

PROCEEDINGS OF SPIE

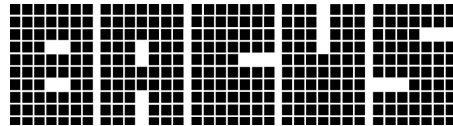
Photomask Technology 2020

Moshe E. Preil

Editor

**21–25 September 2020
Online Only, United States**

Sponsored by



The international technical group of SPIE dedicated
to the advancement of photomask technology

SPIE.

Published by
SPIE

Volume 11518

Proceedings of SPIE 0277-786X, V. 11518

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

Photomask Technology 2020, edited by Moshe E. Preil, Proc. of SPIE Vol. 11518,
1151801 · © 2020 SPIE · CCC code: 0277-786X/20/\$21 · doi: 10.1117/12.2580779

Proc. of SPIE Vol. 11518 1151801-1

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 *Photomask Technology 2020*, edited by Moshe E. Preil, Proceedings of SPIE Vol. 11518 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

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

ISBN: 9781510638433
ISBN: 9781510638440 (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**

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

EUV MASK PROTECTION AND REPAIR: JOINT SESSION WITH CONFERENCES 11517 AND 11518

- 11518 08 **High-end EUV photomask repairs for 5nm technology and beyond** [11518-2]
11518 09 **Laser repair and clean of extreme ultraviolet lithography photomasks** [11518-3]

MASK PROCESS: WRITING AND PROCESSING

- 11518 0B **A novel "high-transmission" phase shift mask for ArF lithographic performance enhancement** [11518-5]
11518 0C **Next generation nanomachining process technologies** [11518-6]

MASK METROLOGY, INSPECTION AND REPAIR

- 11518 0E **2020 mask maker survey conducted by the eBeam initiative (Invited Paper)** [11518-8]
11518 0G **Open-source software for SEM metrology** [11518-10]

COMPUTATIONAL ASPECTS OF MASK MAKING II: MACHINE LEARNING

- 11518 0I **Detecting gaps in deep learning models used for mask process modeling** [11518-13]
11518 0J **The choice of input data and its impact on a deep learning mask model** [11518-14]
11518 0K **Automatic classification of patterned mask defects for requalification at wafer fabs in absence of layout data** [11518-15]
11518 0L **Fast 3D lithography simulation by convolutional neural network: POC study** [11518-16]

COMPUTATIONAL ASPECTS OF MASK MAKING I: MPC, ILT AND DATA MANAGEMENT

- 11518 0O **Design rule optimization for via layers of multiple patterning solution at 7nm technology node** [11518-19]

11518 OR **MRC for curvilinear mask shapes** [11518-22]

NOVEL TECHNOLOGIES

11518 OS **Translating IC-centric photomask manufacturing to photonics-centric applications: Linking photomask processes to photonics waveguide performance (Invited Paper)** [11518-23]

11518 OU **Hybrid E-beam lithography and process improvement for nanodevice fabrication** [11518-25]

11518 OW **Enabling faster VSB writing of 193i curvilinear ILT masks that improve wafer process windows for advanced memory applications** [11518-36]

EUV MASK II: JOINT SESSION WITH CONFERENCES 11517 AND 11518

11518 OY **Stochastic side-lobe printing in EUV lithography: a simulation study** [11518-28]

POSTER SESSION

11518 OZ **Study on physical model of resist surface charge in electron beam mask writer EBM-9500PLUS** [11518-29]

11518 11 **Tip wear improvements in advanced nanomachining** [11518-32]

11518 13 **The mask contribution as part of the intra-field on-product overlay performance** [11518-35]

11518 14 **A deep learning mask analysis toolset using mask SEM digital twins** [11518-37]