PROCEEDINGS OF SPIE

Image Sensing Technologies: Materials, Devices, Systems, and Applications IV

Nibir K. Dhar Achyut K. Dutta Editors

12–13 April 2017 Anaheim, California, United States

Sponsored and Published by SPIE

Volume 10209

Proceedings of SPIE 0277-786X, V. 10209

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

Image Sensing Technologies: Materials, Devices, Systems, and Applications IV, edited by Nibir K. Dhar, Achyut K. Dutta, Proc. of SPIE Vol. 10209, 1020901 © 2017 SPIE · CCC code: 0277-786X/17/\$18 · doi: 10.1117/12.2280646

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 *Image Sensing Technologies: Materials, Devices, Systems, and Applications IV*, edited by Nibir K. Dhar, Achyut K. Dutta, Proceedings of SPIE Vol. 10209 (SPIE, Bellingham, WA, 2017) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510609198

ISBN: 9781510609204 (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 © 2017, 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/17/\$18.00.

Printed in the United States of America.

 $\hbox{Publication of record for individual papers is online in the SPIE Digital Library.}$



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

vii ix	Authors Conference Committee
SESSION 1	NOVEL THZ SENSING TECHNOLOGIES I
10209 04	Plasmonic design based structures for THz antenna sources and detectors (Invited Paper) [10209-3]
	[10207-0]
SESSION 2	NOVEL THZ SENSING TECHNOLOGIES II
10209 06	Ultra-short pulses from quantum cascade lasers for terahertz time domain spectroscopy (Invited Paper) [10209-6]
10209 07	Effective algorithm based on Fourier transform for the passive THz image quality
	enhancement (Invited Paper) [10209-7]
SESSION 3	NOVEL THZ IMAGE SENSING TECHNOLOGIES AND APPLICATIONS III
10209 0A	Design and performance analysis of ultra-massive multi-carrier multiple input multiple
.0207 071	output communications in the terahertz band [10209-10]
10209 OC	Coherent imaging at terahertz frequencies with digital holography at various aspect
	angles (Invited Paper) [10209-12]
10209 0D	Development of nanostructured antireflection coatings for infrared image sensing
	technologies [10209-28]
SESSION 4	NOVEL IMAGE SENSING TECHNOLOGIES: DEVICES I
10209 0G	C-RED One and C-RED 2: SWIR advanced cameras using Saphira e-APD and Snake InGaAs
10207 00	detectors [10209-15]
SESSION 5	NOVEL IMAGE SENSING TECHNOLOGIES: MATERIAL AND DEVICES II
10000 01	Deading for a company and the second ALINI Albina films for the arms all data share [100000.10]
10209 OJ	Radio frequency sputtered Al _x N _y thin films for thermal detectors [10209-18]
10209 OK	Optimization of mesa structured InGaAs based photodiode arrays [10209-19]

SESSION 6	NOVEL IMAGE SENSING TECHNOLOGIES: MATERIAL AND DEVICES III
10209 OM	Materials for microbolometers: vanadium oxide or silicon derivatives (Invited Paper) [10209-21]
10209 0N	Calcium lead titanate thin films for pyroelectric detection [10209-22]
SESSION 7	NOVEL IMAGE SENSING TECHNOLOGIES: DEVICE AND APPLICATIONS IV
10209 OP	Materials and process development for the fabrication of far ultraviolet device-integrated filters for visible-blind Si sensors (Rising Researcher Paper) [10209-24]
10209 0Q	Performance and design differences between PMOS and NMOS CMOS imagers [10209-25]
10209 OR	Terahertz-wave generation using resonant-antenna-integrated uni-traveling-carrier photodiodes (Invited Paper) [10209-4]
	POSTER SESSION
10209 OT	Optical design of wide-angle lens for LWIR earth sensors [10209-31]
10209 OU	Detection and identification of foreign bodies in polymer parts for use in semiconductor manufacturing [10209-32]
10209 OV	Autonomous electromechanical system for gas leaks odor detection [10209-33]
10209 OW	Veiling glare index measurements using novel small footprint test system [10209-34]
10209 0X	Micro-ellipsometry imaging of biostructures aided by 1D reflection grating [10209-35]
10209 0Y	Method for absolute angle positioning by non-distortion laser speckles imaging technique [10209-36]
10209 OZ	Optimal design of dark field illumination optical system for the bacterial colony imaging and selection device [10209-37]
10209 10	Foveal scale space generation with the log-polar transform [10209-38]
10209 12	Analysis of multilayer black phosphorus for photodetector applications [10209-40]
10209 15	Study combination of luminophore and polydiethylsiloxane for alternative option of passive energy lighting [10209-43]
10209 16	Analytical and graphical techniques for solution of transistor circuit transfer functions [10209-44]
10209 17	Tests of irradiated silicon photomultipliers detectors for new high-energy space telescopes [10209-45]

10209 18	Effect of different buffer-layers on near-infrared response of GaAs photocathodes [10209-46]
10209 1A	Magnification enhanced multi-aperture system with distorted lens design [10209-48]
10209 1B	Current calibration algorithm for bolometer-type uncooled infrared image sensor using pipeline signal processing [10209-51]
10209 1C	Panoramic vehicular imaging system [10209-52]
10209 1D	Direct charge handling method for dead-time-less photon counting [10209-53]
10209 1E	Design and performance tests of a high volumetric figure of merit regenerative damper for vehicle suspension systems [10209-54]

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.

Álvarez-Tamayo, R. I., 0V Andrews, James, 0Q Aoki, Toru, 1D Arnold, T., 0U

Barcelata-Pinzón, A., 0V Blednov, Roman G., 07 Boutolleau, David, 0G Braithwaite, Keesean, 0J, 0N Calvano, Nicholas, 0J, 0N Carmignani, Thomas, 0G Carver, Alexander G., 0P

Chan, C. H., 0X Chang, Y. C., 0X Chen, Chun-Ho, 1A Chen, Renwen, 1E Chen, Y. D., 0X Choi, Byoung-Soo, 1B Chrostoski, Philip, 0J, 0N

Circir, Kubra, 0K Clop, Fabien, 0G De Biasio, M., 0U DeCuir, Eric A., Jr., 0D Dhar, Nibir K., 0D, 0M Dolas, M. Halit, 0K Dou, Wei, 0T

Doucouré, Carine, 0G
Efstathiadis, Harry, 0D
Elliott, Tom, 0Q
Fadil, Dalal, 12
Fajkus, Marcel, 15
Feautrier, Philippe, 0G
Feng, Cheng, 18
Gach, Jean-Luc, 0G
Gimenez, T., 17
Greffe, Timothée, 0G
Haldar, Pradeep, 0D

Heimbeck, Martin S., 0C

Hennessy, John, 0P Hirschl, C., 0U Hitlin, David, 0P Hoenk, Michael E., 0P Houret, B., 17 Huang, Teng-Yi, 1C Huang, Yi-Pai, 1A Hwang, Chin-Der, 0Y Hwang, Yi-Yuh, 0Y

Ishibashi, Tadao, OR Ito, Hiroshi, OR Janesick, James, OQ Jargus, Jan, 15 Jewell, April D., 0P Jhabvala, Murzy, 0J, 0N Jones, Todd J., 0P Jornet, Josep M., 0A Kan, JinYan, 0T

Kane, Timothy J., 10 Kaul, Anupama B., 12 Khaleel, M. I., 0X Kim, Sang-Hwan, 1B Knödlseder, J., 17

Kocaman, Serdar, 0K Koike, Akifumi, 1D

Kovalev, Valentine Yu., 07

Kraft, M., 0U Lacombe, K., 17 Lambert, Bruce M., 16 Lee, Kyoung-II, 1B Leitner, R., 0U

Lemarchand, Stephane, 0G

Li, Daoping, 0Z Liao, Chin-Jung, 1C Lin, Wei-Ting, 1A Liu, Lu, 0Z Liu, Xinxin, 18 Liu, Yueh-Sheng, 1A Long, Aaron D., 10 McClish, Mickel, 0P Meislitzer, S., 0U Moldaschl, T., 0U

Moreno-Guzmán, J. A., 0V Moreno-Guzmán, O. M., 0V Muñoz-Aguirre, S., 0V Narayanan, Ram M., 10 Nedoma, Jan, 15 Neumaier, L., 0U Nikzad, Shouleh, OP Novak, Martin, 15 Oh, Chang-Woo, 1B O'Neil, Bakare, 0N Oreski, G., 0U Ottersböck, B., OU Pados, Dimitris A., 0A Park, Jae-Hyoun, 1B Pethuraja, Gopal G., 0D Prabhu, S. S., 04 Prather, Dennis, 0J, 0N Qian, Yunsheng, 18

Qiu, RongSheng, OT

Ramon, P., 17

Rana, Mukti M., OJ, OM, ON

Rangel-Romero, C., 0V

Ren, Long, 1E

Rice, Terence F., 10

Saenz, Gustavo A., 12

Sang, I-Chen, 1C

Scopatz, Stephen, OW

Shestakov, Ivan L., 07

Shi, Feng, 18

Shin, Jang-Kyoo, 1B

Sood, Ashok K., 0D

Stadler, Eric, 0G

Takagi, Katsuyuki, 1D

Talukder, Muhammad Anisuzzaman, 06

Tauber, Michael J., 10

Tower, John, 0Q

Trofimov, Vladislav V., 07

Trofimov, Vyacheslav A., 07

Vasinek, Vladimir, 15

Virmontois, C., 17

Voshell, Andrew, 0J, 0M, 0N

Wang, Kangni, 0Z

Wang, Xiaohui, 18

Wang, Yu-Chen, 1C

Wei, P. K., 0X

Wei, Xiaopeng, 0Z

Welser, Roger E., 0D

Wijewarnasuriya, Priyalal S., 0D

Wu, Yu-Hsiang, 0Y

Xia, Huakang, 1E

You, M. L., 0X

Yu, Kun, OT

Zakrajsek, Luke M., 0A

Zeller, John W., 0D

Zhang, Rongfu, OZ

Zhang, Xiang, 18

Zhang, Yijun, 18 Zheng, Jihong, 0Z

Zhuang, Songlin, OZ

viii

Conference Committee

Symposium Chair

Majid Rabbani, Rochester Institute of Technology (United States)

Symposium Co-chair

Robert Fiete, Harris Corporation (United States)

Conference Chairs

Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (United States)

Achyut K. Dutta, Banpil Photonics, Inc. (United States)

Conference Program Committee

Homayoon Ansari, Jet Propulsion Laboratory (United States)

Arvind I. D'Souza, DRS Sensors & Targeting Systems, Inc. (United States)

Ravi Dutt, Booz Allen Hamilton Inc. (United States)

Michael D. Gerhold, U.S. Army Research Office (United States)

John E. Hubbs, Ball Aerospace & Technologies Corporation (United States)

Margaret Kim, The University of Alabama (United States)

Nobuhiko P. Kobayashi, University of California, Santa Cruz (United States)

Sanjay Krishna, The University of New Mexico (United States)

Rihito Kuroda, Tohoku University (Japan)

Robert Olah, Banpil Photonics, Inc. (United States)

Willie J. Padilla, Duke University (United States)

Adam Piotrowski, VIGO Systems S.A. (Poland)

Siva Sivananthan, EPIR Technologies, Inc. (United States)

Krishna Swaminathan, Intel Corporation (United States)

Priyalal S. Wijewarnasuriya, U.S. Army Research Laboratory (United States)

Session Chairs

Novel THz Sensing Technologies I

Margaret Kim, The University of Alabama (United States)

Willie J. Padilla, Duke University (United States)

- Novel THz Sensing Technologies II
 Willie J. Padilla, Duke University (United States)
 Margaret Kim, The University of Alabama (United States)
- 3 Novel THz Image Sensing Technologies and Applications III Margaret Kim, The University of Alabama (United States) Willie J. Padilla, Duke University (United States)
- Novel Image Sensing Technologies: Devices I
 Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
 Achyut K. Dutta, Banpil Photonics, Inc. (United States)
- 5 Novel Image Sensing Technologies: Material and Devices II Priyalal S. Wijewarnasuriya, U.S. Army Research Laboratory (United States)
 Achyut K. Dutta, Banpil Photonics, Inc. (United States)
- Novel Image Sensing Technologies: Material and Devices III
 Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
 Achyut K. Dutta, Banpil Photonics, Inc. (United States)
- Novel Image Sensing Technologies: Device and Applications IV
 Hidenori Mimura, Shizuoka University (Japan)
 Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (United States)