PROCEEDINGS OF SPIE

Ultrafast Imaging and Spectroscopy

Zhiwen Liu *Editor*

25–26 August 2013 San Diego, California, United States

Sponsored and Published by SPIE

Volume 8845

Proceedings of SPIE 0277-786X, V. 8845

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

Ultrafast Imaging and Spectroscopy, edited by Zhiwen Liu, Proc. of SPIE Vol. 8845, 884501 \cdot © 2013 SPIE \cdot CCC code: 0277-786X/13/\$18 \cdot doi: 10.1117/12.2048663

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 *Ultrafast Imaging and Spectroscopy*, edited by Zhiwen Liu, Proceedings of SPIE Vol. 8845 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X ISBN: 9780819496959

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 © 2013, 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/13/\$18.00.

Printed in the United States of America.

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



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 **ULTRAFAST ELECTRON DIFFRACTION AND IMAGING** 8845 02 Ultrafast 3D imaging of isolated molecules with electron diffraction (Invited Paper) [8845-1] J. Yang, C. J. Hensley, M. Centurion, The Univ. of Nebraska-Lincoln (United States) 8845 04 Use of attosecond electron pulses to image electronic motion in atoms and molecules **(Invited Paper)** [8845-3] H.-C. Shao, A. F. Starace, The Univ. of Nebraska-Lincoln (United States) 8845 06 Photon-induced near field electron microscopy (Invited Paper) [8845-5] S. T. Park, A. H. Zewail, California Institute of Technology (United States) 8845 07 Diffraction contrast as a sensitive indicator of femtosecond sub-nanoscale motion in ultrafast transmission electron microscopy [8845-6] D. R. Cremons, K. B. Schliep, D. J. Flannigan, Univ. of Minnesota (United States) SFG/SHG SPECTROSCOPY AND IMAGING 8845 08 Vibrational sum frequency generation (SFG) spectroscopic study of crystalline cellulose in biomass (Invited Paper) [8845-7] S. H. Kim, C. M. Lee, K. Kafle, Y. B. Park, X. Xi, The Pennsylvania State Univ. (United States) NANOSCALE DEVICES AND IMAGING 8845 0C STED imaging of nitrogen vacancy centers in diamond (Invited Paper) [8845-12] X. Yang, Peking Univ. (China); Y. Liu, Peking Univ. (China) and Shanghai Jiao Tong Univ. (China); J. Wang, Tsinghua Univ. (China); S. Zhang, Beijing Ruichi Instruments (China); H. Xie, X. Chen, P. Xi, Peking Univ. (China) 8845 0D Self-assembled nanomaterials for nonlinear fiber optics and tunable plasmonics (Invited **Paper)** [8845-13] I. Ashry, C. Daengngam, I. Kandas, J. Heflin, H. Robinson, Y. Xu, Virginia Tech (United States) **NOVEL ULTRAFAST NONLINEAR IMAGING AND SPECTROSCOPY TECHNIQUES** 8845 OI Spectrography for 3D analysis from a single spectral view (Invited Paper) [8845-18] Y. Xi, J. Zhao, Shanghai Jiao Tong Univ. (China); X. Huang, Brookhaven National Lab. (United States); H. Yu, Wake Forest Univ. Health Sciences (United States); Y. Wana, Argonne National Lab. (United States); G. Wang, Rensselaer Polytechnic Institute (United States)

8845 0J CMOS: a compressive sensing based template for high-resolution multi-heterodyne optical spectroscopy [8845-19] N. Mehta, Z. Liu, The Pennsylvania State Univ. (United States)

BIOAPPLICATIONS OF ULTRAFAST NONLINEAR SPECTROSCOPY AND IMAGING

8845 OP On-chip optofluidic grating spectrograph for biomedical applications (Invited Paper)
[8845-25]

Z. Li, The George Washington Univ. (United States)

ULTRAFAST SPECTROSCOPY

8845 0U **Ultrafast spectroscopy of hot electron and hole dynamics in GaP** [8845-30] C. M. Collier, B. Born, X. Jin, J. F. Holzman, The Univ. of British Columbia (Canada)

RAMAN SPECTROSCOPY AND IMAGING

Coherence in UV resonance Raman spectroscopy of liquid benzene and toluene, but not ice (Invited Paper) [8845-37]

H. D. Hallen, R. R. Neely III, North Carolina State Univ. (United States); A. H. Willitsford, Johns Hopkins Univ. Applied Physics Lab. (United States); C. T. Chadwick, C. R. Philbrick, North Carolina State Univ. (United States)

8845 12 Raman spectroscopic sensing using whispering gallery microresonators [8845-38]
P. Edwards, C. Janisch, The Pennsylvania State Univ. (United States); B. Peng, S. K. Ozdemir, L. Yang, Washington Univ. (United States); Z. Liu, The Pennsylvania State Univ. (United States)

POSTER SESSION

(Lithuania)

- Portable multispectral imaging system for oral cancer diagnosis [8845-41]
 Y.-F. Hsieh, National Central Univ. (Taiwan); M. Ou-Yang, National Chiao Tung Univ. (Taiwan); C.-C. Lee, National Central Univ. (Taiwan)
- 1D-scanning addressable multiregional multifocal multiphoton microscopy [8845-43] W. Qin, Clemson Univ. (United States); Y. Shao, Shenzhen Univ. (China); H. Liu, Clemson Univ. (United States); X. Peng, H. Niu, Shenzhen Univ. (China); B. Z. Gao, Clemson Univ. (United States)
- Optical parametric oscillators synchronously pumped by fundamental and second harmonic radiation of femtosecond Yb:KGW laser [8845-45]
 K. Stankevičiūtė, I. Pipinytė, J. Vengelis, A. Marcinkevičiūtė, R. Šuminas, R. Grigonis, Vilnius Univ. (Lithuania); R. C. Eckardt, Gooch & Housego (United States); V. Sirutkaitis, Vilnius Univ.

iv

8845 1A Performance evaluation of hybrid VLC using device cost and power over data throughput criteria [8845-46]

C. C. Lee, C. S. Tan, H. Y. Wong, Multimedia Univ. (Malaysia); M. B. Yahya, TM R&D (Malaysia)

8845 1B Enhanced optical second-harmonic generation from current-biased graphene on the substrates of Si and SiC [8845-47]

Y. Q. An, Univ. at Albany (United States); D. B. Dougherty, J. E. Rowe, A. Sandin, North Carolina State Univ. (United States); J. U. Lee, A. C. Diebold, Univ. at Albany (United States)

Author Index

Proc. of SPIE Vol. 8845 884501-6

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 Cochairs

lam Choon Khoo, The Pennsylvania State University (United States)

Demetri Psaltis, École Polytechnique Fédérale de Lausanne (Switzerland)

Conference Program Committee

George Barbastathis, Massachusetts Institute of Technology (United States)

Randy Bartels, Colorado State University (United States)

Martin Centurion, University of Nebraska-Lincoln (United States)

Yujie J. Ding, Lehigh University (United States)

Jason M. Eichenholz, Open Photonics, Inc. (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)

Kebin Shi, Peking University (China)

Yong Xu, Virginia Polytechnic Institute and State University (United States)

Session Chairs

- 1 Ultrafast Electron Diffraction and Imaging Seong H. Kim, The Pennsylvania State University (United States)
- 2 SFG/SHG Spectroscopy and Imaging Martin Centurion, University of Nebraska-Lincoln (United States)
- Nanoscale Devices and Imaging
 Zhenyu Li, The George Washington University (United States)
- 4 Novel Ultrafast Nonlinear Imaging and Spectroscopy Techniques

 Yong Xu, Virginia Polytechnic Institute and State University (United States)
- 5 Bioapplications of Ultrafast Nonlinear Spectroscopy and Imaging **Chuanshan Tian**, Fudan University (China)

- 6 Ultrafast Spectroscopy **Dongping Zhong**, The Ohio State University (United States)
- Novel 3D Imaging MethodsZhiwen Liu, The Pennsylvania State University (United States)
- 8 Raman Spectroscopy and Imaging Jeffrey J. Field, Colorado State University (United States)