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Preface: The 5th International Workshop on X-ray Mirror Design, Fabrication, and Metrology

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Recent developments in synchrotron storage rings and free-electron laser-based x-ray sources with ever-increasing brightness and coherent flux have pushed x-ray optics requirements to new frontiers. This Special Topic gathers a set of articles derived from a subset of the key presentations of the International Workshop on X-ray Mirrors Fabrication (IWXM-2015) and Metrology held at Lawrence Berkley National Laboratory, Berkeley, California, USA, July 14–16, 2015. The workshop objective was to report on recent progress in x-ray synchrotron radiation mirrors fabrication as well as on new developments in related metrology tools and methods. *Published by AIP Publishing.* [http://dx.doi.org/10.1063/1.4950776]

The development of new generations of ultra-bright x-ray light sources pushes the requirements for beamline optics and metrology into new frontiers of quality. For many experimental techniques requiring brighter beams with high spatial coherence, such as coherent diffraction imaging, microscopy, interferometry, and many others, transporting the x-ray beam from the source to the experiment station, and manipulating it without incurring any losses or altering its pristine properties, is essential to the success. Mirror optics, which are often used for this purpose, not only have to be polished to atomic scale roughness but also the deviation of their reflecting surfaces from an ideal shape must be controlled on the sub-nanometer scale. While significant improvements in mirror fabrication methods have been achieved in recent years, metrology is often the limiting factor. Much progress is needed in this area to produce mirrors that will reliably meet future needs within a reasonable time scale and cost (see for example http://science.energy.gov/~/media/bes/pdf/reports/files/BES_XRay_Optics_rpt.pdf).

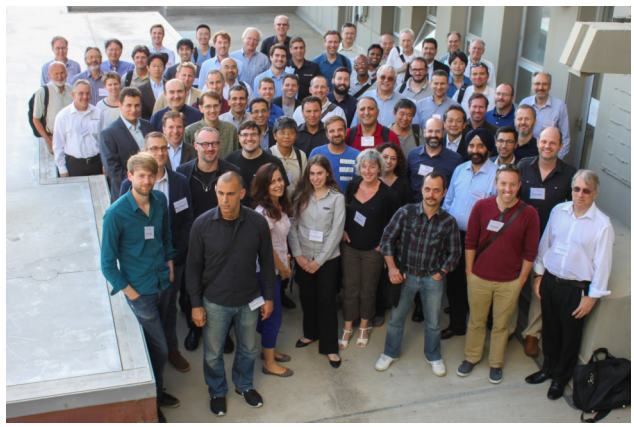
This Special Topic section gathers a set of articles from key presentations of the International Workshop on X-ray Mirrors Fabrication and Metrology, held on July 14-16, 2015, at Lawrence Berkeley National Laboratory, Berkeley, California, USA. The workshop objective was to report on recent progress in x-ray synchrotron radiation mirrors fabrication as well as on new developments in related metrology tools and methods. This three-day workshop was organized as a satellite meeting of 12th International Conference on Synchrotron Radiation Instrumentation, in New York, July 6-10, 2015. It was attended by 87 scientists and engineers representing 11 countries including Australia, France, Germany, Italy, Japan, the Netherlands, Spain, Switzerland, Turkey, the UK, and the USA. The workshop featured 42 oral presentations and 14 posters covering diverse areas including fabrication and finishing technologies of x-ray mirrors, gratings and multilayer optics, and both laboratory optical and *in situ* metrology and wavefront measurements. Thirteen companies sponsored the workshop and showcased their latest products and innovations in optics and related instrumentation.

This Special Topic issue contains 18 papers arranged into three main sections:

Section 1 is devoted to the design, fabrication, and optimization of x-ray mirrors. During the last decade, the quality of mirrors has greatly improved. X-ray mirrors with challenging shapes, such as ellipsoidal mirrors, are now realizable, thanks to the development of deterministic fabrication techniques and advanced metrology tools.

Section 2 focuses on *ex situ* metrology instrumentation and calibration methods. This section features a combination of papers devoted to tools and methods to characterize x-ray mirrors within a defined spatial frequency range and accuracy, and papers covering calibration tools and methods to characterize metrology instrumentation. Developing reliable and fast calibration tools and methods is crucial to fabrication of three-dimensional nanofocusing surfaces and mirrors.

Section 3 covers *in situ*, at-wavelength metrology and wavefront measurements and control. *In situ* metrology is the ultimate tool for evaluating and optimizing the performance of an optic in a real setup and operating conditions.



All of the papers were peer reviewed according to the journal's standard process, as described in the General Editorial Policies, available online at http://scitation.aip.org/content/aip/journal/rsi/info/about?section=Editorial%20Policies. For more information about the workshop and workshop presentations see the IWXM 2015 website: https://sites.google.com/a/lbl.gov/iwxrom2015/.

The workshop organizing committee wishes to thank all of the contributors and the attendees of the workshop. Special thanks to our corporate sponsors who greatly contributed to the success of the workshop. Jason E. Templer (BNL) and Ian Lacy (BNL) deserve a warm acknowledgement for their assistance with the workshop organization. Special thanks are due to Dr. Albert Macrander-Editor and Dr. Jessica Hoy-RSI *Journal Manager*, as well as the entire staff at the Review of Scientific Instruments for their assistance in putting this Special Topic together. Work supported by US Department of Energy, Office of Science, Office of Basic Energy Sciences under Contract No. DE-AC02-05CH11231 at Lawrence Berkley National Laboratory and Contact No. DE-AC02-06CH11357 at Argonne National Laboratory.