

PROCEEDINGS OF SPIE

Physics and Simulation of Optoelectronic Devices XXVI

**Bernd Witzigmann
Marek Osiński
Yasuhiko Arakawa**
Editors

**29 January–1 February 2018
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 10526

Proceedings of SPIE 0277-786X, V. 10526

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

Physics and Simulation of Optoelectronic Devices XXVI, edited by Bernd Witzigmann,
Marek Osiński, Yasuhiko Arakawa, Proc. of SPIE Vol. 10526, 1052601 · © 2018 SPIE
CCC code: 0277-786X/18/\$18 · doi: 10.1117/12.2320762

Proc. of SPIE Vol. 10526 1052601-1

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 these proceedings:

Author(s), "Title of Paper," in *Physics and Simulation of Optoelectronic Devices XXVI*, edited by Bernd Witzigmann, Marek Osiński, Yasuhiko Arakawa, Proceedings of SPIE Vol. 10526 (SPIE, Bellingham, WA, 2018) Seven-digit Article CID Number.

ISSN: 0277-786X
ISSN: 1996-756X (electronic)

ISBN: 9781510615373
ISBN: 9781510615380 (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 © 2018, 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/18/\$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 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	<i>Authors</i>
ix	<i>Conference Committee</i>

QUANTUM DOT LASERS

10526 03	A hybrid quantum-classical modeling approach for electrically driven quantum light sources [10526-2]
10526 05	Design and simulation of quantum-dot-based push-pull DFB lasers [10526-4]
10526 06	Pulse-amplitude modulation of optical injection-locked quantum-dot lasers [10526-5]

PLASMONICS

10526 07	Nanophotonic particle simulation and inverse design using artificial neural networks [10526-6]
10526 09	Optical properties of metal nanoparticles embedded in amorphous silicon analysed using discrete dipole approximation [10526-8]
10526 0A	Optical investigation of porous TiO₂ in mesostructured solar cells [10526-9]

NONLINEAR LASER DYNAMICS

10526 0E	Physical-random number generator using an oscillation frequency stabilized laser diode [10526-13]
10526 0F	Large-signal capabilities of an optically injection-locked semiconductor laser using gain lever [10526-15]

NON-CLASSICAL LIGHT

10526 0G	Quantum many-body correlations in collective phonon-excitations (Invited Paper) [10526-16]
10526 0H	Interaction between stimulated current injection and polariton condensate [10526-14]

ELECTROMAGNETICS I

10526 OR **Optical mode properties for nano-layered aluminum-doped zinc oxide rectangular waveguides at the epsilon-near-zero spectral point** [10526-27]

SENSORS AND DETECTORS

10526 OU **Multi-beam and single-chip LIDAR with discrete beam steering by digital micromirror device** [10526-29]

10526 OV **Measuring and engineering the atomic mass density wave of a Gaussian mass-polariton pulse in optical fibers** [10526-30]

10526 OW **Optical distance measuring method using fast frequency noise characteristics of a laser diode** [10526-31]

10526 OX **A fiber optic temperature sensor based on multi-core microstructured fiber with coupled cores for a high temperature environment** [10526-32]

10526 OY **A model-based analysis of extinction ratio effects on phase-OTDR distributed acoustic sensing system performance** [10526-33]

10526 OZ **Electrical and optical 3D modelling of light-trapping single-photon avalanche diode** [10526-68]

ELECTROMAGNETICS II

10526 11 **Exact analytical modeling of lightwave propagation in planar media with arbitrarily graded index profiles** [10526-35]

10526 12 **Comprehensive modeling on luminescent coupling dependency in multi-junction solar cells** [10526-36]

10526 13 **Analysis of the rectangular resonator with butterfly MMI coupler using SOI** [10526-37]

10526 14 **Transfer function for electromagnetic propagation through anisotropic metamaterials** [10526-38]

10526 15 **Structure-induced asymmetry between counterpropagating modes in three-port couplers** [10526-39]

INTEGRATED OPTO-ELECTRONIC SYSTEMS

10526 16 **High-efficiency power transfer for silicon-based photonic devices** [10526-40]

10526 17 **A polynomial-chaos-expansion-based building block approach for stochastic analysis of photonic circuits** [10526-41]

MINI-SYMPOSIUM ON PLASMONIC NANOSTRUCTURES

- 10526 1C **Hybrid plasmonic systems: from optical transparencies to strong coupling and entanglement (Invited Paper)** [10526-47]

SEMICONDUCTOR LASERS AND LEDS

- 10526 1D **Effect of quantum-well thickness on the optical polarization of AlGaIn-based ultraviolet light-emitting diodes** [10526-48]
- 10526 1E **Thermal comparison of buried-heterostructure and shallow-ridge lasers** [10526-49]
- 10526 1H **Modeling of current spreading in high-power broad-area lasers and its impact on the lateral far field divergence** [10526-52]

PHOTODETECTORS

- 10526 1I **Numerical simulation of the modulation transfer function (MTF) in infrared focal plane arrays: simulation methodology and MTF optimization (Invited Paper)** [10526-53]
- 10526 1J **Reliability testing of ultra-low noise InGaAs quad photoreceivers** [10526-54]
- 10526 1K **2D dark-count-rate modeling of PureB single-photon avalanche diodes in a TCAD environment** [10526-55]
- 10526 1L **Response time of semiconductor photodiodes** [10526-56]
- 10526 1M **A novel biasing dependent circuit model of resonant cavity enhanced avalanche photodetectors (RCE-APDs)** [10526-57]

ACTIVE MATERIALS

- 10526 1Q **Absorption enhancement in type-II coupled quantum rings due to existence of quasi-bound states** [10526-61]

POSTER SESSION

- 10526 1V **Error detecting code for long haul network** [10526-69]
- 10526 1W **Fast physical-random number generation using laser diode's frequency noise: influence of frequency discriminator** [10526-70]
- 10526 1X **Single is better than double: analysis of thermal poling configurations using 2D numerical modeling** [10526-71]

- 10526 20 **Design and analysis of surface plasmon resonance (SPR) sensor to check the quality of food from adulteration** [10526-75]
- 10526 21 **Signal-to-noise ratio of arbitrarily filtered spontaneous emission** [10526-76]
- 10526 22 **Optical modulator based on silicon nanowires racetrack resonator** [10526-77]
- 10526 23 **Leap-frog-based BPM (LF-BPM) method for solving nanophotonic structures** [10526-78]
- 10526 24 **High-performance optical modulator using ultra-thin silicon waveguide in SOI technology** [10526-79]
- 10526 26 **Narrowband spectral filter based on biconical tapered fiber** [10526-81]
- 10526 27 **Effect of rotation on quality factor of single-mode optical resonances in round-cornered square-shaped resonators** [10526-82]
- 10526 2A **Performance analysis of GeSn-alloy-based multiple quantum well transistor laser** [10526-85]
- 10526 2B **Probing the liquid crystal alignment interface and switching dynamics in a slab waveguide architecture** [10526-86]
- 10526 2D **FDTD analysis of Aluminum/a-Si:H surface plasmon waveguides** [10526-88]
- 10526 2E **Novel method of optical image registration in wide wavelength range using matrix of piezoelectric crystals** [10526-89]
- 10526 2G **On the prospects of application and development of solid-state photomultipliers for the task of analog detecting of pulsed optical signals** [10526-91]
- 10526 2H **Numerical analysis of blazed wire-grid polarizer for plasmonic enhancement** [10526-92]
- 10526 2I **Simulated Raman spectral analysis of organic molecules** [10526-93]
- 10526 2K **Novel analytical approach for strongly coupled waveguide arrays** [10526-95]
- 10526 2P **Modeling of the emissivity of super-wavelength black silicon in the geometrical optics regime** [10526-100]

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.

Abdelhamid, Mostafa R., 1M
Abdellatif, S., 0A
Akgun, Toygar, 0Y
Aktas, Metin, 0Y
Alegría, Elisabete C. B. A., 09
Ambrosius, H. P. M. M., 1E
Anwar, Momen, 2P
Anwer Askari, Syed Sadique, 2A
Arai, Hideaki, 1W
Ayoub, Ahmad B., 23, 24
Babić, Dubravko, 21
Bandelow, Uwe, 1H
Banerjee, Partha P., 14
Bardella, P., 05
Bazarov, Timur O., 2E
Bekele, Robel Y., 2B
Bogdanov, S. V., 2G
Bosiljevac, Marko, 21
Brenot, R., 1E
Budnicki, D., 0X
Cano-Renteria, Fidel, 07
Carmelee, Alexander, 0G
Celaschi, Sergio, 26
Chang, Shu-Wei, 1Q
Chen, Kaifeng, 12
Choi, Young-Wan, 13
Das, Mukul K., 2A
Datta, Shubhashish, 1J
De Lucia, F., 1X
Deen, M. Jamal, 1M
Delacy, Brendan, 07
Doi, Kohei, 0E
Droenner, Leon, 0G
El-Batawy, Yasser M., 1M
Erni, D., 0A
Espinoza, Alonzo, 0U
Evans, Dean R., 14
Fan, Shanhui, 12
Fantoni, Alessandro, 09, 2D
Fedorov, Vladimir V., 2E
Fernandes, Miguel, 09, 2D
Fidelus, J., 0X
Frantz, Jesse A., 2B
Ghannam, R., 0A
Gin, Adley, 0U
Gnawali, Rudra, 14
Gotjen, Henry G., 2B
Goushcha, Alexander O., 1L
Grassi, Flavia, 17
Gray, Stephen K., 1C
Grillot, F., 0F
Harris, James S., 0Z, 12
Harter, Andrew C., 1L
Haus, Joseph W., 14
Hellman, Brandon, 0U
Hirai, Kyohei, 0E
Hsieh, Chi-Ti, 1Q
Jeon, Su-Jin, 13
Jia, Jieyang, 12
Jiang, Xiao, 0Z
Jing, Li, 07
Joannopoulos, John D., 07
Joshi, Abhay M., 1J
Josten, S., 0A
Kabuss, Julia, 0G
Kalagara, Hemashilpa, 15
Kamins, Theodore I., 0Z
Kantner, Markus, 03
Kasuya, Yuki, 1W
Kawakami, Daiki, 0W
Kelly, Priscilla, 0R
Khalil, A. S. G., 0A
Khalil, Diaa, 2P
Kim, Donghyun, 2H
Kim, Eudum, 13
Kim, Ji-Hoon, 13
Kim, Sun-Ho, 13
Kimura, Ryotaro, 0W
Kirah, K., 0A
Knežević, Tihomir, 1K
Knigge, Andrea, 1H
Kohli, Niharika, 2K
Kolacz, Jakub, 2B
Kolakowska, A., 0X
Kolobov, N. A., 2G
Kong, Kam, 2I
Koprucki, Thomas, 03
Krapez, J.-C., 11
Kumar, Manish, 20
Kumar, Santosh, 1V
Kumar, Sunil, 27
Kuznetsova, Lyuba, 0R
LaRochelle, S., 0F
Lee, Changhun, 2H
Lee, Hosuk, 15
Lemaître, F., 1E
Levin, E. V., 2G
Lin, Shih-Yen, 1Q

Liu, Cheng, 1D
 Lourenço, Paulo, 2D
 Lu, Ching-Ying, 0Z
 Lu, Lu, 2I
 Lu, Qi, 2I
 Lyu, Zheng, 12
 Makara, M., 0X
 Makowska, A., 0X
 Malheiros-Silveira, Gilliard N., 26
 Manfredi, Paolo, 17
 Maral, Hakan, 0Y
 Markiewicz, K., 0X
 Marlow, F., 0A
 Matsumoto, Kouhei, 1W
 Melati, Daniele, 17
 Melloni, Andrea, 17
 Mergo, P., 0X
 Mittnenzweig, Markus, 03
 Montrosset, I., 05
 Morea, Matthew, 0Z
 Mousavi, N. S. Susan, 27
 Myers, David M., 0H
 Myers, Jason D., 2B
 Naciri, Jawad, 2B
 Nanver, Lis K., 1K
 Nasilowski, T., 0X
 Ohdaira, Yasuo, 0E, 0W, 1W
 Ohkawa, Masashi, 0E, 0W, 1W
 Oliveira-Silva, Rui P., 09
 Osiński, Marek, 15
 Ostrowski, L., 0X
 Ozden, Burcu, 0H
 Pal, Amrindra, 1V
 Panindre, Prabodh, 27
 Pareek, Prakash, 2A
 Park, Jun-Hee, 13
 Partanen, Mikko, 0V
 Peurifoy, John, 07
 Pfeiffer, Loren, 0H
 Pigarev, Aleksey V., 2E
 Poturaj, K., 0X
 Pozdnyakov, Y. I., 2G
 Prasad, Narasimha, 1J
 Prazeres, D. M. F., 09
 Radziunas, Mindaugas, 1H
 Raghuvanshi, Sanjeev Kumar, 20
 Ranjan, Ravi, 2A
 Ren, Jun, 2I
 Ribeiro, Ana P. C., 09
 Rodriguez, Joshua, 0U
 Rustichelli, V., 1E
 Ryabushkin, Oleg A., 2E
 Sabry, Yasser, 2P
 Saito, Takahiro, 0W
 Sakamoto, Shuichi, 0E, 0W, 1W
 Sarraute, J.-M., 0F
 Sato, Takashi, 0E, 0W, 1W
 Sazio, P. J. A., 1X
 Schires, K., 0F
 Schuster, J., 1I
 Shahada, L., 22
 Sharifi, P., 0A
 Sharma, Enakshi K., 2K
 Sharma, Sandeep, 1V
 Shen, Yichen, 07
 Sherif, S. M., 22
 Shubin, V. E., 2G
 Shushakov, D. A., 2G
 Sim, Eunji, 2H
 Sitarsky, K. Yu., 2G
 Sivertz, Michael, 1J
 Smith, Braden, 0U
 Smolyakov, Gennady A., 15
 Snoke, David W., 0H
 Soljačić, Marin, 07
 Son, Gyeongho, 16
 Spillmann, Christopher M., 2B
 Šprem, Marko, 2I
 Srivastava, Sangeeta, 2K
 Srivastava, Vivek Kumar, 1V
 Stanczyk, T., 0X
 Steger, Mark, 0H
 Suligoj, Tomislav, 1K
 Sun, Zhanghao, 12
 Suzuki, Masamichi, 0W
 Swillam, Mohamed A., 22, 23, 24
 Szostkiewicz, L., 0X
 Szymanski, M., 0X
 Tabbert, Bernd, 1L
 Takashima, Yuzuru, 0U
 Taoka, Toshihiro, 0E
 Tegmark, Max, 07
 Tenderenda, T., 0X
 Torgovnikov, R. A., 2G
 Tulkki, Jukka, 0V
 Tyler, Zachary, 2I
 Vieira, Manuela, 09, 2D
 Vygranenko, Yuri, 09, 2D
 Wang, Cheng, 06
 Wang, Shouxun, 0R
 Waqas, Abi, 17
 Wenzel, Hans, 1H
 West, Ken, 0H
 Williams, K. A., 1E
 Wünsche, Hans-Jürgen, 1H
 Wysokinski, K., 0X
 Xue, Muyu, 0Z, 12
 Yang, Yi, 07
 Yu, Kyoungsik, 16
 Yumoto, Mitsuki, 1W
 Zang, Kai, 0Z
 Zeghuzi, Anissa, 1H
 Zhang, Jing, 1D
 Zhang, Qiang, 0Z
 Zhao, Jian, 2I
 Zheng, Tianzhe, 0Z
 Zhou, Yue-Guang, 06

Conference Committee

Symposium Chairs

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

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

Symposium Co-Chairs

Jean-Emmanuel Broquin, IMEP-LAHC (France)

Shibin Jiang, AdValue Photonics, Inc. (United States)

Program Track Chairs

James G. Grote, Air Force Research Laboratory (United States)

Klaus P. Streubel, OSRAM AG (Germany)

Conference Chairs

Bernd Witzigmann, Universität Kassel (Germany)

Marek Osiński, The University of New Mexico (United States)

Yasuhiko Arakawa, The University of Tokyo (Japan)

Conference Program Committee

Hiroshi Amano, Nagoya University (Japan)

Toshihiko Baba, Yokohama National University (Japan)

Jing Bai, University of Minnesota, Duluth (United States)

Enrico Bellotti, Boston University (United States)

Guillermo Carpintero del Barrio, Universidad Carlos III de Madrid
(Spain)

Weng W. Chow, Sandia National Laboratories (United States)

Alexandre Freundlich, University of Houston (United States)

Frédéric Grillot, Télécom ParisTech (France)

Ortwin Hess, Imperial College London (United Kingdom)

Thomas A. Klar, Johannes Kepler Universität Linz (Austria)

Stephan W. Koch, Philipps-Universität Marburg (Germany)

Cun-Zheng Ning, Arizona State University (United States)

Joachim Piprek, NUSOD Institute LLC (United States)

Marc Sciamanna, Supélec (France)

Ikuo Suemune, Hokkaido University (Japan)

Session Chairs

- 1 Quantum Dot Lasers
Alexander Carmele, Technische Universität Berlin (Germany)
- 2 Plasmonics
Stephen Gray, Argonne National Laboratory (United States)
- 3 Nonlinear Laser Dynamics
Bernd Witzigmann, Universität Kassel (Germany)
- 4 Non-Classical Light
Cun-Zheng Ning, Arizona State University (United States) and Tsinghua University (China)
- 5 Photonic Crystal- and Nano-Lasers
Burcu Ozden, University of Pittsburgh (United States)
- 6 Electromagnetics I
Levon V. Asryan, Virginia Polytechnic Institute and State University (United States)
- 7 Sensors and Detectors
Jonathan Schuster, U.S. Army Research Laboratory (United States)
- 8 Electromagnetics II
Jinghui Yang, University of California, Los Angeles (United States)
- 9 Integrated Opto-Electronic Systems
Marek Osinski, The University of New Mexico (United States)
- 10 Mini-Symposium on Plasmonic Nanostructures
Jing Bai, University of Minnesota, Duluth (United States)
- 11 Semiconductor Lasers and LEDs
Sylvain Barbay, Laboratoire de Photonique et de Nanostructures (France)
- 12 Photodetectors
Bernd Witzigmann, Universität Kassel (Germany)
- 13 Active Materials
Joel D. Cox, ICFO - Institut de Ciències Fotòniques (Spain)