

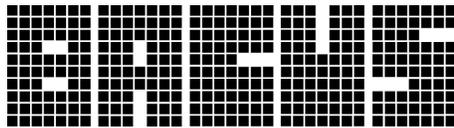
PROCEEDINGS OF SPIE

Photomask Technology 2017

Peter D. Buck
Emily E. Gallagher
Editors

11–14 September 2017
Monterey, California, United States

Sponsored by



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

SPIE.

Published by
SPIE

Volume 10451

Proceedings of SPIE 0277-786X, V. 10451

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

Photomask Technology 2017, edited by Peter D. Buck, Emily E. Gallagher, Proc. of SPIE Vol. 10451,
1045101 · © 2017 SPIE · CCC code: 0277-786X/17/\$18 · doi: 10.1117/12.2293163

Proc. of SPIE Vol. 10451 1045101-1

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 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 *Photomask Technology 2017*, edited by Peter D. Buck, Emily E. Gallagher, Proceedings of SPIE Vol. 10451 (SPIE, Bellingham, WA, 2017) Seven-digit Article CID Number.

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

ISBN: 9781510613768
ISBN: 9781510613775 (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 © 2017, 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. 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/17/\$18.00.

Printed in the United States of America.

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 *Authors*
- xi *Conference Committee*
- xv *Introduction*

KEYNOTE AND INVITED SESSION

- 10451 02 **Extending the era of Moore's Law (Keynote Paper)** [10451-1]
- 10451 03 **2017 mask maker survey conducted by the eBeam Initiative (Invited Paper)** [10451-2]

MASK DATA PREPARATION I

- 10451 04 **Manufacturing challenges for curvilinear masks (Invited Paper)** [10451-3]
- 10451 05 **VSB fracture optimization for mask write time reduction** [10451-5]

MASK DATA PREPARATION II

- 10451 06 **Adopting rigorous verification flow in fabrication of silicon photonic devices** [10451-6]
- 10451 07 **An efficient tool to rewrite a VSB12 format jobdeck for any target VSB12 machine** [10451-7]
- 10451 08 **Full-chip GPU-accelerated curvilinear EUV dose and shape correction** [10451-8]
- 10451 09 **CLMPC: curvilinear MPC in a mask data preparation flow** [10451-9]

MACHINE LEARNING

- 10451 0A **Machine learning for mask/wafer hotspot detection and mask synthesis (Invited Paper)** [10451-10]
- 10451 0C **Impact of feature extraction to accuracy of machine learning based hotspot detection** [10451-12]
- 10451 0D **Machine learning assisted SRAF placement for full chip** [10451-13]

PHOTOMASK JAPAN 2017

- 10451 OG **Fabrication of cylindrical micro-parts using synchronous rotary scan-projection lithography and chemical etching** [10451-15]
- 10451 OH **The capability of measuring cross-sectional profile for hole patterns in nanoimprint templates using small-angle x-ray scattering** [10451-16]

EUV MASK INSPECTION: JOINT SESSION WITH CONFERENCES 10451 AND 10450

- 10451 OJ **Actinic review of EUV masks: challenges and achievements in delivering the perfect mask for EUV production** [10451-18]
- 10451 OK **DUV inspection beyond optical resolution limit for EUV mask of hp 1X nm** [10451-19]
- 10451 OL **EUV reticle print verification with advanced broadband optical wafer inspection and e-Beam review systems** [10451-20]

EUV MASK PELLICLE: JOINT SESSION WITH CONFERENCES 10451 AND 10450

- 10451 OO **Pellicle films supporting the ramp to HVM with EUV** [10451-22]
- 10451 OP **CNT EUV pellicle: moving towards a full-size solution** [10451-23]
- 10451 OQ **Development of EUV pellicle for suppression of contamination, haze, and outgas generation** [10451-24]
- 10451 OR **EUV optical characterization of alternative membrane materials for EUV pellicles** [10451-25]
- 10451 OS **Rigorous simulation of EUV mask pellicle** [10451-26]

STUDENT SESSION: JOINT SESSION WITH CONFERENCES 10451 AND 10450

- 10451 OT **Enhanced critical feature representation for fuzzy-matching for lithography hotspot detection** [10451-37]

MASK/OPC INTERACTIONS

- 10451 OV **The impact of inconsistency in assist feature generation on OPC performance** [10451-60]
- 10451 OW **Edge placement errors in EUV from aberration variation** [10451-58]
- 10451 OX **Process window discovery from mask inspection for hotspot analysis and verification** [10451-30]
- 10451 OY **Estimated mask contours: potential applications** [10451-31]

METROLOGY

- 10451 0Z **Implementation of CDSEM contour extraction on OPC verification** [10451-32]
- 10451 10 **Selective measurement of small metrology targets using CD-GISAXS** [10451-33]
- 10451 11 **Off-line mask-to-mask registration characterization as enabler for computational overlay** [10451-34]
- 10451 13 **Automated defect disposition with AIM AutoAnalysis** [10451-36]

PHOTOMASK LITHOGRAPHY, AND MASK PROCESS & REPAIR

- 10451 14 **Characterization of acoustic cavitation from a megasonic nozzle transducer for photomask cleaning** [10451-38]
- 10451 15 **Advanced photomask chrome etch: selectivity without sacrifice** [10451-39]
- 10451 16 **Improving back end of line productivity through smart automation** [10451-67]
- 10451 17 **Multi-beam mask writer MBM-1000** [10451-42]

NANO IMPRINT LITHOGRAPHY

- 10451 1A **Development of an inkjet-enabled adaptive planarization process** [10451-45]
- 10451 1B **Progress in nanoimprint wafer and mask systems for high volume semiconductor manufacturing** [10451-46]

POSTER SESSION: EUV INSPECTION

- 10451 1D **Dark field technology for EUV and optical mask blank inspection** [10451-48]

POSTER SESSION: MATERIALS AND NOVEL APPLICATIONS

- 10451 1I **Laser-scan lithography and electrolytic etching for fabricating mesh structures on stainless-steel pipes 100 μ m in diameter** [10451-55]

POSTER SESSION: OPC

- 10451 1J **Automatic SRAF printing detection based on contour extraction** [10451-56]
- 10451 1K **Strategies on quantitative data preparation for OPC model calibration to reduce catastrophic failure at 7nm node** [10451-59]

POSTER SESSION: OPC/MASK INTERACTIONS

- 10451 1L **Aerial image ORC checks and their correlation to wafer-edge yield limitation for metals: a study and an OPC resolution** [10451-61]
- 10451 1M **Advanced process control based on litho-patterning density** [10451-62]
- 10451 1N **Improved testpatterns and coverage for complex SRAF to optimize 5nm and below OPC and mask patterning** [10451-63]

POSTER SESSION: PROCESS AND REPAIR

- 10451 1Q **Direct laser writing: virtual mask optimization for optical quality control artefact** [10451-64]
- 10451 1R **Dual-line fabrication method in direct laser lithography to reduce the manufacturing time of diffractive optics elements** [10451-65]
- 10451 1S **Transparent and conductive backside coating of EUV lithography masks for ultra short pulse laser correction** [10451-66]
- 10451 1T **Mask process correction method comparison and study: CD-SEM box versus standard correction method** [10451-4]
- 10451 1U **Micro-defect repair assisted with contour-based 2D metrology** [10451-40]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Abdelghany, Hesham, 1N
Abdo, Amr, 0V
Ackmann, Paul, 1M
Adam, Kostas, 0W
Adelmann, Christoph, 0P
Ahn, Byoung-Sup, 17
Anantha, Vidyasagar, 0L
Ando, Akihiko, 0K
Aupperle, David, 1D
Babighian, Pietro, 1L
Baron, Stanislas, 04, 0D
Batarseh, Fadi, 1L
Bevlin, Kristen, 15
Beyer, Dirk, 11
Biyajima, Tsuneaki, 0Q
Bork, Ingo, 09, 1T
Bouaricha, Ali, 08
Braylovska, Mariya, 0S
Brunner, Johann, 14
Buck, Peter, 09, 1T
Burns, John, 05
Buttgereit, Ute, 13
Candia, Nicolas, 14
Cao, Liang, 0Z, 1J
Cao, Yu, 0D
Capelli, Renzo, 0J
Chen, Been-Der, 04, 0D
Chen, Hong, 1K
Chen, Norman, 0Z
Chen, Yu, 06, 1N
Chen, Yulu, 0S
Cheng, Jackie, 0X
Cheng, James, 0X
Chien, Albert, 0X
Choi, Jin, 17, 1B
Chou, Hsin-Fu, 0X
Chou, William, 0X
Clifford, Chris, 0W
Conklin, David, 0V
Cross, Andrew, 0L
D'havé, Koen, 11
Daneshpanah, Mehdi, 0X
De Simone, Danilo, 0L
Deshpande, Rohan, 1L
Desineni, Rao, 1L
Desouky, Tamer, 1L
Dietzel, Martin, 0J
Dornbusch, Kay, 13
Durvasula, Bhardwaj, 09
Eah, Sang-Kee, 1L
Egodage, Kokila, 16
Eitapence, Scott, 0L
Elshabrawy, Mohamed M., 0T
Fenger, Germain, 0W
Fong, Weichun, 0D
Foubert, Philippe, 0L
Fujimura, Aki, 03, 08
Gallagher, Emily E., 0P, 0R
Gao, Shaowen, 0Z
Garetto, Anthony, 16
Geerpuram, Dwarakanath, 15
Gehrke, Ralf, 0J
Ghim, Young-Sik, 1R
Ghosh, Dhriti Sundar, 1S
Giesbers, A. J. M., 0O
Goodwin, Francis, 0S
Gookassian, John, 0Y
Goonesequera, Arosha, 13
Grigas, Michelle M., 1A
Guajardo, Marco A., 1N
Guo, Eric, 1T, 1U
Hæggström, Edward, 1Q
Hagihara, Kazuki, 0H
Hamaji, Masakazu, 04
Han, Zhenxing, 14
Hayashi, Naoya, 0H
Hayashi, Tatsuya, 1B
Hellweg, Dirk, 0J
Hirano, Takashi, 0K
Hiura, Mitsuru, 1B
Horima, Yasuaki, 04
Horiuchi, Toshiyuki, 0G, 1I
Hou, Jiechang, 0Z, 1J, 1L
Howard, Sam, 14
Howell, Rafael C., 0D
Hsu, Stephen D., 0D
Hu, Xiang, 1M
Hung, Dan, 05
Huyghebaert, Cedric, 0P
Imoto, Kohei, 1B
Inderhees, Gregg, 1D
Inoue, Hideo, 17
Ishikawa, Hisako, 0Q
Ito, Kaiki, 0G
Ito, Yoshiyasu, 0H
Itoh, Masamitsu, 0K
Järvinen, Miikka, 1Q
Jenkins, David, 13

Jeon, Chan-Uk, 17
 Jiang, Wenchao, 1J, 1M
 Johnson, Chris, 15
 Kalsbeck, Bill, 1D
 Kamo, Takashi, 0K
 Kassamakov, Ivan, 1Q
 Kersteen, Grizelda, 0J
 Khalil, Ahmed, 1L
 Khusnatdinov, Niyaz, 1A
 Kim, Young-Gwang, 1R
 Kimura, Atsushi, 1B
 Klootwijk, J. H., 0O
 Klostermann, Ulrich, 0S
 Koch, Markus, 0J
 Kohmura, Kazuo, 0Q
 Krumrey, Michael, 0R, 1O
 Kurganova, E., 0O
 Lam, Michael, 0W
 Laubis, Christian, 0R
 Lee, Heng-Jen, 0X
 Lee, Jae Uk, 0P
 Lee, Sang-Hee, 17
 Lee, Yun-Woo, 1R
 Li, Chuanhai, 06
 Li, Yifan, 1T
 Lin, Chenxi, 0D
 Lin, Yibo, 0A
 Litt, Lloyd, 1M
 Liu, Tsu-Jae King, 02
 Lu, Colbert, 0X
 Lu, Cong, 1T, 1U
 Lu, Yen-Wen, 0D
 Lucas, Kevin, 1N
 Luo, Larry, 0D
 Lyu, Shizhi, 1T
 Maniyara, Rinu Abraham, 1S
 Marokkey, Sajjan, 0S
 Matsumoto, Hiroshi, 17
 Meersschaüt, Johan, 0P
 Meyers, Gary, 07
 Mishra, Kushlendra, 1T
 Mitsuhashi, Takashi, 0C
 Mo, Delin, 1T
 Moore, Bill, 05
 Morgan, Michael, 15
 Morishita, Keiko, 0K
 Morohoshi, Hiroshi, 1B
 Mouraille, Orion, 11
 Naka, Masato, 0K
 Nasalevich, M., 0O
 Nie, Qiuping, 1D
 Niewczas, Mariusz, 08
 Ning, Guoxiang, 0Z, 1M
 Notenboom, A., 0O
 Ogata, Kiyoshi, 0H
 Ohara, Shuichiro, 04
 Okubo, Atsushi, 0Q
 Olate, Juan, 07
 Omote, Kazuhiko, 0H
 Omran, Ahmed, 1N
 Ono, Yosuke, 0Q
 Otoshi, Kenji, 17
 Ou, Jiaojiao, 0A
 Pallachali, Muhammed, 1L
 Pan, David Z., 0A
 Pang, Leo, 08
 Parchuri, Anil, 1T
 Park, Jong-Mun, 17
 Pearman, Ryan, 08
 Pei, Jinhua, 06
 Peter, M., 0O
 Petrov, Nicolai, 1L
 Pflüger, Mika, 10
 Pollentier, Ivan, 0P, 0R
 Preil, Moshe, 0L
 Pruner, Valerio, 1S
 Qian, Jin, 0L
 Raghunathan, Ananthan, 0W
 Rao, Nageswara, 09
 Reddy, Murali, 09
 Ren, Yuping, 1M
 Resnick, Douglas J., 1A
 Rhee, Hyug-Gyo, 1R
 Richard, Olivier, 0P
 Roelofs, Christian, 11
 Rojas, Carlos, 0Y
 Russell, Guy, 13
 Ryan, Deborah, 1L
 Sah, Kaushik, 0L
 Saito, Yasuko, 04
 Samuels, Donald, 0V
 Sanapala, Ravikumar, 0L
 Santo, Izumi, 1U
 Sargsyan, Vahagn, 13
 Sathisivan, Mogana Sundharam A/L, 06
 Scholze, Frank, 0R, 10
 Schulz, Kristian, 16
 Scotti, Gianmario, 1Q
 Sezginer, Apo, 0X
 Sharma, Malavika, 09
 Shendre, Abhishek, 08
 Shi, Irene, 1U
 Shokale, Shweta, 1L
 Shu, Vincent, 04
 Singhal, Shrawan, 1A
 Soltwisch, Victor, 10
 Spence, Chris, 04
 Sreenivasan, S. V., 1A
 Steinert, Steffen, 11
 Straka, Joachim, 14
 Sturtevant, John, 0W
 Su, Bo, 08
 Su, Jing, 0D
 Suman, Shishir, 0L
 Sun, Dezheng, 0D
 Sun, Lei, 05, 0S
 Suzaki, Yoshio, 1B
 Suzuki, Yuta, 0G
 Symens, W., 0O
 Syrel, Oleg, 08

Tabbone, Gilles, 16
Takahashi, Hiroshi, 11
Tamamushi, Shuichi, 17
Tan, Alexander, 1D
Taneichi, Daiki, 0Q
Tang, Teck Jung, 1L
Taniguchi, Rikiya, 0H
Terry, Mark, 1L
Tian, Mingjing, 1T
Timmermans, Marina Y., 0P, 0R
Twu, C. H., 0X
Ueba, Ryosuke, 17
Vainikka, Tuomas, 1Q
van de Krujjs, R. W. E., 0O
Van den Heuvel, Dieter, 0L
van der Zande, W. J., 0O
van Dijk, Leon, 11
van Haren, Richard, 11
van Zwol, P. J., 0O
Viswanathan, Ramya, 0V
Vles, D., 0O
Voorthuijzen, W. P., 0O
Wang, Feng, 1L
Wang, Shibing, 0D
Wang, Wei-long, 1J
Wassal, Amr G., 0T
Westerman, Russ, 15
Wilkinson, William, 0Z
Willis, Jan, 03
Wolke, Conrad, 0J
Wood, Obert, 0S
Wu, David, 0X
Xu, Xiaoqing, 0A
Yahya, Siti Noor Aisyah Binti, 06
Yam, Petrie, 14
Yamada, Hirokazu, 17
Yamanaka, Eiji, 0H
Yamashita, Hiroshi, 17
Yang, Ho-Soon, 1R
Yeh, Mike, 0X
Yin, Haizhou, 1L
Yoshikawa, Ryoji, 0K
Zable, Harold, 08
Zachmann, Hendrik, 13
Zanelli, Claudio, 14
Zhang, Bosheng, 0X
Zhang, Cuiping, 0D
Zhang, Dongqing, 1J
Zhang, Hongxin, 0Z
Zhang, Jie, 0Z, 1J
Zhang, Qiang, 1D
Zhang, Quan, 04, 0D
Zhang, Yixiao, 1L
Zhou, Xiangyu, 0S
Zou, Yi, 0D

Conference Committee

Conference Chairs

Peter D. Buck, Mentor Graphics Corporation (United States)
Emily E. Gallagher, IMEC (Belgium)

BACUS Steering Committee

Frank E. Abboud, Intel Corporation (United States)
Paul W. Ackmann, GLOBALFOUNDRIES Inc. (United States)
Michael D. Archuleta, RAVE LLC (United States)
Artur P. Balasinski, Cypress Semiconductor Corporation
(United States)
Uwe F. W. Behringer, UBC Microelectronics (Germany)
Peter D. Buck, Mentor Graphics Corporation (United States)
Brian Cha, SAMSUNG Electronics Company, Ltd.
(Korea, Republic of)
Jerry Cullins, Hoya Corporation (United States)
Derren Dunn, IBM Corporation (United States)
Thomas B. Faure, GLOBALFOUNDRIES Inc. (United States)
Aki Fujimura, D2S Inc. (Japan)
Brian J. Grenon, Grenon Consulting (United States)
Jon Haines, Micron Technology, Inc. (United States)
Naoya Hayashi, Dai Nippon Printing Company, Ltd. (Japan)
Bryan S. Kasprowicz, Photronics, Inc. (United States)
Patrick M. Martin, Applied Materials, Inc. (United States)
Shane Palmer, Nikon Research Corporation of America
(United States)
Jan Hendrik Peters, bmbg consulting(Germany)
Moshe Preil, KLA-Tencor Corporation (United States)
Douglas J. Resnick, Canon Nanotechnologies, Inc. (United States)
Thomas Scheruebl, Zeiss SMT GmbH (Germany)
Thomas Struck, Infineon Technologies AG (Germany)
Bala Thumma, Synopsys, Inc. (United States)
Anthony Vacca, AVI-Photomask (United States)
Michael Watt, Shin-Etsu MicroSi, Inc. (United States)
Jim N. Wiley, ASML US, Inc. (United States)
Larry S. Zurbrick, Keysight Technologies, Inc. (United States)

Conference Program Committee

Frank E. Abboud, Intel Corporation (United States)
Paul W. Ackmann, GLOBALFOUNDRIES Inc. (United States)
Artur P. Balasinski, Cypress Semiconductor Corporation
(United States)
Lucien Bouchard, Photronics Inc. (United States)
Byungcheol Cha, SAMSUNG Electronics Company, Ltd.
(Korea, Republic of)
Uwe Dietze, SUSS MicroTec Inc. (United States)
Thomas B. Faure, GLOBALFOUNDRIES Inc. (United States)
Aki Fujimura, D2S, Inc. (United States)
Brian J. Grenon, RAVE LLC (United States)
Naoya Hayashi, Dai Nippon Printing Company, Ltd. (Japan)
Izak Kapilevich, Applied Materials, Inc. (United States)
Bryan S. Kasprowitz, Photronics, Inc. (United States)
Byung-Gook Kim, SAMSUNG Electronics Company, Ltd.
(Korea, Republic of)
Lloyd C. Litt, GLOBALFOUNDRIES Inc. (United States)
Paul F. Morgan, Micron Technology, Inc. (United States)
Takahiro Onoue, HOYA Corporation (Japan)
Shane R. Palmer, Nikon Research Corporation of America
(United States)
Moshe E. Preil, KLA-Tencor Corporation (United States)
Douglas J. Resnick, Canon Nanotechnologies, Inc. (United States)
Thomas Scheruebl, Carl Zeiss SMT GmbH (Germany)
Yuyang Sun, Mentor Graphics Corporation (United States)
Banqiu Wu, Applied Materials, Inc. (United States)
Shusuke Yoshitake, NuFlare Technology, Inc. (Japan)

Session Chairs

Opening Remarks

Peter D. Buck, Mentor Graphics Corporation (United States)
Emily E. Gallagher, IMEC (Belgium)

Keynote and Invited Session

Peter D. Buck, Mentor Graphics Corporation (United States)
Emily E. Gallagher, IMEC (Belgium)

Mask Data Preparation I

Paul W. Ackmann, GLOBALFOUNDRIES Inc. (United States)
Peter D. Buck, Mentor Graphics Corporation (United States)

Mask Data Preparation II

Paul W. Ackmann, GLOBALFOUNDRIES Inc. (United States)
Peter D. Buck, Mentor Graphics Corporation (United States)

Machine Learning

Aki Fujimura, D2S, Inc. (United States)

Bryan S. Kasprowicz, Photronics, Inc. (United States)

Photomask Japan 2017

Naoya Hayashi, Dai Nippon Printing Company, Ltd. (Japan)

Takahiro Onoue, HOYA Corporation (Japan)

Keynote Session: Joint Session with conferences 10451 and 10450

Eric M. Panning, Intel Corporation (United States)

Naoya Hayashi, Dai Nippon Printing Company, Ltd. (Japan)

EUV Readiness: Joint session with conferences 10450 and 10451

Eric M. Panning, Intel Corporation (United States)

Naoya Hayashi, Dai Nippon Printing Company, Ltd. (Japan)

EUV Mask Inspection: Joint session with conferences 10451 and 10450

Paul A. Morgan, Micron Technology, Inc. (United States)

EUV Mask Metrology and Inspection: Joint session with conferences 10450 and 10451

Bryan S. Kasprowicz, Photronics, Inc. (United States)

Thomas Scheruebl, Carl Zeiss SMT GmbH (Germany)

EUV Mask Pellicle: Joint session with conferences 10451 and 10450

Emily E. Gallagher, IMEC (Belgium)

Dario L. Goldfarb, IBM Thomas J. Watson Research Center
(United States)

Photomask Posters

Uwe F. W. Behringer, UBC Microelectronics (Germany)

Mask/OPC Interactions

Paul A. Morgan, Micron Technology, Inc. (United States)

Byungcheol Cha, SAMSUNG Electronics Company, Ltd. (Korea,
Republic of)

Metrology

Moshe E. Preil, KLA-Tencor Corporation (United States)

Thomas Scheruebl, Carl Zeiss SMT GmbH (Germany)

Student Session: Joint session with conferences 10451 and 10450

Yuyang Sun, Mentor Graphics Corporation (United States)

Shinji Okazaki, ALITECS Company, Ltd. (Japan)

Photomask Lithography, and Mask Process & Repair

Brian J. Grenon, RAVE LLC (United States)

Uwe Dietze, SUSS MicroTec Inc. (United States)

Nano Imprint Lithography

Douglas J. Resnick, Canon Nanotechnologies, Inc. (United States)

Naoya Hayashi, Dai Nippon Printing Company, Ltd. (Japan)

Panel Discussion: Joint with conferences 10451 and 10450

Byung-Gook Kim, SAMSUNG Electronics Company, Ltd.

(Korea, Republic of)

Fei Wang, Hermes-Microvision Inc., USA (United States)

Jed H. Rankin, GLOBALFOUNDRIES Inc. (United States)

Jeff Farnsworth, Intel Corporation (United States)

Shusuke Yoshitake, NuFlare Technology, Inc. (Japan)

Weston L. Sousa, KLA-Tencor Corporation (United States)

Introduction

The 2017 SPIE Photomask Technology Conference was held September 11-14 in Monterey, California, co-located for the first time with the EUV Lithography Conference. The organizers of these two conferences recognized their synergy and thought that a united conference would have value greater than the two held separately. Indeed, the combined conference integrated naturally and the increased attendance gave the conference a momentum not experienced in years. Since their first date went so well, these two conferences are expected to remain together for the foreseeable future.

EUV lithography readiness for high volume production was the overriding theme of the conference with joint sessions on EUV readiness, pellicles, and inspection/metrology. A joint panel discussion explored options and strategies for early EUVL insertion without initial actinic inspection availability. The general consensus of the panelists and attendees was that this was not a technical barrier but did have a large impact on complexity, cost, and cycle time.

Machine Learning is gaining more and more attention as organizations attempt to make sense of the huge amount of data collected in the process of manufacturing masks and integrated circuits. This year, for the first time, Photomask Technology included a Machine Learning session that explored use models and applications for this exciting emerging data analysis technology. Papers from the conference, covering the latest progress in all areas related to photomasks, follow in this proceedings.

Peter D. Buck
Emily E. Gallagher

