Integrated Optics: Devices, Materials, and Technologies XV

Jean Emmanuel Broquin
Gualtiero Nunzi Conti
Editors

24–26 January 2011
San Francisco, California, United States

Sponsored and Published by
SPIE

Volume 7941
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:


ISSN 0277-786X
ISBN 9780819484789

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 © 2011, 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/11/$18.00.

Printed in the United States of America.

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

SPIEDigitalLibrary.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
- xi  Introduction

### SESSION 1  WAVEGUIDE ENGINEERING I

- **7941 02**  Large-scale planar lightwave circuits (Invited Paper) [7941-01]
  S. Bidnyk, H. Zhang, M. Pearson, A. Balakrishnan, Enablence Inc. (Canada)

- **7941 03**  Characterization of irradiance effects on curing of siloxane for embedded waveguide applications [7941-02]
  T. Daunais, K. Walczak, C. Middlebrook, P. Bergstrom, Michigan Technological Univ. (United States)

- **7941 05**  Monolithic integration of chalcogenide glass/iron garnet waveguides and resonators for on-chip nonreciprocal photonic devices [7941-04]
  L. Bi, J. Hu, G. F. Dionne, L. Kimerling, C. A. Ross, Massachusetts Institute of Technology (United States)

- **7941 06**  Fully compatible magneto-optical sol-gel material with glass waveguides technologies: application to mode converters [7941-05]
  F. Royer, D. Jamon, Univ. de Lyon (France) and Univ. Jean Monnet Saint-Etienne (France); J.-E. Broquin, Institut de Microélectronique Electromagnétisme et Photonique/Lab. d'Hyperfréquences et Caractérisation (France); H. Amata, R. Kekesi, Univ. de Lyon (France) and Univ. Jean Monnet Saint-Etienne (France); S. Neveu, Lab. PESCA, CNRS, Univ. Pierre et Marie Curie (France); M.-F. Blanc-Mignon, Univ. de Lyon (France) and Univ. Jean Monnet Saint-Etienne (France); E. Ghibaudo, Institut de Microélectronique Electromagnétisme et Photonique/Lab. d'Hyperfréquences et Caractérisation (France)

### SESSION 2  AMPLIFIERS AND LASERS

- **7941 07**  Synthesis and tailoring of CdSe core@shell heterostructures for optical applications (Invited Paper) [7941-06]
  A. Antonello, M. Guglielmi, V. Bello, G. Mattei, A. Martucci, Univ. degli Studi di Padova (Italy)

- **7941 08**  Integrated optics dissipative soliton mode-locked laser on glass [7941-07]
  B. Charlet, L. Bastard, J.-E. Broquin, Institut de Microélectronique Electromagnétisme et Photonique/Lab. d'Hyperfréquences et Caractérisation (France)

### SESSION 3  PHOTONIC INTEGRATION

- **7941 0C**  Hybrid photonic integrated circuits for faster and greener optical communication networks (Invited Paper) [7941-11]
  L. Stampoulidis, E. Kehayas, CONSTELEX Technology Enablers (Greece); L. Zimmermann, IHP GmbH (Germany) and Technische Univ. Berlin (Germany)
SESSION 4  MODELLING AND DESIGN

7941 0G  Fast online simulation of 3D nanophotonic structures by the reduced basis method [7941-15]
F. Schmidt, J. Pomplun, Konrad-Zuse-Zentrum für Informationstechnik Berlin (Germany) and JCMwave GmbH (Germany); L. Zschiedrich, JCMwave GmbH (Germany); S. Burger, Konrad-Zuse-Zentrum für Informationstechnik Berlin (Germany) and JCMwave GmbH (Germany)

7941 0H  Far field scattering by a waveguide-coupled nanowire [7941-16]
L. Arnaud, A. Bruyant, M. Renault, Y. Hadjar, G. Léondel, P. Royer, Univ. de Technologie Troyes (France); G. Custillon, A. Morand, P. Benech, Institut de Microélectronique Electromagnétisme et Photonique/Lab. d’Hyperfréquences et Caractérisation (France); J. Ferrand, Univ. Joseph Fourier (France); S. Blaize, Univ. de Technologie Troyes (France)

SESSION 5  SENSORS I

7941 0K  Photonic crystal slot waveguide spectrometer for the detection of methane [7941-20]
S. Chakravarty, Omega Optics, Inc. (United States); W.-C. Lai, The Univ. of Texas at Austin (United States); X. Wang, Omega Optics, Inc. (United States); C. Lin, R. T. Chen, The Univ. of Texas at Austin (United States)

7941 0L  Optimization of waveguide structure for local evanescent field shift detection [7941-21]
Z. Yi, R. Yan, T. A. Erickson, R. Safaisini, K. L. Lear, Colorado State Univ. (United States)

7941 0M  Carbon nanotubes coated fiber optic ammonia gas sensor [7941-22]
S. Manivannan, National Institute of Technology, Tiruchirappalli (India); L. R. Shobin, Anna Univ., Tiruchirappalli (India); A. M. Saranya, B. Renganathan, D. Sastikumar, National Institute of Technology, Tiruchirappalli (India); K. C. Park, Kyung Hee Univ. (Korea, Republic of)

SESSION 6  SENSORS II

7941 0O  Hydrogen absorption effects on the transmittance of sub-wavelength palladium hole arrays with different thicknesses [7941-24]
E. Maeda, S. Mikuriya, I. Yamada, J.-J. Delaunay, The Univ. of Tokyo (Japan)

7941 0P  Consideration of sensitivity with respect to diaphragm thickness and waveguide position in silicon-based guided-wave optical accelerometer [7941-25]
Y. Miura, H. Endo, T. Oshima, M. Ohkawa, T. Sato, Niigata Univ. (Japan)
SESSION 7  WAVEGUIDE ENGINEERING II

7941 0R  New tracks toward 3D light harnessing: high Q slow Bloch mode engineering and coupling to 0D nanophotonic structures (Invited Paper) [7941-27]
T. Benyattou, Ecole Centrale de Lyon (France); A. Bellarouci, X. Letartre, Institut National des Sciences Appliquées de Lyon (France); E. Gerelli, Ecole Centrale de Lyon (France); T. Zhang, P. Viktorovitch, Institut National des Sciences Appliquées de Lyon (France)

7941 0S  GaAs-SOI integration as a path to low-cost optical interconnects [7941-28]
T. Aalto, M. Harjanne, M. Kapulainen, S. Ylinen, VTT Technical Research Ctr. of Finland (Finland); M. Guina, K. Haring, J. Puustinen, Tampere Univ. of Technology (Finland); V. Mikhrin, Innolume GmbH (Germany)

7941 0U  Coupling of lithium niobate disk resonators to integrated waveguides [7941-31]
S. Berneschi, Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi (Italy) and Istituto di Fisica Applicata Nello Carrara, CNR (Italy); F. Cosi, G. Nunzi Conti, S. Pelli, S. Soria, G. C. Righini, Istituto di Fisica Applicata Nello Carrara, CNR (Italy); M. Dispenza, A. Secchi, SELEX Sistemi Integrati S.p.A. (Italy)

SESSION 8  PLASMONIC

7941 0W  Rigorous characterization of surface plasmon modes by using the finite element method [7941-34]

7941 0X  Plasmon-induced transparency in subwavelength metal-dielectric-metal waveguides [7941-35]
Y. Huang, C. Min, G. Veronis, Louisiana State Univ. (United States)

7941 0Z  Linear and nonlinear resonant effects in metallic arrays of sub-wavelength channels filled with GaAs [7941-37]
M. A. Vincenti, D. de Ceglia, The AEgis Technologies Group, Inc. (United States); N. Akozbek, The AEgis Technologies Group, Inc. (United States) and U.S. Army RDECOM (United States); M. Scalora, U.S. Army RDECOM (United States)

7941 10  Characteristics and applications of rectangular waveguide in sensing, slow light, and negative refraction [7941-38]
M. A. Swillam, A. S. Helmy, Univ. of Toronto (Canada)

SESSION 9  SUBWAVELENGTH/DIFRACTIVE PHOTONICS

7941 11  Subwavelength and diffractive waveguide structures and their applications in nanophotonics and sensing (Invited Paper) [7941-39]
P. Cheben, National Research Council Canada (Canada); P. J. Bock, National Research Council Canada (Canada), York Univ. (Canada), and Univ. of Ottawa (Canada); J. H. Schmid, J. Lapointe, S. Janz, D.-X. Xu, R. Mo, A. Densmore, A. Delâge, B. Lamontagne, National Research Council Canada (Canada); T. J. Hall, Univ. of Ottawa (Canada); R. Halir, I. Molina-Fernández, Univ. de Málaga (Spain); J.-M. Fédéli, CEA, LETI (France)
Long period and fiber Bragg gratings written within the same fiber for sensing purposes
[7941-40]
F. Baldini, M. Brenči, Istituto di Fisica Applicata Nello Carrara, CNR (Italy); F. Chiavaioli, Univ. degli Studi di Siena (Italy); R. Falciai, A. Giannetti, Istituto di Fisica Applicata Nello Carrara, CNR (Italy); M. Mugnaini, Univ. degli Studi di Siena (Italy); C. Trono, Istituto di Fisica Applicata Nello Carrara, CNR (Italy)

Pixelated resonant subwavelength grating filters for greenhouse gas monitoring
[7941-41]
D. W. Peters, S. A. Kemme, A. A. Cruz-Cabrera, R. R. Boye, C. A. Bustard, Sandia National Labs. (United States)

High-sensitive nonlinear detection of steroids by resonant double grating waveguide structures-based immunosensors
[7941-42]
A. Muriano, Consejo Superior de Investigaciones Científicas (Spain) and CIBER de Bioingeniería, Biomateriales y Nanomedicina (Spain); J.-P. Salvador, CIBER de Bioingeniería, Biomateriales y Nanomedicina (Spain) and Consejo Superior de Investigaciones Científicas (Spain); R. Galve, M.-P. Marco, Consejo Superior de Investigaciones Científicas (Spain) and CIBER de Bioingeniería, Biomateriales y Nanomedicina (Spain); A. Thayil K.N., P. Loza-Alvarez, Institut de Ciències Fotònicas (Spain); S. Soria, Istituto di Fisica Applicata Nello Carrara, CNR (Italy)

Photonic nanojet engineering: focal point shaping with scattering phenomena of dielectric microspheres
[7941-49]
M.-S. Kim, T. Scharf, École Polytechnique Fédérale de Lausanne (Switzerland); S. Mühlig, C. Rockstuhl, Friedrich-Schiller-Univ. Jena (Germany); H. P. Herzig, École Polytechnique Fédérale de Lausanne (Switzerland)

POSTER SESSION

Waveguide integrated plasmonic platform for sensing and spectroscopy
[7941-44]
F. Degirmenci, I. Bulu, P. Deotare, M. Khan, M. Loncar, F. Capasso, Harvard School of Engineering and Applied Sciences (United States)

Analysis of surface plasmon resonance triangular-resonator sensor
[7941-45]
G.-Y. Oh, Chung-Ang Univ. (Korea, Republic of); D.-G. Kim, Korea Photonics Technology Institute (Korea, Republic of); H.-S. Kim, T.-K. Lee, Y.-W. Choi, Chung-Ang Univ. (Korea, Republic of)

Enhanced light transmission through a metallic nanolens consisting of multiple nanorings
[7941-46]
Y. Oh, J. Choi, K. Kim, D. Kim, Yonsei Univ. (Korea, Republic of)

Analytical modeling of plasmonic-waveguide-based devices for nanophotonic applications
[7941-47]
A. Pannipitiya, I. D. Rukhlenko, M. Premaratne, Monash Univ. (Australia)
Effects of amplitude and timing jitter on the performance of photonic sigma-delta modulators [7941-48]
Y. W. Tan, C. H. Nam, P. E. Pace, Naval Postgraduate School (United States)

Author Index
Conference Committee

Symposium Chair
Liang-Chy Chien, Kent State University (United States)

Symposium Cochair
E. Fred Schubert, Rensselaer Polytechnic Institute (United States)
Klaus P. Streubel, OSRAM GmbH (Germany)

Program Track Chair
Yakov Sidorin, Quarles Brady LLP (United States)

Conference Chairs
Jean Emmanuel Broquin, Institut de Microélectronique
Electromagnétisme et Photonique/Laboratoire d’Hyperfréquences et Caractérisation (France)
Gualtiero Nunzi Conti, Istituto di Fisica Applicata Nello Carrara, CNR (Italy)

Conference Cochair
Christoph M. Greiner, LightSmyth Technologies, Inc. (United States)
Christoph A. Wächter, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany)

Program Committee
Pierre Berini, University of Ottawa (Canada)
Pavel Cheben, National Research Council Canada (Canada)
Xudong Fan, University of Michigan (United States)
Helmut Heidrich, Fraunhofer-Institut für Nachrichtentechnik, Heinrich-Hertz-Institut (Germany)
Andrea Melloni, Politecnico di Milano (Italy)
Robert L. Nelson, Air Force Research Laboratory (United States)
Jens H. Schmid, National Research Council Canada (Canada)
Frank Schmidt, JCMwave GmbH (Germany)
Yakov Sidorin, Quarles Brady LLP (United States)
Stefano Taccheo, Swansea University (United Kingdom)
Session Chairs

1  Waveguide Engineering I
   Jean Emmanuel Broquin, Institut de Microélectronique
   Electromagnétisme et Photonique/Laboratoire d’Hyperfréquences
   et Caractérisation (France)

2  Amplifiers and Lasers
   Guatliero Nunzi Conti, Istituto di Fisica Applicata Nello Carrara, CNR
   (Italy)

3  Photonic Integration
   Stefano Taccheo, Swansea University (United Kingdom)

4  Modelling and Design
   Jean Emmanuel Broquin, Institut de Microélectronique
   Electromagnétisme et Photonique/Laboratoire d’Hyperfréquences
   et Caractérisation (France)

5  Sensors I
   Francesco Baldini, Istituto di Fisica Applicata Nello Carrara, CNR (Italy)

6  Sensors II
   Yakov Sidorin, Quarles Brady LLP (United States)

7  Waveguide Engineering II
   Seppo K. Honkanen, Aalto University School of Science and
   Technology (Finland)

8  Plasmonic
   Pierre Berini, University of Ottawa (Canada)

9  Subwavelength/Diffractive Photonics
   Thomas W. Mossberg, LightSmyth Technologies, Inc. (United States)
Introduction

Since the first Integrated Optics Conference at Photonics West fifteen years ago, it has been noticed that this field of research has kept evolving year after year, renewing itself constantly and, sometimes, surprisingly. Indeed, though the telecom bubble exploded, integrated optics kept on moving finding applications in sensors and bio-chips but also into more exotic fields like astronomy. This variety of uses is also completed by a great variety of technological and design approaches. From the well-known “Silica-on-silicon” based waveguides to new plasmonic devices, from microresonators to diffractive devices, the conference “Integrated Optics: Devices and Materials” has been trying hence to reflect the vitality and the diversity of this field.

In this proceedings volume, the reader will therefore see a wide range of exciting advances ranging from new exotic work on amorphous silicon waveguides for UV detection to different approaches for obtaining magneto-optic waveguides, as well as the coupling of a free space beam into a plasmonic nanometric antenna thanks to a photonic crystal.

The reader will also find articles written by students, who quite often gave their first international talk at this conference, together with papers from renowned scientists of the field. It is indeed because today’s students are tomorrow’s scientific leaders that our conference always promoted their participation and will keep on doing so thanks to the SPIE student grant policy. If “Integrated Optics: Devices and Materials” is now one of the oldest conferences of the SPIE Optoelectronics symposium, it is, of course, because of the quality of the scientific work that had been presented through years, but, it is also because of the dedication of all the members of the program committee who accept willingly to spend a part of their summer in building this conference and finding all the exciting invited talks that we see every year.

To them, to all the speakers and authors, to the SPIE staff who make the logistics run so smoothly, we would like to say thank you very much and we long to see you next year.

Jean Emmanuel Broquin
Gualtiero Nunzi Conti