

PROCEEDINGS OF SPIE

***Advanced Fabrication  
Technologies for Micro/Nano  
Optics and Photonics XII***

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

**3–5 February 2019  
San Francisco, California, United States**

*Sponsored by*  
SPIE

*Cosponsored by*  
Nanoscribe GmbH (Germany)

*Published by*  
SPIE

**Volume 10930**

Proceedings of SPIE 0277-786X, V. 10930

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 SPIEDigitalLibrary.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 *Advanced Fabrication Technologies for Micro/Nano Optics and Photonics XII*, edited by Georg von Freymann, Winston V. Schoenfeld, Raymond C. Rumpf, Proceedings of SPIE Vol. 10930 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510625020

ISBN: 9781510625037 (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 © 2019, 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](http://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/19/\$18.00.

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**

[SPIEDigitalLibrary.org](http://SPIEDigitalLibrary.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

v *Authors*  
vii *Conference Committee*

---

## NOVEL FABRICATION APPROACHES

---

10930 05 **Refinements in membrane projection lithography: a route to fabrication of 3D metamaterials (Invited Paper)** [10930-4]

---

## LARGE AREA FABRICATION

---

10930 0C **Inkjet printing of microlens arrays on large, lithographic structured substrates (Best Paper Award)** [10930-11]

---

## APPLICATIONS FOR DLW

---

10930 0E **Immersion of nanodiamonds into three-dimensional direct-laser-written waveguides** [10930-13]

10930 0G **Characterization of latent three-dimensional exposure patterns in photoresists** [10930-15]

10930 0H **Additive manufacturing of titanium dioxide for dielectric photonic crystals** [10930-16]

---

## PHASE MASKS, PHANTOMS, AND STANDARDS

---

10930 0L **Laser-microfabrication with accurate positioning and metrological traceability** [10930-20]

---

## NEW TECHNOLOGIES IN DLW: JOINT SESSION WITH 10909 AND 10930

---

10930 0V **Stitchless 3D printing of free-form functional mesoscale structures with resolution on-demand** [10930-31]

10930 0W **Super-fine inkjet process for alignment-free integration of non-transparent structures into 3D-printed micro-optics (Best Student Paper Award)** [10930-32]

**HIGH-THROUGHPUT FABRICATION USING A DMD OR OTHER SLM DEVICE: JOINT SESSION WITH 10930 AND 10932**

---

10930 0Z      **Measurement and use of the refractive index distribution in optical elements created by additive manufacturing [10930-35]**

**ADDITIVE MANUFACTURING USING DMD OR OTHER SLM DEVICE: JOINT SESSION WITH 10930 AND 10932**

---

10930 11      **Holographic fabrication of graded photonic super-crystals through pixel-by-pixel phase coding of laser beams in a spatial light modulator [10930-37]**

**POSTER SESSION**

---

10930 12      **Towards inverse design of biomimetic nanostructures exhibiting composite structural coloration [10930-28]**

10930 13      **Nano-fabrication and characterization of non-uniform surface relief gratings in azobenzene molecular glass films [10930-38]**

10930 15      **Comparative study between wet and dry etching of silicon for microchannels fabrication [10930-40]**

10930 17      **A combined laser scanning and DLW tool for measuring and fabrication tasks with NPMM [10930-42]**

10930 1B      **Demonstration of alignment error-free patterning of tapered waveguide using fixed beam moving stage e-beam lithography [10930-46]**

10930 1C      **Are photonic nanojets achromatic? [10930-47]**