PROCEEDINGS OF SPIE

Advanced Environmental, Chemical, and Biological Sensing Technologies XV

Tuan Vo-Dinh *Editors*

14–16 April 2019 Baltimore, Maryland, United States

Sponsored and Published by SPIE

Volume 11007

Proceedings of SPIE 0277-786X, V. 11007

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

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 SPIEDigitalLibrary.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 these proceedings:

Author(s), "Title of Paper," in Advanced Environmental, Chemical, and Biological Sensing Technologies XV, edited by Tuan Vo-Dinh, Proceedings of SPIE Vol. 11007 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510626799

ISBN: 9781510626805 (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 © 2019, 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/19/\$18.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

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



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 seven-digit CID article numbering system structured as follows:

- The first five 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 vii	Authors Conference Committee
	ADVANCED BIOSENSING SYSTEMS I
11007 02	Salivary ISFET sensors for stress monitoring (Invited Paper) [11007-1]
11007 03	Biological sensing technology based on intrinsic molecular charges (Invited Paper) [11007-2]
11007 04	96-well capped gold nanoslits for backside-reflection plasmonic biosensing (Invited Paper) [11007-3]
	ADVANCED BIOSENSING SYSTEMS II
11007 08	In vivo nucleic acid detection and imaging within whole plants using plasmonic nanosensors (Invited Paper) [11007-7]
	ADVANCED CHEMICAL AND BIOMONITORING SYSTEMS
11007 09	Instrumentation and capability status of the Dugway Proving Ground referee Lidar systems (Invited Paper) [11007-8]
11007 OB	Spectroscopic analysis with a monolithic micro-structured microsphere fiber probe (Invited Paper) [11007-10]
11007 0C	Gas-phase biosensors (bio-sniffer and sniff-cam) for volatile chemicals (Invited Paper)
	ENVIRONMENTAL SENSING AND OCCUPATIONAL SAFETY
11007 0D	Drone based technologies for assessing modern farming practices in undergraduate research (Invited Paper) [11007-12]
11007 OF	Application of laser induced breakdown spectroscopy (LIBS) for environmental, chemical, and biological sensing [11007-14]

	ADVANCED SENSING TECHNOLOGIES AND SYSTEMS I
11007 01	Surface-enhanced spatially offset Raman spectroscopy (SESORS) for subsurface detection of nanostar probes (Invited Paper) [11007-17]
	ENVIRONMENTAL MONITORING TECHNOLOGIES AND APPLICATIONS
11007 OK	Triple S: a new tool for soybean high throughput phenotyping from UAS-based multispectral imagery [11007-20]
	ADVANCED SENSING TECHNOLOGIES AND SYSTEMS II
11007 OP	Weed species differentiation using spectral reflectance land image classification [11007-24]
11007 0Q	Electrochemical imaging using redox mediators for cell activity of three-dimensional cultured cells (Invited Paper) [11007-25]
	POSTER SESSION
11007 OS	Hyperspectral imaging applied to asbestos containing materials detection: specimen preparation and handling [11007-27]
11007 OT	Enhancing remotely sensed BT data for environmental analysis [11007-28]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five 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.

Al-Shabi, M., OD
Austin, R., OP
Beal, S., OF
Bonifazi, Giuseppe, OS
Boyanov, Maxim I., 08
Brown, William L., 09
Capobianco, Giuseppe, OS
Cerreta, J., OD
Cherkauer, Keith A., OK
Clausen, J. L., OF
Crawford, Bridget M., 08, Ol
Donovan, Michael J., OB
Everman, W. J., OP
Fukuda, Mika T., OQ
Gadsden, S. A., OD
Govindarajan, Saravanan, OH
Laig, Bernadette, OB

Fukuda, Mika T., 0Q Gadsden, S. A., 0D Govindarajan, Saravanan, OK Haig, Bernadette, OB Herrero-Huerta, Monica, OK Herron, Joshua P., 09 Holler, Stephen, OB Ino, Kosuke, 0Q Kadik, AbdelHamid, 0T Kemner, Kenneth M., 08 Lee, Kuana-Li, 04 Malinconico, Sergio, OS Messan, K., OF Miles, Brett A., OB Mitsubayashi, Kohji, OC Moore, Kori D., 09 Morgan, M., 0F Mosell, A., 0F Nashimoto, Yuji, OQ

Odion, Ren A., 08, 01 Onodera, Takehiro, 0Q Paglietti, Federica, OS Pei, Zhen-Ming, 08 Rahman, Md. Z., OT Rainey, Katy M., 0K Richardson, R. J., OP Riviere, Ryan, OB Roberson, G. T., OP Rosy, Dilara A., 0T Roytman, Leonid, OT Sakata, Toshiya, 03 Sanders, J. T., OP Sanzari, Martin A., OB Serranti, Silvia, OS Shiku, Hitoshi, OQ Sobrero, Maximillino, OB Strobbia, Pietro, 08, 01 Sun, Tai-Ping, 08 Tsai, Po-Cheng, 04 Vaccarelli, Marissa, 0B VerMeulen, H., 0F Vo-Dinh, Tuan, 08, 01 Wakida, Shin-ichi, 02 Wang, Hsin-Neng, 08 Wei, Pei-Kuen, 04 Wilkerson, S. A., 0D You, Meng-Lin, 04 Zentella, Rodolfo, 08

Conference Committee

Symposium Chairs

Jay Kumler, JENOPTIK Optical Systems, LLC (United States)
Ruth L. Moser, Air Force Research Laboratory (United States)

Symposium Co-chair

John Pellegrino, Electro-Optical Systems Laboratory, Georgia Institute of Technology (United States)

Conference Chair

Tuan Vo-Dinh, Fitzpatrick Institute for Photonics, Duke University (United States)

Conference Co-chairs

Laura Maria Lechuga, Institut Català de Nanociència i Nanotecnologia (ICN2) (Spain)Eiichi Tamiya, Osaka University (Japan)

Conference Program Committee

Francesco Baldini, Istituto di Fisica Applicata Nello Carrara (Italy)
Luigi Campanella, Universitá degli Studi di Roma La Sapienza (Italy)
Jesus Delgado Alonso, Intelligent Optical Systems, Inc. (United States)
Franz Ludwig Dickert, Universität Wien (Austria)
Dennis K. Killinger, University of South Florida (United States)
Robert Lascola, Savannah River National Laboratory (United States)
Robert A. Lieberman, Lumoptix LLC (United States)
Edgar A. Mendoza, Redondo Optics, Inc. (United States)
Anna Grazia Mignani, Istituto di Fisica Applicata Nello Carrara (Italy)
Dmitri B. Papkovsky, University College Cork (Ireland)
Klaus Schäfer, Karlsruher Institut für Technologie (Germany)
David L. Stokes, Parsons Corporation (United States)

Session Chairs

- Advanced Biosensing Systems I
 David L. Stokes, Parsons Corporation (United States)
- 2 Advanced Biosensing Systems II Venkat Rao, Parsons Corporation (United States) Tuan Vo-Dinh, Duke University (United States)

- 3 Advanced Chemical and Biomonitoring Systems David L. Stokes, Parsons Corporation (United States) Eiichi Tamiya, Osaka University (Japan)
- 4 Environmental Sensing and Occupational Safety

 David L. Stokes, Parsons Corporation (United States)

 Eiichi Tamiya, Osaka University (Japan)
- Advanced Sensing Technologies and Systems I
 David L. Stokes, Parsons Corporation (United States)
- 6 Environmental Monitoring Technologies and Applications **Mary Williams**, MTEQ, Inc. (United States)
- 7 Advanced Sensing Technologies and Systems II Mary Williams, MTEQ, Inc. (United States)