PROCEEDINGS OF SPIE

Smart Photonic and Optoelectronic Integrated Circuits XIX

Louay A. Eldada El-Hang Lee Sailing He Editors

31 January–2 February 2017 San Francisco, California, United States

Sponsored and Published by SPIE

Volume 10107

Proceedings of SPIE 0277-786X, V. 10107

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 *Smart Photonic and Optoelectronic Integrated Circuits XIX*, edited by Louay A. Eldada, El-Hang Lee, Sailing He, Proceedings of SPIE Vol. 10107 (SPIE, Bellingham, WA, 2017) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic) ISBN: 9781510606555

ISBN: 9781510606562 (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.

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 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
SESSION 1	INTEGRATED NANOPHOTONIC DEVICES I
10107 03	Subwavelength metamaterial engineering for silicon photonics (Invited Paper) [10107-2]
SESSION 2	ADVANCED HYBRID PICs
10107 05	Trends in heteroepitaxy of III-Vs on silicon for photonic and photovoltaic applications (Invited Paper) [10107-4]
10107 06	Efficient plasmonic integrated circuits (Invited Paper) [10107-6]
10107 08	Rapid virtual prototyping of complex photonic integrated circuits using layout-aware schematic-driven design methodology [10107-8]
SESSION 3	SILICON-PLUS PHOTONICS
10107 09	Ion implantation in silicon to facilitate testing of photonic circuits (Invited Paper) [10107-9]
SESSION 4	ON-CHIP OPTICAL SENSING I
10107 OF	Monolithic integration of a plasmonic sensor with CMOS technology [10107-15]
SESSION 5	INTEGRATED NANOPHOTONIC DEVICES II
10107 0G	Using the intrinsic properties of silicon micro-ring modulators for characterization of RF termination (Invited Paper) [10107-16]
SESSION 6	INTEGRATED NANOPHOTONIC DEVICES III
10107 OK	Hybrid integration of carbon nanotubes in silicon photonic structures (Invited Paper) [10107-20]

SESSION 7	SMART STRUCTURES FOR PHOTONIC INTEGRATION
10107 00	Silicon plasmonic microring modulator using embedded conducting oxides [10107-23]
10107 OP	Gbit/s-operation of graphene electro-absorption modulators in a passive polymer waveguide platform for data and telecommunications [10107-24]
10107 OS	Study of an array of grating couplers for wireless optical communications [10107-27]
SESSION 8	ON-CHIP OPTICAL SENSING II
10107 OT	Graphene planar lightwave circuit sensors for chemical detection [10107-28]
10107 0V	Use of photonic jets produced by dielectric microspheres for increasing sensitivity and angle-of-view of MWIR detectors [10107-30]
SESSION 9	SMART LIGHT SOURCES
10107 0W	Indoor visible light communication with smart lighting technology (Invited Paper) [10107-31]
10107 0X	Enhanced electroluminescent cooling in GaN-based light-emitting diodes (Invited Paper) [10107-32]
10107 0Y	The integration of InGaP LEDs with CMOS on 200 mm silicon wafers [10107-33]
SESSION 10	LIDAR TECHNOLOGIES
10107 10	Design and implementation of 3D LIDAR based on pixel-by-pixel scanning and DS-OCDMA [10107-35]
_	POSTER SESSION
10107 13	Analysis on frequency response of trans-impedance amplifier (TIA) for signal-to-noise ratio (SNR) enhancement in optical signal detection system using lock-in amplifier (LIA) [10107-38]
10107 14	The study of LED light source illumination conditions for ideal algae cultivation [10107-39]

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.

Abolmaali, Farzaneh, 0V Alonso-Ramos, C., 0K Al-Rawhani, Mohammed, 0F Astratov, Vasily N., 0V Bach, H.-G., OP Balestrieri, M., OK Bollond, Paul, OT Brettin, Aaron, OV Brinker, W., OP Cabot, Steve, OT Cao, Wei, 09 Caselli, N., 0K Cassan, E., 0K Chang, Pohan, 06 Cheah, Boon C., OF Cheben, Pavel, 03 Chen, Cin-Fu, 14 Chen, Xia, 09

Cumming, David R. S., 0F

Choi, Young-Wan, 13

Dale, Carl, 0F

Das Barman, Abhirup, 0W

de Felipe, D., OP Dietrich, A., 0P

Durán-Valdeiglesias, E., 0K Eom, Jeongsook, 10

Farina, J., 08 Filoramo, A., OK

Fitzgerald, Eugene A., 0Y

Grant, James, 0F Gurioli, M., 0K Halder, Alak, 0W Halir, Robert, 03 Hangartar, Sandra, OT Hao, Danni, OF Helmy, A. S., 06 Hoang, H. C., 0K Hosseini, S., OS

Huang, Chien-Fu, 14 Husaini, Saima, OT Intonti, F., OK Jamshidi, K., OS Janz, Siegfried, 03 Jeon, Su-Jin, 13 Ji, Myung-Gi, 13 Junesand, Carl, 05

Kataria, Himanshu, 05 Keegan, Neil, 0F

Keil, N., OP

Khokhar, Ali Z., 09 Kim, Gunzung, 10 Kim, Ji-Hoon, 13 Kirah, Khaled A., 00

Knights, Andrew P., 0G Koltchanov, I., 08 La China, F., 0K Lapointe, Jean, 03 Le Roux, X., 0K

Kleinert, M., 0P

Lee, Kenneth Eng Kian, 0Y Lee, Kwang Hong, 0Y Li, Zhan-Ming Simon, OX

Limberopoulos, Nicholaos I., 0V

Lin, Charles, 06

Littlejohns, Callum G., 09 Lourdudoss, Sebastian, 05 Luque-González, José M., 03

Made, Riko I., 0Y Maliakal, Ashok, 0T Marris-Morini, D., 0K Mashanovich, Goran Z., 03

McNeil, Calum, 0F

Metaferia, Wondwosen, 05 Michel, Jurgen, 0Y Milosevic, Milan M., 09 Mingaleev, S., 08 Molina-Fernández, Íñigo, 03

Nagy, Bence, OF Namdari, M., 0S Nedeljkovic, Milos, 03

Nguyen, Viet Cuong, 0Y Olsson, Fredrik, 05

Omanakuttan, Giriprasanth, 05 Ortega-Moñux, Alejandro, 03

Park, Jun-Hee, 13 Park, Yongwan, 10 Piprek, Joachim, 0X Polatynski, A., 08 Reed, Graham T., 09

Reinke, P., 0P Reith, Leslie, OT Richter, A., 08 Sabouri, S., OS

Sánchez-Postigo, Alejandro, 03 Sarmiento-Merenguel, Dario, 03

Sarti, F., OK

Sasangka, Wardhana Aji, 0Y

Savitzki, S., 08

Schell, M., OP Schmid, Jens, 03 Serna, S., OK Shakoor, Abdul, 0F Sheehan, Paul, OT Sokolov, E., 08 Soler-Penades, Jordi, 03 Su, Yiwen, 06 Sun, Yan-Ting, 05 Swillam, Mohamed A., 00 Tamanaha, Cy, 0T Tan, Chuan Seng, 0Y Thomson, David J., 09 Tsai, Chun-Chin, 14 Urbas, Augustine M., 0V Vivien, L., 0K Walton, Scott, OT Wang, Bing, 0Y Wang, Cong, 0Y Wang, Hong, 09 Wang, Yue, 0Y Wang, Zhao, 0G Wang, Zhechao, 05 Wangüemert-Pérez, Gonzalo, 03 Xu, Dan-Xia, 03 Yoon, Soon Fatt, OY Yue, Cheng-Feng, 14 Zaki, Aya O., 0O Zawadzki, C., OP Zhang, W., 0K

Conference Committee

Symposium Chairs

Jean-Emmanuel Broquin, IMEP-LAHC (France)
Shibin Jiang, AdValue Photonics, Inc. (United States)

Symposium Co-chairs

Connie J. Chang-Hasnain, University of California, Berkeley (United States)

Graham T. Reed, Optoelectronics Research Centre, University of Southampton (United Kingdom)

Program Track Chair

Yakov Sidorin, Quarles & Brady LLP (United States)

Conference Chairs

Louay A. Eldada, Quanergy Systems, Inc. (United States) El-Hang Lee, Inha University (Korea, Republic of) Sailing He, KTH Royal Institute of Technology (Sweden)

Conference Program Committee

Pavel Cheben, National Research Council Canada (Canada)

Ray T. Chen, The University of Texas at Austin (United States)

Shanhui Fan, Stanford University (United States)

Chennupati Jagadish, The Australian National University (Australia)

Stefan A. Maier, Imperial College London (United Kingdom)

Joachim Piprek, NUSOD Institute LLC (United States)

David V. Plant, McGill University (Canada)

Andrew W. Poon, Hong Kong University of Science and Technology (Hong Kong, China)

Ali Serpengüzel, Koç University (Turkey)

Qian Wang, A*STAR - Data Storage Institute (Singapore)

Michael R. Watts, Massachusetts Institute of Technology

(United States)

Lin Yang, Institute of Semiconductors (China)

Session Chairs

Integrated Nanophotonic Devices I
Sailing He, KTH Royal Institute of Technology (Sweden)

- Advanced Hybrid PICs
 Robert Halir, University de Málaga (Spain)
- 3 Silicon-plus Photonics
 Sebastian Lourdudoss, KTH Royal Institute of Technology (Sweden)
- 4 On-Chip Optical Sensing I
 Seng-Tiong Ho, Northwestern University (United States)
- Integrated Nanophotonic Devices IIAlan X. Wang, Oregon State University (United States)
- 6 Integrated Nanophotonic Devices III **Robert Halir**, University de Málaga (Spain)
- 7 Smart Structures for Photonic Integration
 Lin Yang, Institute of Semiconductors (China)
- On-Chip Optical Sensing II
 Alan X. Wang, Oregon State University (United States)
- 9 Smart Light Sources Sailing He, KTH Royal Institute of Technology (Sweden)
- 10 LIDAR Technologies Joachim Piprek, NUSOD Institute LLC (United States)