

PROCEEDINGS OF SPIE

SPIEDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 8249

, "Front Matter: Volume 8249," Proc. SPIE 8249, Advanced Fabrication Technologies for Micro/Nano Optics and Photonics V, 824901 (21 March 2012); doi: 10.1117/12.928109

SPIE.

Event: SPIE MOEMS-MEMS, 2012, San Francisco, California, United States

PROCEEDINGS OF SPIE

Advanced Fabrication Technologies for Micro/Nano Optics and Photonics V

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

24–25 January 2012
San Francisco, California, United States

Sponsored by
SPIE

Cosponsored by
Dyoptika (Ireland)
VUZIX Corporation (United States)

Published by
SPIE

Volume 8249

Proceedings of SPIE, 0277-786X, v. 8249

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

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 V*, edited by Winston V. Schoenfeld, Raymond C. Rumpf, Georg von Freymann, Proceedings of SPIE Vol. 8249 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN 0277-786X
ISBN 9780819488923

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 © 2012, 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/12/\$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 *Powering the wireless world with MEMS (Plenary Paper) [8248-102]*
S. B. Schaevitz, Lilliputian Systems, Inc. (United States)
- xxvii *New optical, acoustic, and electrical diagnostics for the developing world (Plenary Paper) [8251-103]*
S. L. Neale, C. Witte, Y. Bourquin, C. Kremer, A. Menachery, Y. Zhang, R. Wilson, J. Reboud, J. M. Cooper, Univ. of Glasgow (United Kingdom)

SESSION 1 STED LITHOGRAPHY FOCUS SESSION

- 8249 02 **Elucidating the kinetics and mechanism of RAPID lithography (Invited Paper) [8249-01]**
M. P. Stocker, J. T. Fourkas, Univ. of Maryland, College Park (United States)
- 8249 04 **Materials development for photo-inhibited super-resolution (PINSR) lithography [8249-03]**
D. L. Forman, Univ. of Colorado at Boulder (United States); G. L. Heuvelman, Heidelberg Instruments Mikrotechnik GmbH (Germany); R. R. McLeod, Univ. of Colorado at Boulder (United States)

SESSION 2 LASER-BASED FABRICATION I

- 8249 0A **Synthesis of super-dense phase of aluminum under extreme pressure and temperature conditions created by femtosecond laser pulses in sapphire (Invited Paper) [8249-09]**
V. Mizeikis, Shizuoka Univ. (Japan); A. Vailionis, Stanford Univ. (United States) and SLAC National Accelerator Lab. (United States); E. G. Gamaly, The Australian National Univ. (Australia); W. Yang, Carnegie Institution (United States) and Argonne National Lab. (United States); A. V. Rode, The Australian National Univ. (Australia); S. Juodkazis, Swinburne Univ. of Technology (Australia)
- 8249 0B **Effect of configuration of the microchannels fabricated by femtosecond laser micromachining on topological defects in confined liquid crystals [8249-10]**
K. C. Vishnubhatla, Politecnico di Milano (Italy); R. Osellame, G. Cerullo, Istituto di Fotonica e Nanotecnologie, CNR, Politecnico di Milano (Italy); F. Serra, R. Cerbino, M. Buscaglia, T. Bellini, Univ. degli Studi di Milano (Italy)

SESSION 3 MICRO AND NANO OPTICS

- 8249 0C **High precision fabrication of polarization insensitive resonant grating filters [8249-11]**
R. R. Boye, D. W. Peters, J. R. Wendt, S. Samora, J. Stevens, R. J. Shul, J. Hunker, R. A. Kellogg, S. A. Kemme, Sandia National Labs. (United States)

- 8249 0D **Monolithic fabrication and performance control of multilayered, polarization sensitive, guided-mode resonance filters** [8249-12]
M. K. Poutous, The Univ. of North Carolina at Charlotte (United States); I. Raghu Srimathi, E. G. Johnson, Clemson Univ. (United States)
- 8249 0E **Ultrafast diffractive optical micro-trap arrays for neutral atom quantum computing** [8249-13]
S. A. Kemme, G. R. Brady, A. R. Ellis, J. R. Wendt, D. W. Peters, G. W. Biedermann, T. R. Carter, S. Samora, Sandia National Labs. (United States); J. A. Isaacs, V. V. Ivanov, M. Saffman, Univ. of Wisconsin-Madison (United States)
- 8249 0F **Fabrication of optically monolithic, low-index guided mode resonance filters** [8249-14]
A. J. Pung, M. K. Poutous, Clemson Univ. (United States); R. C. Rumpf, The Univ. of Texas at El Paso (United States); Z. A. Roth, The Univ. of North Carolina at Charlotte (United States); E. G. Johnson, Clemson Univ. (United States)
- 8249 0G **HSQ resist for replication stamp in polymers** [8249-15]
M. R. Saleem, Univ. of Eastern Finland (Finland) and National Univ. of Sciences and Technology (Pakistan); P. A. Stenberg, Univ. of Eastern Finland (Finland); M. B. Khan, Z. M. Khan, National Univ. of Sciences and Technology (Pakistan); S. Honkanen, Univ. of Eastern Finland (Finland) and Aalto Univ. (Finland); J. Turunen, Univ. of Eastern Finland (Finland)
- 8249 0H **Spatially and spectrally varying guided mode resonant filter by modifying the waveguide layer** [8249-16]
Z. A. Roth, The Univ. of North Carolina at Charlotte (United States); M. K. Poutous, E. G. Johnson, Clemson Univ. (United States)

SESSION 4 3D LITHOGRAPHY

- 8249 0K **Thermal and optical properties of sol-gel and SU-8 resists** [8249-19]
T. Suzuki, Perkin Elmer Japan Co., Ltd. (Japan); J. Morikawa, T. Hashimoto, Tokyo Institute of Technology (Japan); R. Buividas, G. Gervinskas, Swinburne Univ. of Technology (Australia); D. Paipulas, M. Malinauskas, Vilnius Univ. (Lithuania); V. Mizeikis, Shizuoka Univ. (Japan); S. Juodkazis, Swinburne Univ. of Technology (Australia) and Melbourne Ctr. for Nanofabrication (Australia)
- 8249 0L **3D microstructures fabricated by prism-assisted inclined UV lithography** [8249-20]
G. Jiang, S. Baig, M. R. Wang, Univ. of Miami (United States)
- 8249 0M **Active and adaptive optical methods for rapid fabrication of 3D photonic structures** [8249-21]
P. Salter, R. Simmonds, M. J. Booth, Univ. of Oxford (United Kingdom)
- 8249 0N **Material processing with 12 femtosecond picojoule laser pulses** [8249-22]
K. König, M. Licht, M. Straub, A. Uchugonova, Univ. des Saarlandes (Germany)

SESSION 5 ADVANCED LITHOGRAPHY I

- 8249 0O **Rolling mask nanolithography: the pathway to large area and low cost nanofabrication (Invited Paper) [8249-23]**
B. Kobrin, E. S. Barnard, M. L. Brongersma, Rolith, Inc. (United States); M. K. Kwak, L. J. Guo, Univ. of Michigan (United States)
- 8249 0P **Fabrication of eight-channel array single-mode waveguides via vacuum assisted microfluidics [8249-24]**
S. Baig, G. Jiang, Univ. of Miami (United States); Q. Sun, New Span Opto-Technology Inc. (United States); M. R. Wang, Univ. of Miami (United States)
- 8249 0Q **Submicrometer pattern generation by diffractive mask-aligner lithography [8249-25]**
U. D. Zeitner, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer Institute of Applied Optics and Precision Engineering (Germany); L. Stuerzebecher, Friedrich-Schiller-Univ. Jena (Germany); T. Harzendorf, F. Fuchs, D. Michaelis, Fraunhofer Institute of Applied Optics and Precision Engineering (Germany)
- 8249 0R **Wafer scale fabrication of submicron chessboard gratings using phase masks in proximity lithography [8249-26]**
L. Stuerzebecher, Friedrich-Schiller-Univ. Jena (Germany); T. Harzendorf, F. Fuchs, Fraunhofer Institute of Applied Optics and Precision Engineering (Germany); U. D. Zeitner, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer Institute of Applied Optics and Precision Engineering (Germany)

SESSION 6 PHOTONIC DEVICE FABRICATION

- 8249 0T **Tuning of random rough surface statistics for optoelectronics [8249-28]**
V. Brissonneau, Thales Optronique S.A. (France) and Institut Matériaux Microélectronique Nanosciences de Provence, Aix Marseille Univ. (France); L. Escoubas, Institut Matériaux Microélectronique Nanosciences de Provence, Aix Marseille Univ. (France); F. Flory, Institut Matériaux Microélectronique Nanosciences de Provence, Ecole Centrale Marseille (France); G. Berginc, Thales Optronique S.A. (France); J.-J. Simon, Institut Matériaux Microélectronique Nanosciences de Provence, Aix Marseille Univ. (France)
- 8249 0U **High precision geometrical characterization and alignment of miniaturized optics [8249-29]**
P. Langehanenberg, J. Heinisch, E. Dumitrescu, TRIOPTICS GmbH (Germany)
- 8249 0V **Gallium-nitride-based logpile photonic crystals for visible lighting [8249-57]**
G. Subramania, Sandia National Labs. (United States) and Univ. of New Mexico (United States); Q. Li, Sandia National Labs. (United States); Y.-J. Lee, Univ. of Texas at Dallas (United States); J. J. Figiel, C. A. Sanchez, G. T. Wang, A. J. Fischer, Sandia National Labs. (United States); R. Biswas, Iowa State Univ. (United States)
- 8249 0W **Programmed resist sidewall profiles using subresolution binary grayscale masks for Si-photonics applications (MOEMS-MEMS Best Paper Award) [8249-31]**
O. Gan, Micron Semiconductor Israel Ltd. (Israel); P. Allen, Toppan Photomasks, Inc. (United States); A. Barkai, Micron Semiconductor Israel Ltd. (Israel); P. Buck, Toppan Photomasks, Inc. (United States); B. Connolly, Toppan Photomasks Germany GmbH (Germany); H. Frish, Micron Semiconductor Israel Ltd. (Israel); M. Pindo, Toppan Photomasks (France) SA (France)

SESSION 7 LASER-BASED FABRICATION II

- 8249 10 **Hybrid optics for three-dimensional microstructuring of polymers via direct laser writing** [8249-35]
F. Burmeister, U. D. Zeitner, S. Nolte, A. Tünnermann, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer Institute of Applied Optics and Precision Engineering (Germany)
- 8249 12 **Generating high DOF light by using tapered hollow tube in a lithography system** [8249-37]
C.-Y. Chen, Y.-H. Lee, C.-J. Chien, Y.-Y. Yu, National Taiwan Univ. (Taiwan); C.-K. Lee, National Taiwan Univ. (Taiwan) and Institute for Information Industry (Taiwan)

SESSION 8 ADVANCED LITHOGRAPHY II

- 8249 14 **Magnetostatic response of 3D metallic traces created using dynamic membrane projection lithography (Invited Paper)** [8249-39]
D. B. Burckel, Sandia National Labs. (United States)
- 8249 15 **Fabrication of large arrays of plasmonic nanostructures via double casting** [8249-40]
J. C. Lo, Sandia National Labs. (United States) and Univ. of California, Davis (United States); D. A. Horsley, Univ. of California, Davis (United States); J. L. Skinner, Sandia National Labs. (United States)
- 8249 16 **Radio frequency plasma pre-treatment for selective electroless Ag coating of three-dimensional SU-8 microstructures** [8249-41]
A. A. Bettoli, Y. Yan, National Univ. of Singapore (Singapore); E. J. Teo, H. Tanoto, J. Teng, A*STAR Institute of Materials Research and Engineering (Singapore)
- 8249 17 **Exposure controlled projection lithography for microlens fabrication** [8249-42]
A. S. Jariwala, Georgia Institute of Technology (United States) and AlpZhi, Inc. (United States); R. E. Schwerzel, AlpZhi, Inc. (United States); H. A. Nikoue, D. W. Rosen, Georgia Institute of Technology (United States)
- 8249 18 **Optical microcavities fabricated using direct proton beam writing** [8249-43]
S. Kumar Vanga, National Univ. of Singapore (Singapore); S. Prashant Turaga, E. J. Teo, A*STAR Institute of Materials Research and Engineering (Singapore); A. Bettoli, National Univ. of Singapore (Singapore)

POSTER SESSION

- 8249 19 **Monitoring of the formation of a photosensitive device by electric breakdown of an impurity containing oxide in a MOS capacitor** [8249-30]
R. Di Giacomo, Univ. degli Studi di Salerno (Italy); G. Landi, Fern Univ. GHS Hagen (Germany); C. Boit, Technische Univ. Berlin (Germany); H. C. Neitzert, Univ. degli Studi di Salerno (Italy)
- 8249 1A **Use of ALD thin film Bragg mirror stacks in tuneable visible light MEMS Fabry-Perot interferometers** [8249-44]
A. Rissanen, R. L. Puurunen, VTT Technical Research Ctr. of Finland (Finland)

- 8249 1B **Optical characterization of subwavelength-scale solid immersion lenses** [8249-45]
M.-S. Kim, T. Scharf, Ecole Polytechnique Fédérale de Lausanne (Switzerland); M. T. Haq, W. Nakagawa, Montana State Univ. (United States); H. P. Herzog, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 8249 1C **Performance evaluation of direct laser lithography system for rotationally symmetric diffractive optical elements** [8249-46]
D.-I. Kim, Korea Basic Science Institute (Korea, Republic of); H.-G. Rhee, Korea Research Institute of Standards and Science (Korea, Republic of); G. H. Kim, Korea Basic Science Institute (Korea, Republic of)
- 8249 1D **Energy-dependent temperature dynamics in femtosecond laser microprocessing clarified by Raman temperature measurement** [8249-47]
T. Yoshino, M. Matsumoto, Y. Ozeki, K. Itoh, Osaka Univ. (Japan)
- 8249 1E **Effect of reactive monomer on PS-b-P2VP film with UV irradiation** [8249-48]
H. J. Kim, D. M. Shin, Hongik Univ. (Korea, Republic of)
- 8249 1G **Effects of electric fields on the photonic crystal formation from block copolymers** [8249-50]
T. Lee, J. Ju, W. Ryoo, Hongik Univ. (Korea, Republic of)
- 8249 1I **Plasmon-enhanced optical photodiodes based on MEH-PPV polymer and fullerene blend on ITO** [8249-52]
F. Semendy, P. Wijewarnasuriya, U.S. Army Research Lab. (United States); G. Meissner, General Technical Services (United States)
- 8249 1K **Using a dwell-time increase to compensate for SLM pixelation-limited diffraction efficiency in DMHL** [8249-54]
D. R. McAdams, D. G. Cole, Univ. of Pittsburgh (United States)
- 8249 1M **Photoresist roughness characterization in additive lithography processes for the fabrication of phase-only optical vortices** [8249-56]
Z. Hosseinimakarem, M. K. Poutous, The Univ. of North Carolina at Charlotte (United States); E. G. Johnson, Clemson Univ. (United States)

Author Index

Conference Committee

Symposium Chair

Harald Schenk, Fraunhofer Institute for Photonic Microsystems
(Germany)

Symposium Cochair

David L. Dickensheets, Montana State University (United States)

Conference Chairs

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)
Georg von Freymann, Technische Universität Kaiserslautern (Germany)

Program Committee

Stefano Cabrini, Lawrence Berkeley National Laboratory (United States)
Aaron R. Hawkins, Brigham Young University (United States)
Babak Heidari, OBDUCAT AB (Sweden)
Saulius Juodkazis, Swinburne University of Technology (Australia)
Shanaly A. Kemme, Sandia National Laboratories (United States)
Ernst-Bernhard Kley, Friedrich-Schiller-Universität Jena (Germany)
Stephen M. Kuebler, CREOL, The College of Optics and Photonics,
University of Central Florida (United States)
Dwayne L. LaBrake, Molecular Imprints, Inc. (United States)
Akhlesh Lakhtakia, The Pennsylvania State University (United States)
Uriel Levy, The Hebrew University of Jerusalem (Israel)
Wen Liu, Accelink Technologies Company, Ltd. (China)
Marko Loncar, Harvard University (United States)
Robert R. McLeod, University of Colorado at Boulder (United States)
Yosuke Mizuyama, Panasonic Boston Laboratory (United States)
Patrick P. Naulleau, Lawrence Berkeley National Laboratory
(United States)
Mahesh Pitchumani, Ostendo Technologies, Inc. (United States)
Menelaos K. Poutous, The University of North Carolina at Charlotte
(United States)
Dennis W. Prather, University of Delaware (United States)
John A. Rogers, University of Illinois at Urbana-Champaign
(United States)
Pradeep Srinivasan, Intel Corporation (United States)

Thomas J. Suleski, The University of North Carolina at Charlotte
(United States)

Jian Jim Wang, OmniPV Inc. (United States)

Michael P. Watts, Impattern Solutions (United States)

Session Chairs

- 1 STED Lithography Focus Session
Georg von Freymann, Technische Universität Kaiserslautern (Germany)
- 2 Laser-Based Fabrication I
John T. Fourkas, University of Maryland, College Park (United States)
- 3 Micro and Nano Optics
Thomas J. Suleski, The University of North Carolina at Charlotte
(United States)
- 4 3D Lithography
Menelaos K. Poutous, The University of North Carolina at Charlotte
(United States)
- 5 Advanced Lithography I
Raymond C. Rumpf, The University of Texas at El Paso (United States)
- 6 Photonic Device Fabrication
Winston V. Schoenfeld, CREOL, The College of Optics and Photonics,
University of Central Florida (United States)
- 7 Laser-Based Fabrication II
Vygantas Mizeikis, Shizuoka University (Japan)
- 8 Advanced Lithography II
Pradeep Srinivasan, Intel Corporation (United States)