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Abstract

The next generation of synchrotrons and free electron laser facilities requires x-ray optical systems with extremely high performance, generally of diffraction limited quality. Fabrication and use of such optics requires highly accurate metrology, both optical and at-wavelength, and dedicated instrumentation. Moreover, our belief is that investment in x-ray optics and dedicated metrology is one of the most effective ways to increase brightness of beam-lines of modern high performance synchrotron radiation light sources, such as the Advanced Light Source (ALS). At the ALS, we are developing a program directed at increasing the performance, precision, and reliability of the x-ray optics and metrology. In the area of traditional optical metrology, we have recently upgraded our main optical slope measuring instrument, the long trace profiler LTP-II. This instrument, together with an original method for averaging over some systematic errors has demonstrated 0.25 μrad (rms) precision, comparable with the performance of the world's best instrument, the NOM developed at BESSY in Germany. We have also developed an original method for calibration of the Modulation Transfer Function (MTF) of surface profilometers. The method is based on the use of an original test surface, built as a binary pseudo-random sequence/array, with a very well known theoretical Power Spectral Density (PSD) spectrum. This method can now be established as the basis for an international standard for evaluation of the MTF at specific frequencies. Going beyond the precision possible with light optics, we are also developing various at-wavelength methodologies, largely based on the highly successful program led by the CXRO group at LBNL, in developing interferometric x-ray techniques. Our work in this area is based at a beamline dedicated for optical metrology and detector development. In this poster, we will also illustrate the needs for advanced metrology by describing recent work to develop ultrahigh line density gratings based on high order multilayer gratings fabricated on anisotropic etched Si substrates.

Due to the high demands for and cost of x-ray optics and metrology, we suggest that a comprehensive optics program for technology development should be initiated within the DOE, as one element of an international effort to advance the state of the art in x-ray optics. This should include the synchrotron community, but as well reach across into other areas such as EUV optics for projection lithography, and optics for next generation space based astrophysics projects.
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Keywords: X-ray optical metrology, X-ray optics, metrology instrumentation, long trace profiler, interferometric microscopy, power spectral density, calibration