PROCEEDINGS OF SPIE

Vertical-Cavity Surface-Emitting Lasers XVII

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Editors

6–7 February 2013
San Francisco, California, United States

Sponsored and Published by
SPIE

Volume 8639

Proceedings of SPIE 0277-786X, V.8639

Vertical-Cavity Surface-Emitting Lasers XVII, edited by Kent D. Choquette, James K. Guenter,
Proc. of SPIE Vol. 8639, 863901 · © 2013 SPIE · CCC code: 0277-786X/13/$18
doi: 10.1117/12.2022486

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Please use the following format to cite material from this book:
Author(s), "Title of Paper," in *Vertical-Cavity Surface-Emitting Lasers XVII*, edited by Kent D. Choquette, James K. Guenter, Proceedings of SPIE Vol. 8639 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X
ISBN: 9780819494085

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

Printed in the United States of America.

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

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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:

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Introduction:

It has been two decades since VCSEL papers began to appear at Photonics West and this is the seventeenth Proceedings of the conference dedicated to VCSELs. Many aspects of VCSELs have seen enormous progress. In these Proceedings you will find VCSELs with wavelengths ranging from the blue to two microns in the infrared, with effective apertures ranging from a few hundred nanometers to many tens of micrometers, and with optical powers ranging from less than 1 milliwatt to many watts. Additionally, you will discover VCSELs with data-communication modulation rates near 50 gigabits per second, VCSELs with wavelengths tunable over a range of a hundred nanometers or more, and VCSELs with a range of materials and structures incorporated into their construction so as to afford control of characteristics unthinkable two decades ago.

At the same time, as other papers in these Proceedings demonstrate, some of the details of VCSEL degradation mechanisms remain mysterious even as the reliability continues to improve.

While they had many obvious potential manufacturing advantages, the original VCSELs were all low power devices with limited applications. (Limited application *types*, rather, as total volumes in the data communication and laser mouse markets have reached many hundreds of millions of devices.) It seemed likely that applications requiring high power would perpetually be the realm of edge-emitting lasers. Over the last decade or so, as documented in previous editions of these proceedings, arrays of VCSELs have demonstrated very high optical power and, as they became available, it was found that some of their emission characteristics such as low coherence and circular symmetry made them more effective than any alternative in some applications.

Similar processions of VCSEL-impossible, to possible, to product are in process today. One example uses widely tunable VCSELs fabricated with monolithic dome structures. This first appeared here only a few years ago. Originally aimed at gas sensing applications, they now have been found also to be nearly ideal light sources for optical coherence tomography (OCT), and are today available in commercial imaging products. OCT has become so important in medical and other imaging fields that there is an entire Photonics West BIOS conference dedicated to it with over a hundred papers this year, several dedicated to the significant advantages the tunable VCSEL brings.

What will cause VCSELs to shine next? Maybe it will be the control of polarization properties afforded by integration with liquid crystals as explored in more than one paper in this Proceedings. Otherwise, maybe red VCSELs will enter the high-power arena as another paper portends. Yogi Berra famously said something like, "It's tough to make predictions, especially about the future." This is as true of technology as of any other field. But it seems nevertheless that we can predict with confidence that the ways in which we can exploit VCSELs have not yet been exhausted, and we'll have interesting material for many VCSEL conferences yet to come.

James Guenter
Kent Choquette