PROCEEDINGS OF SPIE

Novel Patterning Technologies 2024

J. Alexander Liddle Ricardo Ruiz Editors

26–29 February 2024 San Jose, California, United States

Sponsored and Published by SPIE

Volume 12956

Proceedings of SPIE 0277-786X, V. 12956

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 *Novel Patterning Technologies 2024*, edited by J. Alexander Liddle, Ricardo Ruiz, Proc. of SPIE 12956, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X ISSN: 1996-756X (electronic)

ISBN: 9781510672185 ISBN: 9781510672192 (electronic)

Published by **SPIE** P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) SPIE.org Copyright © 2024 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. 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.



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

	MBMW
12956 02	Multi-beam mask writer MBM-3000 for next generation EUV mask production (Invited Paper) [12956-7]
	NIL I
12956 03	Nanoimprint lithography performance advances for new application spaces (Invited Paper) [12956-10]
12956 04	Optimization of NIL and associated pattern transfer processes for the fabrication of advanced devices [12956-12]
	PACKAGING
12956 05	Enhancing M ² beam quality factor for high power KrF laser for glass micro-via fabrication in advanced packaging [12956-17]
12956 06	Characterization and mitigation of local wafer deformations introduced by direct wafer-to- wafer bonding [12956-19]
	NIL II
12956 07	Novel multi-layer nanoimprint lithography material system enabling nano-patterning of functional optical layers [12956-22]
12956 08	Inkjet coating combined with nanoimprinting for complex 3D patterns with progressive height increase and low residual layer [12956-23]
12956 09	Manufacturing and metrology of 3D holographic structure nanopatterns in roll-to-roll fabrication (Invited Paper) [12956-24]
	OPTICAL
12956 0A	Advanced patterning strategies for maskless laser direct write lithography [12956-28]

12956 OB	Maskless exposure of die annotations and image sensor patterns employing 7th generation RGB resists [12956-120]
	SPL
12956 OC	Atomically precise advanced manufacturing for 2D bipolar devices (Invited Paper) [12956-29]
12956 OD	High-precision nanopositioning and nanomeasuring machines for alternative nanofabrication (Invited Paper) [12956-32]
	AR/VR
12956 OE	lonic liquid mediated directed self-assembly of diblock/triblock copolymer thin films for advanced lithography (Invited Paper) [12956-36]
	DSA
12956 OF	Directed self-assembly: PS-b-PMMA materials readiness and high-chi platforms for extended geometry scaling (Invited Paper) [12956-38]
12956 OG	Material and process optimization for EUV pattern rectification by DSA (Invited Paper) [12956-39]
	NOVEL PATTERNING
12956 OH	Challenges of photomask-based greyscale lithography with a highly-sensitive positive photoresist designed for>100µm deep greyscale patterns [12956-48]
12956 01	Advanced EUV patterning of 2D TMDs for CMOS integration [12956-47]
	POSTER SESSION
12956 OJ	2.5D-patterning via i-line grayscale exposure for photonic structures and micro lens arrays [12956-49]
12956 OK	Fabrication of 3D microstructures by controlled bending of suspended microdisks [12956-50]
12956 OL	Manufacturing of 3D submicronic structures at wafer scale [12956-51]

12956 ON	Impact of e-beam lithography and data preparation optimization on optical performance of integrated photonic waveguides [12956-54]
12956 00	Past progress, current status, and future perspective of digital EUV lithography for high- resolution semiconductor manufacturing [12956-56]
12956 OP	The resolution enhancement lithography assisted by chemical shrink based on KrF lithography technology [12956-57]
12956 OQ	Fabrication process of flexibly patterned grating by interference lithography system with automated beam alignment module [12956-58]
12956 OR	Assessing hybrid polymers as innovative photolithography material allowing advanced high aspect ratio/high resolution patterns for micro-optics and patterned passivation layers [12956-59]
12956 OS	Full-wafer, maskless patterning with sub-50nm resolution and large depth-of-focus enabled by multicolumn electron beam lithography [12956-62]
12956 OT	Patterning processes with thermally decomposable polymers [12956-65]
12956 OU	Studies on resolution with ZEP530A for EUV mask [12956-70]
12956 OW	Open/short-TEG evaluation of 24nm-half-pitch-W damascene interconnects based on nanoimprint lithography [12956-73]
12956 OX	B-spline and Bézier curvilinear representations: a comparative discussion [12956-149]
12956 OY	Al-enhanced optical critical dimension metrology for high aspect ratio structures in semiconductor advanced packaging [12956-18]