

PROCEEDINGS OF SPIE

Micromachining and Microfabrication Process Technology XV

**Mary Ann Maher
Jung-Chih Chiao
Paul J. Resnick**
Editors

**26 January 2010
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 7590

Proceedings of SPIE, 0277-786X, v. 7590

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 *Micromachining and Microfabrication Process Technology XV*, edited by Mary Ann Maher, Jung-Chih Chiao, Paul J. Resnick, Proceedings of SPIE Vol. 7590 (SPIE, Bellingham, WA, 2010) Article CID Number.

ISSN 0277-786X

ISBN 9780819479860

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 © 2010, 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/10/\$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 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 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

- vii Conference Committee
- ix *Emerging research in micro and nano systems: opportunities and challenges for societal impact (Plenary Paper) [7593-201]*
Y. B. Gianchandani, Univ. of Michigan (United States)
- xvii *MEMS technologies for artificial retinas (Plenary Paper) [7594-202]*
W. Mokwa, RWTH Aachen Univ. (Germany)
- xxi *Shaping light: MOEMS deformable mirrors for microscopes and telescopes (Plenary Paper) [7595-203]*
T. Bifano, Boston Univ. Photonics Ctr. (United States)

SESSION 1 LASERS AND LASER-BASED PROCESSING

- 7590 02 **Ultrafast pulsed laser micro-deposition printing on transparent media [7590-01]**
B. Liu, Z. Hu, Y. Che, IMRA America, Inc. (United States)
- 7590 03 **Coaxial real-time metrology and gas assisted laser micromachining: process development, stochastic behavior, and feedback control [7590-02]**
P. J. L. Webster, B. Y. C. Leung, J. X. Z. Yu, M. D. Anderson, Queen's Univ. (Canada); T. P. Hoult, IPG Photonics Corp. (United States); J. M. Fraser, Queen's Univ. (Canada)
- 7590 04 **Sub-micron machining of semiconductors: femtosecond surface ripples on GaAs by 2 μ m laser light [7590-03]**
M. Ramme, J. Choi, T. Anderson, I. Mingareev, M. Richardson, The College of Optics and Photonics, Univ. of Central Florida (United States)
- 7590 06 **Polarization converted laser beams for micromachining applications [7590-05]**
U. Klug, J. F. Düsing, Laser Zentrum Hannover e.V. (Germany); T. Sato, Photonic Lattice, Inc. (Japan); K. Washio, Paradigm Laser Research Ltd. (Japan); R. Kling, Laser Zentrum Hannover e.V. (Germany)
- 7590 07 **Enhancing laser scanner accuracy by grid correction [7590-06]**
R.-J. Halme, T. Kumpulainen, R. Tuokko, Tampere Univ. of Technology (Finland)

SESSION 2 DEVICE PROCESSING

- 7590 09 **Multilayer metal micromachining for THz waveguide fabrication [7590-08]**
A. Rowen, A. E. Hollowell, M. Wanke, C. D. Nordquist, Sandia National Labs. (United States); C. Arrington, LMATA Government Services, LLC (United States); R. Gillen, J. J. Coleman, Sandia National Labs. (United States)

- 7590 0A **Fabrication of plastic microlens arrays for array microscopy by diamond milling techniques** [7590-09]
B. McCall, Rice Univ. (United States); G. Birch, M. Descour, College of Optical Sciences, The Univ. of Arizona (United States); T. Tkaczyk, Rice Univ. (United States)
- 7590 0B **Diamond turning of aspheric steel molds for optics replication** [7590-10]
F. Klocke, O. Dambon, B. Bulla, Fraunhofer Institute for Production Technology (Germany)
- 7590 0D **Alternative technology for fabrication of nano- or microstructured mould inserts used for optical components** [7590-12]
M. Wissmann, M. Guttman, M. Hartmann, Karlsruhe Institute of Technology (Germany)
- 7590 0E **Development of micro-incandescent light sources on silicon substrate** [7590-13]
A. H. Gollub, D. O. Carvalho, G. Rehder, M. I. Alayo, Univ. de São Paulo (Brazil)

SESSION 3 PROCESSING, METROLOGY, COATINGS

- 7590 0F **Optimizing galvanic pulse plating parameters to improve indium bump to bump bonding** [7590-14]
J. J. Coleman, A. Rowen, S. S. Mani, W. G. Yelton, C. Arrington, R. Gillen, A. E. Hollowell, Sandia National Labs. (United States); D. Okerlund, A. Ionescu, DRS Technologies, Inc. (United States)
- 7590 0G **Advances in photonic MOEMS-MEMS device thinning and polishing** [7590-15]
J. J. McAneny, M. Kennedy, T. McGrogan, Logitech Ltd. (United Kingdom)
- 7590 0I **Kinetic investigations on TiO₂ nanoparticles as photo initiators for UV-polymerization in acrylic matrix** [7590-17]
C. Becker-Willing, S. Schmitz-Stöwe, D. Bentz, M. Veith, Leibniz Institute for New Materials (Germany)
- 7590 0J **Investigation on particle generation by micro-electro discharge machining** [7590-18]
S. Mitra, Muralidhara, V. N. J., S. M., Indian Institute of Technology Madras (India)
- 7590 0K **Estimation of tool wear compensation during micro-electro-discharge machining of silicon using process simulation** [7590-19]
Muralidhara, V. N. J., S. M., Indian Institute of Technology Madras (India)

POSTER SESSION

- 7590 0L **Alternative method for steam generation for thermal oxidation of silicon** [7590-20]
J. J. Spiegelman, RASIRC (United States)
- 7590 0M **Manufacturability of gas sensor with ZnO nanoparticles suspension deposited by ink jet printing** [7590-21]
V. Conedera, P. Yoboue, F. Mesnilgrente, N. Fabre, P. Menini, CNRS-LAAS (France) and Univ. de Toulouse (France)

- 7590 0N **Electrode micropatterning by microcontact printing method to large area substrates using nickel mold** [7590-22]
A. Takakuwa, Japan Chemical Innovation Institute (Japan) and Seiko Epson Corp. (Japan);
T. Shibuya, Japan Chemical Innovation Institute (Japan) and Ricoh Co., Ltd. (Japan);
K. Yase, National Institute of Advanced Industrial Science and Technology (Japan)
- 7590 0O **Laser microstructuring of sapphire wafer and fiber** [7590-23]
Y. Dai, G. Xu, J. Cui, F. Bai, Wuhan Univ. of Technology (China)

Author Index

Conference Committee

Symposium Chair

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

Symposium Cochair

Harald Schenk, Fraunhofer Institute for Photonic Microsystems
(Germany)

Conference Chairs

Mary Ann Maher, SoftMEMS (United States)
Jung-Chih Chiao, The University of Texas at Arlington (United States)
Paul J. Resnick, Sandia National Laboratories (United States)

Program Committee

Mu Chiao, The University of British Columbia (Canada)
Debabani Choudhury, HRL Laboratories, LLC (United States)
Sanjay Krishna, The University of New Mexico (United States)
Tamal Mukherjee, Carnegie Mellon University (United States)
Metin Ozen, Ozen Engineering, Inc. (United States)
Yu-Chuan Su, National Tsing Hua University (Taiwan)
T. C. Yih, Oakland University (United States)
Nan Zhang, General MEMS Corporation (United States)

Session Chairs

- 1 Lasers and Laser-Based Processing
Mary Ann Maher, SoftMEMS (United States)
- 2 Device Processing
Mary Ann Maher, SoftMEMS (United States)
- 3 Processing, Metrology, Coatings
Mary Ann Maher, SoftMEMS (United States)

