PROCEEDINGS OF SPIE

X-Ray Nanoimaging: Instruments and Methods

Barry Lai
Editor

28–29 August 2013
San Diego, California, United States

Sponsored and Published by
SPIE

Volume 8851

Proceedings of SPIE 0277-786X, V. 8851

X-Ray Nanoimaging: Instruments and Methods, edited by Barry Lai, Proc. of SPIE Vol. 8851, 885101
© 2013 SPIE · CCC code: 0277-786X/13/$18 · doi: 10.1117/12.2045770

Please use the following format to cite material from this book:
Author(s), "Title of Paper," in *X-Ray Nanoimaging: Instruments and Methods*, edited by Barry Lai, Proceedings of SPIE Vol. 8851 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X
ISBN: 9780819497017

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

Printed in the United States of America.

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

SPIE Digital Library
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 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.

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*
ix *Introduction*

SCANNING PROBES I

8851 02 **Sub-100-nm 3D-elemental mapping of frozen-hydrated cells using the bionanoprobe (Invited Paper)** [8851-1]
S. Chen, Argonne National Lab. (United States); Y. Yuan, J. Deng, R. Mak, Q. Jin, T. Paunesku, Northwestern Univ. (United States); S. C. Gleber, D. Vine, Argonne National Lab. (United States); C. Flachenecker, B. Hornberger, Carl Zeiss X-ray Microscopy, Inc. (United States); D. Shu, B. Lai, J. Maser, L. Finney, C. Roehrig, Argonne National Lab. (United States); J. VonOsinski, M. Bolbat, K. Brister, Northwestern Synchrotron Research Ctr. (United States); C. Jacobsen, Argonne National Lab. (United States); G. Woloschak, Northwestern Univ. (United States); S. Vogt, Argonne National Lab. (United States)

8851 04 **Status of the Nanoscopium scanning nanoprobe beamline of Synchrotron Soleil** [8851-3]
A. Somogyi, K. Medjoubi, C. M. Kewish, V. Leroux, M. Ribbens, G. Baranton, F. Polack, J. P. Samama, Synchrotron SOLEIL (France)

8851 06 **A next-generation in-situ nanoprobe beamline for the Advanced Photon Source** [8851-5]
J. Maser, B. Lai, Argonne National Lab. (United States); T. Buonassisi, Massachusetts Institute of Technology (United States); Z. Cai, S. Chen, L. Finney, S.-C. Gleber, R. Harder, C. Jacobsen, W. Liu, Argonne National Lab. (United States); C. Murray, IBM Thomas J. Watson Research Ctr. (United States); C. Preissner, C. Roehrig, V. Rose, D. Shu, D. Vine, S. Vogt, Argonne National Lab. (United States)

FULL-FIELD MICROSCOPES

8851 07 **Development of achromatic full-field x-ray microscopy with compact imaging mirror system (Invited Paper)** [8851-6]
S. Matsuyama, Y. Emi, H. Kino, Y. Sano, Osaka Univ. (Japan); Y. Kohmura, K. Tamasaku, M. Yabashi, T. Ishikawa, SPring-8/RIKEN (Japan); K. Yamauchi, Osaka Univ. (Japan)

8851 09 **Development of large-field high-resolution hard x-ray imaging microscopy and microtomography with Fresnel zone plate objective** [8851-8]
Y. Suzuki, A. Takeuchi, Y. Terada, K. Uesugi, Japan Synchrotron Radiation Research Institute (Japan); S. Tamura, National Institute of Advanced Industrial Science and Technology (Japan)

IN-SITU TXM STUDIES

8851 0A **Data-processing strategies for nano-tomography with elemental specification (Invited Paper)** [8851-9]
Y. Liu, SLAC National Accelerator Lab. (United States); K. H. Cats, Utrecht Univ. (Netherlands); J. Nelson Weker, J. C. Andrews, SLAC National Accelerator Lab. (United States); B. M. Weckhuysen, Utrecht Univ. (Netherlands); P. Pianetta, SLAC National Accelerator Lab. (United States)

8851 0B **Identifying and managing radiation damage during *in situ* transmission x-ray microscopy of Li-ion batteries** [8851-10]
J. Nelson, SLAC National Accelerator Lab. (United States); Y. Yang, Stanford Univ. (United States); S. Misra, BASF Nederlands B.V. (Netherlands); J. C. Andrews, SLAC National Accelerator Lab. (United States); Y. Cui, Stanford Univ. (United States); M. F. Toney, SLAC National Accelerator Lab. (United States)

8851 0C **Development of in-situ full-field spectroscopic imaging analysis and application on Li-ion battery using transmission x-ray microscopy** [8851-11]
Y. K. Chen-Wiegart, J. Wang, J. Wang, Brookhaven National Lab. (United States)

8851 0D **Development of in-line furnace for *in-situ* nanoscale resolution x-ray microscopy** [8851-12]
C. Eng, Brookhaven National Lab. (United States) and Stony Brook Univ. (United States); Y. K. Chen-Wiegart, J. Wang, Brookhaven National Lab. (United States)

NANOFOCUSING OPTICS

8851 0G **Design optimization of ultra-precise elliptical mirrors for hard x-ray nanofocusing at Nanoscopium** [8851-15]
C. M. Kewish, F. Polack, Synchrotron SOLEIL (France); R. Signorato, Bruker ASC GmbH (Germany); A. Somogyi, Synchrotron SOLEIL (France)

SCANNING PROBES II

8851 0K **Development of an in-vacuum x-ray microscope with cryogenic sample cooling for beamline P11 at PETRA III** [8851-19]
A. Meents, B. Reime, N. Stuebe, P. Fischer, M. Warmer, D. Goeries, J. Roever, J. Meyer, J. Fischer, A. Burkhardt, Deutsches Elektronen-Synchrotron (Germany); I. Vartiainen, P. Karvinen, C. David, Paul Scherrer Institut (Switzerland)

8851 0L **NanoMAX: a hard x-ray nanoprobe beamline at MAX IV** [8851-20]
U. Johansson, Lund Univ. (Sweden); U. Vogt, KTH Royal Institute of Technology (Sweden); A. Mikkelsen, Lund. Univ. (Sweden)

8851 0M **Preliminary design of a zone plate based hard X-ray monochromatic diffraction nanoprobe for materials studies at APS** [8851-21]
Z. Cai, W. Liu, J. Z. Tischler, D. Shu, R. Xu, O. Schmidt, Argonne National Lab. (United States)

FAST INSTRUMENTATION

8851 0P **Simultaneous fast scanning XRF, dark field, phase-, and absorption contrast tomography** [8851-24]
K. Medjoubi, Synchrotron SOLEIL (France); A. Bonissent, Ctr. de Physique des Particules de Marseille (France) and CNRS/IN2P3 (France); N. Leclercq, F. Langlois, P. Mercère, A. Somogyi, Synchrotron SOLEIL (France)

8851 0Q **The Maia detector array and x-ray fluorescence imaging system: locating rare precious metal phases in complex samples** [8851-25]
C. G. Ryan, Commonwealth Scientific and Industrial Research Organisation (Australia); D. P. Siddons, Brookhaven National Lab. (United States); R. Kirkham, Commonwealth Scientific and Industrial Research Organisation (Australia); Z. Y. Li, Brookhaven National Lab. (United States); M. D. de Jonge, D. Paterson, Australian Synchrotron (Australia); J. S. Cleverley, Commonwealth Scientific and Industrial Research Organisation (Australia); A. Kuczewski, Brookhaven National Lab. (United States); P. A. Dunn, M. Jensen, Commonwealth Scientific and Industrial Research Organisation (Australia); G. De Geronimo, Brookhaven National Lab. (United States); D. L. Howard, Australian Synchrotron (Australia); B. Godel, Commonwealth Scientific and Industrial Research Organisation (Australia); K. A. Dyl, Commonwealth Scientific and Industrial Research Organisation (Australia) and Curtin Univ. (Australia); L. A. Fisher, R. H. Hough, S. J. Barnes, Commonwealth Scientific and Industrial Research Organisation (Australia); P. A. Bland, Curtin Univ. (Australia); G. Moorhead, Commonwealth Scientific and Industrial Research Organisation (Australia); S. A. James, K. M. Spiers, Australian Synchrotron (Australia); G. Falkenberg, U. Boesenberg, G. Wellenreuther, Hasylab, Deutsches Elektronen-Synchrotron (Germany)

NOVEL NANOIMAGING METHODS

8851 0T **A universal measure for coherence requirements in diffractive imaging** [8851-28]
B. Chen, B. Abbey, E. Balaur, G. van Reissen, M. Junker, M. W. M. Jones, La Trobe Univ. (Australia); A. G. Peele, La Trobe Univ. (Australia) and Australian Synchrotron (Australia); C. T. Putkunz, The Univ. of Melbourne (Australia); D. Vine, Advanced Photon Source, Argonne National Lab. (United States); H. M. Quiney, The Univ. of Melbourne (Australia); K. A. Nugent, La Trobe Univ. (Australia)

LAB-BASED INSTRUMENTS

8851 0W **Optimized cavity-enhanced x-ray sources for x-ray microscopy (Invited Paper)** [8851-31]
J. M. J. Madey, E. B. Szarmes, M. R. Hadmack, Univ. of Hawai'i at Manoa (United States); B. T. Jacobson, RadiaBeam Technologies, LLC (United States); J. M. D. Kowalczyk, P. Niknejadi, Univ. of Hawai'i at Manoa (United States)

8851 0Y **Tabletop coherent diffractive imaging of extended objects in transmission and reflection geometry** [8851-33]
M. D. Seaberg, B. Zhang, D. E. Adams, D. F. Gardner, H. C. Kapteyn, M. M. Murnane, Univ. of Colorado at Boulder (United States)

POSTER SESSION

8851 0Z **High efficiency x-ray nanofocusing by the blazed stacking of binary zone plates** [8851-34]
I. Mohacsi, P. Karvinen, I. Vartiainen, A. Diaz, Paul Scherrer Institut (Switzerland); A. Somogyi, C. M. Kewish, P. Mercere, Synchrotron SOLEIL (France); C. David, Paul Scherrer Institut (Switzerland)

8851 12 **Analysis of impact of sintering temperature on microstructure of LSCF-SDC composite cathodes using nano-CT** [8851-37]
Y. Guan, X. Pan, G. Liu, Z. Liang, S. Chen, X. Zhang, Y. Xiong, Y. Tian, C. Xia, Univ. of Science and Technology of China (China)

8851 13 **Reconstruction of limited-angle and few-view nano-CT image via total variation iterative reconstruction** [8851-38]
Z. Liang, Y. Guan, G. Liu, R. Bian, X. Zhang, Y. Xiong, Y. Tian, Univ. of Science and Technology of China (China)

8851 17 **A soft x-ray beamline for quantitative nanotomography using ptychography** [8851-43]
G. A. van Riessen, M. Junker, N. W. Phillips, Australian Research Council Ctr. of Excellence in Coherent X-Ray Science (Australia) and La Trobe Univ. (Australia); A. G. Peele, Australian Research Council Ctr. of Excellence in Coherent X-Ray Science (Australia), La Trobe Univ. (Australia), and Australian Synchrotron (Australia)

8851 19 **Recent advances in use of atomic layer deposition and focused ion beams for fabrication of Fresnel zone plates for hard x-rays** [8851-45]
K. Keskinbora, Max-Planck Institut für Intelligente Systeme (Germany); A.-L. Robisch, Univ. Göttingen (Germany); M. Mayer, C. Grévent, Max-Planck Institut für Intelligente Systeme (Germany); A. V. Szeghalmi, Friedrich-Schiller-Univ. Jena (Germany); M. Knez, CIC nanoGUNE Consolider (Spain) and Ikerbasque, Basque Foundation for Science (Spain); M. Weigand, Max-Planck Institut für Intelligente Systeme (Germany); I. Snigireva, A. Snigirev, European Synchrotron Radiation Facility (France); T. Salditt, Univ. Göttingen (Germany); G. Schütz, Max-Planck Institut für Intelligente Systeme (Germany)

8851 1D **Full-field x-ray nano-imaging at SSRF** [8851-49]
B. Deng, Y. Ren, Y. Wang, G. Du, H. Xie, T. Xiao, Shanghai Institute of Applied Physics (China)

Author Index

Conference Committee

Program Track Chair

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

Conference Chair

Barry Lai, Argonne National Laboratory (United States)

Conference Program Committee

Michael Feser, Carl Zeiss X-ray Microscopy (United States)
Hans M. Hertz, Royal Institute of Technology (Sweden)
Ian McNulty, Argonne National Laboratory (United States)
David Paterson, Australian Synchrotron (Australia)
Christian G. Schroer, Technische Universität Dresden (Germany)
Andrea Somogyi, Synchrotron SOLEIL (France)
Kazuto Yamauchi, Osaka University (Japan)

Session Chairs

1 Scanning Probes I
Barry Lai, Argonne National Laboratory (United States)

2 Full-Field Microscopes
David J. Paterson, Australian Synchrotron (Australia)

3 In-situ TXM Studies
Benjamin Hornberger, Carl Zeiss X-ray Microscopy (United States)

4 Nanofocusing Optics
Christian G. Schroer, Technische Universität Dresden (Germany)

5 Beam Characterization
Christian G. Schroer, Technische Universität Dresden (Germany)

6 Scanning Probes II
Andrea Somogyi, Synchrotron SOLEIL (France)

7 Fast Instrumentation
Stefan Vogt, Argonne National Laboratory (United States)

8 Novel Nanoimaging Methods
Ian McNulty, Argonne National Laboratory (United States)

9 Lab-based Instruments
Hans M. Hertz, Royal Institute of Technology (Sweden)

Introduction

It has been a pleasure to organize the SPIE X-ray Nanoimaging Conference. It started from a simple office visit by a longtime colleague, Ali Khounsary, who had organized numerous SPIE x-ray conferences. With Ali's encouragement and advice, I started to contact potential members of the program committee. Surprisingly everyone accepted and agreed to serve, and an international program committee was quickly established. However the most remarkable occurrence had to be the enthusiastic response from the x-ray nanoimaging community: 48 original and exciting abstracts were submitted within a short time. It demonstrated the breadth and depth of the x-ray nanoimaging community in general, which had seen substantial growth recently due to construction of new and upgrade of existing synchrotron facilities worldwide.

The conference was organized into two days of oral presentations, with a lively evening poster session in between. Topics included scanning probes, full-field microscopes, in-situ studies, nanofocusing optics, beam characterization, fast instrumentation, novel methods, and lab-based instruments. Overall the presentations were exciting, the audiences were engaging, and it was particularly gratifying to see new researchers participating at the conference. Special thanks to the program committee members for their volunteer but hard work, the SPIE staff for their professional support, session chairs for managing the thoughtful discussions, authors and presenters for sharing the latest developments, and all the active participants, who together made this a very rewarding experience.

Barry Lai