

PROCEEDINGS OF SPIE

Advances in X-Ray/EUV Optics and Components X

Shunji Goto
Christian Morawe
Ali M. Khounsary
Editors

11–12 August 2015
San Diego, California, United States

Sponsored and Published by
SPIE

Volume 9588

Proceedings of SPIE 0277-786X, V. 9588

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

Advances in X-Ray/EUV Optics and Components X, edited by Shunji Goto, Christian Morawe, Ali M. Khounsary,
Proc. of SPIE Vol. 9588, 958801 · © 2015 SPIE · CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2217992

Proc. of SPIE Vol. 9588 958801-1

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.

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 this proceedings:

Author(s), "Title of Paper," in *Advances in X-Ray/EUV Optics and Components X*, edited by Shunji Goto, Christian Morawe, Ali M. Khounsary, Proceedings of SPIE Vol. 9588 (SPIE, Bellingham, WA, 2015) Six-digit Article CID Number.

ISSN: 0277-786X
ISSN: 1996-756X (electronic)
ISBN: 9781628417548

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445
SPIE.org

Copyright © 2015, Society of Photo-Optical Instrumentation Engineers.

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 copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at 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. The CCC fee code is 0277-786X/15/\$18.00.

Printed in the United States of America.

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

**SPIE. DIGITAL
LIBRARY**

SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print. Papers are published as they are submitted and meet publication criteria. A unique citation identifier (CID) number is assigned to each article at the time of the first 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, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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.

Contents

- v *Authors*
- vii *Conference Committee*
- ix *Introduction*

SESSION 1 MULTILAYERS

- 9588 02 **Multilayer coatings for free electron laser sources** [9588-1]
- 9588 03 **Graded multilayers for figured Kirkpatrick-Baez mirrors on the new ESRF end station ID16A** [9588-2]
- 9588 04 **In-situ GISAXS monitoring of ultrashort period W/B₄C multilayer x-ray mirror growth** [9588-3]
- 9588 05 **Multilayer optics for monochromatic high-resolution x-ray imaging mircoscopes** [9588-4]

SESSION 2 FOCUSING

- 9588 08 **MZP design and fabrication for efficient hard x-ray nano-focusing and imaging** [9588-6]
- 9588 0A **Evaluation of surface figure error profile of ellipsoidal mirror for soft x-ray focusing** [9588-8]

SESSION 3 OPTICS DEVELOPMENT AND FABRICATION

- 9588 0D **Development of polycapillary x-ray optics for synchrotron spectroscopy** [9588-11]
- 9588 0E **2D and 3D micro-XRF based on polycapillary optics at XLab Frascati** [9588-12]
- 9588 0F **Large-area kapton x-ray windows** [9588-13]

SESSION 4 INSTRUMENTS AND IMAGING

- 9588 0G **Effect of beamline optics vibration on the source size and divergence for synchrotron radiation** [9588-14]

SESSION 5 OPTICS FOR COHERENT SOURCES: JOINT SESSION WITH CONFERENCES 9588 AND 9589

- 9588 0L **Development of ellipsoidal focusing mirror for soft x-ray and extreme ultraviolet light** [9588-19]

Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Adams, Bernhard, 0D
Antimonov, M., 0F
Attenkofer, Klaus, 0D
Bacco, Davide, 02
Barrett, R., 03
Bencivenga, Filippo, 02
Bennis, Daniel, 0D
Bond, Justin L., 0D
Cappuccio, G., 0E
Cloetens, P., 03
Corso, Alain Jody, 02
Craven, Christopher A., 0D
Dabagov, S. B., 0E
Dennetiere, D., 05
Do, A., 05
Döring, Florian, 08
Eberl, Christian, 08
Egawa, Satoru, 0L
Foley, Michael R., 0D
Gerlin, Francesca, 02
Gessini, Alessandro, 02
Giangrisostomi, Erika, 02
Giglia, A., 02
Gontier, D., 05
Goto, Shunji, 0G
Halahovets, Yuriy, 04
Hampai, D., 0E
Hedacq, S., 05
Higashi, Takahiro, 0L
Hodas, Martin, 04
Høghøj, P., 05
Jansma, W., 0F
Jergel, Matej, 04
Johnson, A., 0F
Khounsary, A., 0F
Krebs, Hans-Ulrich, 08
Kume, Takehiro, 0L
Lantelme, B., 03
Liedl, A., 0E
Majkova, Eva, 04
Masciovecchio, C., 02
Mimura, Hidekazu, 0A, 0L
Minot, Michael J., 0D
Morawe, Ch., 03
Motoyama, Hiroto, 0L
Nannarone, S., 02
Nardello, Marco, 02
O'Mahony, Aileen, 0D
Osterhoff, Markus, 08
Pace, E., 0E
Peffen, J.-Ch., 03
Pelizzo, Maria Guglielmina, 02
Pelletta, Marco, 04
Polese, C., 0E
Popecki, Mark A., 0D
Principi, Emiliano, 02
Renaud, Joseph M., 0D
Grudzinski, J. J., 0F
Saito, Takahiro, 0A, 0L
Siffalovic, Peter, 04
Stavitski, Eli, 0D
Stochaj, Michael E., 0D
Takei, Yoshinori, 0L
Takeo, Yoko, 0A, 0L
Tessarolo, Enrico, 02
Troussel, Ph., 05
Vegso, Karol, 04
Vivo, A., 03
Weigland, S., 0F
Zhou, Z., 0F
Zuppella, Paola, 02

Conference Committee

Program Track Chairs

Ali M. Khounsary, X-ray Optics, Inc. (United States) and Illinois Institute of Technology (United States)

Ralph B. James, Brookhaven National Laboratory (United States)

Conference Chairs

Shunji Goto, Japan Synchrotron Radiation Research Institute (Japan)

Christian Morawe, European Synchrotron Radiation Facility (France)

Ali M. Khounsary, X-ray Optics, Inc. (United States) and Illinois Institute of Technology (United States)

Conference Program Committee

Lucia Alianelli, Diamond Light Source Ltd. (United Kingdom)

Lahsen Assoufid, Argonne National Laboratory (United States)

Stefan Braun, Fraunhofer IWS Dresden (Germany)

Shih-Lin Chang, National Tsing Hua University (Taiwan)

Raymond Conley Jr., Argonne National Laboratory (United States)

Sultan B. Dabagov, Istituto Nazionale di Fisica Nucleare (Italy)

Christian David, Paul Scherrer Institut (Switzerland)

Hans M. Hertz, KTH Royal Institute of Technology (Sweden)

Werner H. Jark, Elettra-Sincrotrone Trieste S.C.p.A. (Italy)

George A. Kyrala, Los Alamos National Laboratory (United States)

Eric Louis, University Twente (Netherlands)

Carolyn A. MacDonald, University at Albany (United States)

Howard A. Padmore, Lawrence Berkeley National Laboratory (United States)

Ladislav Pina, Czech Technical University in Prague (Czech Republic)

Yuriy Ya Platonov, Rigaku Innovative Technologies, Inc. (United States)

Seungyu Rah, Pohang University of Science and Technology (Korea, Republic of)

Peter Revesz, Cornell University (United States)

Horst Schulte-Schrepping, Deutsches Elektronen-Synchrotron (Germany)

Regina Soufli, Lawrence Livermore National Laboratory (United States)

Stanislav Stoupin, Argonne National Laboratory (United States)

Akihiko Ueda, JTEC Corporation (Japan)

Joerg Wiesmann, Incoatec GmbH (Germany)

Makina Yabashi, RIKEN (Japan) and Japan Synchrotron Radiation
Research Institute (Japan)
Kazuto Yamauchi, Osaka University (Japan)
Brian W. Yates, Canadian Light Source Inc. (Canada)

Session Chairs

- 1 Multilayers
Shunji Goto, Japan Synchrotron Radiation Research Institute (Japan)
Raymond Conley Jr., Argonne National Laboratory (United States)
- 2 Focusing
Ali M. Khounsary, X-ray Optics, Inc. (United States) and Illinois Institute
of Technology (United States)
Kazuto Yamauchi, Osaka University (Japan)
- 3 Optics Development and Fabrication
Christian Morawe, European Synchrotron Radiation Facility (France)
Hidekazu Mimura, The University of Tokyo (Japan)
- 4 Instruments and Imaging
Ladislav Pina, Czech Technical University in Prague (Czech Republic)
Shunji Goto, Japan Synchrotron Radiation Research Institute (Japan)
- 5 Optics for Coherent Sources: Joint Session with Conferences 9588 and
9589
Carmen S. Menoni, Colorado State University (United States)
Ali M. Khounsary, X-ray Optics, Inc. (United States) and Illinois Institute
of Technology (United States)

Introduction

This volume contains papers presented at the conference on "Advances in X-Ray/EUV Optics and Components X," which was held in San Diego, California, United States on 11–12 August 2015 as part of the SPIE 2015 International Symposium on Optics + Photonics.

The conference was composed of five oral sessions: Multilayers, Focusing, Optics Development and Fabrication, Instrumentation and Imaging, and Optics for Coherent Sources. The final session was held jointly with the conference on "X-ray Lasers and Coherent X-Ray Sources: Development and Application XI."

The focus of the conference was technological developments in X-ray/EUV optics for synchrotron and FEL beamlines. Presentations covered a wide spectrum, from vacuum ultra violet to hard X-rays. Topics related to X-ray lasers, coherent X-ray sources, laboratory-based X-ray sources, and X-ray imaging were presented in independent conferences at the same symposium.

Scheduled for nearly one and a half days of oral presentations with an accompanying evening poster session, the conference was lively and well attended. We would like to thank the authors, speakers, session and joint session chairs, program committee members, the conference participants for their contributions, and the SPIE staff for their help in organizing the conference.

Shunji Goto
Christian Morawe
Ali M. Khounsary

