PROCEEDINGS OF SPIE

Semiconductor Lasers and Applications VIII

Ning Hua Zhu Werner H. Hofmann Editors

12–13 October 2018 Beijing, China

Sponsored by
SPIE
COS—Chinese Optical Society

Cooperating Organizations

Tsinghua University (China) • Peking University (China) • University of Science and Technology of China (China) • Zhejiang University (China) • Tianjin University (China) • Beijing Institute of Technology (China) • Beijing University of Posts and Telecommunications (China) • Nankai University (China) • Changchun University of Science and Technology (China) • University of Shanghai for Science and Technology (China) • Capital Normal University (China) • Huazhong University of Science and Technology (China) • Beijing Jiaotong University (China) • Shanghai Institute of Optics and Fine Mechanics (China) • Changchun Institute of Optics and Fine Mechanics (China) • Institute of Semiconductors (China) • Institute of Optics and Electronics (China) • Institute of Technical Physics (China) • China Instrument and Control Society (China) • Opticelectronics Technology Committee, COS (China) • Optical Society of Japan (Japan) • Optical Society of Korea (Korea, Republic of) • The Australian Optical Society (Australia) • Optics and Photonics Society of Singapore (Singapore) • European Optical Society

Supporting Organizations

CAST—China Association for Science and Technology (China) NSFC—National Nature Science Foundation (China)

Published by SPIE

Volume 10812

Proceedings of SPIE 0277-786X, V. 10812

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

Semiconductor Lasers and Applications VIII, edited by Ning Hua Zhu, Werner H. Hofmann, Proc. of SPIE Vol. 10812, 1081201 · © 2018 SPIE · CCC code: 0277-786X/18/\$18 · doi: 10.1117/12.2520994

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 Semiconductor Lasers and Applications VIII, edited by Ning Hua Zhu, Werner H. Hofmann, Proceedings of SPIE Vol. 10812 (SPIE, Bellingham, WA, 2018) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510622227

ISBN: 9781510622234 (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.



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

| ∨ii | Authors |
|-----------------------------------|---|
| ix | Symposium Committees |
| xiii | Conference Committee |
| SESSION 1 | VCSELS I |
| 10812 02 | VCSEL with finite-size high-contrast metastructure (Invited Paper) [10812-1] |
| 10812 03 | Modulation response, impedance, and equivalent circuit of ultra-high-speed multi-mode VCSELs (Invited Paper) [10812-2] |
| 10812 04 | Rigorous full-vectorial optical analysis of VCSEL using FDFD method [10812-3] |
| 10812 05 | Theoretical investigation on the propagation characteristics of inhibited spiking dynamics between two VCSEL-based photonic neurons [10812-4] |
| SESSION 2 | APPLICATIONS OF LASER DIODES I |
| | |
| 10812 06 | Wideband signal generation for radar application based on optically injected semiconductor laser (Invited Paper) $[10812-6]$ |
| 10812 06 | |
| | laser (Invited Paper) [10812-6] Modulator-free optoelectronic oscillator based on an optically injected semiconductor laser |
| 10812 07 | laser (Invited Paper) [10812-6] Modulator-free optoelectronic oscillator based on an optically injected semiconductor laser (Invited Paper) [10812-7] Image quality evaluation of target surface in the subgrade settlement monitoring system |
| 10812 07 | laser (Invited Paper) [10812-6] Modulator-free optoelectronic oscillator based on an optically injected semiconductor laser (Invited Paper) [10812-7] Image quality evaluation of target surface in the subgrade settlement monitoring system |
| 10812 07 10812 08 | Iaser (Invited Paper) [10812-6] Modulator-free optoelectronic oscillator based on an optically injected semiconductor laser (Invited Paper) [10812-7] Image quality evaluation of target surface in the subgrade settlement monitoring system [10812-9] |
| 10812 07 10812 08 SESSION 3 | Modulator-free optoelectronic oscillator based on an optically injected semiconductor laser (Invited Paper) [10812-7] Image quality evaluation of target surface in the subgrade settlement monitoring system [10812-9] APPLICATIONS OF LASER DIODES II One physical-enhanced security strategy for all-optical chaos communication based on |

| 10812 0D | Wavelength-tunability chaos synchronization based on two unidirectionally coupled WRC-FPLDs [10812-15] |
|-----------|--|
| 10812 OE | Accurate time-delay measurement of optical delay components based on frequency-shifted self-heterodyne spectrum [10812-16] |
| SESSION 4 | INTEGRATED OPTOELECTRONIC DEVICES |
| 10812 OF | Silicon-plus photonics for light manipulation and photodetection (Invited Paper) [10812-18] |
| 10812 0H | Magnitude response measurement of electro-optic intensity modulator based on photonic downconversion sampling [10812-20] |
| 10812 01 | 32-channel hybrid III-V/silicon laser arrays with 100GHz wavelength spacing based on LSBG structures on silicon waveguide [10812-21] |
| SESSION 5 | VCSELS II |
| 10812 0K | Multimode optical interconnects based on VCSEL and MMF for more than 100-Gb/s/lane and 100m transmission (Invited Paper) [10812-23] |
| 10812 0M | Design and investigation of stable polarization tunable VCSEL with intercavity subwavelength grating [10812-25] |
| 10812 0N | Advanced modulation response analysis of high-speed VCSELs [10812-26] |
| SESSION 6 | SEMICONDUCTOR LASERS I |
| 10812 OP | Diode laser wavelength standard based on 13C2H2 near-infrared spectroscopy at NIM [10812-28] |
| 10812 OS | Relative intensity noise properties of quantum dot lasers [10812-31] |
| SESSION 7 | SEMICONDUCTOR LASERS II |
| 10812 OU | A method of designing water-cooled horizontal-array diode lasers for uniform junction temperature [10812-33] |
| 10812 0V | Low-spatial coherence electrically pumped red-emitting semiconductor laser [10812-34] |
| 10812 0W | Thermal analysis of the direct pumping process in a 1064-nm monolithic non-planar ring oscillator Nd/YAG laser [10812-35] |

| 10812 0X | The quality assurance method of semiconductor pump laser for space application [10812-36] |
|----------|--|
| 10812 OY | Intrinsic phase response retrieval of notch in reflection spectrum of a phase-shifted fiber Bragg grating based on magnitude response measurement [10812-41] |
| | POSTER SESSION |
| 10812 OZ | Dual-channel physical random bits generation using a vertical-cavity surface-emitting laser under dual-path polarization-preserved chaotic optical injection [10812-5] |
| 10812 10 | Influence of system bandwidth on self-mixing signal [10812-8] |
| 10812 11 | Profile measurement using a self-mixing laser diode [10812-12] |
| 10812 12 | Experimental study on simultaneously measuring Young's modulus and internal fraction using self-mixing system [10812-17] |
| 10812 13 | Design super-narrow linewidth of coupled resonant cavity by investing phase shift [10812-37] |
| 10812 14 | Screening and qualification methods of semiconductor lasers used for aerospace environments [10812-38] |
| 10812 16 | Lateral thermal dissipation of InP-based InGaAsP ridge waveguide laser [10812-40] |
| 10812 19 | High-power 910 nm vertical-cavity surface-emitting laser arrays for light detection and ranging [10812-44] |
| 10812 1A | An optical power supply scheme for ultrahigh voltage grid with high reliability [10812-45] |
| 10812 1B | The attitude measurement system of high-speed railway foundation settlement monitoring target surface [10812-46] |
| 10812 1C | High-power high-efficiency tilted waved laser based on the quasi-periodicity photonic crystal structure [10812-47] |
| 10812 1D | Theoretical analysis of band structure and material gain of InGaAs quantum wells in a semiconductor disk laser [10812-48] |
| 10812 1E | Research on InP based DBR laser and its application in optical fiber sensing system [10812-49] |

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.

Aboul Hosn, Bassel, 03 Ajemian, Vana, 03 Bimberg, Dieter, 02

Bou Sanayeh, Marwan, 03, 0N

Bu, Xiande, 1E Cai, Shan, OP Cao, Jianping, 0W Cao, Lingzhi, 10, 11, 12 Chang, Mingchao, 0X Chang, Minachao, 14 Chen, Lisheng, 0W Chen, Zhiwen, 19 Chen, Zhonghao, 1C Cong, Shan, 0X, 14 Dai, Daoxin, 0F Dang, Jianwu, 08 Deng, Lu, 1A

Deng, Tao, 05, 0D Deng, Weiping, 0W Dong, Chen, 0M Dong, Fengxin, 01 Duan, Jianan, OS Fang, Zhanjun, OW Ge, Ling, 0K Grillot, Frédéric, OS

Guan, Baolu, 0M, 13

Guo, Qinghua, 10, 11, 12 Guo, Wei, 1B Guoyu, Heyang, 1D Hamad, Mustapha, 03, 0N Hamad, Wissam, 03, 0N

He, Zuyuan, OK

Hofmann, Werner, 03, 0N, 19

Hu, Pili, 0M, 13 Hu, Yixiang, 0E Hua, Lingling, 1D Huang, Hui, 1A Jia, Tao, 08 Jia, Yufei, 0V Jiang, Ning, 0A Lestrade, Michel, 04 Li, Binglin, 1E Li, Heping, 0C Li, Jiang, OF Li, Liufeng, 0W

Li, Z. Q., 04 Liang, Chenyu, 0K Liang, Jin, 0M, 13 Lin, Xiao-Dong, OB

Liu, Anjin, 02 Liu, Bin, 10, 12 Liu, Kefu, 19 Liu, Lin-Jie, 0D Liu, Shiqin, 0A Liu, Xingsheng, 0U

Liu, Yong, 07, 0C, 0E, 0H, 0Y

Li, Xiao, 16 Lu, Lidong, 1E Lu, Shenting, 1A Lv, Banghuan, 08 Ma, Pijie, Ol Ma, Yangxue, 0H, 0Y

Meng, Ranzhe, Ol Min, Yongzhi, 08, 1B Nashed, A. I., 04 Ning, Yongcheng, 14 Ning, Yongqiang, 19 Qi, Aiyi, 0V, 1C Qian, Jin, 0P Qin, Li, 19 Qiu, Bocang, 16 Qiu, Jian, 19 Qiu, Kun, 0A Qu, Hongwei, 1C Ran, Can, 0Z Ren, Weizhuo, 08 Ruan, Yuxi, 10, 11 Shang, Zhou, OB Shi, Chunying, 0P Simon Li, Z. M., 04 Song, Yanrong, 1D Sun, Xiaoyan, 1E Tang, Xi, OZ Tao, Jia, 1B Tao, Jing, 1E Tao, Yang, 0W Tian, Jinrong, 1D Tian, Zhi-Fu, 05, 0D Tong, Jun, 10, 11, 12 Wang, Cheng, 0S Wang, Hailing, 01 Wang, Han, 11 Wang, Hanping, OP Wang, Heng, 0E Wang, Jianbo, OP

Wang, Lijun, 19 Wang, Menake, 0E Wang, Mingjin, Ol

Wang, Xing-Guang, 0\$

Wang, Xueyou, 1C

Wang, Yufei, 0V

Wang, Zheng, 0X

Wang, Zhi-Jing, 05, 0D

Wei, Pu, 1A

Wu, Di-Hai, 0U

Wu, Hao, 19

Wu, Zheng-Mao, 05, 0B, 0D, 0Z

Xi, Jiangtao, 10, 11, 12

Xia, Fei, 12

Xia, Guang-Qiong, 05, 0B, 0D, 0Z

Xia, Yuan, 07

Xiao, Y. G., 04

Xing, Xiaoxu, 1C

Xu, Linhai, 0V

Xue, Chengpeng, 0A

Yan, Yingying, 19

Yehia, Rami, 03

Yin, Cong, 0P

Yin, Yanlong, 0F

Yu, Yanguang, 10, 11, 12

Yuan, Fei, 0Y

Yuan, Jun, 07

Yue, Zhao, 16

Zah, Chung-En, 0U

Zang, Erjun, OW

Zeng, Zhen, 0H

Zhang, Dayu, 0X

Zhang, Fangzheng, 06

Zhang, Jianwei, 19 Zhang, Jitao, 11

Zhang, Lingjie, 0C

Zhang, Peng, 1D

Zhang, Ruiying, 16

Zhang, Shangjian, 07, 0E, 0H, 0Y

Zhang, Wenjia, 0K

Zhang, Xing, 19

Zhang, Xuyan, 0C

Zhang, Yali, 07, 0E

Zhang, Zhiyao, 07, 0C, 0H, 0Y

Zhao, Anke, 0A

Zhao, Jing, 1A

Zhao, Shaoyu, OV, 1C

Zheng, Wanhua, 02, 01, 0V, 1C

Zhou, Xuyan, 1C Zhou, Y. J., 04

Zhou, Yue-Guang, OS

Zhu, Hongbo, 19

Zou, Jielong, 07

Zou, Xinhai, 0E

Zouein, Eliane, 03

viii

Symposium Committees

General Chairs

Maryellen Giger, *President*, SPIE and The University of Chicago (United States)

Qihuang Gong, *President,* Chinese Optical Society and Peking University (China)

General Co-chairs

Arthur Chiou, National Yang-Ming University (Taiwan, China)
 Guangcan Guo, Past President, Chinese Optical Society and University of Science and Technology of China (China)
 Zejin Liu, Vice President, Chinese Optical Society and National University of Defense Technology (China)

Technical Program Chairs

Ruxin Li, Vice President, Chinese Optical Society and Shanghai Institute of Optics and Fine Mechanics (China) Xingde Li, Johns Hopkins University (United States)

Technical Program Co-chairs

Tianchu Li, National Institute of Metrology (China)
Wei Huang, Northwestern Polytechnical University (China)
Ying Gu, Vice President, Chinese Optical Society and PLA General Hospital (China)
Huilin Jiang, Changchun University of Science and Technology

Huilin Jiang, Changchun University of Science and Technology (China)

Local Organizing Committee Chair

Xu Liu, Secretary General, Chinese Optical Society and Zhejiang University (China)

Local Organizing Committee Co-chairs

Wenqing Liu, Vice President, Chinese Optical Society and Anhui Institute of Optics and Fine Mechanics (China)

Guobin Fan, China Academy of Engineering Physics (China)

Local Organizing Committee

Xiaomin Ren, Vice President, Chinese Optical Society and Beijing University of Posts and Telecommunications (China)

Suotang Jia, Vice President, Chinese Optical Society and Shanxi University (China)

Wenjie Wang, Vice President, Chinese Optical Society and Sunny Group Company, Ltd. (China)

Qingming Luo, Huazhong University of Science and Technology (China)

Ping Jia, Changchun Institute of Optics, Fine Mechanics and Physics (China)

Wei Zhao, Xi'an Institute of Optics and Precision Mechanics (China) Yudong Zhang, Chengdu Branch, Chinese Academy of Sciences (China)

Ninghua Zhu, Institute of Semiconductors (China)

Yongtian Wang, Beijing Institute of Technology (China)

Xiaocong Yuan, Shenzhen University (China)

Limin Tong, Zhejing University (China)

Weimin Chen, Chongging University (China)

Yidong Huang, Tsinghua University (China)

Tiegen Liu, Tianjin University (China)

Zhiping Zhou, Peking University (China)

Changhe Zhou, Jinan University (China)

Yiping Cui, Southeast University (China)

Zhongwei Fan, Academy of Optoelectronics, CAS (China)

Xiaoying Li, Tianjin University (China)

Yan Li, Deputy Secretary General, Chinese Optical Society and Peking University (China)

Caiwen Ma, Xi'an Institute of Optics and Precision Mechanics (China)

Xinliang Zhang, Huazhong University of Science and Technology (China)

Jianxin Chen, Fujian Normal University (China)

Yihua Hu, College of Electronic Engineering, National Univ. of Defense Technology (China)

Secretaries-General

Bo Gu, Deputy Secretary General, Chinese Optical Society (China) **Hong Yang**, Deputy Secretary General, Chinese Optical Society and Peking University (China)

Executive Organizing Committee

David J. Bergman, Tel Aviv University (Israel)

Qionghai Dai, Tsinghua University (China)

Keisuke Goda, The University of Tokyo (Japan)

Qihuang Gong, Peking University (China)

Ying Gu, Chinese PLA General Hospital (China)

Guang-Can Guo, University of Science and Technology of China (China)

Byoung S. Ham, Gwangju Institute of Science and Technology (Korea, Republic of)

Sen Han, University of Shanghai for Science and Technology (China) and Suzhou H&L Instruments LLC (China)

Werner H. Hofmann, Technische Universität Berlin (Germany)

Minghui Hong, National University of Singapore (Singapore)

Bahram Jalali, University of California, Los Angeles (United States)

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

Satoshi Kawata, Osaka University (Japan)

Tina E. Kidger, Kidger Optics Associates (United Kingdom)

Baojun Li, Jinan University (China)

Ming Li, Institute of Semiconductors (China)

Ruxin Li, Shanghai Institute of Optics and Fine Mechanics (China)

Xingde Li, Johns Hopkins University (United States)

Jian Liu, PolarOnyx, Inc. (United States)

Tiegen Liu, Tianjin University (China)

Yongfeng Lu, University of Nebraska-Lincoln (United States)

Qingming Luo, Huazhong University of Science and Technology (China)

Yuji Sano, ImPACT (Japan)

Yunlong Sheng, Université Laval (Canada)

Kebin Shi, Peking University (China)

Tsutomu Shimura, The University of Tokyo (Japan)

Upendra N. Singh, NASA Langley Research Center (United States)

Michael G. Somekh, The Hong Kong Polytechnic University (Hong Kong, China)

Yuguo Tang, Suzhou Institute of Biomedical Engineering and Technology (China)

Masahiko Tani, University of Fukui (Japan)

Kimio Tatsuno, Koga Research Institute, Ltd. (Japan)

Kevin K. Tsia, The University of Hong Kong (Hong Kong, China)

Kazumi Wada, Massachusetts Institute of Technology (United States)

Yongtian Wang, Beijing Institute of Technology (China)

Rongshi Xiao, Beijing University of Technology (China)

Hongxing Xu, Wuhan University (China)

Toru Yoshizawa, Tokyo University of Agriculture and Technology (Japan) and 3D Associates (Japan)

Changyuan Yu, The Hong Kong Polytechnic University (Hong Kong, China)

Chongxiu Yu, Beijing University of Posts and Telecommunications (China)

Xiao-Cong Yuan, Shenzhen University (China)

Xiaoyan Zeng, Huazhong University of Science and Technology (China)

Cunlin Zhang, Capital Normal University (China)

Song Zhang, Purdue University (United States)

Xi-Cheng Zhang, University of Rochester (United States)

Xinliang Zhang, Wuhan National Laboratory for Optoelectronics (China)

Xuping Zhang, Nanjing University (China)

Changhe Zhou, Shanghai Institute of Optics and Fine Mechanics (China)

Zhiping Zhou, Peking University (China)

Dan Zhu, Huazhong University of Science and Technology (China)

Ning Hua Zhu, Institute of Semiconductors (China)

Conference Committee

Conference Chairs

Ning Hua Zhu, Institute of Semiconductors (China)
Werner H. Hofmann, Technische Universität Berlin (Germany)

Conference Program Committee

Minghua Chen, Tsinghua University (China)

Xiangfei Chen, Nanjing University (China)

Nan Chi, Fudan University (China)

Brian Corbett, Tyndall National Institute (Ireland)

Jian-Jun He, Zhejiang University (China)

Qianggao Hu, Accelink Technologies Company, Ltd. (China)

Weisheng Hu, Shanghai Jiao Tong University (China)

Yongzhen Huang, Beijing University of Posts and Telecommunications (China)

Jimin Li, Institute of Semiconductors (China)

Ming Li, Institute of Semiconductors (China)

Wei Li, Institute of Semiconductors (China)

Xianjie Li, China Electronics Technology Group Corporation (China)

Ning Liu, Huawei Technologies Company, Ltd. (China)

Wenhan Liu, University of Science and Technology of China (China)

Yong Liu, University of Electronic Science and Technology of China (China)

Xiaoyu Ma, Institute of Optics and Electronics (China)

Frank Hudson Peters, Tyndall National Institute (Ireland)

Edwin Y. Pun, City University of Hong Kong (Hong Kong, China)

Hong-Bo Sun, Jilin University (China)

Ji Wang, Changchun Institute of Optics, Fine Mechanics and Physics (China)

Shawn Wang, Luxtera, Inc. (United States)

Yixin Wang, Institute for Infocomm Research (Singapore)

Guang-Qiong Xia, Southwest University (China)

Kun Xu, Beijing University of Posts and Telecommunications (China)

Zhaowen Xu, Institute for Infocomm Research (Singapore)

Lianshan Yan, Southwest Jiaotong University (China)

Jinlong Yu, Tianjin University (China)

Siyuan Yu, University of Bristol (United Kingdom)

Li Zeng, Huawei Technologies Company, Ltd. (China)

Baoping Zhang, Xiamen University (China)

Guo-yi Zhang, Peking University (China)

Shangjian Zhang, University of Electronic Science and Technology of China (China)

Xinliang Zhang, Wuhan National Laboratory for Optoelectronics (China)

Zhiping Zhou, Peking University (China)

Xihua Zou, Southwest Jiaotong University (China)

Session Chairs

1 VCSELs

Werner H. Hofmann, Technische Universität Berlin (Germany)

2 Applications of Laser Diodes I

Shangjian Zhang Sr., University of Electronic Science and Technology of China (China)

3 Applications of Laser Diodes II

Fangzheng Zhang, Nanjing University of Aeronautics and Astronautics (China)

4 Integrated Optoelectronic Devices

Xingjun Wang, Peking University (China)

5 VCSELs II

Xiangfei Chen, Nanjing University (China)

6 Semiconductor Lasers I

Jian Wang, Huazhong University of Science and Technology (China)

7 Semiconductor Lasers II

Yuqing Jiao, Eindhoven University of Technology (Netherlands)