PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 9002

, "Front Matter: Volume 9002," Proc. SPIE 9002, Novel In-Plane
Semiconductor Lasers XIII, 900201 (27 March 2014); doi:
10.1117/12.2063990

SPIE.

Event: SPIE OPTO, 2014, San Francisco, California, United States

PROCEEDINGS OF SPIE

Novel In-Plane Semiconductor Lasers XIII

Alexey A. Belyanin
Peter M. Smowton
Editors

3–6 February 2014
San Francisco, California, United States

Sponsored and Published by
SPIE

Volume 9002

Proceedings of SPIE 0277-786X, V. 9002

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

Novel In-Plane Semiconductor Lasers XIII, edited by Alexey A. Belyanin,
Peter M. Smowton, Proc. of SPIE Vol. 9002, 900201 · © 2014 SPIE
CCC code: 0277-786X/14/\$18 · doi: 10.1117/12.2063990

Proc. of SPIE Vol. 9002 900201-1

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 *Novel In-Plane Semiconductor Lasers XIII*, edited by Alexey A. Belyanin, Peter M. Smowton, Proceedings of SPIE Vol. 9002 (SPIE, Bellingham, WA, 2014) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819499158

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 © 2014, 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/14/\$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 and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent 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. Numbers in the index correspond to the last two digits of the six-digit CID Number.

Contents

ix Conference Committee

QUANTUM DOTS

- 9002 04 **Development of broad spectral bandwidth hybrid QW/QD structures from 1000-1400 nm** [9002-3]
N. Peyvast, S. Chen, K. Zhou, N. Babazadeh, A. A. Khozim, Z. Zhang, D. T. D. Childs, O. Wada, M. Hugues, R. A. Hogg, The Univ. of Sheffield (United Kingdom); T. Kageyama, K. Nishi, K. Takemasa, M. Sugawara, QD Laser, Inc. (Japan)

NEW MATERIALS AND GRATING CONTROLLED

- 9002 08 **Red emitting monolithic dual wavelength DBR diode lasers for shifted excitation Raman difference spectroscopy** [9002-7]
B. Sumpf, M. Maiwald, A. Müller, F. Bugge, J. Fricke, P. Ressel, J. Pohl, G. Erbert, G. Tränkle, Ferdinand-Braun-Institut (Germany)
- 9002 09 **Bragg-grating-stabilized external cavity lasers for gas sensing using tunable diode laser spectroscopy** [9002-8]
S. G. Lynch, Univ. of Southampton (United Kingdom); F. Chen, Cranfield Univ. (United Kingdom); J. C. Gates, C. Holmes, Univ. of Southampton (United Kingdom); S. E. Staines, S. W. James, J. Hodgkinson, Cranfield Univ. (United Kingdom); P. G. R. Smith, Univ. of Southampton (United Kingdom); R. P. Tatam, Cranfield Univ. (United Kingdom)
- 9002 0A **Properties of 62x nm red-emitting single-mode diode lasers** [9002-9]
K. Paschke, J. Pohl, D. Feise, G. Blume, G. Erbert, Ferdinand-Braun-Institut (Germany)

MODE LOCKED

- 9002 0C **Mode-locked InAs/InP quantum-dash-based DBR laser with monolithically integrated SOA (Invited Paper)** [9002-11]
S. Joshi, N. Chimot, S. Barbet, A. Accard, F. Lelarge, III-V Lab., Thales Research and Technology (France), and CEA-LETI (France)
- 9002 0D **Femtosecond semiconductor laser system with arbitrary intracavity phase and amplitude manipulation** [9002-12]
J. C. Balzer, B. Döpke, Ruhr-Univ. Bochum (Germany); A. Klehr, G. Erbert, G. Tränkle, Ferdinand-Braun-Institut (Germany); M. R. Hofmann, Ruhr-Univ. Bochum (Germany)

- 9002 OE **Femtosecond pulse generation from a two-section mode-locked quantum-dot laser using random population** [9002-13]
P. Finch, Tyndall National Institute (Ireland) and Cork Institute of Technology (Ireland); P. Blood, P. M. Smowton, A. Sobiesierski, Cardiff Univ. (United Kingdom); R. M. Gwilliam, Univ. of Surrey (United Kingdom); I. O'Driscoll, Tyndall National Institute (Ireland) and Cork Institute of Technology (Ireland)
- 9002 OF **Second harmonic pico-second pulse generation with mode-locked 1064nm DBR laser diodes** [9002-14]
A. Klehr, T. Przywarka, D. Jedrzejczyk, O. Brox, F. Bugge, H. Wenzel, K. Paschke, G. Ebert, G. Tränkle, Ferdinand-Braun-Institut (Germany)

NITRIDES

- 9002 OH **Optically pumped deep-ultraviolet AlGaIn multi-quantum-well lasers grown by metalorganic chemical vapor deposition (Invited Paper)** [9002-16]
Y.-S. Liu, T.-T. Kao, Md. M. Satter, Z. Lochner, X.-H. Li, S.-C. Shen, P. D. Yoder, T. Detchprohm, R. D. Dupuis, Georgia Institute of Technology (United States); Y. Wei, H. Xie, A. Fischer, F. A. Ponce, Arizona State Univ. (United States)
- 9002 OI **Influence of surface roughness on the optical mode profile in GaN-based violet ridge waveguide laser diodes** [9002-17]
K. Holc, A. Jakob, T. Weig, K. Köhler, O. Ambacher, Fraunhofer-Institut für Angewandte Festkörperphysik (Germany); U. T. Schwarz, Fraunhofer-Institut für Angewandte Festkörperphysik (Germany) and Albert-Ludwigs-Univ. Freiburg (Germany)
- 9002 OK **Absorption at large reverse bias in monolithic GaN-based short-pulse-multi-section laser diodes** [9002-19]
T. Weig, G. Lükens, K. Holc, K. Köhler, J. Wagner, Fraunhofer-Institut für Angewandte Festkörperphysik (Germany); U. T. Schwarz, Fraunhofer-Institut für Angewandte Festkörperphysik (Germany) and Albert-Ludwigs-Univ. Freiburg (Germany)

LASERS ON SILICON

- 9002 OU **Heterogeneously integrated lasers on silicon (Invited Paper)** [9002-29]
B. R. Koch, E. J. Norberg, J. E. Roth, B. Kim, A. Ramaswamy, R. S. Guzzon, J. Hutchinson, J.-H. Shin, J. Imamura, B. Gomez, G. Fish, A. Fang, Aurion, Inc. (United States)
- 9002 OX **Hybrid III-V on silicon lasers for photonic integrated circuits on silicon (Invited Paper)** [9002-32]
G.-H. Duan, C. Jany, A. Le Liepvre, A. Accard, M. Lamponi, D. Make, P. Kaspar, G. Levaufre, N. Girard, F. Lelarge, III-V Lab., Thales Research and Technology (France) and CEA-LETI (France); J.-M. Fedeli, S. Messaoudene, D. Bordel, S. Olivier, CEA-LETI-Minatec (France)

PHOTONIC BANDGAP AND MICROCAVITY

- 9002 0Z **Photonic crystal surface-emitting lasers as a pumping light source for second harmonic generation** [9002-34]
A. Watanabe, Hamamatsu Photonics K.K. (Japan); K. Hirose, Y. Kurosaka, Hamamatsu Photonics K.K. (Japan) and Kyoto Univ. (Japan); T. Sugiyama, Hamamatsu Photonics K.K. (Japan); Y. Liang, S. Noda, Kyoto Univ. (Japan)

MID-INFRARED LASERS: SB-BASED

- 9002 13 **Cascade pumping of GaSb-based type-I quantum well diode lasers (Invited Paper)** [9002-38]
L. Shterengas, R. Liang, G. Kipshidze, T. Hosoda, S. Suchalkin, G. Belenky, Stony Brook Univ. (United States)
- 9002 14 **Ultra-low input power long-wavelength GaSb type-I laser diodes at 2.7-3.0 μm** [9002-39]
A. Vizbaras, M. Greibus, E. Dvinelis, A. Trinkūnas, D. Kovalenkovas, I. Šimonytė, K. Vizbaras, Brolis Semiconductors UAB (Lithuania)
- 9002 16 **2-micron GaSb-based metamorphic laser grown on GaAs (Invited Paper)** [9002-41]
P. Apiratikul, L. He, R. P. Leavitt, N. P. Siwak, Univ. of Maryland, College Park (United States) and Lab. for Physical Sciences (United States); J. Duperre, C. J. K. Richardson, Lab. for Physical Sciences (United States)

MID-INFRARED QCLS II

- 9002 1A **AIAs/InAIAs-InGaAs QCLs grown by gas-source molecular-beam epitaxy (Invited Paper)** [9002-45]
W. T. Masselink, M. P. Semtsiv, Y. V. Flores, S. Kurlov, M. Elagin, G. Monastyrskiy, J.-F. Kischkat, A. Aleksandrova, Humboldt Univ. (Germany)

MID-INFRARED LASERS II

- 9002 1B **Interband cascade lasers for the mid-infrared spectral region (Invited Paper)** [9002-46]
S. Höfling, R. Weih, M. Dallner, M. Kamp, Julius-Maximilians-Univ. Würzburg (Germany)
- 9002 1C **High-power CW performance of 7-stage interband cascade lasers** [9002-47]
C. L. Canedy, J. Abell, C. D. Merritt, W. W. Bewley, C. S. Kim, U.S. Naval Research Lab. (United States); M. Kim, Sotera Defense Solutions, Inc. (United States); I. Vurgaftman, J. R. Meyer, U.S. Naval Research Lab. (United States)
- 9002 1D **Quantum band engineering of nitride semiconductors for infrared lasers (Invited Paper)** [9002-48]
O. Malis, C. Edmunds, D. Li, J. Shao, G. Gardner, Purdue Univ. (United States); W. Li, P. Fay, Univ. of Notre Dame (United States); M. J. Manfra, Purdue Univ. (United States)

- 9002 1E **High-performance InP-based InAs triangular quantum well lasers operating beyond 2 μm** [9002-49]
Y. Gu, Y. G. Zhang, Y. Y. Cao, X. Y. Chen, H. Li, L. Zhou, Shanghai Institute of Microsystem and Information Technology (China)

HIGH BRIGHTNESS/HIGH EFFICIENCY

- 9002 1F **High-power and high-efficiency broad-area diode laser emitting at 1.5 μm (Invited Paper)** [9002-50]
T. Garrod, D. Olson, M. Klaus, C. Zenner, C. Galstad, F. Brunet, Compound Photonics (United States); L. Mawst, D. Botez, Univ. of Wisconsin-Madison (United States)
- 9002 1G **Very high-power broad area laser diode with internal wavelength stabilization at 975 nm for Yb fibre laser pumping** [9002-51]
M. Krakowski, M. Lamponi, M. Lecomte, M. Maria, P. Resneau, Y. Robert, E. Vinet, M. Garcia, O. Parillaud, III-V Lab. (France)
- 9002 1H **Defect temperature kinetics during catastrophic optical damage in high power diode lasers** [9002-52]
M. Hempel, J. W. Tamm, Max-Born-Institut (Germany)
- 9002 1I **Cryogenic ultra-high power infrared diode laser bars (Invited Paper)** [9002-53]
P. Crump, C. Frevert, H. Hösler, F. Bugge, S. Knigge, W. Pittroff, G. Erbert, G. Tränkle, Ferdinand-Braun-Institut (Germany)
- 9002 1J **Realization of high-power narrow beam divergence in photonic-crystal surface-emitting laser** [9002-54]
K. Hirose, Y. Kurosaka, Hamamatsu Photonics K.K. (Japan) and Kyoto Univ. (Japan); A. Watanabe, T. Sugiyama, Hamamatsu Photonics K.K. (Japan); Y. Liang, S. Noda, Kyoto Univ. (Japan)

QCL ARRAYS/TUNABLE QCLS

- 9002 1N **Integrated widely tunable quantum cascade lasers with super-structure gratings** [9002-58]
D. Guo, X. Chen, Univ. of Maryland, Baltimore County (United States); J.-Y. Li, Princeton Univ. (United States); L. Cheng, T. Worchesky, F.-S. Choa, Univ. of Maryland, Baltimore County (United States)
- 9002 1O **InGaAs/InP-based Echelle mirror multiplexer using dual Rowland circle gratings for DFB QCL arrays in the mid-long infrared range** [9002-59]
L. J. Orbe, C. Gordon, G. Carpintero, Univ. Carlos III de Madrid (Spain); G. Maisons, M. Carras, III-V Lab. (France)

MID-INFRARED QCLS III

- 9002 1R **The role of electron temperature in the leakage current in QCLs and its impact on the quantum efficiency** [9002-62]
Y. V. Flores, S. S. Kurllov, M. Elagin, M. P. Semtsiv, W. T. Masselink, Humboldt Univ. (Germany)

- 9002 1T **Non-resonant optical modulation of quantum cascade laser and its application potential in infrared spectroscopy (Invited Paper)** [9002-64]
T. Yang, C. Tian, Stevens Institute of Technology (United States); G. Chen, Chongqing Univ. (China); R. Martini, Stevens Institute of Technology (United States)

Author Index

Conference Committee

Symposium Chairs

David L. Andrews, University of East Anglia Norwich (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

Klaus P. Streubel, OSRAM AG (Germany)

Conference Chairs

Alexey A. Belyanin, Texas A&M University (United States)
Peter M. Smowton, Cardiff University (United Kingdom)

Conference Program Committee

Yasuhiko Arakawa, The University of Tokyo (Japan)
Dan Botez, University of Wisconsin-Madison (United States)
Federico Capasso, Harvard School of Engineering and Applied Sciences (United States)
Gary A. Evans, Southern Methodist University (United States)
Claire F. Gmachl, Princeton University (United States)
Michael Kneissl, Technische Universität Berlin (Germany)
Luke F. Lester, The University of New Mexico (United States)
Hui Chun Liu, Shanghai Jiao Tong University (China)
Luke J. Mawst, University of Wisconsin-Madison (United States)
Jerry R. Meyer, U.S. Naval Research Laboratory (United States)
Richard V. Pentty, University of Cambridge (United Kingdom)
Johann Peter Reithmaier, Universität Kassel (Germany)
Haisheng Rong, Intel Corporation (United States)
Nelson Tansu, Lehigh University (United States)
Shinji Tsuji, Hitachi, Ltd. (Japan)
Kresten Yvind, Technical University of Denmark (Denmark)

Session Chairs

- 1 Quantum Dots
Luke F. Lester, Virginia Polytechnic Institute and State University (United States)
- 2 New Materials and Grating Controlled
Luke Mawst, University of Wisconsin-Madison (United States)
- 3 Mode Locked
Johann Peter Reithmaier, Universität Kassel (Germany)
- 4 Nitrides
Michael Kneissl, Technische Universität Berlin (Germany)
- 5 Mid-Infrared QCLs I
Alexey A. Belyanin, Texas A&M University (United States)
- 6 Terahertz QCLs
Jerome Faist, ETH Zurich (Switzerland)
- 7 Lasers on Silicon
Jonathan K. Doylend, Intel Corporation (United States)
- 8 Photonic Bandgap and Microcavity
Kresten Yvind, Technical University of Denmark (Denmark)
- 9 Mid-Infrared Lasers: Sb-based
Oana Malis, Purdue University (United States)
- 10 Mid-Infrared QCLs II
Jerry R. Meyer, U.S. Naval Research Laboratory (United States)
- 11 Mid-Infrared Lasers II
William T. Masselink, Humboldt-Universität zu Berlin (Germany)
- 12 High Brightness/High Efficiency
Gary A. Evans, Southern Methodist University (United States)
- 13 QCL Arrays/Tunable QCLs
Qijie Wang, Nanyang Technological University (Singapore)
- 14 Mid-Infrared QCLs III
Christian J. Pflügl, EOS Photonics (United States)