

PROCEEDINGS OF SPIE

Ultrafast Nonlinear Imaging and Spectroscopy IV

Zhiwen Liu
Iam Choon Khoo
Demetri Psaltis
Kebin Shi
Editors

28–30 August 2016
San Diego, California, United States

Sponsored and Published by
SPIE

Volume 9956

Proceedings of SPIE 0277-786X, V. 9956

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

Ultrafast Nonlinear Imaging and Spectroscopy IV, edited by Zhiwen Liu, Iam Choon Khoo, Demetri Psaltis, Kebin Shi,
Proc. of SPIE Vol. 9956, 995601 · © 2016 SPIE · CCC code: 0277-786X/16/\$18 · doi: 10.1117/12.2256097

Proc. of SPIE Vol. 9956 995601-1

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 book:

Author(s), "Title of Paper," in *Ultrafast Nonlinear Imaging and Spectroscopy IV*, edited by Zhiwen Liu, Iam Choon Khoo, Demetri Psaltis, Kebin Shi, Proceedings of SPIE Vol. 9956 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510603035

ISBN: 9781510603042 (electronic)

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 © 2016, 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/16/\$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. A unique citation identifier (CID) number is assigned to each article 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 six-digit CID article numbering system structured as follows:

- 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.

Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>

ULTRAFAST ELECTRON DIFFRACTION AND IMAGING

- 9956 02 **Femtosecond electron pulse generation and measurement for diffractive imaging of isolated molecules** [9956-1]
- 9956 04 **Ultrafast electron microscopy for investigating fundamental physics phenomena (Invited Paper)** [9956-3]

SFG/SHG SPECTROSCOPY AND IMAGING

- 9956 08 **Second-harmonic radiating imaging probes and harmonic holography (Invited Paper)** [9956-7]

BIOLOGICAL IMAGING AND SENSING APPLICATIONS

- 9956 0K **Fluorescence fluctuation analysis of BACE1-GFP fusion protein in cultured HEK293 cells (Invited Paper)** [9956-20]

MULTIDIMENSIONAL SPECTROSCOPY

- 9956 0Q **Two-dimensional coherent spectroscopy of excitons, biexcitons, and exciton-polaritons (Invited Paper)** [9956-26]

ULTRAFAST TECHNIQUES

- 9956 0T **Superluminality effect for laser pulse propagation in medium containing nanorods under the two-photon luminescence** [9956-29]
- 9956 0U **Ultrafast dynamics of single ZnO nanowires using ultraviolet femtosecond Kerr-gated wide-field fluorescence microscopy** [9956-30]
- 9956 0V **Capturing ultrafast spectral evolution with transient grating photoluminescence spectroscopy** [9956-31]

ULTRAFAST SOURCES AND APPLICATIONS

- 9956 0Y **Nonlinear photothermal mid-infrared spectroscopy (Invited Paper)** [9956-34]

NOVEL IMAGING TECHNIQUES

9956 12 **Adaptive mode control in few mode fibers and its applications (Invited Paper) [9956-38]**

POSTER SESSION

9956 18 **Studies of cartilaginous tissue using Raman spectroscopy method [9956-46]**

9956 19 **Application of Raman spectroscopy method for analysis of biopolymer materials [9956-47]**

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.

Asadova, Anna A., 19
Ashry, Islam, 12
Barwick, Brett, 04
Basnet, Aashwin, 04
Blake, Jolie C., 0U
Bristow, Alan D., 0Q
Brown, Parker W., 04
Centurion, Martin, 02
Chen, Kai, 0V
Dahal, Prawesh, 04
DeSimone, Alice J., 02
Dolgyskin, Dmitry A., 18
Erramilli, Shyamsunder, 0Y
Gallaher, Joseph K., 0V
Gardeen, Spencer, 0K
Gundlach, Lars, 0U
Heikal, Ahmed A., 0K
Hodgkiss, Justin M., 0V
Johnson, Joseph L., 0K
Kornilin, Dmitriy V., 18, 19
Kylabyhova, A. Y., 18
Li, Zhengxin, 0U
Lu, Peng, 12
Lysak, Tatyana M., 0T
Mahortova, Aleksandra O., 19
Markova, Maria D., 18
Mudvari, Akrit, 04
Nieto-Pescador, Jesus, 0U
Prasad, Shyamal K. K., 0V
Psaltis, Demetri, 08
Pu, Ye, 08
Sander, Michelle Y., 0Y
Thordarson, Pall, 0V
Timchenko, Elena V., 18, 19
Timchenko, Pavel E., 18, 19
Totachawattana, Atcha, 0Y
Trofimov, Vyacheslav A., 0T
Volchkov, S. E., 19
Volova, Larisa T., 18
Webb, James E. A., 0V
Wilkin, Kyle J., 02
Xu, Yong, 12
Yang, Jie, 02
Zandi, Omid, 02

Conference Committee

Program Track Chairs

Shizhuo Yin, The Pennsylvania State University (United States)
Ruyan Guo, The University of Texas at San Antonio (United States)

Conference Chair

Zhiwen Liu, The Pennsylvania State University (United States)

Conference Co-chairs

Iam Choon Khoo, The Pennsylvania State University (United States)
Demetri Psaltis, Ecole Polytechnique Fédérale de Lausanne
(Switzerland)
Kebin Shi, Peking University (China)

Conference Program Committee

George Barbastathis, Massachusetts Institute of Technology
(United States)
Randy A. Bartels, Colorado State University (United States)
Martin Centurion, University of Nebraska-Lincoln (United States)
Jason M. Eichenholz, Open Photonics, Inc. (United States)
Kenan Gundogdu, North Carolina State University (United States)
Hans D. Hallen, North Carolina State University (United States)
Zhenyu Li, The George Washington University (United States)
Fiorenzo Gabriele Omenetto, Tufts University (United States)
Michelle Y. Sander, Boston University (United States)
Jigang Wang, Iowa State University of Science and Technology
(United States)
Yong Xu, Virginia Polytechnic Institute and State University
(United States)

Session Chairs

- 1 Ultrafast Electron Diffraction and Imaging
Kebin Shi, Peking University (China)
- 2 SFG/SHG Spectroscopy and Imaging
Jie Yang, University of Nebraska-Lincoln (United States)

- 3 Raman Imaging and Sensing
Jigang Wang, Iowa State University of Science and Technology
(United States)
- 4 Nanoscale Phenomena
Alexander Cocking, The Pennsylvania State University (United States)
- 5 Biological Imaging and Sensing Applications
Corey Janisch, The Pennsylvania State University (United States)
- 6 Multidimensional Spectroscopy
Chenji Zhang, The Pennsylvania State University (United States)
- 7 Ultrafast Techniques
Zhenyu Li, The George Washington University (United States)
- 8 Ultrafast Sources and Applications
Perry S. Edwards, Atoptix, LLC (United States)
- 9 Novel Imaging Techniques
Zhiwen Liu, The Pennsylvania State University (United States)