

PROCEEDINGS OF SPIE

# ***Novel Patterning Technologies 2026***

**Ricardo Ruiz**  
**Richard A. Farrell**  
*Editors*

**23–26 February 2026**  
**San Jose, California, United States**

*Sponsored and Published by*  
SPIE

**Volume 13982**

Proceedings of SPIE 0277-786X, V. 13982

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](http://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 *Novel Patterning Technologies 2026*, edited by Ricardo Ruiz, Richard A. Farrell, Proc. of SPIE 13982, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510699106

ISBN: 9781510699113 (electronic)

Published by

**SPIE**

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time)

[SPIE.org](http://SPIE.org)

Copyright © 2026 Society of Photo-Optical Instrumentation Engineers (SPIE).

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 fees. To obtain permission to use and share articles in this volume, visit Copyright Clearance Center 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.

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:** A unique citation identifier (CID) number is assigned to each article in the Proceedings of SPIE 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 *Conference Committee*

---

## SCANNING PROBE/TIP-BASED LITHOGRAPHY

---

- 13982 02 **Scanning probe lithography-based mix-and-match technique as an enabling tool for the pilot production of nanowire-based next-generation electromechanical sensors (Invited Paper)** [13982-4]

---

## NOVEL PATTERNING

---

- 13982 03 **Advanced comparative simulation analysis of displacement Talbot lithography and DUV dry projection lithography for high-resolution periodic patterning** [13982-8]
- 13982 04 **1D, 1.5D, and 2D high-speed spatial light modulators for direct-write lithography** [13982-100]

---

## DIRECTED SELF-ASSEMBLY I

---

- 13982 05 **Integrated patterning of self-aligned trench contacts using directed self-assembly (DSA) (Invited Paper)** [13982-9]
- 13982 06 **High-resolution chemical patterns from negative-tone resists for directed self-assembly: extension to EUV lithography and Al<sub>2</sub>O<sub>3</sub> sacrificial patterns** [13982-12]

---

## ELECTRON MULTIBEAM MASK WRITER

---

- 13982 07 **Enhancing advanced nodes curvilinear patterning via multi e-beam writer (Invited Paper)** [13982-14]
- 13982 08 **MBMW technical requirements for enabling high-NA era mask fabrication (Invited Paper)** [13982-15]
- 13982 09 **EUV mask patterning by using MBMW for memory (Invited Paper)** [13982-16]
- 13982 0A **MBM-4000: advanced features and applications (Invited Paper)** [13982-17]
- 13982 0B **Advances in multibeam mask writing with MBMW-401 (Invited Paper)** [13982-18]

---

#### NANOIMPRINT LITHOGRAPHY I

---

- 13982 0C **Nanoimprint lithography progress in manufacturing and integration (Invited Paper)** [13982-19]
- 13982 0D **NIL process integration toward HP 1X nm generation** [13982-20]
- 13982 0E **Development of spin-coating UV-NIL resist for semiconductor device manufacturing** [13982-22]

---

#### DIRECTED SELF-ASSEMBLY II

---

- 13982 0F **Directed self assembly for advanced nodes: material and process innovations for P24LS (Invited Paper)** [13982-23]

---

#### HETEROGENEOUS INTEGRATION AND ADVANCED PACKAGING I

---

- 13982 0G **High aspect ratio copper pillar structures enabled by digital lithography patterning of thick resists for AI and HPC device packages (Invited Paper)** [13982-28]

---

#### HETEROGENEOUS INTEGRATION AND ADVANCED PACKAGING II

---

- 13982 0H **Advances in single-layer gate and triple-layer gate EUV patterning for 300mm silicon quantum dot spin qubit devices (Invited Paper)** [13982-40]
- 13982 0I **Hybrid patterning of 3D silicon fin capacitors for quantum circuits** [13982-41]
- 13982 0J **Exploration and mitigation of local wafer deformations resulting from direct wafer-to-wafer bonding** [13982-42]

---

#### TWO-PHOTON, MULTICOLOR AND DIRECT WRITE LITHOGRAPHY

---

- 13982 0K **Lithography digitalization in semiconductor technologies through advanced software development of high throughput maskless exposure** [13982-43]

---

#### ELECTRON, ION AND ATOM BEAM LITHOGRAPHY

---

- 13982 0L **Fabrication technology and optical properties of ebeam generated effective index metamaterials for UV-applications (Invited Paper)** [13982-48]
- 13982 0M **Advances in metastable helium (He) atom lithography (Invited Paper)** [13982-76]

---

**POSTER SESSION**

---

- 13982 ON **Introducing thermal scanning probe lithography to the fabrication of semiconductor quantum devices** [13982-50]
- 13982 OO **Seamless line continuation in latent photoresist for customizable micro- and nanofabrication** [13982-51]
- 13982 OP **Dry patterning of positive tone resists via projection-based femtosecond laser ablation (Novel Patterning Technologies Student Award)** [13982-52]
- 13982 OQ **Geometry-induced effects on infiltration process for line edge roughness mitigation of polymeric nanopatterns (Novel Patterning Technologies Student Award)** [13982-54]
- 13982 OR **Direct patterning of phase change materials (PCMs) using the Raith Picomaster-150 laser beam lithography** [13982-55]
- 13982 OS **Integrated fabrication of GaN nanowires on silicon (111) cantilevers for multifunctional scanning probe metrology, lithography, and optical spectroscopy** [13982-56]
- 13982 OT **Unsupervised neural-network proximity correction (NNPC) for large-area chiral metasurface** [13982-57]
- 13982 OU **Patterning sub-10nm lines on silicon using cylindrical block copolymer** [13982-60]
- 13982 OV **Orientation control of 5nm fast self-assembling fluorinated side-chained BCPs** [13982-61]
- 13982 OW **Synthesis and self-assembly behaviour of fluorine-containing polymeric photoacid generator forming sub-10nm micro domains** [13982-62]
- 13982 OX **High aspect ratio processing of high CTE glass using KrF excimer laser** [13982-64]
- 13982 OY **Next-generation digital lithography technology (DLT) for high-volume manufacturing of advanced packaging** [13982-66]
- 13982 OZ **Curvilinear OPC with inverse lithography technology eliminates Manhattan OPC non-convergence under MRC rules** [13982-67]
- 13982 IO **Improving pattern fidelity for DSA line/space structures at 24nm pitch** [13982-72]
- 13982 I1 **Optimization of printed tungsten disulfide (WS<sub>2</sub>) thin films for flexible electronics using inkjet technology** [13982-74]

---

**DIGITAL POSTER SESSION**

---

- 13982 I2 **Wafer-scale maskless process to fabricate sub-20nm silicon nitride nanopores for ultrafiltration** [13982-63]