

PROCEEDINGS OF SPIE

Lithography Asia 2009

Alek C. Chen
Woo-Sung Han
Burn J. Lin
Anthony Yen
Editors

18–19 November 2009
Taipei, Taiwan

Sponsored and Published by
SPIE

Cooperating Organization
TSIA—Taiwan Semiconductor Industry Association (Taiwan)

Volume 7520

Proceedings of SPIE, 0277-786X, v. 7520

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

The papers included 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. The papers published in these proceedings 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 this book:

Author(s), "Title of Paper," in *Lithography Asia 2009*, edited by Alek C. Chen, Woo-Sung Han, Burn J. Lin, Anthony Yen, Proceedings of SPIE Vol. 7520 (SPIE, Bellingham, WA, 2009) Article CID Number.

ISSN 0277-786X

ISBN 9780819479099

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 © 2009, 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/09/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.



SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

xv	Conference Committee
xix	Introduction

SESSION 1 PLENARY SESSION

7520 03	3D integration opportunities, issues, and solutions: a designer's perspective (Plenary Paper) [7520-02] D.-M. Kwai, Industrial Technology Research Institute (Taiwan); C.-W. Wu, National Tsing Hua Univ. (Taiwan) and Industrial Technology Research Institute (Taiwan)
7520 04	Decades of rivalry and complementary of photon and electron beams (Plenary Paper) [7520-03] B. J. Lin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

SESSION 2 EUV LITHOGRAPHY AND EMERGENT TECHNOLOGY I

7520 07	High power LPP EUV source system development status [7520-06] B. S.-M. Lin, Cymer Southeast Asia, Ltd. (Taiwan); D. Brandt, N. Farrar, Cymer Inc. (United States)
7520 08	EUVL: towards implementation in production [7520-07] H. Meiling, N. Buzing, ASML Netherlands B.V. (Netherlands); K. Cummings, ASML US, Inc. (United States); N. Harned, ASML Wilton (United States); B. Hultermans, R. de Jonge, ASML Netherlands B.V. (Netherlands); B. Kessels, ASML US, Inc. (United States); P. Kürz, Carl Zeiss SMT AG (Germany); S. Lok, ASML Netherlands B.V. (Netherlands); M. Lowisch, Carl Zeiss SMT AG (Germany); J. Mallman, ASML Netherlands B.V. (Netherlands); B. Pierson, ASML US, Inc. (United States); C. Wagner, A. van Dijk, E. van Setten, ASML Netherlands B.V. (Netherlands); J. Zimmerman, ASML Wilton (United States); P. Cheang, A. Chen, ASML Taiwan Ltd. (Taiwan)
7520 09	Imaging performance of production-worthy multiple-E-beam maskless lithography [7520-08] S. J. Lin, W. C. Wang, J. J. H. Chen, F. Krecinic, B. J. Lin, Taiwan Semiconductor Manufacturing Co., Ltd. (Taiwan); G. de Boer, E. Slot, R. Jager, S. Steenbrink, B.-J. Kampherbeek, M. Wieland, MAPPER Lithography (Netherlands)
7520 0A	Advances in maskless and mask-based optical lithography on plastic flexible substrates [7520-09] I. Barbu, M. G. Ivan, P. Giesen, TNO Science and Industry (Netherlands); M. Van de Moosdijk, ASML Netherlands B.V. (Netherlands); E. R. Meinders, TNO Science and Industry (Netherlands)

SESSION 3 COMPUTATIONAL LITHO: SMO

- 7520 0B **Source-mask selection using computational lithography: further investigation incorporating rigorous resist models** [7520-11]
S. Kapasi, S. Robertson, J. Biafore, M. D. Smith, KLA-Tencor Corp. (United States)
- 7520 0C **Feasibility studies of source and mask optimization** [7520-12]
T. Nakashima, T. Matsuyama, S. Owa, Nikon Corp. (Japan)
- 7520 0D **Source-mask co-optimization: optimize design for imaging and impact of source complexity on lithography performance** [7520-13]
S. Hsu, Z. Li, L. Chen, K. Gronlund, H. Liu, Brion Technologies, Inc. (United States); R. Socha, ASML TDC (United States)
- 7520 0E **Regularization of inverse photomask synthesis to enhance manufacturability** [7520-32]
N. Jia, The Univ. of Hong Kong (Hong Kong, China); A. K. Wong, Consultant (United States); E. Y. Lam, The Univ. of Hong Kong (Hong Kong, China)

SESSION 4 METROLOGY AND PROCESS CONTROL I

- 7520 0F **The LER/LWR metrology challenge for advance process control through 3D-AFM and CD-SEM** [7520-14]
P. Faurie, J. Foucher, A.-L. Foucher, CEA-LETI/MINATEC (France)
- 7520 0G **Optimization of alignment/overlay sampling and marker layout to improve overlay performance for double patterning technology** [7520-15]
C.-F. Chue, Nanya Technology Corp. (Taiwan); T.-B. Chiou, ASML TDC Asia (Taiwan); C.-Y. Huang, Nanya Technology Corp. (Taiwan); A. C. Chen, ASML TDC Asia (Taiwan); C.-L. Shih, Nanya Technology Corp. (Taiwan)
- 7520 0H **Optical critical dimension measurements for patterned media with 10's nm feature size** [7520-16]
Y. Liu, M. Tabet, J. Hu, Nanometrics, Inc. (United States); Z. Yu, J. Hwu, W. Hu, S. Zhu, G. Gauzner, K. Lee, S. Lee, Seagate Technology (United States)
- 7520 0I **Ultra-sensitive optical metrology for hard disk DTR and BPM imprints** [7520-17]
J. Roberts, L. Hu, I. Bloomer, n&k Technology, Inc. (United States); S.-F. Lee, Y. Liu, Seagate Technology (United States)
- 7520 0J **After development inspection (ADI) studies of photo resist defectivity of an advanced memory device** [7520-18]
H.-S. Kim, Y. M. Cho, B.-H. Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); R. Yeh, Hermes Microvision, Inc. (Taiwan); E. Ma, F. Wang, Y. Zhao, K. Kanai, H. Xiao, J. Jau, Hermes Microvision, Inc. (United States)
- 7520 0K **Challenges in development and construction of stand-alone inspection, metrology, and calibration tools for EUV lithographic applications** [7520-90]
J. H. Underwood, D. C. Houser, A. T. Latzke, R. C. C. Perera, EUV Technology (United States)

SESSION 5 RESIST MATERIAL AND PROCESSING I

- 7520 0L **Image reversal trilayer materials and processing** [7520-19]
D. J. Abdallah, AZ Electronic Materials (United States); K. Kurosawa, AZ Electronic Materials (Japan); E. Wolfer, V. Monreal, M. Dalil Rahman, D. Lee, M. Neisser, R. R. Dammel, AZ Electronic Materials (United States)
- 7520 0M **Resist double patterning on BARCs and spin-on multilayer materials** [7520-20]
D. J. Guerrero, D. M. Sullivan, R.-M. L. Mercado, Brewer Science, Inc. (United States)
- 7520 0N **Latest developments in photosensitive developable bottom anti-reflective coating (DBARC)** [7520-21]
T. Kudo, S. Chakrapani, A. Dioses, E. Ng, C. Antonio, D. Parthasarathy, AZ Electronic Materials USA Corp. (United States); S. Miyazaki, Y. Ubayashi, K. Yamamoto, Y. Akiyama, AZ Electronic Materials Japan K.K. (Japan); R. Collett, M. Neisser, M. Padmanaban, AZ Electronic Materials USA Corp. (United States)
- 7520 0O **High Si content anti-reflective coatings and their extension to a UV freeze dual patterning process** [7520-23]
J. Kennedy, Z. Wu, K. Flanigan, Honeywell (United States); J. Dai, Sokudo Co., Ltd. (United States); T. Wallow, Global Foundries Inc. (United States)

SESSION 6 EUV LITHOGRAPHY AND EMERGENT TECHNOLOGY II

- 7520 0R **EUV sensitive photo-acid generator sans chromophore** [7520-26]
K. S. Mayya, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Y. Kang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) and Kyung Hee Univ. (Korea, Republic of); T. Yasue, S.-H. Oh, S.-W. Choi, C.-H. Park, SAMSUNG Electronics Co., Ltd. (Korea, Republic of)
- 7520 0S **A fully model-based methodology for simultaneously correcting EUV mask shadowing and optical proximity effects with improved pattern transfer fidelity and process windows** [7520-27]
P. C. W. Ng, K.-Y. Tsai, Y.-M. Lee, T.-H. Pei, F.-M. Wang, J.-H. Li, National Taiwan Univ. (Taiwan); A. C. Chen, ASML Taiwan Ltd. (Taiwan)
- 7520 0T **Comparison of simulation and wafer results for shadowing and flare effect on EUV alpha demo tool** [7520-28]
J. Moon, C.-K. Kim, B.-S. Nam, B.-H. Nam, C.-M. Lim, D. Yim, S.-K. Park, Hynix Semiconductor Inc. (Korea, Republic of)

SESSION 7 COMPUTATIONAL LITHOGRAPHY

- 7520 0U **Development and evaluation of new MRC parameter for aggressive mask optimization** [7520-29]
S. Shim, Y. Kim, S. Jang, H. Kim, S. Lee, S. Choi, H. Cho, C. Park, SAMSUNG Electronics Co., Ltd. Electronics Co., Ltd. (Korea, Republic of)
- 7520 0V **Fast converging inverse lithography algorithm incorporating image gradient descent methods** [7520-59]
J.-C. Yu, P. Yu, National Chiao Tung Univ. (Taiwan)

- 7520 0W **Using transmission line theory to calculate equivalent refractive index of EUV mask multilayer structures for efficient scattering simulation by finite-difference time-domain method (Best Student Paper Award)** [7520-61]
Y.-M. Lee, J.-H. Li, P. C. W. Ng, T.-H. Pei, F.-M. Wang, K.-Y. Tsai, National Taiwan Univ. (Taiwan); A. C. Chen, ASML Taiwan Ltd. (Taiwan)
- 7520 0X **Source mask optimization (SMO) at full chip scale using inverse lithography technology (ILT) based on level set methods** [7520-10]
L. Pang, P. Hu, D. Peng, D. Chen, T. Cecil, L. He, G. Xiao, V. Tolani, T. Dam, K.-H. Baik, B. Gleason, Luminescent Technologies, Inc. (United States)

SESSION 8 OPTICAL LITHOGRAPHY AND EXTENSION

- 7520 0Y **Performance of a programmable illuminator for generation of freeform sources on high NA immersion systems** [7520-33]
M. Mulder, A. Engelen, O. Noordman, R. Kazinczi, G. Streutker, B. van Driehuisen, ASML Netherlands B.V. (Netherlands); S. Hsu, K. Gronlund, ASML Brion Technologies, Inc. (United States); M. Degünther, D. Jürgens, J. Eisenmenger, M. Patra, A. Major, Carl Zeiss SMT AG (Germany)
- 7520 0Z **Latest results from the Nikon NSR-S620 double patterning immersion scanner** [7520-34]
K. Hirano, Y. Shibasaki, M. Hamatani, J. Ishikawa, Y. Iriuchijima, Nikon Corp. (Japan)
- 7520 11 **Comparison of rule-based versus model-based decomposition technique** [7520-110]
P. LaCour, A. Dave, D. Chou, O. El Sewefy, Mentor Graphics Corp. (United States)
- 7520 12 **Mueller matrix polarimetry for immersion lithography tools with a polarization monitoring system at the wafer plane** [7520-36]
H. Nomura, I. Higashikawa, Toshiba Corp. Semiconductor Co. (Japan)
- 7520 13 **Flexible 60–90W ArF light source for double patterning immersion lithography in high volume manufacturing** [7520-37]
S. Rokitski, T. Ishihara, R. Rao, R. Jiang, D. Riggs, M. Haviland, T. Cacouris, D. Brown, Cymer, Inc. (United States)

SESSION 9 OPTICAL LITHOGRAPHY: MASK

- 7520 14 **Mask defect specification in the spacer patterning process by using a fail-bit-map analysis** [7520-38]
S. Miyoshi, S. Yamaguchi, M. Naka, K. Morishita, T. Hirano, H. Morinaga, H. Mashita, A. Kobiki, M. Kaneko, H. Mukai, M. Kajimoto, T. Sugihara, Y. Horii, Y. Yanai, T. Fujisawa, K. Hashimoto, S. Inoue, Toshiba Corp. (Japan)
- 7520 15 **Analyzing electrostatic induced damage risk to reticles with an in situ e-reticle system** [7520-39]
R. Tu, Benchmark Technologies Inc. (United States); T. Sebald, Estion GmbH & Co. KG (Germany)
- 7520 16 **In-die actinic metrology on photomasks for low k1 lithography** [7520-40]
D. Beyer, U. Buttgerit, T. Scheruebl, A. Zibold, Carl Zeiss SMS GmbH (Germany)

- 7520 17 **Revisiting adoption of high transmission PSM: pros, cons and path forward** [7520-41]
Z. M. Ma, S. McDonald, C. Progler, Photonics (United States)
- 7520 18 **Back side photomask haze revisited** [7520-42]
B. J. Grenon, Grenon Consulting, Inc. (United States); O. Kishkovich, Entegris, Inc. (United States)

SESSION 10 METROLOGY AND PROCESS CONTROL II

- 7520 19 **In-shot (intra-field) overlay measurement considering overlay mark pattern dependency and illumination source dependency** [7520-43]
D. Lee, J. Kim, G. Lee, S. Lee, Y. Cho, Y.-S. Kang, W.-S. Han, SAMSUNG Electronics Co., Ltd. (Korea, Republic of)
- 7520 1A **A sophisticated metrology solution for advanced lithography: addressing the most stringent needs of today as well as future lithography** [7520-44]
V. Shih, J. Huang, W. Wang, G. T. Huang, H. L. Chung, A. Ho, W. T. Yang, S. Wang, C.-M. Ke, L. J. Chen, C. R. Liang, H. H. Liu, H. J. Lee, L. G. Terng, T. S. Gau, J. Lin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); K. Bhattacharyya, M. van der Schaar, N. Wright, M. Shahrjerdy, V. Wang, ASML Netherlands B.V. (Netherlands); S. Lin, J. Wu, S. Peng, D. Chang, C. Wang, ASML Taiwan Ltd. (Taiwan); A. Fuchs, O. Adam, K. van der Mast, ASML Netherlands B.V. (Netherlands)
- 7520 1B **Scatterometry measurement of asymmetric gratings** [7520-45]
J. Li, Nanometrics Inc. (United States); J. J. Hwu, Seagate Technology (United States); Y. Liu, S. Rabello, Z. Liu, J. Hu, Nanometrics Inc. (United States)
- 7520 1C **Systematic defect management by design aware inspection** [7520-46]
E. Chang, A. Park, KLA-Tencor Corp. (United States)
- 7520 1D **EUV mask pattern inspection with an advanced electron beam inspection system** [7520-47]
T. Shimomura, Dai Nippon Printing Co. America, Inc. (United States); Y. Inazuki, A. Tsukasa, T. Takikawa, Y. Morikawa, H. Mohri, N. Hayashi, Dai Nippon Printing Co., Ltd. (Japan); F. Wang, L. Ma, Y. Zhao, C. Kuan, H. Xiao, J. Jau, Hermes Microvision, Inc. (United States)

SESSION 11 DOUBLE PATTERNING AND DOUBLE PROCESSING

- 7520 1E **Implementation of double patterning process toward 22-nm node (Invited Paper)** [7520-48]
H. Yaegashi, Tokyo Electron Ltd. (Japan); E. Nisimura, Tokyo Electron AT Ltd. (Japan); K. Hasebe, Tokyo Electron Tohoku Ltd. (Japan); T. Kawasaki, Tokyo Electron Kyushu Ltd. (Japan); M. Kushibiki, Tokyo Electron AT Ltd. (Japan); A. Hara, S. Yamauchi, S. Natori, Tokyo Electron Ltd. (Japan); N. Shigeru, H. Murakami, Tokyo Electron Tohoku Ltd. (Japan); K. Yabe, Tokyo Electron Ltd. (Japan); S. Shimura, F. Iwao, Tokyo Electron Kyushu Ltd. (Japan); K. Oyama, Tokyo Electron Ltd. (Japan)
- 7520 1F **Development of silicon glass for etch reverse layer (SiGERL) materials and BARCs for double patterning process** [7520-49]
Y. Sakaida, H. Yaguchi, R. Sakamoto, B.-C. Ho, Nissan Chemical Industries, Ltd. (Japan)

- 7520 1G **Advanced patterning solutions based on double exposure: double patterning and beyond** [7520-50]
Y. C. Bae, Y. Liu, T. Cardolaccia, K. Spizuoco, R. Bell, L. Joesten, A. Picon, M. Reilly, S. Ablaza, P. Trefonas, G. G. Barclay, The Dow Chemical Co. (United States)
- 7520 1H **Litho-freeze-litho-etch (LFLE) enabling dual wafer flow coat/develop process and freeze CD tuning bake for >200wph immersion ArF photolithography double patterning** [7520-51]
C. N. Pieczulewski, SOKUDO Co., Ltd. (Japan); C. A. Rosslee, SOKUDO USA, LLC (United States)

SESSION 12 RESIST MATERIAL AND PROCESSING II

- 7520 1J **Low temperature plasma-enhanced ALD enables cost-effective spacer defined double patterning (SDDP)** [7520-53]
J. Beynef, ASM Belgium (Belgium); P. Wong, A. Miller, S. Locorotondo, D. Vangoidsenhoven, IMEC (Belgium); T.-H. Yoon, ASM Genitech Korea Ltd. (Korea, Republic of); M. Demand, IMEC (Belgium); H.-S. Park, ASM Genitech Korea Ltd. (Korea, Republic of); T. Vandeweyer, IMEC (Belgium); H. Sprey, ASM Belgium (Belgium); Y.-M. Yoo, ASM Genitech Korea Ltd. (Korea, Republic of); M. Maenhoudt, IMEC (Belgium)
- 7520 1K **Filtration condition study for enhanced microbridge reduction** [7520-54]
T. Umeda, F. Watanabe, S. Tsuzuki, T. Numaguchi, Nihon Pall Ltd. (Japan)
- 7520 1L **Possible line edge roughness reduction by anisotropic molecular resist (Best Student Paper Award)** [7520-55]
H. Kim, I. W. Cho, H. Jang, M. Kang, S. W. Kim, H.-K. Oh, Hanyang Univ. (Korea, Republic of)
- 7520 1M **A proven methodology for detecting photo-resist residue and for qualifying photo-resist material by measuring fluorescence using SP2 bare wafer inspection and SURFmonitor** [7520-56]
D. Feiler, S. Radovanovic, P. Dighe, A. Kitnan, G. Simpson, KLA-Tencor Corp. (United States); G. Schwager, A. Eynis, D. Enidjer, Numonyx Israel Ltd. (Israel)

SESSION 13 COMPUTATIONAL LITHOGRAPHY II

- 7520 1N **Validation of the predictive power of a calibrated physical stochastic resist model** [7520-57]
S. A. Robertson, J. J. Biafore, M. D. Smith, KLA-Tencor Corp. (United States); M. T. Reilly, J. Wandell, Dow Electronic Materials (United States)
- 7520 1O **Hierarchical DPT mask planning for contact layer** [7520-58]
Q. Li, P. Ghosh, P. LaCour, Mentor Graphics Corp. (United States)
- 7520 1P **Pattern prediction in EUV resists** [7520-30]
J. J. Biafore, M. D. Smith, KLA-Tencor (United States); T. Wallow, Global Foundries (United States); P. Nalleau, Lawrence Berkeley National Lab. (United States); D. Blankenship, KLA-Tencor (United States); Y. Deng, Global Foundries (United States)

- 7520 1Q **Model-based scanner tuning for process optimization** [7520-60]
T.-C. Chien, C. Y. Shih, R. C. Peng, H. H. Liu, Y. C. Chen, H. J. Lee, J. Lin, K. W. Chang, C. M. Wu, W. H. Hung, T. Lee, H. C. Wu, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); X. Xie, W. J. Shao, C. H. Chang, R. Aldana, Y. Cao, R. J. G. Goossens, Brion Technologies (United States); S. Hsieh, ASML Taiwan Ltd. (Taiwan)

POSTER SESSION

- 7520 1R **The synthesis and imaging study of a series of novel photoactive polymers with diazoketo groups in their side chains** [7520-22]
L. Liu, Y. Zou, Y. Yang, Y. Huang, Q. Liu, H. Niu, Beijing Normal Univ. (China)
- 7520 1U **Hot spot management through design based metrology: measurement and filtering** [7520-63]
T. Lee, H. Yang, J. Kim, A. Jung, G. Yoo, D. Yim, S. Park, Hynix Semiconductor Inc. (Korea, Republic of); A. Ishikawa, M. Yamamoto, NanoGeometry Research Inc. (Japan); A. Vikram, Anchor Semiconductor, Inc. (United States)
- 7520 1W **Immersion and dry lithography monitoring for flash memories (after develop inspection and photo cell monitor) using a darkfield imaging inspector with advanced binning technology** [7520-66]
P. Parisi, A. Mani, C. Perry-Sullivan, J. Kopp, G. Simpson, KLA-Tencor Corp. (United States); M. Renis, M. Padovani, C. Severgnini, P. Piacentini, P. Piazza, A. Beccalli, Numonyx R2 Technology Ctr. (Italy)
- 7520 1X **Control of CD errors and hotspots by using a design based verification system** [7520-67]
B.-S. Choi, S.-H. Lee, Y.-S. Kang, W.-S. Han, SAMSUNG Electronics Co., Ltd. (Korea, Republic of)
- 7520 1Y **Bottom-anti-reflective coatings (BARC) for LFLE double patterning process** [7520-68]
R. Sakamoto, T. Endo, B.-C. Ho, S. Kimura, T. Ishida, M. Kato, N. Fujitani, R. Onishi, Y. Hiroi, D. Maruyama, Nissan Chemical Industries, Ltd. (Japan)
- 7520 23 **Overlay improvement by ASML HOWA 5th alignment strategy** [7520-73]
R. Wang, C. Y. Chiang, W. Hsu, R. Yang, T. Shih, Inotera Memories Inc. (Taiwan); J. Chen, J. Chiu, W. Lin, ASML Taiwan Ltd. (Taiwan)
- 7520 24 **Characterizing the 65nm through-pitch sensitivity to scanner parameters by CD SEM and scatterometry metrologies** [7520-74]
J. Shieh, A. Chen, ASML Taiwan Ltd. (Taiwan)
- 7520 25 **Litho scenario solutions for FinFET SRAM 22nm node** [7520-75]
S.-E. Tseng, S.-D. Wu, J. Wang, J. Kou, ASML Taiwan Ltd. (Taiwan); O. Mouraille, ASML Netherlands B.V. (Netherlands); R. Jungblut, T.-B. Chiou, ASML Taiwan Ltd. (Taiwan); J. Finders, ASML Netherlands B.V. (Netherlands); A. Chen, ASML Taiwan Ltd. (Taiwan); M. Dusa, ASML Belgium (Belgium); S. Hsu, Brion Technologies, Inc. (United States)
- 7520 26 **Implementation of new recticle inspection technology for progressive mask defect detection strategy on memory fab** [7520-76]
A. Lan, J. Hsu, T. T. Shih, T. Tien, Inotera Memories Inc. (Taiwan); J. Cheng, M. Yeh, E. Chen, D. Wu, KLA-Tencor Corp. (Taiwan)

- 7520 28 **Fabrication of diamond and diamond-like carbon molds for nano-imprinting lithography** [7520-78]
J. W.-C. Yu, C.-Y. Cheng, National Cheng Kung Univ. (Taiwan); Y.-B. Guo, Toppan CFI (Taiwan) Co., Ltd. (Taiwan); F. C.-N. Hong, National Cheng Kung Univ. (Taiwan)
- 7520 2A **Study of OPC accuracy by illumination source types** [7520-80]
K. Yang, D. Park, J. Lee, S. Oh, J. Jeon, T. You, C. Park, D. Yim, S. Park, Hynix Semiconductor Inc. (Korea, Republic of)
- 7520 2B **Expanding the lithography process window (PW) with CDC technology** [7520-81]
S.-H. Wang, Powerchip Semiconductor Corp. (Taiwan); G. Ben-Zvi, Pixar Technology Ltd. (Israel); Y.-W. Chen, C. M. Kuo, Powerchip Semiconductor Corp. (Taiwan); E. Graitzer, A. Cohen, Pixar Technology Ltd. (Israel)
- 7520 2D **Green binary and phase shifting mask** [7520-83]
S. L. Shy, C.-S. Hong, C.-S. Wu, S. J. Chen, H. Y. Wu, National Nano Device Labs. (Taiwan); Y.-C. Ting, Far East Univ. (Taiwan)
- 7520 2G **Abbe-PCA-SMO: microlithography source and mask optimization based on Abbe-PCA** [7520-86]
S.-J. Chang, C. C. P. Chen, National Taiwan Univ. (Taiwan); L. S. Melvin III, Synopsys Inc. (United States)
- 7520 2I **Heat conduction from hot plate to photoresist on top of wafer including heat loss to the environment** [7520-88]
M. Jung, S. Kim, D. W. Kim, H.-K. Oh, Hanyang Univ. (Korea, Republic of)
- 7520 2J **FAST-LH: a manufacturing-environmental friendly method of lens heating monitoring** [7520-89]
S. I. Yet, F. Lim, X-FAB Sarawak Sdn. Bhd. (Malaysia)
- 7520 2K **Preliminary design of a two-dimensional electron beam position monitor system for multiple-electron-beam-direct-write lithography** [7520-91]
S.-Y. Chen, K.-Y. Tsai, H.-T. Ng, C.-H. Fan, T.-H. Pei, C.-H. Kuan, Y.-Y. Chen, J.-Y. Yen, National Taiwan Univ. (Taiwan)
- 7520 2P **Generation and characterization of spatially distributed laser produced plasma extreme ultraviolet source** [7520-96]
K.-P. Chang, Industrial Technology Research Institute (Taiwan); O. Morris, F. O'Reilly, P. Dunne, G. O'Sullivan, Univ. College Dublin (Ireland)
- 7520 2U **Evaluation of 172-nm wavelength as a possible candidate for 22-nm and below** [7520-101]
J.-H. You, E.-J. Kim, H.-K. Oh, Hanyang Univ. (Korea, Republic of)
- 7520 2V **The effect of UPW quality on photolithography defect** [7520-102]
W. H. Ng, S. I. Yet, C. Y. Liao, X-FAB Sarawak Sdn. Bhd. (Malaysia)
- 7520 2X **Relaxation properties of dielectric dipoles of photo resist materials** [7520-106]
H. Sasazaki, A. Kawai, Nagaoka Univ. of Technology (Japan)

- 7520 2Y **Spontaneous deformation of resist micro pattern due to van der Waals interaction**
[7520-107]
A. Kawai, T. Yamaji, Nagaoka Univ. of Technology (Japan)
- 7520 2Z **Micro bubble removal from micro pattern structure under alternating electric field**
[7520-108]
H. Sasazaki, A. Kawai, Nagaoka Univ. of Technology (Japan)
- 7520 32 **Durability of self-standing resist sheet composed with micro holes** [7520-112]
A. Takano, A. Kawai, Nagaoka Univ. of Technology (Japan)
- 7520 33 **PH control of water flowing in micro structure by local electrical field method** [7520-113]
A. Takano, A. Kawai, Nagaoka Univ. of Technology (Japan)
- 7520 34 **Micro bubble condensation in micro channel controlled by local electrical field method**
[7520-114]
S. Ohata, A. Kawai, Nagaoka Univ. of Technology (Japan)
- 7520 35 **In situ monitoring and control of photoresist parameters during thermal processing in the lithography sequence** [7520-115]
X. Wu, G. Yang, E. X. Lim, A. Tay, National Univ. of Singapore (Singapore)
- 7520 36 **Improving 1D optical proximity effect matching for 45-nm node by scatterometry metrology**
[7520-116]
D. Chang, R. Jungblut, J. Shieh, A. Chen, ASML Taiwan Ltd. (Taiwan); P. Hinnen, H. Megens, K. Schreel, ASML Netherlands B.V. (Netherlands)
- 7520 37 **Novel assist feature design to improve depth of focus in low k1 EUV lithography** [7520-117]
H. Kang, ASML Korea Co., Ltd. (Korea, Republic of)
- 7520 39 **Dissolved gas quantification and bubble formation in liquid chemical dispense** [7520-119]
G. Tom, W. Liu, Advanced Technology Materials Inc. (United States)

Author Index

Conference Committee

Conference Chairs

Alek C. Chen, ASML Taiwan Ltd. (Taiwan)
Woo-Sung Han, SAMSUNG Electronics Company, Ltd. (Korea, Republic of)
Burn J. Lin, Taiwan Semiconductor Manufacturing Company Ltd. (Taiwan)
Anthony Yen, Taiwan Semiconductor Manufacturing Company Ltd. (Taiwan)

Program Committee

Tsann-Bim Chiou, ASML Taiwan Ltd. (Taiwan)
Nigel R. Farrar, Cymer, Inc. (United States)
Koji Hashimoto, Toshiba Materials Company, Ltd. (Japan)
Naoya Hayashi, Dai Nippon Printing Company, Ltd. (Japan)
Tokuyuki Honda, Canon Inc. (Japan)
Peter Huang, United Microelectronics Corporation (Taiwan)
Hideki Ina, Canon Inc. (Japan)
Masaomi Kameyama, Nikon Corporation (Japan)
Ho-Young Kang, ASML Korea Company, Ltd. (Korea, Republic of)
Nelson Lai, Powerchip Semiconductor Corporation (Taiwan)
Edmund Y. Lam, The University of Hong Kong (Hong Kong, China)
Benjamin Szu-Min Lin, Cymer Southeast Asia, Ltd. (Taiwan)
Wen-Yi Lin, AU Optronics Corporation (Taiwan)
Mark Neisser, AZ Electronic Materials USA Corporation (United States)
Hye-Keun Oh, Hanyang University (Korea, Republic of)
Junichi Onodera, Tokyo Ohka Kogyo Company, Ltd. (Japan)
Christopher J. Progler, Photronics, Inc. (United States)
Kuen-Yu Tsai, National Taiwan University (Taiwan)
Geert Vandenberghe, IMEC (Belgium)
Dong-Gyu Yim, Hynix Semiconductor Inc. (Korea, Republic of)
Gary Guohong Zhang, The Dow Chemical Company (United States)

Session Chairs

- 1 Plenary Session
Alek C. Chen, ASML Taiwan Ltd. (Taiwan)
Woo-Sung Han, SAMSUNG Electronics Company, Ltd. (Korea, Republic of)

- 2 EUV Lithography and Emergent Technology I
Jack Jeng-Horng Chen, Taiwan Semiconductor Manufacturing Company Ltd. (Taiwan)
Ho-Young Kang, ASML Korea Company, Ltd. (Korea, Republic of)
- 3 Computational Litho: SMO
Edmund Lam, The University of Hong Kong (Hong Kong, China)
Tim Chen, ASML Taiwan Ltd. (Taiwan)
- 4 Metrology and Process Control I
Kuen-Yu Tsai, National Taiwan University (Taiwan)
Arthur Tay, National University of Singapore (Singapore)
- 5 Resist Material and Processing I
Mark Neisser, AZ Electronic Materials USA Corporation (United States)
Benjamin Szu-Min Lin, Cymer Southeast Asia, Ltd. (Taiwan)
- 6 EUV Lithography and Emergent Technology II
Stephen D. Hsu, Brion Technologies, Inc. (United States)
Hye-Keun Oh, Hanyang University (Korea, Republic of)
- 7 Computational Litho
Geert Vandenbergh, IMEC (Belgium)
Kuen-Yu Tsai, National Taiwan University (Taiwan)
- 8 Optical Lithography and Extension
Stephen D. Hsu, Brion Technologies, Inc. (United States)
Tsann-Bim Chiou, ASML Taiwan Ltd. (Taiwan)
- 9 Optical Lithography: Mask
Naoya Hayashi, Dai Nippon Printing Company, Ltd. (Japan)
Geert Vandenbergh, IMEC (Belgium)
- 10 Metrology and Process Control II
Tsann-Bim Chiou, ASML Taiwan Ltd. (Taiwan)
Benjamin Szu-Min Lin, Cymer Southeast Asia, Ltd. (Taiwan)
- 11 Double Patterning and Double Processing
Chun-Kuang Chen, Taiwan Semiconductor Manufacturing Company Ltd. (Taiwan)
Hye-Keun Oh, Hanyang University (Korea, Republic of)
- 12 Resist Material and Processing II
Mark Neisser, AZ Electronic Materials USA Corporation (United States)

- 13 Computational Litho II
Ho-Young Kang, ASML Korea Company, Ltd. (Korea, Republic of)
Tsann-Bim Chiou, ASML Taiwan Ltd. (Taiwan)
- Best Student Paper Award
Alek C. Chen, ASML Taiwan Ltd. (Taiwan)
Woo-Sung Han, SAMSUNG Electronics Company, Ltd. (Korea, Republic of)
Burn J. Lin, Taiwan Semiconductor Manufacturing Company Ltd. (Taiwan)
Anthony Yen, Taiwan Semiconductor Manufacturing Company Ltd. (Taiwan)

Introduction

Welcome to the 2009 Lithography Asia conference held in Taipei, Taiwan. This is the second year in a row that we have held a general conference on lithographic science and technology in Asia. This conference demonstrated the continuing increase in research and development activities in lithography in Asia. We are very pleased to have been the chairs of this conference, and in this volume you will find papers describing some very exciting developments in many fields.

2009 was not the best year for the economy. With great uncertainty in world markets, there is no doubt that times are troubled; although, a sign of recovery appears toward the end of the year. In spite of that, we were very pleased to see a fairly robust attendance for this year. This demonstrates an industry wide willingness to continue to pursue research, creativity, and innovation to address manufacturing problems, and it gives great hope for the future of these promising technologies.

We have seen promising development not only in the EUV Lithography but also in parallel e-beam technology. Also, outstanding work was presented on the double patterning/process technology as well as on the source mask optimization to extend the life of water immersion ArF lithography. Of course, we received significant numbers of paper on the continual innovative work on process control including related metrology technology, mask fabrication and especially on lithographic material and process advancement.

We are very impressed by the strength and diversity of the work presented here; we hope you are as well. Of course, this would not be possible without the help of the conference Program Committee, and the SPIE staff. We thank them especially for their contributions in making this conference a success.

Alek C. Chen
Woo-Sung Han
Burn J. Lin
Anthony Yen

