PHOTOMASK TECHNOLOGY

The premier international technical meeting for the photomask industry

Advance Technical Program

Monterey Conference Center and Monterey Marriott
Monterey, California, USA
Conferences:
29 September–1 October 2015
Exhibition:
29–30 September 2015

www.spie.org/pm15program

Co-located with SPIE Scanning Microscopies 2015
One registration fee, two conferences
Join your peers in Monterey for the semiconductor mask industry’s largest and most important annual event. SPIE Photomask Technology addresses a number of critical topics in the photomask industry, including current technical issues, emerging technologies, and future trends.

Keynote Presentation

Tuesday 29 September 2015 · 8:20 to 9:00 am
Location: Steinbeck Forum

Lithography and Mask Challenges at the Leading Edge

Harry J. Levinson
Senior Director, GLOBALFOUNDRIES Inc.

Continued scaling using multiple patterning is resulting in large increases in mask counts. Mask defect inspection times are increasing much faster than write times. Pushing optical lithography to its limits necessitates exceedingly tight mask-making process control. The use of EUV lithography introduces many new technical challenges associated with a mask architecture very different from optical masks. Because of higher resolution, smaller defects and LER at higher spatial frequencies print with EUV lithography than with optical lithography.

Dr. Levinson spent most of his career working in the field of lithography, starting at AMD. He then spent some time at Sierra Semiconductor and IBM before returning to AMD – now GLOBALFOUNDRIES – in 1994. During the course of his career, Dr. Levinson has applied lithography to many different technologies, including bipolar memories, 64Mb and 256Mb DRAM development, the manufacturing of applications-specific integrated circuits, thin film heads for magnetic recording, flash memories and advanced logic. He was one of the first users of 5x steppers in Silicon Valley and was an early participant in 248 nm and 193 nm lithography.
Contents

Invitation .................................. 2
Daily Event Schedule ........................ 3
Exhibition .................................. 4
Sponsors .................................. 5
Special Events and Reception .............. 6-7
Conference .............................. 8-11
Proceedings of SPIE ........................ 12
General Information ..................... 14–16
Policies ................................ 18–19

SPIE GREEN INITIATIVE

As host to events that bring together scientists and engineers from around the globe, SPIE is committed to making our symposia as environmentally friendly as possible.

Ongoing efforts of SPIE include using non-disposable materials such as glass plates and metal flatware as often as possible, and encouraging facilities to donate surplus meals to soup kitchens. Many partnering facilities have robust recycling programs for paper, plastic, and aluminum products. SPIE continues to collaborate with venues, hotels, suppliers and the local Chambers of Commerce to assess and ease the conference’s environmental impact. SPIE is currently working to implement solutions from the Green Meetings Industry Council guidelines with a goal to take our environmental efficiency to a whole new level.

When at this event, SPIE encourages you to take advantage of recycling bins, to reuse towels at your hotel, and to carpool whenever transportation is required during your stay in Monterey.

SPIE is the international society for optics and photonics, an educational not-for-profit organization founded in 1955 to advance light-based technologies. The Society serves nearly 264,000 constituents from 166 countries, offering conferences, continuing education, books, journals, and a digital library in support of interdisciplinary information exchange, professional networking, and patent precedent. SPIE provided more than $4 million in support of education and outreach programs in 2014.

VISIT THE SPIE PHOTOMASK TECHNOLOGY WEBSITE TO MAKE YOUR TIME IN MONTEREY A SUCCESS!

- Up-to-date paper listings, session times, participants, and locations
- New exhibiting companies and activities on the show floor
- Hotel, travel, and parking information
- Full registration information and pricing

Reserve Hotel Rooms by: 4 SEPTEMBER 2015

Registration Rates Increase after: 11 SEPTEMBER 2015
Plan to Attend

On behalf of SPIE, BACUS, and the Organizing Committee, we invite you to attend the 35th Annual SPIE/BACUS Photomask Symposium in Monterey, California.

In 2015, mask making and mask makers continue to support the requirements for more complex optical extensions to realize 10 nm and below. These elements will continue to put pressure on the industry. The mask makers must excel at optical multiple patterning, EUV, NIL, DSA and all the other varieties of photolithography to support the wafer technology with patterning solutions. As EUV lithography continues to move closer to volume manufacturing, we shall focus on EUV reticles and related infrastructures as a key enabler. We also continue to discuss how 450mm wafers implementation, scaling of non-IC patterning such as display panel and MEMS, will impact the mask industry.

This year we start the conference off with a Keynote Presentation from Harry J. Levinson, GLOBALFOUNDRIES Inc. We have 2 joint sessions planned with the co-located Scanning Microscopies conference.

We hope that you will be joining us in beautiful Monterey, California, 29 September - 1 October 2015. Not only will you have a great experience attending the sessions, you will also have fun on the California coast in the middle of its best season.
<table>
<thead>
<tr>
<th>TUESDAY 29 September</th>
<th>WEDNESDAY 30 September</th>
<th>THURSDAY 1 October</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHOTOMASK TECHNOLOGY 2015</strong></td>
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<td></td>
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<tr>
<td>Opening Remarks and Award Presentation</td>
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<td>8:15 am to 8:20 am</td>
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<tr>
<td><strong>SESSION 1:</strong> Keynote Session</td>
<td><strong>SESSION 6:</strong> Scanning Beam Technologies and Applications: Joint Session with Photomask and Scanning Microscopies</td>
<td><strong>SESSION 10:</strong> Invited and Best Papers, 8:30 am to 9:40 am (Session Chairs: Uwe F. W. Behringer, Brian J. Grenon)</td>
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<td>8:20 am to 9:00 am</td>
<td>8:30 to 10:10 am, (Session Chairs: Michael T. Postek, Jan Hendrik Peters)</td>
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<td><strong>KEYNOTE PRESENTATION</strong></td>
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<td>Lithography and Mask Challenges at the Leading Edge, Harry J. Levinson</td>
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<tr>
<td><strong>SESSION 2:</strong> Invited Session: Joint Session with Photomask and Scanning Microscopies, 9:00 to 10:30 am (Session Chairs: Naoya Hayashi, Bryan S. Kasprowicz, Michael T. Postek)</td>
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<td><strong>SESSION 7:</strong> EUV Simulation, 10:40 am to 12:00 pm (Session Chairs: Paul C. Allen, Banqiu Wu)</td>
<td><strong>PANEL DISCUSSION:</strong> EUV Mask Readiness: Where are we? 10:30 am to 12:30 pm, Moderators: Bryan S. Kasprowicz, Photronics, Inc. and Naoya Hayashi</td>
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<td><strong>SESSION 8:</strong> Photomask Technology for Alternating Lithography: NIL, 1:30 pm to 2:30 pm (Session Chairs: Douglas J. Resnick, Uwe Dietze)</td>
<td><strong>SESSION 11:</strong> Metrology and Inspection, 2:00 pm to 3:20 pm (Session Chairs: Mark M. Wylie, Mark T. Jee)</td>
</tr>
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<td><strong>SESSION 4:</strong> EUV Mask Infrastructure Readiness, 2:00 pm to 3:30 pm (Session Chairs: Emily E. Gallagher, Thomas B. Faure)</td>
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<td><strong>SESSION 9:</strong> Mask Data Preparation and Mask Process Correction, 3:50 pm to 5:30 pm (Session Chairs: Bala Thumma, Linyong Pang)</td>
<td><strong>SESSION 12:</strong> Patterning and Process, 3:50 pm to 5:30 pm (Session Chairs: Kenichi Saito, Russell B. Cinque)</td>
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<td><strong>SESSION 5:</strong> Student Session, 4:00 pm to 6:00 pm (Session Chairs: Bryan S. Kasprowicz, Jim N. Wiley)</td>
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<td><strong>EXHIBITION</strong> - 10:00 AM TO 4:00 PM</td>
<td><strong>POSTER/EXHIBITION RECEPTION</strong> 6:00 to 7:30 pm One ticket included with your full registration</td>
<td><strong>PHOTOMASK RECEPTION</strong> 6:00 to 8:00 pm</td>
</tr>
<tr>
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- Co-located Sessions with Scanning Microscopies
The SPIE Photomask Technology Exhibition, the mask-making industry’s premier event.

JOIN US AS AN EXHIBITOR OR WALK THE FLOOR TO MEET KEY SUPPLIERS.

STAY UP TO DATE ON INDUSTRY TRENDS. SEE THE LATEST IN:
- Mask Making
- Mask Application
- Emerging Mask Technologies
- Mask Business

LOOK WHO IS EXHIBITING!
Join us as an exhibitor or walk the floor to meet key suppliers of mask components, software, and manufacturing equipment. Exhibition List (Current as of 6/15/2015)
- Carl Zeiss SMS GmbH
- Cyber Optics Corp.
- Ibss Group, Inc.
- INKO Industrial Corp.
- Micro Lithography, Inc.
- Mitsui Chemicals America, Inc.
- MSP Corporation
- Nippon Control System Corp.
- Pozzetta, Inc.
- RAVE LLC
- S&S Tech
- Shin-Etsu MicroSi
- Solid State Technology
- Synopsys, Inc

“This conference is critical for getting the core people together to have discussions. The exchange of technology really helps us to innovate new technologies and that’s what we need with all these emerging markets.”

– Petrie Yam
KLA-Tencor
SPIE thanks the following sponsors for their generous support.*

<table>
<thead>
<tr>
<th>BANNERS</th>
<th>BREAKFAST BREADS</th>
<th>BREAKFAST BREADS</th>
<th>COFFEE BREAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;S TECH</td>
<td>ULCOAT FOR CREATIVE Fine &amp; BRIGHT PRODUCTS</td>
<td>TOPPAN</td>
<td>Nikon</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COFFEE BREAK</th>
<th>COFFEE BREAK</th>
<th>COFFEE BREAK</th>
<th>CONFERENCE BAGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NuFlare</td>
<td>Photronics</td>
<td>RAVE Nanomachining</td>
<td>Synopsys</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOOR DECALS</th>
<th>GENERAL SPONSOR</th>
<th>GENERAL SPONSOR</th>
<th>GENERAL SPONSOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zeiss</td>
<td>Applied Materials</td>
<td>Cyberoptics</td>
<td>Mli Micro Lithography, Inc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GENERAL SPONSOR</th>
<th>INTERNET PAVILION</th>
<th>LANYARDS</th>
<th>LUNCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSP</td>
<td>Jeol</td>
<td>Zeiss</td>
<td>Applied Materials</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LUNCH CO-SHARE</th>
<th>METERBOARD</th>
<th>PHOTOMASK RECEPTION - BEER/WINE</th>
<th>RECEPTION ENTERTAINMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mentor Graphics</td>
<td>S&amp;S TECH</td>
<td>Hoya</td>
<td>Ulcoat For Creative Fine &amp; Bright Products</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RECEPTION ENTERTAINMENT</th>
<th>RECEPTION ENTERTAINMENT</th>
<th>SESSION NOTEPAD</th>
<th>STAIRWAY STRIPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam Initiative</td>
<td>TEL</td>
<td>Advantest</td>
<td>Kla-Tencor</td>
</tr>
</tbody>
</table>

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<tr>
<th>STAIRWAY STRIPS</th>
<th>MEMORY STICKS</th>
<th>WI-FI</th>
<th>GENERAL SPONSOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma-Therm</td>
<td>S&amp;S TECH</td>
<td>Shin-Etsu MicroSi</td>
<td>Ulcoat For Creative Fine &amp; Bright Products</td>
</tr>
</tbody>
</table>

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*as of 16 June 2015
Poster Viewing
10:00 am to 3:00 pm
Poster authors may set up their poster papers between 10:00 am and 4:00 pm on Tuesday and will leave them up until Wednesday afternoon. Authors will be present during the Poster Reception 6:00 to 7:30 pm Tuesday to answer questions and provide in-depth discussion regarding their papers.

Wednesday Lunch
12:00 to 1:30 pm
Buffet style lunches are served Tuesday, Wednesday, and Thursday. Admission is included with your paid Photomask Registration. Extra guest tickets may be purchased at the SPIE Registration Desk.

Photomask Reception
Don’t Miss the Photomask Reception
6:00 to 8:00 pm · Marriott San Carlos Ballroom
Make plans to join your colleagues and friends at the annual Photomask Reception. This year’s event focuses on good food, beverages, and plenty of time to socialize or talk business with fellow conference attendees. Awards, entertainment, and other presentations will be included in the evening.
Admission is included with your paid Photomask registration. Extra guest tickets may be purchased with your preregistration or onsite (we highly recommend purchasing in advance to assure your reservation).
Thursday 1 October.

PANEL DISCUSSION
10:20 am to 12:30 pm
EUV Mask Readiness: Where Are We?
Moderators: Bryan S. Kasprowicz, Photronics, Inc. and Naoya Hayashi, Dai Nippon Printing Co., Ltd.
Panelists: Laurent Tuo, Taiwan Semiconductor Manufacturing Co. Ltd.; Jeff Farnsworth, Intel Corp., Peter D. Buck, Mentor Graphics Corp.; Emily E. Gallagher, IMEC; Jan Hendrik Peters, Carl Zeiss SMS GmbH; Yalin Xiong, KLA-Tencor Corp.; Takahiro Onoue, HOYA Corp.

What mask challenges currently exist to introduce EUV into manufacturing? Which are show-stoppers? What are the workarounds while solutions are being developed?

Thursday Lunch
12:30 to 2:00 pm
Buffet style lunches are served Tuesday, Wednesday, and Thursday. Admission is included with your paid Photomask Registration. Extra guest tickets may be purchased at the SPIE Registration Desk.

Light-based technologies respond to the needs of humankind

Join us in celebrating the International Year of Light

The International Year of Light is a global initiative highlighting to the citizens of the world the importance of light and light-based technologies in their lives, for their futures, and for the development of society.

We hope that the International Year of Light will increase global awareness of the central role of light in human activities and that the brightest young minds continue to be attracted to careers in this field.

For more information on how you and your organization can participate, visit www.spie.org/IYL
CONFERENCE 9635

Tuesday–Thursday 29 September–1 October 2015 • Proceedings of SPIE Vol. 9635

Photomask Technology 2015

Conference Chair: Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan)
Conference Co-Chair: Bryan S. Kasprowicz, Photronics, Inc. (USA)

Program Committee: Frank E. Abboud, Intel Corp. (USA); Paul W. Ackmann, GLOBALFOUNDRIES Inc. (USA); Lucien Bouchard, Photronics, Inc. (USA); Ron R. Rozak, RAVE LLC (USA); Russell B. Cinque, JEOL USA Inc. (USA); Uwe Dietze, SUSS MicroTec Inc. (USA); Aki Fujimura, D2S, Inc. (USA); Emily E. Gallagher, IMEC (USA); Rik Jonckheere, IMEC (Belgium); Byung Gook Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Shy-Jay Lin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); Pieter J. Mangat, GLOBALFOUNDRIES Inc. (USA); M. Warren Montgomery, SUNY College of Nanoscale Science and Engineering (USA); Linyong Pang, D2S, Inc. (USA); Kenichi Saito, NuFlare Technology, Inc. (Japan); Thomas Scherübl, Carl Zeiss SMS GmbH (Germany); Steffen F. Schulze, Mentor Graphics Corp. (USA); Anna Tchikoulaeva, Lasertec U.S.A., Inc. Zweigniederlassung Deutschland (Germany); Banqiu Wu, Applied Materials, Inc. (USA); Stefan Wurm, SEMATECH Inc. (USA); Mark Wylie, KLA-Tencor Idaho (USA)

TUESDAY 29 SEPTEMBER

OPENING REMARKS AND AWARD PRESENTATION ............... 8:15 AM TO 8:20 AM
Session Chairs: Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan); Bryan S. Kasprowicz, Photronics, Inc. (USA)
2015 BACUS SCHOLARSHIP AWARD
Presented to
Yow-Gwo (Henry) Wang
Univ. of California at Berkeley

SESSION 1 .................. TUE 8:20 AM TO 9:00 AM
Keynote Session
Harry J. Levinson
Senior Director
GLOBALFOUNDRIES Inc.
Lithography and Mask Challenges at the Leading Edge (Keynote Presentation), Harry J. Levinson, GLOBALFOUNDRIES Inc. (USA) ........................................... [9635-1]

SESSION 2 .................. TUE 9:00 AM TO 10:30 AM
Invited Session
Joint with Photomask and Scanning Microscopies
Session Chairs: Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan); Bryan S. Kasprowicz, Photronics, Inc. (USA); Michael T. Postek, National Institute of Standards and Technology (USA)
EUV lithography scanner and mask optimization for sub-8nm resolution (Invited Paper), Jan van Schoot, Koen van Ingen Schenau, Carsten Troost, ASML Netherlands B.V. (Netherlands); John D. Zimmerman, ASML (USA); Sascha Migura, Jens Timo Neumann, Bernhard Kneer, Carl Zeiss SMT GmbH (Germany). ........................................... [9635-2]
Scanning microscopy: The next 50 years (Invited Paper), David C. Joy, The Univ. of Tennessee Knoxville (USA) .................. [9635-1]
How to make EUV work! (Invited Paper), Hermann Gerlinger, Carl Zeiss SMT GmbH (Germany) ........................................... [9635-3]

SESSION 3 .................. TUE 11:00 AM TO 12:30 PM
Edge Placement Error Issue and Solution for Multi-Patterning
Session Chairs: Peter D. Buck, Mentor Graphics Corp. (USA); Aki Fujimura, D2S, Inc. (USA)
Accurate mask registration on tilted lines for 6F2 DRAM manufacturing, Frank Laske, KLA-Tencor MIE GmbH (Germany); Wonsok Choi, SK Hynix, Inc. (Korea, Republic of); Michael Ferber, KLA-Tencor MIE GmbH (Germany); Mehdi Daneshshahah, KLA-Tencor Corp. (USA); Eric Kwon, KLA-Tencor Korea (Korea, Republic of); Klaus-Dieter Roeth, KLA-Tencor MIE GmbH (Germany); Youngmo Lee, Sangpyo Kim, Donggyu Yim, SK Hynix, Inc. (Korea, Republic of) ........ [9635-5]
Higher order feed-forward control of reticle writing error fingerprints, Richard J. F. van Haren, ASML Netherlands B.V. (Netherlands) ......... [9635-6]
Exploring the origin of pattern positioning errors induced by the charging effect in mask making using e-beam writers, Chien-Cheng Chen, Tzu-Ling Liu, Shao-Wen Chang, Chia-Jen Chen, Chih-Cheng Lin, Hsin-Chang Lee, Anthony Yen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) .................. [9635-7]
Lunch/Exhibition Break .................. Tue 12:30 pm to 2:00 pm

SESSION 4 .................. TUE 2:00 PM TO 3:30 PM
EUV Mask Infrastructure Readiness
Session Chairs: Emily E. Gallagher, IMEC (Belgium); Thomas B. Faure, IBM Corp. (USA)
EUV mask infrastructure readiness and gaps for TD and HVM (Invited Paper), Ted Liang, Brittany McClinton, John Magana, Guojie Zhang, Kishore Chakravorty, Eric Panning, Rajesh Nagpal, Intel Corp. (USA) ........ [9635-8]
Fabrication of a full-size EUV pellicle based on silicon nitride, Dario L. Goldfarb, IBM Thomas J. Watson Research Ctr. (USA) .......... [9635-9]
Detection capability enhancement with a learning system for PEM mask inspection tool, Ryoichi Hirano, EULV Infrastructure Development Ctr., Inc. (Japan); Masahiro Hatakeyama, Kenji Terao, EBARA Corp. (Japan); Hidehiro Watanabe, EUVL Infrastructure Development Ctr., Inc. (Japan) ........ [9635-10]
Film loss-free cleaning chemicals for EUV mask lifetime elongation developed through combinatorial chemical screening, Jaeyouk Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) ........ [9635-11]
The study of mask shadowing defect on absorber defect to improve EUV actinic pattern inspection, Yow-Gwo Wang, Univ. of California, Berkeley (USA) and Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Univ. of California, Berkeley (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA).  

ILP-based co-optimization of cut-mask layout, dummy fill and timing for sub-14nm BEOL technology, Kwangsoo Han, Andrew B. Kangh, Hyein Lee, Lutong Wang, Univ. of California, San Diego (USA).  

Phase retrieval algorithms for patterned mask metrology in EUV, Rene A. Claus, Yow-Gwo Wang, Univ. of California, Berkeley (USA); Antoine J. Woydyla, Markus P. Benk, Kenneth A. Goldberg, Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Univ. of California, Berkeley (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA); Laura Waller, Univ. of California, Berkeley (USA).  

Absorption dependence of phase edge effects in OMOG masks, Aamod Shanker, Univ. of California, Berkeley (USA); Martin Sczytska, Falk Lange, Advanced Mask Technology Ctr. GmbH Co. KG (Germany); Brid Connolly, Toppman Photomasks, Inc. (Germany); Laura Waller, Andrew R. Neureuther, Univ. of California, Berkeley (USA).  

PMJ Best Student Paper: Extreme ultraviolet mask observations using a coherent extreme ultraviolet scatterometry microscope with a high-harmonic-generation source, Takahiro Fujiino, Yusuke Tanaka, Tetsuo Harada, Univ. of Hyogo (Japan); Yutaka Nagata, RIKEN (Japan); Takeo Watanebe, Hiro Kinoshita, Univ. of Hyogo (Japan).  

EMLC Best Student Paper: TBD.  

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**Poster/Exhibition Reception**

**TUE 6:00 PM TO 7:30 PM**

Symposium attendees are invited to attend the Poster/Exhibition Reception on Tuesday evening in the Serra Grand Ballroom. The reception provides an opportunity for attendees to meet with colleagues, network, view poster papers and interact with the authors, and visit the exhibition booths. Refreshments will be served. Attendees are requested to wear their conference registration badges.

**ADDITIONAL POSTER VIEWING**

Tuesday 29 September ................................. 10 am to 4 pm  
Wednesday 30 September ............................. 10 am to 3 pm  

Attendees are requested to wear their conference registration badges.

**POSTER SESSION ................. TUE 6:00 PM TO 7:30 PM**

EUV Masks

Automatic defect review for EUV photomask reticles by atomic force microscope, Ardavan Zandiatashbar, Byong Kim, Young-kook Yoo, Keibock Lee, Park Systems Inc. (USA); Ahjin Jo, Ju Suk Lee, Sang-Joon Cho, Sang-il Park, Park Systems Corp. (Korea, Republic of).  

Ruthenium capping layer preservation for 100X clean through pH driven effects, Davide Dattilo, SUSS MicroTec Photomask Equipment GmbH & Co. KG (Germany); Jyh-Wei Hsu, SUSS MicroTec (Taiwan) Co., Ltd. (Taiwan); Uwe Dietze, SUSS MicroTec Inc. (USA).  

Process capability of etched multilayer EUV mask, Kosuke Takai, Takashi Kamo, Noriko Iida, Toshiba Corp. (Japan); Yasutaka Morikawa, Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan).  

Actinic review of EUV masks: status and recent results of the AIMS™ EUV System, Sascha Perlitz, Markus Weiss, Kark Hellweg, Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Univ. of California, Berkeley (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA); Laura Waller, Univ. of California, Berkeley (USA).  

OPC and MPC options to correct systematic CD offsets for implant layers, Nan Fu, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany); Guo Xiang Ning, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (USA); Florian Werle, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany); Stefan Roiling, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Paul W. Ackmann, GLOBALFOUNDIONS Inc. (USA); Christian Buergerl, Advanced Mask Technology Ctr. GmbH Co. KG (Germany).  

Material and Process

Attenuated phase-shift mask (PSM) blanks for flat panel display, Kagehiro Kageyama, Satoru Mochizuki, Hiroyuki Yamakawa, Shigeru Uchida, ULVAC Coating Corp. (Japan).  

Advanced repair solution of clear defects on HTSMP by using nanomachining tool, Hyemi Lee, MunSik Kim, Hoyong Jung, Sangpyo Kim, Donggyu Yim, SK Hynix, Inc. (Korea, Republic of).  

Exposure characterizations of polymer type electron-beam resist with various molecular weights for next-generation photomask, Tomohiro Takayama, Hironori Asada, Yukiko Kishimura, Yamaguchi Univ. (Japan); Ryochi Hoshino, Atsushi Kawata, Gluon Lab., LLC (Japan).  

New grade of 9-inch size mask blanks for 450mm wafer process (2015), Noriyuki Harashima, ULVAC Coating Corp. (Japan).  

Printability evaluation of programmed defects on OMOG masks, Irene Shi, Eric Guo, Max Lu, Catherine Ren, Bojan Yan, Rivan Li, Eric Tian, Semiconductor Manufacturing International Corp. (China).  

Mask repair and verification for the next generation, Vic Kley, Attoscopy, Inc. (USA).  

Investigation of scum type growing defects on attenuated PSM and its prevention, Jiwhan Choi, Yongho Kim, Dong-Wook Lee, Hoyong Jung, Sangpyo Kim, Donggyu Yim, SK Hynix, Inc. (Korea, Republic of).
**Metrology**

A study of in die mask overlay control for 14nm double-patterning lithography, Chin-kuei Chang, William Chou, J. K. Wu, Chain Ting Huang, Ming Jui Chen, Simon C. C. Hsu, Y. C. Pai, United Microelectronics Corp. (Taiwan). .................................................. [9635-60]

Reduction of in-lot overlay variation with integrated metrology, and a holistic control strategy. Hong-Goo Lee, Sang-Jun Han, Won Kwang Ma, Young-Sik Kim, Noh-Jung Kwak, SK Hynix, Inc. (Korea, Republic of); Paul Böcker, David Deckers, Kevin Ryan, Elliott McNamara, ASML Netherlands B.V. (Netherlands); Gyu-Hyun Shin, Kyu-Tae Sun, ASML Korea Co., Ltd. (Korea, Republic of); Young-Wan Lim, ASML Netherlands B.V. (Korea, Republic of); Jin-Moo Byun, Jung-Joon Suh, ASML Korea Co., Ltd. (Korea, Republic of). .................................................. [9635-61]

Novel CD control of HTSPM by advanced process for sub-20nm tech, Sang Jin Jo, Chunseo Choi, SungHyun Oh, Tae-Joong Ha, Youngmo Lee, Sanggyo Kim, Donggyu Yim, SK Hynix, Inc. (Korea, Republic of). .................................................. [9635-62]

A study of reticle CD behavior for inter-area pattern loading difference, Dai Nippon Printing Co., Ltd. (Japan); Lynne Gignac, Christopher M. Breslin, Jemima Gonsalves, (Invited Paper).

**SESSION 6 ....................... WED 8:30 AM TO 10:10 AM**

Scanning Beam Technologies and Applications

**Joint Session with Photomask and Scanning Microscopies**

Session Chairs: Michael T. Postek, National Institute of Standards and Technology (USA); Jan Hendrik Peters, Carl Zeiss SMS GmbH (Germany)

Very-high energy (300-400 keV) SEM imaging of Cu interconnects (Invited Paper), Lynne Gignac, Christopher M. Breslin, Jenima Gonsalves, Franco Stellari, Chu-Cheng Lin, IBM Thomas J. Watson Research Center (USA). .................................................. [9635-12]

Contour metrology: methodology and applications on metal patterning study for random-logic applications with 193nm (Invited Paper), Julien Maillart, Peter De Bisschop, IMEC (Belgium); Kristin De Meyer, IMEC (Belgium) and KU Leuven (Belgium). .................................................. [9635-18]

Application of gas field ion source to photomask repairs (Invited Paper), Fumio Aramaki, Tomokazu Kozakai, Osamu Matsuda, Hiroshi Oba, Yasuhiro Sugiyama, Kazuo Aita, Anto Yasaka, Hitachi High-Tech Science Corp. (Japan). .................................................. [9635-13]

The reparability of various pattern and material for 10nm lithography mask and beyond, Shingo Yoshikawa, Takeshi Kosuge, Taka Nishiguchi, Koichi Kanno, Hidemichi Imai, Masaaki Kurihara, Jun Matsumoto, Takeyuki Nakamura, Advantest Corp. (Japan); Shohei Matsushita, Daisuke Haru, D2S K.K. (Japan); Linyong Pang, D2S Inc. (USA). .................................................. [9635-67]

A study on the factors that affect the advanced mask defect verification, Sungha Woo, Heejeong Yang, Youngmoo Lee, Sanggyo Kim, Donggyu Yim, SK Hynix, Inc. (Korea, Republic of). .................................................. [9635-68]

Contour based two-dimension mask pattern metrology, Eric Tian, Semiconductor Manufacturing International Corp. (China); Hideaki Bandoh, Jinwei Wang, Holon Co., Ltd. (Japan); Eric Guo, Max Lu, Semiconductor Manufacturing International Corp. (China). .................................................. [9635-69]

Improvement accuracy of defect size measurement by automatic defect classification, Bhamidipati Samir, Sankaranarayanan Parinath Ayappan, Mentor Graphics (India) Pvt. Ltd. (India); Hong-Yul Jung, Gi-Sung Yoon, Dong-Hoon Chung, Chan-Uk Jeon, Samsung Electronics Co., Ltd. (Korea, Republic of); Mark Pereira, Mentor Graphics (India) Pvt. Ltd. (India). .................................................. [9635-70]

**Patterning**

The comparison of effects of a charging dissolution coating layer and an e-beam correction on a registration error, Chunseo Choi, Wonseok Choi, SungHyun Oh, Tae-Joong Ha, Sanggyo Kim, Donggyu Yim, SK Hynix, Inc. (Korea, Republic of). .................................................. [9635-71]

Quantitative analysis of CD error induced by the fogging effect in e-beam lithography, Shaowen Chang, Tzu-Yi Wang, Ta Cheng Lin, Chia-Jen Chen, Chih-Cheng Lin, Shin-Chang Lee, Anthony Yen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan). .................................................. [9635-72]

Model-based multiple patterning layout decomposition, Dafeng Guo, Haitong Tian, Martin D. F. Wong, Univ. of Illinois at Urbana-Champaign (USA). .................................................. [9635-73]

Experimental verification of SWHL physical concept and mask size optimization methods, Vitaly Chemik, Alexey Shamaev, Vadim I. Rakovsky, Michael Borisov, Dmitriy A. Chelyubeev, Petr A. Mikheev, Nanotech SWHL (Russian Federation). .................................................. [9635-74]

**WEDNESDAY 30 SEPTEMBER**

**SESSION 7 ....................... WED 10:40 AM TO 12:00 PM**

**EUV Simulation**

Session Chairs: Paul C. Allen, Toppan Photomasks, Inc. (USA); Banqiu Wu, Applied Materials, Inc. (USA)

Mask topography-induced phase aberrations in EUVL: impact, fundamental understanding, mitigation, Thorsten Last, Laurens C. de Winter, Jo Finders, ASML Netherlands B.V. (Netherlands). .................................................. [9635-20]

EUV photomask defects: What prints, what doesn’t, and what is required for HVM, Jed H. Rankin, Zhengjing J. Qi, Mark Lawliss, IBM Corp. (USA); Eiisuke Narita, Kazunori Seki, Toppan Photomasks, Inc. (USA); Karen D. Badger, Ravi K. Bonam, Scott D. Halle, Christina Turley, IBM Corp. (USA). .................................................. [9635-21]


Viability of pattern shift for defect-free EUV photomasks at the 7nm node, Zhengjing J. Qi, Jed H. Rankin, IBM Corp. (USA); Eiisuke Narita, Toppan Photomasks, Inc. (USA). .................................................. [9635-23]

Lunch/Exhibition Break. ........................................... Wed 12:00 pm to 1:30 pm
SESSION 11 ........................ THU 2:00 PM TO 3:20 PM
Metrology and Inspection
Session Chairs: Mark M. Wylie, KLA-Tencor Idaho (USA); Mark T. Lee, HOYA Corp. USA (USA)
From nightmares to sweet dreams: inspection of aggressive OPC on 14nm reticles (and beyond) using a novel high-NA and low-NA dual method, Karen D. Badger, Michael S. Hibbs, IBM Corp. (USA); Kazunori Seki, Toppan Photomasks, Inc. (USA); William H. Broadbent Jr., Vincent A. Redding, Trent Hutchinson, KLA-Tencor Corp. (USA). [9635-37]

Lunch Break .......................... Thu 12:30 pm to 2:00 pm

SESSION 12 ........................ THU 3:50 PM TO 5:30 PM
Patterning and Process
Session Chairs: Kenichi Saito, Canon Inc. (Japan); Russell B. Cinque, JEOI USA Inc. (USA)
Sensitivity analysis for the high-accuracy proximity effect correction, Kang-Hoon Choi, Fraunhofer-Institut für Photonic Mikrosysteme (Germany); Clyde H. Browning, Thiago Figueiro, Aselta Nanographics (France); Christoph K. Hohle, Fraunhofer-Institut für Photonic Mikrosysteme (Germany) and Fraunhofer-Ctr. Nanoelektronische Technologien (Germany); Mohamed Saib, Patrick Schiavone, Aselta Nanographics (France); Xaver Thrun, Fraunhofer-Ctr. Nanoelektronische Technologien (Germany) and Fraunhofer-Institut für Photonic Mikrosysteme (Germany). [9635-41]
Photomask etch process for 10nm technology node and beyond, Madhavi R. Chandrachood, Michael Grimmelbre, Kevan Yu, Tol-Yue B. Leung, Jeffrey X. Tran, Jeff Chen, Darin D. Bivens, Ryan S. Islamanchil, Richard E. Wistrom, Applied Materials, Inc. (USA); Thomas B. Faure, Peter Bartlau, Shawn Crawford, Xianyi Huang, Jeff Chen, IBM Corp. (USA). [9635-42]
High-durability phase-shift film with variable transmittance, Osamu Notsaka, HOYA Corp. (Japan). [9635-43]
Evaluation of multilayer defect repair viability and protection techniques for EUV masks, Takeshi Isogawa, Kazunori Seki, Toppan Photomasks, Inc. (USA); Mark Lawless, Zhengqiang Ji, Jie H. Hanakin, IBM Corp. (USA); Shingi Akima, Toppan Photomasks, Inc. (USA). [9635-44]
Relationship between mask surface wettability and cleaning effectiveness, Chen-Yang Lin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan). [9635-45]
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Tuesday 29 September .......................... 7:15 am to 4:00 pm
Wednesday 30 September ....................... 7:30 am to 4:00 pm
Thursday 1 October ............................ 8:00 am to 10:30 am

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Wednesday 30 September .............. 10:10 am and 3:00 pm
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