

PROCEEDINGS OF SPIE

Vertical-Cavity Surface-Emitting Lasers XXI

**Kent D. Choquette
Chun Lei**
Editors

**1–2 February 2017
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 10122

Proceedings of SPIE 0277-786X, V. 10122

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 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 *Vertical-Cavity Surface-Emitting Lasers XXI*, edited by Kent D. Choquette, Chun Lei, Proceedings of SPIE Vol. 10122 (SPIE, Bellingham, WA, 2017) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-786X (electronic)

ISBN: 9781510606852

ISBN: 9781510606869 (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.

**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

v	<i>Authors</i>
vii	<i>Conference Committee</i>

SESSION 1 COMMERCIAL VCSELS FOR APPLICATIONS

10122 02	50Gb/s PAM-4 oxide VCSEL development progress at Broadcom (Invited Paper) [10122-1]
10122 03	VCSELS for optical communication at Fuji Xerox (Invited Paper) [10122-2]
10122 04	VCSELS as light source for time-of-flight sensors [10122-3]
10122 05	Progress in optimization of high-power high-speed VCSEL arrays [10122-4]
10122 06	Progress on high-power 808nm VCSELS and applications [10122-5]

SESSION 2 MODULATION AND MANUFACTURING

10122 07	Modulation enhancements of photonic crystal VCSELS [10122-6]
10122 08	Continuous wave and modulation performance of 1550nm band wafer-fused VCSELS with MBE-grown InP-based active region and GaAs-based DBRs [10122-7]
10122 09	Towards a SFP+ module for WDM applications using an ultra-widely-tunable high-speed MEMS-VCSEL [10122-8]
10122 0A	Modelling of the modulation properties of arsenide and nitride VCSELS [10122-9]
10122 0B	Tunnel junction 850-nm VCSEL for aperture uniformity and reliability [10122-10]
10122 0C	Comparative study of contact geometry for bottom-emitting 980-nm VCSELS [10122-11]

SESSION 3 50GBPS AND BEYOND

10122 0E	VCSEL modal dynamics and implications for 100Gbps links (Invited Paper) [10122-13]
10122 0F	Single-mode 850-nm vertical-cavity surface-emitting lasers with Zn-diffusion and oxide-relief apertures for > 50 Gbit/sec OOK and 4-PAM transmission (Invited Paper) [10122-14]
10122 0G	High-speed optical interconnects with 850nm VCSELS and advanced modulation formats (Invited Paper) [10122-15]

SESSION 4 EMERGING VCSEL TECHNOLOGIES

- 10122 0H **Hybrid vertical-cavity laser integration on silicon (Invited Paper)** [10122-16]
10122 0J **Intracavity and extracavity-contacted 980-nm oxide-confined VCSELs for optical interconnects and integration (Invited Paper)** [10122-18]

SESSION 5 MODES AND POLARIZATION

- 10122 0K **Robustness versus thermal effects of single-mode operation of vertical-cavity surface-emitting lasers with engineered leakage of high-order transverse optical modes** [10122-19]
10122 0L **Transverse mode control in proton-implanted and oxide-confined VCSELs via patterned dielectric anti-phase filters** [10122-20]
10122 0M **Semiconductor-metal subwavelength grating VCSELs: new concept of emission mirror enabling vertical current injection** [10122-21]
10122 0N **Transverse mode selection in vertical-cavity surface-emitting lasers via deep impurity-induced disordering** [10122-22]
10122 0O **Investigations on polarization oscillation amplitudes in spin-VCSELs** [10122-23]
10122 0P **Correlation between polarization modes in VCSEL with optical feedback** [10122-24]