

PROCEEDINGS OF SPIE

Advanced Fabrication Technologies for Micro/Nano Optics and Photonics VIII

**Georg von Freymann
Winston V. Schoenfeld
Raymond C. Rumpf**
Editors

**8–11 February 2015
San Francisco, California, United States**

Sponsored by
SPIE

Cosponsored by
Nanoscribe GmbH (Germany)

Published by
SPIE

Volume 9374

Proceedings of SPIE 0277-786X, V. 9374

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

Advanced Fabrication Technologies for Micro/Nano Optics and Photonics VIII, edited by Georg von Freymann,
Winston V. Schoenfeld, Raymond C. Rumpf, Proc. of SPIE Vol. 9374, 937401 · © 2015 SPIE
CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2190568

Proc. of SPIE Vol. 9374 937401-1

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:

Author(s), "Title of Paper," in *Advanced Fabrication Technologies for Micro/Nano Optics and Photonics VIII*, edited by Georg von Freymann, Winston V. Schoenfeld, Raymond C. Rumpf, Proceedings of SPIE Vol. 9374 (SPIE, Bellingham, WA, 2015) Article CID Number.

ISSN: 0277-786X

ISBN: 9781628414646

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 © 2015, 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/15/\$18.00.

Printed in the United States of America.

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



SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print. Papers are published as they are submitted and meet publication criteria. A unique 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.

Contents

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

3D DIRECT LASER WRITING I

9374 02	Fabricating microscopic tools: towards optically actuated micro-robotics (Invited Paper, Best Paper Award) [9374-1]
9374 03	Fabrication and characterization of micro-structures created by direct laser writing in multi-layered chalcogenide glasses [9374-2]
9374 04	Fabrication of chirped and multi-period waveguide embedded Bragg gratings in lithium niobate [9374-3]
9374 05	Nano-scale optical actuation based on two-dimensional heterostructure photonic crystal cavities [9374-4]

3D DIRECT LASER WRITING II

9374 08	Reversible deformation in hybrid organic-inorganic photoresists processed by ultrafast direct laser write technique [9374-7]
9374 0B	Volumetric integration of photorefractive micromodifications in lithium niobate with femtosecond laser pulses [9374-10]

3D STRUCTURES

9374 0D	Fiber endface Fabry-Perot vapor microsensors fabricated by multiphoton polymerization technique [9374-12]
9374 0E	Focused ion beam 3D nano-patterned optical fiber tips for advanced beam profile engineering [9374-13]

LIGHT HARVESTING

9374 0J	Thermal to electrical energy converter based on black Si (Best Student Paper Award) [9374-18]
9374 0K	Nanotextured CuO: sensing and light harvesting platform [9374-19]

PLASMONICS AND METAMATERIALS I

- 9374 0O **Rapid production of structural color images with optical data storage capabilities** [9374-23]
- 9374 0P **Nanoscale precision in ion milling for optical and terahertz antennas** [9374-24]

PLASMONICS AND METAMATERIALS II

- 9374 0Q **Template-guided self-assembly strategies for discrete and extended optoplasmonic materials (Invited Paper)** [9374-25]
- 9374 0R **Parallel fabrication of wafer-scale plasmonic metamaterials for nano-optics** [9374-26]
- 9374 0T **Design and fabrication of two-dimensional deterministic aperiodic photonic lattices by optical induction** [9374-28]

ADVANCED MANUFACTURING USING A DMD OR OTHER SLM: JOINT SESSION WITH CONFERENCES 9374 AND 9376

- 9374 0V **Spatial light modulator based holographic fabrication of 3D spatially varying photonic crystal templates** [9374-30]

DIFFRACTIVE OPTICAL ELEMENTS I

- 9374 0W **Design and fabrication of sub-wavelength athermal resonant waveguide replicated gratings on different polymer substrates** [9374-31]
- 9374 0X **Mask aligner lithography for TSV-structures using a double-sided (structured) photomask** [9374-32]
- 9374 0Y **Design and fabrication of diffractive optics for orbital angular momentum space division multiplexing** [9374-33]
- 9374 0Z **Design and fabrication of a resonant mirrors for locking blue laser diodes** [9374-34]
- 9374 10 **Multilevel micro-structuring of glassy carbon for precision glass molding of diffractive optical elements** [9374-35]

DIFFRACTIVE OPTICAL ELEMENTS II

- 9374 11 **Finely control groove-depth variations of large-area diffraction gratings** [9374-36]
- 9374 12 **Electron beam written subwavelength gratings for polarization separation in the infrared** [9374-37]

MICROOPTICAL ELEMENTS

- 9374 14 **A tiny VIS-NIR snapshot multispectral camera** [9374-39]
- 9374 15 **Process optimization for a 3D optical coupler and waveguide fabrication on a single substrate using buffer coat material** [9374-40]

POSTER SESSION

- 9374 18 **Fabrication of sine-top broadband gold-coated gratings** [9374-43]
- 9374 1A **Monte Carlo simulations applying rigorous coupled-wave analysis for tolerance analysis of diffractive optical elements** [9374-45]
- 9374 1B **Simple volume expanding fabrication method for focal length controlled micro-lens array** [9374-46]
- 9374 1F **High contrast and metal-less alignment process for all-polymer optical interconnect devices** [9374-50]
- 9374 1G **Engineering of the extraordinary optical transmission of metallic gratings via Er³⁺-doped tellurite glass** [9374-51]
- 9374 1I **Quantification of microscopic surface features of single point diamond turned optics with subsequent chemical polishing** [9374-53]

Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four 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.

Ahn, Wonmi, 0Q
Ali, Rizwan, 0W
Baghdady, Joshua, 0Z
Balčytis, A., 0J, 0K, 0P
Bhattacharya, Shanti, 12
Binun, Paul, 0Z
Blanch, Carolina, 14
Boguslawski, M., 0T
Byrd, Matthew, 0Z
Cardenas, Nelson, 11
Čerkauskaitė, A., 0B
Chau, Fook Siong, 05
Clark, F., 0P
Claytor, Nelson, 11
Claytor, Richard, 11
Cowie, B. C. C., 0K
Deng, Jie, 05
Denz, C., 04, 0T
Diebel, F., 0T
Dukwen, Julia, 10
Eslami, S., 0R
Farsari, Maria, 0D
Fischer, P., 0R
Flores, Raquel, 0E
Fraelich, Margaret, 11
Fu, Shaojun, 11
Fujimura, Kayoko, 1A
Gayathri, M. S., 12
Ge, Tao, 15, 1F
Geelen, Bert, 14
George, David, 0V
Gervinskas, G., 0P
Gibbs, J. G., 0R
Gleason, Benn, 03
Gonzalez, Pilar, 14
Grabill, Chris N., 03
Hermerschmidt, Andreas, 10
Herzig, Hans Peter, 10
Hong, Yan, 0Q
Hong, Yilin, 11, 18
Honkanen, Seppo, 0W
Imbrock, J., 04
Inomata, Toru, 1A
Janeiro, Ricardo, 0E
Jeong, H.- H., 0R
Jiang, Hao, 0O
Jiang, Xiaolong, 11, 18
Johnson, Eric G., 0Y, 0Z
Johnson, Lee, 15, 1F
Jorge, Pedro, 0E
Jović Savić, Dragana M., 0T
Juodkazis, Saulius, 08, 0B, 0J, 0K, 0P
Juodkazytė, J., 0K
Kaminska, Bozena, 0O
Kanakugi, Tomohiro, 1A
Kim, Cheol Joong, 1B
Kim, I., 0R
Kim, Junoh, 1B
Kimura, Hitoshi, 1A
Kitagawa, Seiichiro, 1A
Komatsu, R., 0J
Konidakis, Ioannis, 0D
Kroesen, S., 04
Krotkus, A., 0P
Kuebler, Stephen M., 03
Kyrish, Matthew, 11
Lambrechts, Andy, 14
Lapierre, F., 0K
Lechuga, Oscar, 11
Lee, Jin Su, 1B
Lee, Kyu, 0Z
Lee, Muyung, 1B
Lee, T. C., 0R
Lewis, Anna M., 03
Lin, Tong, 05
Lin, Yuankun, 0V
Lučić, Nemanja M., 0T
Lutkenhaus, Jeffrey, 0V
Magnusson, Robert, 0Z
Marega, E., Jr., 1G
Mark, A G., 0R
Mayer, Theresa S., 03
McCormick, Kyle, 0Z
Melissinaki, Vasileia, 0D
Miles, Mervyn J., 02
Milster, Tom, 15, 1F
Mizeikis, Vygantas, 08, 0B
Molis, G., 0P
Morgan, Kaitlyn S., 0Y
Muhutijiang, Bilali, 18
Naghshineh, Mohammad, 0O
Nishijima, Y., 0J, 0P
Okano, Masato, 1A
Padgett, Miles J., 02
Paipulas, D., 0B
Philipose, Usha, 0V
Phillips, David B., 02
Pissadakis, Savros, 0D

Plöger, Sven, 10
Pogrebnyakov, Alexej, 03
Pramitha, V., 12
Prater, Karin, 10
Pung, Aaron, 0Z
Purlys, Vytautas, 08, 0B
Qarehbaghi, Reza, 0O
Qiu, Keqiang, 11, 18
Raghu, Indumathi S., 0Y
Rarity, John G., 02
Reinhard, Björn M., 0Q
Rekštytė, Sima, 08
Rezaei, Mohamad, 0O
Ribeiro, Ana Rita, 0E
Richardson, Gerald D., 03
Richardson, Kathleen A., 03
Rivera, V. A. G., 1G
Rivero-Baleine, Clara, 03
Saleem, Muhammad Rizwan, 0W
Scharf, Toralf, 10
Schwarz, Casey M., 03
Seniutinas, G., 0J, 0K, 0P
Silva, O. B., 1G
Simpson, Stephen H., 02
Stuerzebecher, L., 0X
Summitt, Chris, 15, 1F
Tack, Nicolaas, 14
Takashima, Yuzuru, 15, 1F
Taylor, Daniel, 1I
Tian, Feng, 05
Turunen, Jari, 0W
Valušis, G., 0P
Viegas, Jaime, 0E
Vyas, Aadit, 03
Wang, Sunclin, 15, 1F
Weichelt, T., 0X
Won, Yong Hyub, 1B
Wong, B. T., 0J
Wu, Lixiang, 11
Xu, Xiangdong, 11
Yamamoto, Kazuya, 1A
Yamamoto, Takeshi, 1A
Yamamura, T., 0J
Yang, Jilin, 1F
Zaverton, Melissa, 15, 1F
Zeitner, U. D., 0X
Zhang, Hualiang, 0V
Zhao, Xin, 0Q
Zheng, Yanchang, 11, 18
Zhou, Guangya, 05

Conference Committee

Symposium Chairs

David L. Andrews, University of East Anglia
(United Kingdom)
Alexei L. Glebov, OptiGrate Corporation (United States)

Symposium Co-chairs

Jean-Emmanuel Broquin, IMEP-LAHC (France)
Shibin Jiang, AdValue Photonics, Inc. (United States)

Program Track Chairs

Holger Becker, microfluidic ChipShop GmbH (Germany)
Winston V. Schoenfeld, CREOL, The College of Optics and Photonics,
University of Central Florida (United States)

Conference Chairs

Georg von Freymann, Technische Universität Kaiserslautern
(Germany)
Winston V. Schoenfeld, CREOL, The College of Optics and Photonics,
University of Central Florida (United States)
Raymond C. Rumpf, The University of Texas at El Paso (United States)

Conference Program Committee

Cornelia Denz, Westfälische Wilhelms-Universität Münster (Germany)
Ruth Houbertz, Multiphoton Optics GmbH (Germany)
Saulius Juodkazis, Swinburne University of Technology (Australia)
Stephen M. Kuebler, CREOL, The College of Optics and Photonics,
University of Central Florida (United States)
Akhlesh Lakhtakia, The Pennsylvania State University (United States)
Robert R. McLeod, University of Colorado at Boulder (United States)
Hernán R. Míguez, Institute of Materials Science of Seville (Spain)
Dennis W. Prather, University of Delaware (United States)
Aaron J. Pung, Clemson University (United States)
John A. Rogers, University of Illinois at Urbana-Champaign
(United States)
Thomas J. Suleski, The University of North Carolina at Charlotte
(United States)
Michael Thiel, Nanoscribe GmbH (Germany)

Session Chairs

- 1 3D Direct Laser Writing I
Stephen M. Kuebler, CREOL, The College of Optics and Photonics,
University of Central Florida (United States)
- 2 3D Direct Laser Writing II
Ruth Houbertz, Multiphoton Optics GmbH (Germany)
- 3 3D Structures
Ruth Houbertz, Multiphoton Optics GmbH (Germany)
- 4 Light Harvesting
Björn M. Reinhard, Boston University (United States)
- 5 Plasmonics and Metamaterials I
Debashis Chanda, University of Central Florida (United States)
- 6 Plasmonics and Metamaterials II
Georg von Freymann, Technische Universität Kaiserslautern
(Germany)
- 7 Advanced Manufacturing using a DMD or other SLM: Joint Session
with Conferences 9374 and 9376
Philip S. King, Texas Instruments Inc. (United States)
Cornelia Denz, Westfälische Wilhelms-Universität Münster (Germany)
- 8 Structured Light Applications: Metrology and 3D Machine Vision:
Joint Session with Conferences 9374 and 9376
Roland Höfling, ViALUX GmbH (Germany)
Michael R. Douglass, Texas Instruments Inc. (United States)
- 9 Diffractive Optical Elements I
Winston V. Schoenfeld, CREOL, The College of Optics and Photonics,
University of Central Florida (United States)
- 10 Diffractive Optical Elements II
Casey M. Schwarz, University of Central Florida (United States)
- 11 Microoptical Elements
Casey M. Schwarz, University of Central Florida (United States)