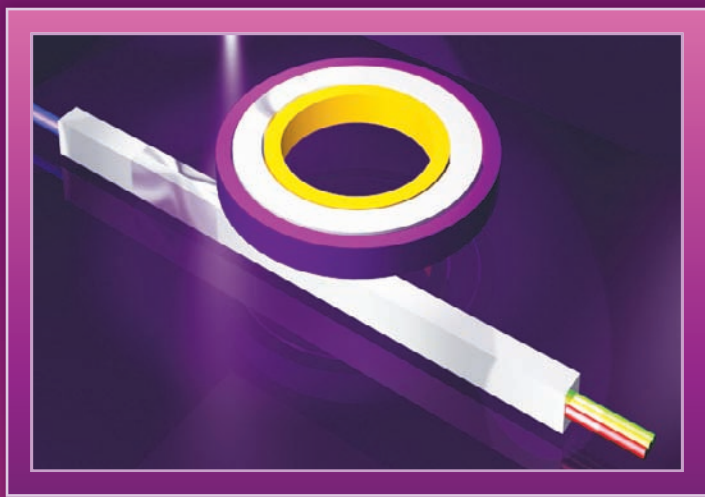


SILICON PHOTONICS

FOR TELECOMMUNICATIONS
AND BIOMEDICINE



EDITED BY
SASAN FATHPOUR
BAHRAM JALALI



CRC Press
Taylor & Francis Group

SILICON PHOTONICS

FOR TELECOMMUNICATIONS
AND BIOMEDICINE

SILICON PHOTONICS

FOR TELECOMMUNICATIONS
AND BIOMEDICINE

EDITED BY
SASAN FATHPOUR
BAHRAM JALALI



CRC Press

Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

© 2012 by Taylor & Francis Group, LLC
CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works
Version Date: 20111101

International Standard Book Number-13: 978-1-4398-0638-8 (eBook - PDF)

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access www.copyright.com (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

Visit the Taylor & Francis Web site at
<http://www.taylorandfrancis.com>

and the CRC Press Web site at
<http://www.crcpress.com>

To Our Wives: Haleh and Mojgan

Contents

| | |
|---|------|
| Preface | ix |
| Editors | xiii |
| Contributors | xv |
| Chapter 1 Silicon Photonics—The Evolution of Integration | 1 |
| <i>Graham T. Reed, William R. Headley, Goran Z. Mashanovich, Frederic Y. Gardes, David J. Thomson, and Milan M. Milosevic</i> | |
| Chapter 2 Silicon Plasmonic Waveguides | 51 |
| <i>Richard Soref, Sang-Yeon Cho, Walter Buchwald, Robert E. Peale, and Justin Cleary</i> | |
| Chapter 3 Stress and Piezoelectric Tuning of Silicon's Optical Properties | 77 |
| <i>Kevin K. Tsia, Sasan Fathpour, and Bahram Jalali</i> | |
| Chapter 4 Pulse Shaping and Applications of Two-Photon Absorption | 107 |
| <i>Ozdal Boyraz</i> | |
| Chapter 5 Theory of Silicon Raman Amplifiers and Lasers | 131 |
| <i>Michael Krause, Hagen Renner, and Ernst Brinkmeyer</i> | |
| Chapter 6 Silicon Photonics for Biosensing Applications | 201 |
| <i>Jenifer L. Lawrie and Sharon M. Weiss</i> | |
| Chapter 7 Mid-Wavelength Infrared Silicon Photonics for High-Power and Biomedical Applications | 231 |
| <i>Varun Raghunathan, Sasan Fathpour, and Bahram Jalali</i> | |
| Chapter 8 Novel III-V on Silicon Growth Techniques | 255 |
| <i>Diana L. Huffaker and Jun Tatebayashi</i> | |

| | | |
|-------------------|--|-----|
| Chapter 9 | Hybrid III-V Lasers on Silicon | 297 |
| | <i>Jun Yang, Zetian Mi, and Pallab Bhattacharya</i> | |
| Chapter 10 | Three-Dimensional Integration of CMOS and Photonics | 341 |
| | <i>Prakash Koonath, Tejaswi Indukuri, and Bahram Jalali</i> | |
| Chapter 11 | Nonlinear Photovoltaics and Energy Harvesting | 363 |
| | <i>Sasan Fathpour, Kevin K. Tsia, and Bahram Jalali</i> | |
| Chapter 12 | Computer-Aided Design for CMOS Photonics | 383 |
| | <i>Attila Mekis, Daniel Kucharski, Gianlorenzo Masini, and Thierry Pinguet</i> | |