

PROCEEDINGS OF SPIE

***Novel Patterning Technologies
for Semiconductors, MEMS/NEMS
and MOEMS 2020***

Martha I. Sanchez
Eric M. Panning
Editors

24–27 February 2020
San Jose, California, United States

Sponsored and Published by
SPIE

Volume 11324

Proceedings of SPIE 0277-786X, V. 11324

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

The papers 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. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIDigitalLibrary.org.

The papers 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 these proceedings:

Author(s), "Title of Paper," in *Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020*, edited by Martha I. Sanchez, Eric M. Panning, Proceedings of SPIE Vol. 11324 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510634152

ISBN: 9781510634169 (electronic)

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 © 2020, 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 \$21.00 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/20/\$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

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

SPIE. DIGITAL LIBRARY

SPIDigitalLibrary.org

Paper Numbering: *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of 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 and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five 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.

Contents

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

IMPRINT LITHOGRAPHY

11324 05	Lithography today: challenges and solutions across a diverse market (Invited Paper) [11324-3]
----------	--

SCANNING PROBE LITHOGRAPHY

11324 0A	Tip- and laser-based nanofabrication up to 100 mm with sub-nanometre precision [11324-8]
----------	---

NANOIMPRINT LITHOGRAPHY FOR SEMICONDUCTORS

11324 0B	Nanoimprint system alignment and overlay improvement for high volume semiconductor manufacturing [11324-9]
11324 0C	Addressing nanoimprint lithography mix and match overlay using drop pattern compensation [11324-10]

QUANTUM COMPUTING

11324 0J	Quantum Inspire: QuTech's platform for co-development and collaboration in quantum computing [11324-17]
----------	--

MULTI-BEAM MASK WRITING

11324 0K	Development and deployment of advanced multi-beam mask writer (Invited Paper) [11324-18]
11324 0N	Extending deep-UV multi-beam laser writing for optical and EUV masks [11324-21]

3-D PRINTING

11324 OT **Development of bovine serum albumin-based resins for additive manufacturing via vat photopolymerization (Invited Paper)** [11324-27]

NEUROMORPHIC COMPUTING

11324 OV **Highly efficient neuromorphic computing systems with emerging nonvolatile memories (Invited Paper)** [11324-29]

11324 OW **An introduction to SemiSynBio Initiative and selected convergence results (Invited Paper)** [11324-30]

ATOMICALLY PRECISE LITHOGRAPHY: TOPDOWN APPROACH

11324 OX **Atomically precise digital e-beam lithography (Invited Paper)** [11324-31]

11324 OY **A new approach to removing H atoms in hydrogen depassivation lithography (Invited Paper)** [11324-32]

11324 OZ **Photothermal alternative to device fabrication using atomic precision advanced manufacturing techniques (Invited Paper)** [11324-33]

ATOMICALLY PRECISE LITHOGRAPHY: BOTTOMUP APPROACH

11324 12 **Selective electroless plating on non-conductive materials by applying a gradient of magnetic field** [11324-36]

MEMS/NEMS

11324 14 **Nonlinear mode coupling in a MEMS resonator (Invited Paper)** [11324-37]

11324 16 **Design and fabrication of microlens array homogenizer for laser beam shaping using two-photon polymerization** [11324-39]

NOVEL PATTERNING AND APPLICATIONS

11324 17 **Sub-wavelength holographic lithography (SWHL) (Invited Paper)** [11324-40]

POSTER SESSION

- 11324 1A **Contribution ratio of process fidelity and beam accuracy in multi-beam mask writing**
[11324-42]
- 11324 1B **Electron beam mask writer EBM-8000P for high throughput mask production** [11324-43]
- 11324 1I **Mathematical problems of holographic mask synthesis** [11324-50]
- 11324 1J **Experimental verification of sub-wavelength holographic lithography (SWHL) concept**
[11324-51]
- 11324 1K **Maskless holographic schemes based on phase micromirror SLMs** [11324-52]