

PROCEEDINGS OF SPIE

# ***Advances in Metrology for X-Ray and EUV Optics X***

**Lahsen Assoufid  
Haruhiko Ohashi  
Frank Siewert**  
*Editors*

**23 August 2023  
San Diego, California, United States**

*Sponsored and Published by*  
SPIE

**Volume 12695**

Proceedings of SPIE 0277-786X, V. 12695

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at [SPIDigitalLibrary.org](http://SPIDigitalLibrary.org).

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Advances in Metrology for X-Ray and EUV Optics X*, edited by Lahsen Assoufid, Haruhiko Ohashi, Frank Siewert, Proc. of SPIE 12695, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510666047

ISBN: 9781510666054 (electronic)

Published by

**SPIE**

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time)

[SPIE.org](http://SPIE.org)

Copyright © 2023 Society of Photo-Optical Instrumentation Engineers (SPIE).

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of fees. To obtain permission to use and share articles in this volume, visit Copyright Clearance Center at [copyright.com](http://copyright.com). Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL  
LIBRARY**

[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**Paper Numbering:** A unique citation identifier (CID) number is assigned to each article in the Proceedings of SPIE at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

# Contents

v *Conference Committee*

---

## MIRROR SLOPE PROFILOMETRY

---

- 12695 02 **Towards a new generation long trace profiler LTP-2020: optical design of pencil beam interferometry sensor** [12695-1]
- 12695 03 **Development of an inner surface profile measurement system for precise electroformed Wolter mirrors for x-ray telescopes** [12695-2]
- 12695 05 **Towards new generation long trace profiler LTP-2020: system design with different sensors in different operation modes** [12695-4]
- 12695 06 **Developing bendable air bearing slide supporting long trace profiler to compensate gravity effect during measuring process** [12695-5]

---

## X-RAY/EUV OPTICS TESTING AND MEASUREMENTS WITH INTERFEROMETRY

---

- 12695 07 **Metrology and characterization of two optical delay line mirrors before and after B4C coating at European XFEL** [12695-9]
- 12695 08 **Modeling and characterizing transmission windows for in-situ interferometric measurements of cryogenically cooled mirrors** [12695-11]

---

## OPTICS TESTING, CALIBRATION, POLARIZATION-RESOLVED REFLECTANCE, AND WAVEFRONT CORRECTION

---

- 12695 09 **The multiple array detector optical lever deflection angle metrology for x-ray mirrors, and semiconductor applications** [12695-24]
- 12695 0A **Diamond-VeNOM: a high-speed slope profiler for characterizing x-ray mirrors** [12695-23]

---

## AT-WAVELENGTH WAVEFRONTS SENSORS, MEASUREMENT, AND CONTROL

---

- 12695 0B **X-ray wavefront sensor development at the Advanced Light Source** [12695-17]
- 12695 0C **Design, manufacturing, and characterization of x-ray optics for the cavity-based x-ray free-electron laser project** [12695-19]

**POSTER SESSION**

---

- 12695 0D **Advances in at-wavelength metrology of x-ray optics at the Advanced Photon Source**  
[12695-22]
- 12695 0E **Preparing for cost-effective soft x-ray metrology for 3D chip architecture** [12695-25]