantages of an optimal measurement strategy method [2] for effective suppression of the instrumental errors due to random noise, temporal drifts, and systematic effects.

We have further expended the application range of an original technique for precise measurement of the modulation transfer function (MTF) of metrology instruments [3]. Besides the MFT calibration of interferometric microscopes, large area interferometers, scatterometers, scanning and transmission electron microscopes [4], the method has been successfully applied for the MTF calibration of an x-ray microscope.

Using an in situ metrology procedure based on modified shearing interferometry and Hartman tests [5] developed at the ALS to optimally align and tune two bendable, actively temperature-stabilized mirrors in the Kirpatrick-Baez configuration [6], we have achieved two-dimensional diffraction limited forcusing with soft x-rays.

Application of autoregressive-moving-average (ARMA) modeling to parametrize residual surface slope data obtained with high quality x-ray mirror [7] is also discussed.

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