

PROCEEDINGS OF SPIE

***Advances in X-Ray/EUV Optics  
and Components II***

**Ali M. Khounsary**  
**Christian Morawe**  
**Shunji Goto**  
*Editors*

**27–28 August 2007**  
**San Diego, California, USA**

Sponsored and Published by  
SPIE

**Volume 6705**

Proceedings of SPIE, 0277-786X, v. 6705

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

The papers included 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. The papers published in these proceedings 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 book:

Author(s), "Title of Paper," in *Advances in X-Ray/EUV Optics and Components II*, edited by Ali M. Khounsary, Christian Morawe, Shunji Goto, Proceedings of SPIE Vol. 6705 (SPIE, Bellingham, WA, 2007) Article CID Number.

ISSN 0277-786X  
ISBN 9780819468536

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 © 2007, 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](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. The CCC fee code is 0277-786X/07/\$18.00.

Printed in the United States of America.

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



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

---

**Paper Numbering:** Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent 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 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.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

# Contents

vii Conference Committee

---

## SESSION 1 OPTICS DEVELOPMENT FACILITIES

---

- 6705 02 **Active microstructured arrays for x-ray optics** [6705-01]  
A. Michette, King's College London (United Kingdom); T. Button, Univ. of Birmingham (United Kingdom); C. Dunare, Univ. of Edinburgh (United Kingdom); C. Feldman, Univ. of Leicester (United Kingdom); M. Folkard, D. Hart, Gray Cancer Institute, Mount Vernon Hospital (United Kingdom); C. McFaull, G. R. Morrison, King's College London (United Kingdom); W. Parkes, Univ. of Edinburgh (United Kingdom); S. Pfauntsch, A. K. Powell, King's College London (United Kingdom); D. Rodriguez-Sanmartin, Univ. of Birmingham (United Kingdom); S. Sahraei, King's College London (United Kingdom); T. Stevenson, Univ. of Edinburgh (United Kingdom); B. Vojnovic, Gray Cancer Institute, Mount Vernon Hospital (United Kingdom); R. Willingale, Univ. of Leicester (United Kingdom); D. Zhang, Univ. of Birmingham (United Kingdom)
- 6705 04 **The new ESRF multilayer deposition facility** [6705-03]  
Ch. Morawe, Ch. Borel, J.-Ch. Peffen, European Synchrotron Radiation Facility (France)
- 6705 05 **Multilayer growth in the APS rotary deposition system** [6705-04]  
R. Conley, C. Liu, C. M. Kewish, A. T. Macrander, Argonne National Lab. (USA); C. Morawe, European Synchrotron Radiation Facility (France)

---

## SESSION 2 X-RAY LENSES AND APPLICATIONS

---

- 6705 06 **Silicon planar lenses for high-energy x-ray nanofocusing** [6705-05]  
A. Snigirev, I. Snigireva, European Synchrotron Radiation Facility (France); M. Grigoriev, V. Yunkin, Institute of Microelectronics Technology (Russia); M. Di Michiel, European Synchrotron Radiation Facility (France); S. Kuznetsov, Institute of Microelectronics Technology (Russia); G. Vaughan, European Synchrotron Radiation Facility (France)
- 6705 07 **Development of refractive x-ray focusing optics at Diamond Light Source** [6705-06]  
L. Alianelli, K. J. S. Sawhney, Diamond Light Source, Ltd. (United Kingdom); I. M. Loader, D. W. K. Jenkins, R. Stevens, Rutherford Appleton Lab. (United Kingdom); A. Snigirev, I. Snigireva, European Synchrotron Radiation Facility (France)
- 6705 08 **Nanopositioning of the silicon planar lenses used for 2D high energy x-ray nanofocusing** [6705-07]  
P. Van Vaerenbergh, A. Snigirev, M. A. Nicola, I. Snigireva, ESRF (France); M. Grigoriev, V. Yunkin, IMT (Russia); G. Vaughan, L. Claustre, H.-P. Van Der Kleij, J. Massonnat, ESRF (France)

- 6705 09 **Projection-type x-ray microscope based on a spherical compound refractive x-ray lens** [6705-08]  
Yu. I. Dudchik, Belarus State Univ. (Belarus); C. K. Gary, H. Park, Adelphi Technology, Inc. (USA); R. H. Pantell, Stanford Univ. (USA); M. A. Piestrup, Adelphi Technology, Inc. (USA)

---

### SESSION 3 MULTILAYER OPTICS

---

- 6705 0A **Deposition and analysis of small d-spacing depth graded multilayer structures** [6705-09]  
D. M. Broadway, Y. Y. Platonov, Rigaku Innovative Technologies (USA); R. Mancini, Univ. of Nevada, Reno (USA); R. Tommasini, Lawrence Livermore National Lab. (USA)
- 6705 0C **XUV optics for attosecond applications** [6705-11]  
J. Gautier, A. S. Morlens, P. Zeitoun, G. Rey, C. Valentin, E. Papalarazou, J. P. Goddet, S. Sebban, Lab. d'Optique Appliquée (France); F. Delmotte, M. F. Ravet, F. Bridou, Lab. Charles Fabry de l'institut d'Optique, CNRS, Univ. Paris Sud (France)
- 6705 0D **Metrology of micromirrors with replicated multilayers** [6705-12]  
L. Sveda, Czech Technical Univ. in Prague (Czech Republic) and Reflex s.r.o. (Czech Republic); A. Inneman, V. Semencova, Reflex s.r.o. (Czech Republic); L. Pina, Czech Technical Univ. in Prague (Czech Republic) and Reflex s.r.o. (Czech Republic); R. Hudec, Reflex s.r.o (Czech Republic) and Astronomical Institute of the Academy of Sciences (Czech Republic); R. Havlikova, Czech Technical Univ. in Prague (Czech Republic)
- 6705 0E **Development of an ultrahigh-resolution diffraction grating for soft x-rays** [6705-13]  
D. L. Voronov, Lawrence Berkeley National Lab. (USA) and Kharkov Polytechnic Univ. (Ukraine); R. Cambie, Lawrence Berkeley National Lab. (USA); R. M. Feshchenko, P.N. Lebedev Physical Institute (Russia); E. M. Gullikson, H. A. Padmore, Lawrence Berkeley National Lab. (USA); A. V. Vinogradov, P.N. Lebedev Physical Institute (Russia); V. V. Yashchuk, Lawrence Berkeley National Lab. (USA)

---

### SESSION 4 ZONE PLATES AND APPLICATIONS

---

- 6705 0F **Zone plate efficiency measurements with a laser-plasma source** [6705-14]  
M. C. Bertilson, P. A. C. Takman, A. Holmberg, U. Vogt, H. M. Hertz, Royal Institute of Technology (Sweden)
- 6705 0G **Hard x-ray focusing by stacked Fresnel zone plates** [6705-15]  
I. Snigireva, A. Snigirev, European Synchrotron Radiation Facility (France); V. Kohn, Russian Research Ctr. Kurchatov Institute (Russia); V. Yunkin, M. Grigoriev, S. Kuznetsov, Institute of Microelectronics Technology (Russia); G. Vaughan, M. Di Michiel, European Synchrotron Radiation Facility (France)

---

### SESSION 5 OPTICS AND BEAM COHERENCE

---

- 6705 0H **Characterization of beryllium and CVD diamond for synchrotron radiation beamline windows and x-ray beam monitor** [6705-17]  
S. Goto, S. Takahashi, T. Kudo, SPring-8/JASRI (Japan); M. Yabashi, K. Tamasaku, Y. Nishino, T. Ishikawa, SPring-8/RIKEN (Japan)

- 6705 0I **Simulation of partially coherent image formation in x-ray microscopy** [6705-18]  
O. von Hofsten, M. Bertilson, U. Vogt, Royal Institute of Technology, Albanova (Sweden)
- 6705 0J **Analysis and modification of x-ray mutual coherence with perfect-crystal diffraction**  
[6705-19]  
H. Yamazaki, SPring-8/JASRI (Japan); T. Ishikawa, RIKEN SPring-8 Ctr. (Japan)
- 6705 0K **Diamonds for x-ray optical applications at 3<sup>rd</sup> and 4<sup>th</sup> generation x-ray sources** [6705-20]  
R. C. Burns, Element Six Technologies (South Africa); A. Chumakov, G. Carbone, European Synchrotron Radiation Facility (France); S. H. Connell, D. Dube, Univ. of the Witwatersrand (South Africa); H. P. Godfryd, Element Six BV (Netherlands); J. O. Hansen, Element Six Technologies (South Africa); J. Härtwig, F. Masiello, European Synchrotron Radiation Facility (France); M. Rebak, Univ. of the Witwatersrand (South Africa); A. Rommeveaux, European Synchrotron Radiation Facility (France); R. Setshedi, Univ. of the Witwatersrand (South Africa); P. Van Vaerenbergh, European Synchrotron Radiation Facility (France); A. Gibaud, Univ. du Maine Le Mans (France)

---

## SESSION 6 MIRRORS AND APPLICATIONS

---

- 6705 0L **Reflective optics for sub-10nm hard x-ray focusing** [6705-21]  
H. Mimura, S. Matsuyama, H. Yumoto, S. Handa, T. Kimura, Y. Sano, Osaka Univ. (Japan); K. Tamasaku, Y. Nishino, SPring-8/Japan Synchrotron Radiation Research Institute (Japan); M. Yabashi, SPring-8/RIKEN (Japan); T. Ishikawa, SPring-8/Japan Synchrotron Radiation Research Institute (Japan) and SPring-8/RIKEN (Japan); K. Yamauchi, Osaka Univ. (Japan)
- 6705 0M **Large thin adaptive x-ray mirrors** [6705-22]  
P. Doel, C. Atkins, S. Thompson, D. Brooks, Univ. College London (United Kingdom); J. Yao, Institute of Optics and Electronics (China); C. Feldman, R. Willingale, Univ. of Leicester (United Kingdom); T. Button, D. Zhang, Univ. of Birmingham (United Kingdom); A. James, Mullard Space Science Lab., Univ. College London (United Kingdom)
- 6705 0N **Effect of x-ray beamline optics on x-ray photon correlation spectroscopy experiments**  
[6705-23]  
A. R. Sandy, Argonne National Lab. (USA); K. Evans-Lutterodt, Brookhaven National Lab. (USA); K. Fezzaa, Argonne National Lab. (USA); S. Kim, Gwangju Institute of Science and Technology (South Korea); S. Narayanan, M. Sprung, Argonne National Lab. (USA); A. Stein, Brookhaven National Lab. (USA)
- 6705 0O **Soft x-ray mirrors for the Linac Coherent Light Source** [6705-24]  
M. J. Pivovaroff, R. M. Bionta, T. J. McCarville, R. Soufli, Lawrence Livermore National Lab. (USA); P. M. Stefan, Stanford Linear Accelerator Ctr. (USA)
- 6705 0P **Beam splitting mirrors for an APS beamline** [6705-25]  
A. Khounsary, I. McNulty, Argonne National Lab. (USA)

---

**SESSION 7 THERMAL ISSUES AND PROSPECTS IN EUV AND X-RAY OPTICS**

---

- 6705 0Q **Directly water-cooled crystal development for SPring-8 bending magnet beamlines**  
[6705-26]  
K. Takeshita, S. Goto, SPring-8/JASRI (Japan); T. Ishikawa, SPring-8/JASRI (Japan) and SPring-8/RIKEN (Japan)
- 6705 0U **Measurement of thermal contact conductance of SPring-8 beamline components**  
[6705-29]  
T. Mochizuki, H. Ohashi, M. Sano, S. Takahashi, S. Goto, Japan Synchrotron Radiation Research Institute (Japan)

---

**POSTER SESSION**

---

- 6705 0V **Performance of newly developed Mg/SiC multilayer mirrors** [6705-31]  
T. Toyota, G. Murakami, K. Yoshioka, I. Yoshikawa, The Univ. of Tokyo (Japan)
- 6705 0Y **High-performance multilayer coatings for 106 nm** [6705-34]  
E. Taracheva, S. Yulin, T. Feigl, N. Kaiser, Fraunhofer-Institute for Applied Optics and Precision Engineering (Germany)
- 6705 11 **Micro-optics test bench at the ESRF** [6705-37]  
A. Snigirev, R. Hustache, P. Duboc, J.-Y. Massonnat, L. Claustre, P. Van Vaerenbergh, I. Snigireva, European Synchrotron Radiation Facility (France); M. Grigoriev, V. Yunkin, Institute of Microelectronics Technology (Russia)
- 6705 12 **High-energy-resolution monochromator for nuclear resonant scattering of synchrotron radiation by Te-125 at 35.49 keV** [6705-38]  
Y. Imai, Y. Yoda, Japan Synchrotron Radiation Research Institute (Japan) and CREST, Japan Science and Technology Agency (Japan); S. Kitao, R. Masuda, S. Higashitaniguchi, Kyoto Univ. (Japan) and CREST, Japan Science and Technology Agency (Japan); C. Inaba, Kyoto Univ. (Japan); M. Seto, Kyoto Univ. (Japan), Japan Atomic Energy Agency (Japan), and CREST, Japan Science and Technology Agency (Japan)

Author Index

# Conference Committee

## Conference Chairs

**Ali M. Khounsary**, Argonne National Laboratory (USA)  
**Christian Morawe**, European Synchrotron Radiation Facility (France)  
**Shunji Goto**, Japan Synchrotron Radiation Research Institute (Japan)

## Program Committee

**Lahsen Assoufid**, Argonne National Laboratory (USA)  
**Sasa Bajt**, Lawrence Livermore National Laboratory (USA)  
**Stefan Braun**, Fraunhofer-Institut für Werkstoff- und Strahltechnik  
(Germany)  
**Sultan B. Dabagov**, Istituto Nazionale di Fisica Nucleare (Italy)  
**Hans M. Hertz**, Royal Institute of Technology (Sweden)  
**Olivier Hignette**, European Synchrotron Radiation Facility (France)  
**Werner H. Jark**, Sincrotrone Trieste S.C.p.A. (Italy)  
**Igor V. Kozhevnikov**, A.V. Shubnikov Institute of Crystallography  
(Russia)  
**George A. Kyrala**, Los Alamos National Laboratory (USA)  
**Carolyn A. MacDonald**, SUNY/University at Albany (USA)  
**Howard A. Padmore**, Lawrence Berkeley National Laboratory (USA)  
**Ladislav Pina**, Czech Technical University in Prague (Czech Republic)  
**Yuriy Y. Platonov**, Rigaku/MSC, Inc. (USA)  
**Kawal J. S. Sawhney**, Diamond Light Source Ltd. (United Kingdom)  
**Anatoly A. Snigirev**, European Synchrotron Radiation Facility (France)  
**Peter Z. Takacs**, Brookhaven National Laboratory (USA)  
**John S. Taylor**, Lawrence Livermore National Laboratory (USA)  
**Edmond I. C. Turcu**, Rutherford Appleton Laboratory (United Kingdom)  
**Kazuto Yamauchi**, Osaka University (Japan)

## Session Chairs

- 1 Optics Development Facilities  
**Shunji Goto**, Japan Synchrotron Radiation Research Institute (Japan)  
**Hans M. Hertz**, Kungliga Tekniska Högskolan (Sweden)
- 2 X-Ray Lenses and Applications  
**Ali M. Khounsary**, Argonne National Laboratory (USA)  
**Howard A. Padmore**, Lawrence Berkeley National Laboratory (USA)

- 3 Multilayer Optics  
**Christian Morawe**, European Synchrotron Radiation Facility (France)  
**Yuriy Y. Platonov**, Rigaku/MSC, Inc. (USA)
- 4 Zone Plates and Applications  
**John S. Taylor**, Lawrence Livermore National Laboratory (USA)  
**Anatoly A. Snigirev**, European Synchrotron Radiation Facility (France)
- 5 Optics and Beam Coherence  
**Christian Morawe**, European Synchrotron Radiation Facility (France)  
**Howard A. Padmore**, Lawrence Berkeley National Laboratory (USA)
- 6 Mirrors and Applications  
**Shunji Goto**, Japan Synchrotron Radiation Research Institute (Japan)
- 7 Thermal Issues and Prospects in EUV and X-Ray Optics  
**Ali M. Khounsary**, Argonne National Laboratory (USA)  
**Kazuto Yamauchi**, Osaka University (Japan)