

PROCEEDINGS OF SPIE

Physics and Simulation of Optoelectronic Devices XXIII

**Bernd Witzigmann
Marek Osiński
Fritz Henneberger
Yasuhiko Arakawa**
Editors

**9–12 February 2015
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 9357

Proceedings of SPIE 0277-786X, V. 9357

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

Physics and Simulation of Optoelectronic Devices XXIII, edited by Bernd Witzigmann,
Marek Osiński, Fritz Henneberger, Yasuhiko Arakawa, Proc. of SPIE Vol. 9357, 935701
© 2015 SPIE · CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2191481

Proc. of SPIE Vol. 9357 935701-1

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 *Physics and Simulation of Optoelectronic Devices XXIII*, edited by Bernd Witzigmann, Marek Osinski, Fritz Henneberger, Yasuhiko Arakawa, Proceedings of SPIE Vol. 9357 (SPIE, Bellingham, WA, 2015) Article CID Number.

ISSN: 0277-786X

ISBN: 9781628414479

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 © 2015, 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/15/\$18.00.

Printed in the United States of America.

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



SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print. Papers are published as they are submitted and meet publication criteria. A unique 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.

Contents

- vii *Authors*
- ix *Conference Committee*
- xi *Introduction*

SESSION 1 NONLINEAR EFFECTS IN SEMICONDUCTOR LASERS

- 9357 03 **Free space ranging based on a chaotic long-wavelength VCSEL with optical feedback**
[9357-2]
- 9357 04 **Optothermal excitabilities and instabilities in quantum dot lasers** [9357-3]
- 9357 05 **Spectral phase aberration and its influence on pulse compression in an actively modulated ultrafast laser system** [9357-4]

SESSION 2 PLASMONIC MATERIALS

- 9357 06 **Coupled simulation of carrier transport and electrostatics: the EMC/FDTD/MD technique (Invited Paper)** [9357-5]
- 9357 07 **Large-area gate-tunable terahertz plasmonic metasurfaces employing graphene based structures** [9357-6]

SESSION 3 OPTOELECTRONICS ACTIVE MATERIALS I

- 9357 09 **Modeling of optical amplifier waveguide based on silicon nanostructures and rare earth ions doped silica matrix gain media by a finite-difference time-domain method: comparison of achievable gain with Er³⁺ or Nd³⁺ ions dopants** [9357-9]

SESSION 4 OPTOELECTRONICS ACTIVE MATERIALS II

- 9357 0C **Atomistic description of wave function localization effects in In_xGa_{1-x}N alloys and quantum wells (Invited Paper)** [9357-13]
- 9357 0D **Dual-wavelength GaInNAs semiconductor quantum-well distributed feedback laser**
[9357-14]
- 9357 0E **Modeling extreme-ultraviolet emission from laser-produced plasma using particle-in-cell method** [9357-15]

SESSION 5 PLASMONICS	
9357 0G	Mid-infrared plasmonic resonances exploiting heavily-doped Ge on Si (Invited Paper) [9357-17]
9357 0I	Propagation characteristics of multilayered subwavelength gratings composed of metallic nanoparticles [9357-19]
9357 0J	Optimized plasmonic light emission enhancement in III-N quantum-well emitters [9357-20]
SESSION 6 QUANTUM DOT LASERS	
9357 0K	Impact of the carrier relaxation paths on two-state operation in quantum dot lasers [9357-21]
9357 0L	Influence of inhomogeneous broadening on the dynamics of quantum dot lasers [9357-22]
9357 0M	Ultrafast dynamic switching between two lasing states in quantum dot lasers [9357-23]
SESSION 7 NANOLASERS	
9357 0P	Theory of an optically driven quantum-dot phonon laser (Invited Paper) [9357-27]
SESSION 8 NON-CLASSICAL LIGHT	
9357 0S	Strong coupling of a Rydberg superatom to a moving membrane (Invited Paper) [9357-30]
9357 0W	Photon pairs from a biexciton cascade with feedback-controlled polarization entanglement [9357-34]
SESSION 9 SEMICONDUCTOR LASERS	
9357 0X	Passive cavity laser and tilted wave laser for Bessel-like beam coherently coupled bars and stacks [9357-35]
9357 0Y	Nonlinear conversion efficiency of InAs/InP nanostructured Fabry-Perot lasers [9357-37]
9357 0Z	Phase and frequency dynamics of Fourier domain mode locked OCT lasers [9357-38]
SESSION 10 SOLAR CELL SIMULATION: JOINT SESSION WITH CONFERENCES 9357 AND 9358	
9357 11	Simulation of solid-state dye solar cells based on organic and Perovskite sensitizers (Invited Paper) [9357-39]

SESSION 11 ELECTROMAGNETICS

- 9357 13 **Modes analysis in random structures varying the disorder magnitude** [9357-42]
- 9357 14 **Compact polarization beam splitter for silicon-based slot waveguides based on an asymmetrical multimode interference coupler** [9357-43]
- 9357 15 **Simulating the focusing of light onto 1D nanostructures with a B-spline modal method** [9357-44]

SESSION 12 OPTICAL SYSTEMS

- 9357 16 **Coupled semiconductor laser network topologies for efficient synchronization** [9357-45]
- 9357 17 **Fiber-optic analog-to-NRZ binary conversion** [9357-46]
- 9357 18 **On-chip generation and in-plane transmission of indistinguishable photons** [9357-47]
- 9357 19 **Comparison of photonic integrated circuits for millimeter-wave signal generation between dual-wavelength sources for optical heterodyning and pulsed mode-locked lasers** [9357-48]
- 9357 1A **Ultra-high sensitivity optical biosensor based on Vernier effect in triangular ring resonators (TRRs) with SPR** [9357-49]

POSTER SESSION

- 9357 1B **Graphene-based metamaterial structures with single and multiple tunable transparency windows** [9357-50]
- 9357 1C **Tunable graphene-based dual-frequency cross polarization converters** [9357-51]
- 9357 1E **Multichannel high-current-sensitivity all-fiber current sensor** [9357-53]
- 9357 1F **Polarization-dependent photocurrent in MoS₂ phototransistor** [9357-54]
- 9357 1G **Plasmonic waveguides in mid-infrared using silicon-insulator-silicon** [9357-55]
- 9357 1I **Automatic modulation format recognition for the next generation optical communication networks using artificial neural networks** [9357-57]
- 9357 1J **High Q/V_m hybrid photonic-plasmonic crystal nanowire cavity at telecommunication wavelengths** [9357-58]
- 9357 1K **High detection efficiency and rate superconducting nanowire single-photon detector with a composite optical structure** [9357-59]
- 9357 1L **Investigation of degraded efficiency in blue InGaN multiple-quantum well light-emitting diodes** [9357-60]

- 9357 1N **Analysis of microwave frequency combs generated by semiconductor lasers under hybrid optical injections** [9357-63]
- 9357 1O **Investigation of the influence of unwanted micro lenses caused by semiconductor processing excursions on optical behavior of CMOS photodiodes** [9357-64]
- 9357 1R **Circuit-level simulation of transistor lasers and its application to modelling of microwave photonic links** [9357-67]
- 9357 1S **2D constant-loss taper for mode conversion** [9357-68]
- 9357 1U **A complete theoretical description of the first-order delta-sigma modulation for analog-to-NRZ binary conversion** [9357-70]
- 9357 1W **Simulation of the influence of asymmetrical metallic apertures of the plasmonic infrared filter** [9357-73]
- 9357 1X **Optoelectronic properties of graphene on silicon substrate: effect of defects in graphene** [9357-74]

Authors

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

Ajmalghan, M., 1X
Argyris, Apostolos, 16
Arigong, Bayaner, 1B, 1C
Balakier, Katarzyna, 19
Baldassarre, L., 0G
Bennett, Anthony J., 18
Biagioni, P., 0G
Bouchon, P., 15
Bourmpos, Michail, 16
Brandt, O., 0C
Brody, Yarden, 18
Butler, T., 0Z
Caetano da Silva, Juarez, 0I
Calandrini, E., 0G
Cardin, Julien, 09
Carmelee, Alexander, 0S, 0W
Caro, M. A., 0C
Carpintero, Guillermo, 19
Chaibi, Mohamed, 0Y
Chang, Jih-Yuan, 1L
Chang, Qingjiang, 0D
Chang, Shu-Wei, 1J
Chen, Shih-Hung, 0E
Cheng, Pi-Ju, 1J
Chevalier, P., 15
Chiang, Chih-Kai, 1J
Cho, Hui-Sup, 1W
Choi, Young-Wan, 1A
Christou, Andreas, 1R
Chu, Saisai, 1F
Chung, Yi-Cheng, 1J
Costanzo-Caso, P., 1U
Coughlan, C., 0C
Cucinotta, Annamaria, 13
Deryagin, A. G., 0K
Di Carlo, Aldo, 1I
Ding, Jun, 1B, 1C
Droenner, Leon, 0P
Dudelev, V. V., 0K
Dufour, Christian, 09
Ellis, David J. P., 18
Erasme, Didier, 0Y
Erneux, Thomas, 04, 0K
Esquivias, Ignacio, 03
Even, J., 0L
Fafin, Alexandre, 09
Faist, Jerome, 07
Farrer, Ian, 18
Fice, Martyn J., 19
Frigerio, J., 0G
Gagliardi, Alessio, 1I
Gallacher, K., 0G
Gamal, Rania, 1G
Gentilini, Desirée, 1I
Gioannini, M., 0L
Gong, Qihuang, 1F
Gordeev, N. Yu., 0X
Gordon, Carlos, 19
Goulding, David, 04, 0M, 0Z
Gourbilleau, Fabrice, 09
Griffiths, Jonathan P., 18
Grillot, Frédéric, 0L, 0Y
Gu, Min, 1K
Guesmi, Latifa, 1I
Guzman, Robinson, 19
Hagness, S. C, 06
Haïdar, R., 15
Hegarty, Stephen P., 04, 0M, 0Z
Hegde, G. M., 1X
Hein, Sven M., 0W
Héron, S., 15
Horth, Alexandre, 1S
Hraghi, Abir 1I
Huang, Heming, 0Y
Huang, Zhangting, 1E
Huyet, Guillaume, 04, 0M, 0Z
Iezekiel, Stavros, 1R
Isella, G., 0G
Isídio de Lima, Joaquim Júnior, 0I
Ismail, Yehea, 1G
Javvaji, Brahmanandam, 1X
Jia, Tao, 1K
Jiang, Junzhen, 1E
Jo, Sung-Hyun, 1W
Jones, Geb A. C., 18
Juan, Yu-Shan, 1N
Kabuss, Julia, 0P
Kalliakos, Sokratis, 18
Kaluzhniy, N. A., 0X
Kang, Lin, 1K
Kashyap, Raman, 1S
Kelleher, Bryan, 04, 0M, 0Z
Keller, Janine, 07
Kervella, Gaël, 19
Kim, Doo-Gun, 1A
Kim, Hong-Seung, 1A
Kim, Tae-Ryong, 1A
Knezevic, I., 06

Knorr, Andreas, 0W
 Kolykhalova, E. D., 0K
 Kraxner, Andrea, 1O
 Kuchinskii, V. I., 0K
 Kulagina, M. M., 0X
 Kuo, Yen-Kuang, 1L
 Lai, Po-Yen, 0E
 Ledentsov, N. N., 0X
 Leijtens, Xaveer, 19
 Li, Jiu, 1F
 Li, Jun, 1A
 Liang, Houkun, 13
 Lin, Baocheng, 1E
 Lin, Cheng-Ting, 1N
 Lin, Tzy-Rong, 1J
 Lin, Yuankun, 1B, 1C
 Liu, Peter Q., 07
 Lyu, Hong-Kun, 1W
 Maissen, Curdin, 07
 Marquardt, O., 0C
 Maximov, M. V., 0K, 0X
 Menif, Mourad, 1I
 Minixhofer, Rainer, 1O
 Mintairov, S. A., 0X
 Molardi, Carlo, 13
 Montrosset, I., 0L
 Novikov, I. I., 0K
 Oh, Geum-Yoon, 1A
 Oksanen, Jani, 0J
 O'Reilly, E. P., 0C
 Ortolani, M., 0G
 O'Shaughnessy, B., 0Z
 Panajotov, Krassimir, 03
 Pardo, F., 15
 Park, Jong Mun, 1O
 Park, Young-Jin, 1W
 Paul, D. J., 0G
 Payusov, A. S., 0X
 Pelouard, J.-L., 15
 Perez, Pablo, 03
 Pesquera, Luis, 03
 Poole, Philip, 0Y
 Qiu, Ping, 05
 Qiu, Yishen, 1E
 Quirce, Ana, 03
 Quitariano, Nathaniel J., 1S
 Rafailov, E. U., 0K
 Rahman, M. R., 1X
 Reeves, E., 17, 1U
 Ren, Han, 1B, 1C
 Renaud, Cyril C., 19
 Ritchie, David A., 18
 Rodriguez-Esquerre, Vitaly Felix, 0I
 Roy Mahapatra, D., 1X
 Sadi, Toufik, 0J
 Sakat, E., 0G
 Samarelli, A., 0G
 Scaliari, Giacomo, 07
 Schmidt, N. Yu., 0X
 Schires, Kevin, 0Y
 Schulz, S., 0C
 Schulze, Franz, 0W
 Schwagmann, Andre, 18
 Selleri, Stefano, 13
 Shafaay, Sarah, 1G
 Shao, Jin, 1B, 1C
 Shchukin, V. A., 0X
 Shernyakov, Yu. M., 0X
 Shi, Kebin, 1F
 Shields, Andrew J., 18
 Shin, Jang-Kyoo, 1W
 Siahmakoun, A., 17, 1U
 Sibbett, W., 0K
 Skiba-Szymanska, Joanna, 18
 Slepneva, S., 0Z
 Soboleva, K. K., 0K
 Sokolovskii, G. S., 0K
 Sule, N., 06
 Sun, Xiao, 0D
 Sun, Xiaohan, 14
 Swillam, Mohamed, 1G
 Syvridis, Dimitris, 16
 Thienpont, Hugo, 03
 Tulkki, Jukka, 0J
 Tykalewicz, Boguslaw, 04, 0M
 Ustinov, V. M., 0K
 Valle, Angel, 03
 Valmorra, Federico, 07
 Van Dijk, Frédéric, 19
 Vashanova, K. A., 0X
 Viktorov, Evgeny A., 04, 0K, 0M
 Vladimirov, A. G., 0Z
 Wan, Chao, 1K
 Wang, C., 0L
 Wang, Kai, 05
 Wang, Ke, 05
 Ward, Martin B., 18
 Willis, K. J., 06
 Wu, Chien-Wei, 1J
 Wu, Peiheng, 1K
 Wu, Yi-Hua, 1N
 Xiao, Jinbiao, 14
 Xu, Ruiying, 1K
 Xu, Yin, 14
 Yang, Hong, 1F
 Yang, Xiaozhong, 1K
 Yu, Wentao, 1F
 Yu, Xia, 13
 Zhang, Hao, 1E
 Zhang, Hualiang, 1B, 1C
 Zhang, Labao, 1K
 Zhang, Ying, 13
 Zhou, Mi, 1B, 1C
 Zhukov, A. E., 0K

Conference Committee

Symposium Chairs

David L. Andrews, University of East Anglia (United Kingdom)
Alexei L. Glebov, OptiGrate Corporation (United States)

Symposium Co-chairs

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

Program Track Chair

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

Conference Chairs

Bernd Witzigmann, Universität Kassel (Germany)
Marek Osiński, The University of New Mexico (United States)
Fritz Henneberger, Humboldt-Universität zu Berlin (Germany)
Yasuhiko Arakawa, The University of Tokyo (Japan)

Conference Program Committee

Hiroshi Amano, Nagoya University (Japan)
Toshihiko Baba, Yokohama National University (Japan)
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)
Vassilios I. Kovanis, Air Force Research Laboratory (United States)
Cun-Zheng Ning, Arizona State University (United States)
Joachim Piprek, NUSOD Institute LLC (United States)
Ikuo Suemune, Hokkaido University (Japan)

Session Chairs

- 1 Nonlinear Effects in Semiconductor Lasers
Frédéric Grillot, Télécom ParisTech (France)

- 2 Plasmonic Materials
Paolo Biagioni, Politecnico di Milano (Italy)
- 3 Optoelectronics Active Materials I
Irena Knezevic, University of Wisconsin-Madison (United States)
- 4 Optoelectronics Active Materials II
Shi-Wei Chu, National Taiwan University (Taiwan)
- 5 Plasmonics
Yong-Hee Lee, KAIST (Korea, Republic of)
- 6 Quantum Dot Lasers
Alexander Carmele, Technische Universität Berlin (Germany)
- 7 Nanolasers
Eoin P. O'Reilly, Tyndall National Institute (Ireland)
- 8 Non-Classical Light
Aldo Di Carlo, Università degli Studi di Roma Tor Vergata (Italy)
- 9 Semiconductor Lasers
Bernd Witzigmann, Universität Kassel (Germany)
- 10 Solar Cell Simulation: Joint Session with Conferences 9357 and 9358
Bernd Witzigmann, Universität Kassel (Germany)
Alexandre Freundlich, University of Houston (United States)
- 11 Electromagnetics
Frédéric Grillot, Télécom ParisTech (France)
- 12 Optical Systems
Marek Osinski, The University of New Mexico (United States)

Introduction

In 2015, the 23rd SPIE Conference on Physics and Simulation of Optoelectronic Devices was held at the Photonics West symposium in San Francisco. The scope of this well-established conference was to unveil and study the physical principles of optoelectronic materials, devices, and systems with the help of theory and simulation.

With 11 invited, 43 contributed talks and 19 posters, the conference presented latest findings in fields such as plasmonics, quantum optics, nonlinear optical phenomena and their applications in lasers, detectors, light-emitting diodes and solar cells. For attendees of Photonics West, it complemented the conferences with experimental and technology focus in a seamless fashion.

The Physics and Simulation of Optoelectronic Devices conference has had a successful history due to the highly valuable contributions of the program committee and the organizational team. With great sadness we would like to report that our co-chair Prof. Dr. Fritz Henneberger passed away just before the 2015 conference. He was a pillar of strength in the conference as a part of the program committee since 1997, and with his move to the co-chair position in 2004. As an author, he was active since 1991. He organized and proposed many special sessions with highest quality contributions, identified novel topics to bring into the conference, and hence made a lasting impact which we will remember for a long time.

Bernd Witzigmann
Marek Osiński
Yasuhiko Arakawa

