

**SPIE.** ADVANCED  
LITHOGRAPHY



INTERNATIONAL  
YEAR OF LIGHT  
2015



# ADVANCED LITHOGRAPHY.

TECHNICAL  
PROGRAM

[WWW.SPIE.ORG/AL](http://WWW.SPIE.ORG/AL)

Conferences & Courses  
22-26 February 2015

Exhibition  
24-25 February 2015

San Jose Marriott and  
San Jose Convention Center  
San Jose, California, USA



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**SPIE.** ADVANCED  
LITHOGRAPHY

TECHNICAL  
PROGRAM

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# Technologies for semiconductor lithography R&D, devices, tools, fabrication, and services.

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## LOCATION

San Jose Marriott and  
San Jose Convention Center  
San Jose, California, USA

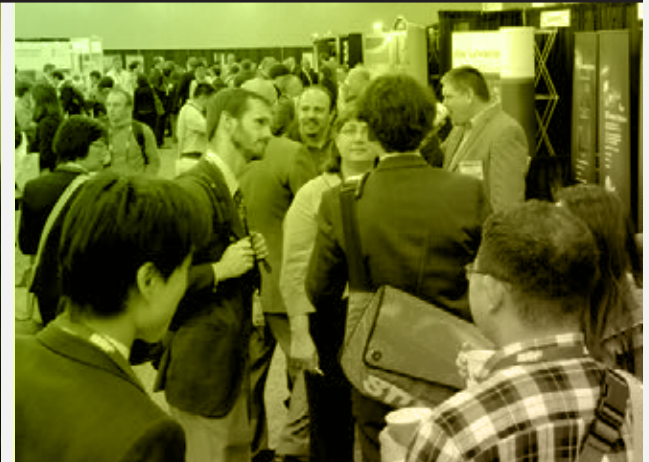
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## DATES

Conferences & Courses: 22-26 February 2015  
Exhibition: 24-25 February 2015

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## TECHNICAL CONFERENCES

<b>Extreme Ultraviolet (EUV) Lithography VI</b> <i>(Wood, Panning)</i> .....	18-52
<b>Alternative Lithographic Technologies VII</b> <i>(Resnick, Bencher, Cheng)</i> .....	18-54
<b>Metrology, Inspection, and Process Control for Microlithography XXIX</b> <i>(Cain, Sanchez)</i> .....	18-54
<b>Advances in Patterning Materials and Processes XXXII</b> <i>(Wallow, Hohle)</i> .....	18-51
<b>Optical Microlithography XXVIII</b> <i>(Lai, Erdmann)</i> .....	19-55
<b>Design-Process-Technology Co-optimization for Manufacturability IX</b> <i>(Sturtevant, Capodieci)</i> .....	19-55
<b>Advanced Etch Technology for Nanopatterning IV</b> <i>(Lin, Engelmann)</i> .....	19-39

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SPIE would like to express its deepest appreciation to the symposium chairs, conference chairs, program committees, session chairs, and authors who have so generously given their time and advice to make this symposium possible.

The symposium, like our other conferences and activities, would not be possible without the dedicated contribution of our participants and members. This program is based on commitments received up to the time of publication and is subject to change without notice.

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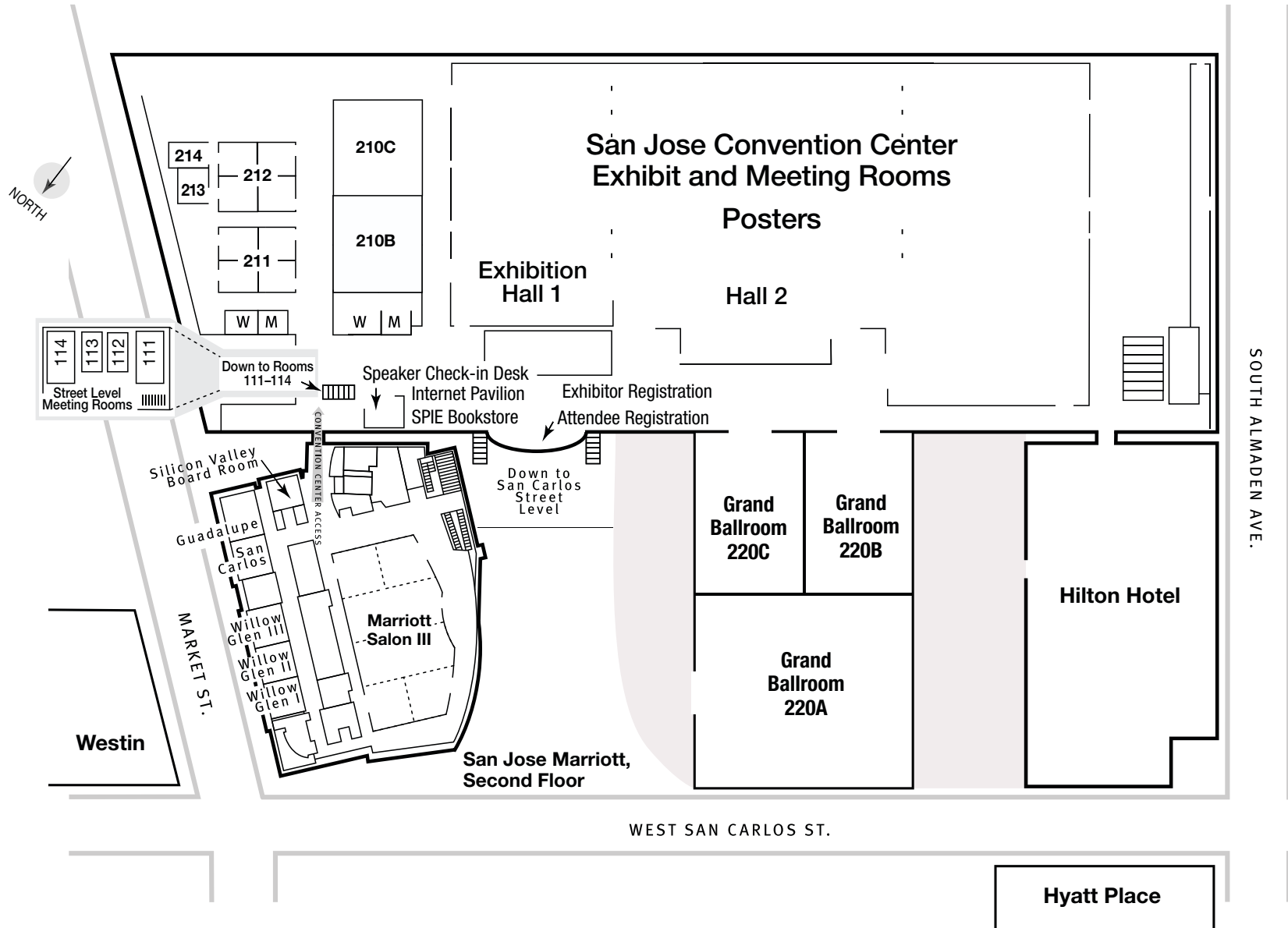
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# SAN JOSE CONVENTION CENTER AND MARRIOTT HOTEL 2ND LEVEL



# DAILY SCHEDULE

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
<p>Special Events</p> 	<p><b>Welcome and Announcements</b>, (<i>Dusa, Smith</i>), 8:00 to 8:40 am, p. 6</p> <p><i>Plenary presentation: Activities of the National Photonics Initiative</i>, (<i>Willner</i>), 8:30 to 9:10 am, p. 6</p> <p><i>Plenary presentation: Sustaining the Silicon Revolution: From 3D Transistors to 3D Integration</i>, (<i>Liu</i>), 9:10 to 9:50 am, p. 7</p> <p><i>Plenary presentation: Internet-of-Things: Cloud Platform and Industry Solutions</i>, (<i>Shen</i>), 9:50 to 10:30 am, p. 7</p> <p><b>Award Announcement for Conf. 9424: Presentation of the 2014 Diana Nyssonen Memorial Award for Best Paper</b>, 11:00 to 11:10 am, p. 9</p> <p><b>Award Announcements for Conf. 9425: Presentation of the 2014 C. Grant Willson Best Paper Award; the 2014 Hiroshi Ito Memorial Award for the Best Student Paper; and the 2015 Jeffrey Byers Memorial Best Poster Award</b>, 11:00 to 11:20 am, p. 9</p> <p><b>Nanotechnology in Microlithography Panel Discussion: Preparing for 3D 2.0: Metrology for the Next Wave of 3D Devices</b>, (<i>Barnes, Bunday, Kline</i>), 6:00 to 7:30 pm, p. 8</p>	<p><b>Panel Discussion: Dimensional Scaling, Design Optimization, and Metrology: What are we missing?</b> (<i>Liddle, Sanchez</i>) 5:00 to 6:30 pm, p. 8</p> <p><b>Poster/Exhibition Reception</b>, (Conferences 9422, 9423, 9425, 9428), 6:00 to 8:00 pm, p. 8</p> <p><b>EXHIBITION</b>, p.10 10:00 am to 5:00 pm; 6:00 to 8:00 pm</p> 	<p><b>Poster Reception</b>, (Conferences 9424, 9426, 9427), 6:00 to 8:00 pm, p. 8</p> <p><b>EXHIBITION</b>, p.10 10:00 am to 4:00 pm</p>	<p><b>Award Announcement for Conf. 9424: Presentation of the 2015 Karel Urbanek Best Student Paper Award</b>, 10:35 to 10:45 am, p. 9</p> <p><b>Award Announcement for Conf. 9426: Presentation of the 2015 Best Student Award in Microlithography</b>, 10:10 to 10:15 am, p. 9</p> <p><b>Award Announcement for Conf. 9427: Presentation of the Luigi Franco Cerrina Memorial Best Student Paper Award</b>, 4:00 to 4:10 pm, p. 9</p>
<p>Conferences</p>	<p><b>Extreme Ultraviolet (EUV) Lithography VI</b> (<i>Wood, Panning</i>), p. 18-52</p> <p><b>Alternative Lithographic Technologies VII</b> (<i>Resnick, Bencher, Cheng</i>), p. 18-54</p> <p><b>Metrology, Inspection, and Process Control for Microlithography XXIX</b> (<i>Cain, Sanchez</i>), p. 18-54</p> <p><b>Advances in Patterning Materials and Processes XXXII</b> (<i>Wallow, Hohle</i>), p. 18-51</p> <p><b>Optical Microlithography XXVIII</b> (<i>Lai, Erdmann</i>), p.19-55</p> <p><b>Design-Process-Technology Co-optimization for Manufacturability IX</b> (<i>Sturtevant, Capodieci</i>), p.19-55</p> <p><b>Advanced Etch Technology for Nanopatterning IV</b> (<i>Lin, Engelmann</i>), p. 19-39</p>			
<p>Courses</p> <p><b>Sunday and Monday Courses</b>, see page 15.</p>				

See Course descriptions and register for courses onsite.

# Welcome

## *Executive Committee*

**Christopher Bencher**, Applied Materials, Inc.  
**Jason P. Cain**, Advanced Micro Devices, Inc.  
**Luigi Capodici**, GLOBALFOUNDRIES Inc.  
**Mircea V. Dusa**, ASML US, Inc.  
**Sebastian U. Engelmann**, IBM Thomas J. Watson Research Ctr.  
**Andreas Erdmann**, Fraunhofer Institute of Integrated Systems and Device Technology  
**Christoph K. Hohle**, Fraunhofer Institute for Photonic Microsystems  
**Kafai Lai**, IBM Corp.  
**Qinghuang Lin**, IBM Thomas J. Watson Research Ctr.  
**Eric M. Panning**, Intel Corp.  
**Douglas J. Resnick**, Canon Nanotechnologies, Inc.  
**Martha I. Sanchez**, IBM Research - Almaden  
**Bruce W. Smith**, Rochester Institute of Technology  
**John L. Sturtevant**, Mentor Graphics Corp.  
**Thomas I. Wallow**, ASML Brion Technologies  
**Obert R. Wood II**, GLOBALFOUNDRIES Inc.

## *Advisory Committee*

**Robert D. Allen**, IBM Research - Almaden  
**William H. Arnold**, ASML US, Inc.  
**Timothy A. Brunner**, IBM Thomas J. Watson Research Ctr.  
**Ralph R. Dammel**, AZ Electronic Materials USA Corp.  
**Donis G. Flagello**, Nikon Research Corp. of America  
**Harry J. Levinson**, GLOBALFOUNDRIES Inc.  
**Burn Lin**, Taiwan Semiconductor Manufacturing Co., Ltd.  
**Chris A. Mack**, lithoguru.com  
**Wilhelm Maurer**, Infineon Technologies AG  
**Christopher J. Proglor**, Photonics, Inc.  
**Michael T. Postek**, National Institute of Standards and Technology  
**Luc Van den hove**, IMEC  
**C. Grant Willson**, The Univ. of Texas at Austin  
**Anthony Yen**, Taiwan Semiconductor Manufacturing Co., Ltd.

Lithography continues to be challenged with extending patterning toward physical limits while remaining manufacturable and cost effective. State-of-the-art processes are now largely carried out using immersion imaging combined with multiple-exposure and etch processes. This is done while striving to bring EUV lithography closer to production readiness. Along with all of this, the lithography community is aggressively pursuing other new patterning approaches and driving implementation of complementary solutions. Success calls for unique interdisciplinary interactions and coordinated efforts between lithographers, layout designers, materials scientists, and metrology/process control engineers to enable cost-efficient patterning solutions.

For the past 40 years, SPIE Advanced Lithography has played a key role in bringing together the micro- and nano-lithography communities. The addition of other patterning-related technology over the past several years has sought to solve the challenges presented by the continuous scaling of the semiconductor industry. A full spectrum of lithography and patterning topics are encompassed by this year's symposium across seven complementary conferences. Participants come from a broad array of backgrounds to share and learn about state-of-the-art lithographic tools, resists, metrology, materials, etch, design, and process integration. Through a series of provocative panel discussions and seminars, the symposium also probes current issues being faced as we extend current methods, move toward alternative approaches, and identify new ways to complement one technology with another.

Over the years, SPIE Advanced Lithography has provided the unique and primary forum for meeting and interacting with a wide range of industry experts, researchers, and key players working on patterning technology development. Attendance ensures that participants learn and share the latest developments in areas of central importance to many vital technology fields.

This year, SPIE Advanced Lithography is structured into the following conferences. Joint sessions between the conferences also offer opportunities to cover topics common across these interest areas.

- Alternative Lithographic Technologies
- Extreme Ultraviolet Lithography
- Metrology, Inspection, and Process Control for Microlithography
- Advances in Patterning Materials and Processing Technology
- Optical Microlithography
- Design-Process-Technology Co-optimization for Manufacturability
- Advanced Etch Technology for Nanopatterning

All conferences are organized by current practitioners of the art working together with organizing committees of experts in these fields. Numerous courses have also been organized, which are taught by recognized experts from industry and academia. Additional information is available from the many manufacturers' exhibits that allow tool makers, material suppliers, and software groups to showcase new products while interacting one-on-one with participants.

We welcome you to the 40th SPIE Advanced Lithography!



**Mircea V. Dusa**  
ASML US, Inc.  
2015 Symposium Chair



**Bruce W. Smith**  
Rochester Institute of Technology  
2015 Symposium Co-Chair

# SPECIAL EVENTS.

## Plenary Presentations

Monday 23 February · 8:00 AM to 10:30 AM  
Location: Convention Center 220A

### Welcome and Announcements

Monday 23 February 2015 · 8:00 AM - 8:30 AM  
Location: Convention Center 220A

*Symposium Chairs:* **Mircea V. Dusa**, ASML US, Inc. and  
**Bruce W. Smith**, Rochester Institute of Technology

### Introduction of New SPIE Fellows

### 12th Frits Zernike Award for Advances in Optical Microlithography

*Award Sponsored by:*

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*Plenary Presentations Sponsored by*

**ASML**



8:30 to 9:10 AM

### ACTIVITIES OF THE NATIONAL PHOTONICS INITIATIVE



#### **Prof. Alan Willner**

Sample Chaired Professor of Engineering  
Univ. of Southern California

The National Photonics Initiative was started by multiple professional societies as a result of a 2012 U.S. National Academies Study Recommendation in order to help enable the coordination of industry, government and academia in advancing issues of critical importance to our community. Key application areas that have been highlighted within the NPI include manufacturing, communications, health, defense, and sensing. This talk will describe the NPI, discuss several recent successes in advocacy and raising awareness, and explore the importance of the NPI to the semiconductor lithography and manufacturing communities.

**Alan Willner** (Ph.D., Columbia) worked at AT&T Bell Labs and Bellcore, and he is the Sample Chaired Professor of Engineering at USC. He received the Int'l Fellow of U.K. Royal Society of Engineering, IEEE Eric Sumner Award, NSF Presidential Faculty Fellows Award from White House, Guggenheim Foundation Fellowship, Packard Foundation Fellowship, Fulbright Foundation Senior Scholars Award, OSA Forman Eng. Excellence Award, IEEE Photonics Society Eng. Achievement Award, and Eddy Best Technical Paper Award from Pennwell. Prof. Willner is a Fellow of AAAS, IEEE, OSA, and SPIE. He was Co-Chair of National Academies Committee on Optics and Photonics, President of IEEE Photonics Society, Vice-President of OSA, Co-Chair of OSA Science and Engineering Council, General Co-Chair of CLEO, and Editor-in-Chief of Optics Letters, IEEE/OSA Journal of Lightwave Technology and IEEE JSTQE. Prof. Willner has over 1000 publications, including 1 book and 25 U.S. patents.



9:10 to 9:50 AM

## SUSTAINING THE SILICON REVOLUTION: FROM 3D TRANSISTORS TO 3D INTEGRATION



### Dr. Tsu-Jae King Liu,

Chair of the Dept. of Electrical Engineering and Computer Sciences, Univ. of California, Berkeley

Steady advancement in integrated circuit (IC) manufacturing and design over the past five decades has resulted in the proliferation of information technology, with dramatic impact on virtually every aspect of life in modern society. Today, three-dimensional (3D) transistor structures are being adopted in the most advanced processes to facilitate continued transistor miniaturization for increased functional density and lower cost per function. 3D integration represents a complementary approach for increasing functional density, and will become predominant as practical limits for transistor scaling are reached. This paper will discuss fundamental challenges for transistor scaling and for cost-effective 3D integration to sustain the growth of the semiconductor industry beyond the next decade.

**Dr. Tsu-Jae King Liu** received the B.S., M.S., and Ph.D. degrees in Electrical Engineering from Stanford Univ. From 1992 to 1996 she was a Member of Research Staff at the Xerox Palo Alto Research Ctr. (Palo Alto, CA). In August 1996 she joined the faculty of the Univ. of California, Berkeley, where she is currently the TSMC Distinguished Professor in Microelectronics, and Chair of the Department of Electrical Engineering and Computer Sciences.

Dr. Liu's research awards include the DARPA Significant Technical Achievement Award (2000) for development of the FinFET, the IEEE Kiyo Tomiyasu Award (2010) for contributions to nanoscale MOS transistors, memory devices, and MEMs devices, the Intel Outstanding Researcher in Nanotechnology Award (2012), and the Semiconductor Industry Association Outstanding Researcher Award (2014). She has authored or co-authored close to 500 publications and holds over 90 U.S. patents, and is a Fellow of the IEEE. Her research activities are presently in advanced materials, process technology and devices for energy-efficient electronics.

9:50 to 10:30 AM

## INTERNET-OF-THINGS: CLOUD PLATFORM AND INDUSTRY SOLUTIONS



### Dr. Xiaowei Shen

Director, IBM Research - China

Various studies have predicted that tens of billions of connected sensors and devices will be deployed on this planet in the next decade, and these devices will help monitor, manage and optimize the physical world. Internet-of-Things (IoT) provides the foundational infrastructure for a smarter planet. Integrated

with cloud and big data technologies, IoT is accelerating transformations of many industries and changing the way we live and work. We will discuss technical challenges of building IoT cloud platforms and delivering IoT solutions from cloud, and share our experience of building IoT industry solutions in fields such as renewable energy forecast, air quality management, connected vehicles, and chronic disease management.

**Dr. Xiaowei Shen** is the Director of IBM Research - China. Before his assignment in China, Dr. Shen was a Research Staff Member at the IBM T. J. Watson Research Center, where he managed the Server Network and Memory Systems Department. Dr. Shen received his PhD degree in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology, and his BS degree in Computer Science from the University of Science and Technology of China. His research interests include computer architectures, software and hardware co-design, distributed computing, and innovations for big data and cloud computing. Dr. Shen led IBM's Global Technology Outlook on internet-of-things, and is the principal investigator of the internet-of-things research at IBM.

Coffee Break · 10:30 AM - 11:00 AM



# Technical Events

## Nanotechnology in Microlithography Panel Discussion: Preparing for 3D 2.0: Metrology for the Next Wave of 3D Devices

Monday 23 February · 6:00 PM to 7:30 PM  
Location: Convention Center, 220B

*Moderators:* **Bryan Barnes**, National Institute of Standards and Technology; **Ben Bunday**, SEMATECH; **R. Joseph Kline**, National Institute of Standards and Technology

The rate of introduction for new production nodes has slowed, due in part to a decreasing dependence upon direct scaling and the wide-scale adoption of three-dimensional components. This transition is not without cost, and the previously ever-decreasing cost per transistor has been reported to have flattened out with forecasts projecting higher costs ahead. In the fab, the semiconductor metrology community has readily addressed the challenges brought on by 3D device nanotechnology. However, not only are minimum feature sizes rapidly approaching the sub-10-nm level but the desired architecture of those features will rapidly increase in complexity requiring ever more accurate three-dimensional metrology. How is semiconductor metrology positioned to respond these changing technological and business environments? Our assembled panel of experts will discuss and evaluate the value added by current metrologies as well as the potential of new metrology technologies to tackle emerging 3D design solutions, such as gate-all-around, while achieving acceptable throughput. The panel will also address the metrological solutions required to address emerging lithographic techniques such as direct self-assembly and EUV lithography. Join us as we discuss the critical impact of metrology upon this pivotal crossroads for the industry.

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## Panel Discussion: Dimensional Scaling, Design Optimization, and Metrology: What are we missing?

Tuesday 24 February · 5:00 PM to 6:30 PM  
Location: Convention Center, 220A

*Moderators:* **James Alexander Liddle**, National Institute of Standards and Technology; **Martha Sanchez**, IBM Research - Almaden

Dimensional scaling for both logic and memory devices continues to drive the semiconductor industry. Optical lithography remains the industry standard, but patterning of dimensions less than 40nm requires both design optimization and densification techniques (such as multiple spacer patterning and directed self-assembly) that are both complex and costly. In addition to planar scaling, device manufacturers are now developing three dimension structures for advanced memory solutions. The options for next generation lithography and alternative patterning include EUVL, electron beam direct write and nanoimprint lithography.

Each of the patterning and patterning integration methods mentioned above has its own merits, but also requires inspection techniques that push or exceed the limits of today's metrology solutions. This panel is assembled to address the critical metrology solutions needed to continue dimensional scaling. Potential topics for discussion include:

- Accurate mask topography characterization - amplitude and phase
- Standardization of LER/LWR measurement - metrics and methods
- Analytics for massive scale data analysis
- Characterization of critical dimension and phase separation for DSA processes
- Actinic inspection vs. optical or electron beam inspection methods
- Inspection and repair of imprint masks at critical dimensions less than 20nm
- Wafer level inspection requirements for an e-beam direct write process
- Fast "Physical" OPC model calibration including 3D profiling
- Characterization of deep trench etch or the filling processes required for 3D NAND devices

(Conf. 9423 and 9424)

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## Poster Sessions

### Poster/Exhibition Reception

Tuesday 24 February · 6:00 PM to 8:00 PM  
Location: Convention Center, Hall 1

(Conferences 9422, 9423, 9425, 9428)

*Tuesday Poster/Exhibition Reception Sponsor:*



The exhibition will be open during the Poster/Exhibition Reception on Tuesday only. Be sure to visit the exhibition booths during this time for insight on what is new or coming soon.

Posters will be on display Tuesday from 10:00 am to 5:00 pm, and from 6:00 pm to 8:00 pm during the poster session. Come and view the high-quality papers that are presented in this alternative format, and interact with the poster authors who will be present during the poster session. Enjoy light refreshments while networking with your colleagues.

Full author or technical registration is required for entry to the poster sessions. Please wear your registration badge.

### Poster Reception

Wednesday 25 February · 6:00 PM to 8:00 PM  
Location: Convention Center, Hall 2

(Conferences 9424, 9426, 9427)

*Wednesday Poster Reception Co-Sponsors:*



Posters will be on display Wednesday from 10:00 am to 5:00 pm, and from 6:00 pm to 8:00 pm. Come and view the high-quality papers that are presented in this alternative format, and interact with the poster authors who will be present during the poster session. Enjoy light refreshments while networking with your colleagues.

Full author or technical registration is required for entry to the poster sessions. Please wear your registration badge.

# Award Announcements

## **Award Announcements for Conference 9424—Metrology, Inspection, and Process Control for Microlithography**

Monday 23 February · 11:00 AM to 11:10 AM  
Location: Convention Center, 220B

### **Presentation of the 2014 Diana Nyssonen Memorial Award for Best Paper**

*Award Sponsored by*

**HITACHI**  
Inspire the Next

Thursday 26 February · 10:35 AM to 10:45 AM  
Location: Convention Center, 220B

### **Presentation of the 2015 Karel Urbanek Best Student Paper Award**

*Award Sponsored by*

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## **Award Announcements for Conference 9425—Advances in Patterning Materials and Processes**

Monday 23 February · 11:00 AM to 11:20 AM  
Location: Convention Center, 220C

### **Presentation of the 2014 C. Grant Willson Best Paper Award**

### **Presentation of the 2014 Hiroshi Ito Memorial Award for the Best Student Paper**

*These Two Awards Sponsored by*



### **Presentation of the 2015 Jeffrey Byers Memorial Best Poster Award**

*Award Sponsored by*

  
**TOKYO ELECTRON**

## **Award Announcement for Conference 9426—Optical Microlithography**

Thursday 26 February · 10:10 AM to 10:15 AM  
Location: San Jose Marriott, Salon III

### **Presentation of the 2015 Best Student Award in Microlithography**

*Award Sponsored by*

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## **Award Announcement for Conference 9427—Design-Process-Technology Co-optimization for Manufacturability**

Thursday 26 February · 4:00 PM to 4:10 PM  
Location: San Jose Marriott, Salon III

### **Presentation of the Luigi Franco Cerrina Memorial Best Student Paper Award**

# E.

**EXHIBITION**



## Visit the Exhibition

See the industry's most important exhibition for lithography research and development, devices, tools, fabrication, and services.

Convention Center Hall 1

Tuesday 24 February  
10:00 am to 5:00 pm;  
6:00 to 8:00 pm

Wednesday 25 February  
10:00 am to 4:00 pm

### TECHNOLOGIES

- Etch technology for nanoprinting
- Lithography: immersion, double patterning, e-beam, EUV, optical/laser, and RET
- Metrology, inspection, OPC, and process control
- Design and manufacturing software
- Materials and chemicals
- Imaging equipment
- Lasers
- Resist materials and processing
- Nano-imprint
- IC and chip fabrication
- Nanoscale imaging

### Exhibiting Companies as of 21 January 2015

Abeam Technologies, Inc.  
Amuneal Mfg Corp.  
ASML  
attocube systems Inc.  
Benchmark Technologies  
Brewer Science, Inc.  
Cadence Design Systems  
Canon USA  
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DNS Electronics  
Energetiq Technology, Inc.  
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# GENERAL INFORMATION

## REGISTRATION

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### ONSITE REGISTRATION AND BADGE PICK-UP HOURS

San Jose Convention Center

Sunday 22 February · 7:15 AM to 5:00 PM

Monday 23 February · 7:00 AM to 4:00 PM

Tuesday 24 February · 7:30 AM to 5:00 PM

Wednesday 25 February · 7:30 AM to 4:00 PM

Thursday 26 February · 7:45 AM to 4:00 PM

### CONFERENCE REGISTRATION

Includes admission to all conference sessions, plenaries, panels, technical group meetings, poster sessions, admission to the Exhibition, lunches and desserts served on Tuesday and Wednesday, breakfast pastries, coffee breaks, and a choice of proceedings. Student pricing does not include proceedings.

### COURSE AND WORKSHOP REGISTRATION

Courses and workshops are priced separately. Course-only registration includes your selected course(s), course notes, coffee breaks, and admittance to the exhibition. Course prices include applicable taxes. Onsite, please go to Course Materials Desk after you pick up your badge.

### EXHIBITION REGISTRATION

Exhibition-Only visitor registration is complimentary and is open Tuesday and Wednesday only.

### SPIE MEMBER, SPIE STUDENT MEMBER, AND STUDENT PRICING

- SPIE Members receive conference and course registration discounts. Discounts are applied at the time of registration.
- SPIE Student Members receive a 50% discount on all courses.
- Student registration rates are available only to undergraduate and graduate students who are enrolled full time and have not yet received their Ph.D. Post-docs may not register as students. A student ID number or proof of student status is required with your registration.

### PRESS REGISTRATION

For credentialed press and media representatives only. Please email contact information, title, and organization to [media@spie.org](mailto:media@spie.org).

### SPIE CASHIER

Registration Area - Open during registration hours

#### • Receipts and Certificate of Attendance

Preregistered attendees who did not receive a receipt or attendees who need a Certificate of Attendance may obtain those from the SPIE Cashier.

#### • Badge Corrections

Badge corrections can be made by the SPIE Cashier. Please have your badge removed from the badge holder and marked with your changes before approaching the counter.

#### • Registration Payments

If you are paying by cash or check as part of your onsite registration, wish to add a course, workshop, or special event requiring payment, or have questions regarding your registration, please see the SPIE Cashier.

#### • Refund Information

There is a US\$50 service charge for processing refunds. Requests for refunds must be received by 12 February 2015; all registration fees will be forfeited after this date. Membership dues, reception tickets, and SPIE Digital Library subscriptions are not refundable.

#### • U.S. Government Credit Cards

U.S. government credit card users: have your purchasing officer contact the credit card company and get prior authorization before attempting to register. Advise your purchasing agent that SPIE is considered a 5968 company for authorization purposes. If you are paying by cash or check as part of your onsite registration, wish to add a course, workshop, or special event requiring payment, or have questions regarding your registration, please see the SPIE Cashier.

## AUTHOR / PRESENTER INFORMATION

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Speaker Check-In and Preview Station  
Convention Center, Ballroom Concourse

Sunday through Thursday · 7:30 AM to 5:00 PM

All conference rooms have a computer workstation, projector, screen, lapel microphone, and laser pointer. All presenters are requested to come to Speaker Check-In with their memory devices or laptops to confirm their presentation display settings.

### Poster Setup Instructions & Poster Previewing Hours

Convention Center Hall 2

Tuesday 24 February · 10:00 AM to 5:00 PM

Wednesday 25 February · 10:00 AM to 4:00 PM

Poster authors are to be present and at their posters during the sessions to answer questions and provide in-depth discussion concerning their posters.

- Poster authors may set up their posters between 10:00 am and 5:00 pm on the day of their poster session. Paper numbers will be posted on the poster boards in numerical order. Push pins will be provided. Posters can be previewed during the day until one hour before the formal poster sessions begin at 6:00 pm.
- Presenters who have not placed their papers on their assigned board by 5:00 pm on the day of their presentation will be considered a “no show”, and their manuscript will not be published.
- The author is responsible to remove their posters and all other materials at the conclusion of the poster session for that day. All posters and material not removed will be considered unwanted and will be discarded. SPIE assumes no responsibility for posters left up after the end of each night’s poster session.

Your technical or participant registration badge is required to be worn to attend the poster sessions.


# GENERAL INFORMATION

## ONSITE SERVICES

### Internet Options

Location of Internet - Convention Center Ballroom Concourse

Complimentary wired Internet access is available; attendees can hook up their laptops or use provided workstations.

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### WiFi

Location of WiFi – Convention Center Upper Level Concourse

Complimentary wireless access is also available; instructions will be posted onsite.

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Convention Center Lobby near Registration

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### SPIE Education Services

Located near SPIE Registration  
Open during registration hours

Browse course offerings and the other education services available: SPIE courses, videos, and CDs, as well as customized in-company courses.

If you have registered to attend a course, please stop by the Course Materials AFTER you pick up your badge. You must obtain your course notes to find out class location.

### SPIE Press Room

Marriott Think Tank Room  
Open during registration hours

For Registered Press only. The Press Room provides meeting space, refreshments, access to exhibitor press releases, and Internet connections. Press are urged to register before the meeting by emailing name, contact information, and name of publication to [media@spie.org](mailto:media@spie.org). Preregistration closes approximately 14 days before the start of the event.

### Child Care Services

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Email: [info@bayareasittersunlimited.com](mailto:info@bayareasittersunlimited.com)  
Website: [www.bayareasittersunlimited.com](http://www.bayareasittersunlimited.com)

SPIE does not imply endorsement or recommendation for this service. Information provided as "information only" for your further analysis and decision. Other services may be available.

### Urgent Message Line

SPIE has an urgent message line available during registration hours Sunday through Thursday: 408 271 6105.

### Lost and Found

Located at the SPIE Cashier  
Open During Registration Hours

Found items will be kept at the SPIE Registration Cashier. At the end of the meeting, all found items will be turned over to the San Jose Convention Center Security: 408 271 6105.

## FOOD AND BEVERAGE SERVICES

### Coffee Breaks

Served daily · 7:30 AM, 10:00 AM, and 3:00 PM


Check individual conference listings for exact times and locations.

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### Breakfast Breads

Convention Center, Ballroom Concourse  
Monday – Thursday · 7:30 AM

Monday and Wednesday sponsored by 

### Food and Refreshments for Purchase

Exhibition Hall Concession Stand  
Tuesday – Wednesday · 11:00 AM to 2:00 PM

Hot and cold snacks, hot entrees, deli sandwiches, salads, and pastries are available for purchase. Cash and credit cards accepted.

### SPIE-Hosted Lunches

Exhibition Hall  
Tuesday – Wednesday · 11:30 AM to 1:00 PM

Check individual conference listings for exact times.

Complimentary tickets for these lunches will be included with full conference registrations. Exhibitors and students may purchase tickets at the Cashier Desk.

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### Desserts

Exhibition Hall · Tuesday–Wednesday

Complimentary tickets for the dessert snacks will be included in conference attendee registration packets.

# GENERAL INFORMATION

## TRAVEL TO SAN JOSE

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SPIE Advanced Lithography 2015 is being held at the San Jose McEnery Convention Center, 150 West San Carlos Street, San Jose, CA 95110

San Jose, California, boasts the largest concentration of technology expertise in the world. Over half of the adult population holds a college degree. San Jose also leads the nation in patent generation. The city has 25 companies with 1,000 employees or more, including the headquarters of Adobe Systems, BAE Systems, Cisco, Xilinx, Novellus Systems, and eBay, as well as major facilities for Flextronics, Hewlett-Packard, IBM, Hitachi, Agilent Technologies, and Lockheed Martin.

### DISCOUNTS FOR CONFERENCE ATTENDEES

The City of San Jose offers many discounts to conference attendees. Go online for more information about San Jose.

## Travel information

### AIRPORTS

#### San Jose International Airport

SJC is conveniently located approximately 4 miles from downtown hotels.

#### San Francisco International Airport

SFO is approximately one hour's drive from San Jose.

### AIRPORT SHUTTLES

- SuperShuttle with Discount for SPIE attendees

ShareRide offers \$2 OFF to/from SJC & San Jose, and \$3 OFF to/from SFO/OAK & San Jose.

Advance reservation required at least 24 hours prior for discount to apply. Book Online or call 1-800-258-3826 and refer to discount code SPISJ.

- South & East Bay Airport Shuttle
- Airport Commuter Limo Service

### TAXI SERVICE

Taxis are stationed at the Airport for on-demand service. They are accessible from Terminal A and Terminal B.

### METRO LIGHT RAIL

From SJC, take the free Airport Flyer #10 toward Metro Light Rail and transfer at Metro/Airport Light Rail Station. Go southbound on Santa Teresa Line or Winchester Line to Convention Center Station. San Jose Convention Center is adjacent to the Convention Center Station on San Carlos Street.

### CAR RENTAL

Hertz Car Rental has been selected as the official car rental agency for this symposium. To reserve a car, identify yourself as an Advanced Lithography Conference attendee using the Hertz Meeting Code CV# 029B0020. Discount rates apply to roundtrip rentals up to one week prior through one week after the conference dates. Note: When booking from International Hertz locations, the CV # must be entered with the letters CV before the number, i.e. CVO29B0020.

- In the United States call 1-800-654-2240.
- In Canada call 1-800-263-0600, or 1-416-620-9620 in Toronto.
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## SPIE COURSES

**SPIE STUDENT MEMBERS GET 50% OFF COURSES—SEE DETAILS AT REGISTRATION**

### SUNDAY

SC1099 **Chemistry and Lithography** (Okoroanyanwu) 8:30 am to 5:30 pm, \$700 / \$810

SC888 **EUV Lithography** (Bakshi, Ahn, Naulleau) 8:30 am to 5:30 pm, \$830 / \$940

SC101 **Introduction to Microlithography: Theory, Materials, and Processing** (Willson, Bowden) 8:30 am to 5:30 pm, \$600 / \$710

SC1155 **Key Concepts of Design Technology CoOptimization: A topological look at standard cell logic design** (Liebmann) 8:30 am to 12:30 pm, \$375 / \$430

SC116 **Lithographic Optimization: A Theoretical Approach** (Mack) 8:30 am to 5:30 pm, \$650 / \$760

SC992 **Lithography Integration for Semiconductor FEOL & BEOL Fabrication** (Lin, Zhang) 8:30 am to 5:30 pm, \$600 / \$710

SC1133 **Metrology Toolset Monitoring, Matching, Maintenance and Management** (Solecky, Adan) 8:30 am to 12:30 pm, \$375 / \$430

SC1132 **Modeling and Computational Lithography Fundamentals** (Lai) 8:30 am to 5:30 pm, \$600 / \$710

SC885 **Principles and Practical Implementation of Multiple Patterning** (Dusa, Hsu) 8:30 am to 5:30 pm, \$600 / \$710

SC1067 **Directed Self Assembly and its Application to Nanoscale Fabrication** (de Pablo, Nealey, Ruiz) 1:30 pm to 5:30 pm, \$375 / \$430

SC1158 **Metrology of Image Placement** (Starikov) 1:30 to 5:30 pm, \$375 / \$430

### MONDAY

SC1030 **Interaction of Physical Design and Lithography** (Yuan) 1:30 pm to 5:30 pm, \$375 / \$430

SC1159 **Optimization Methods for Lithographers** (Granik) 1:30 to 5:30 pm, \$375 / \$430

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### NEW COURSES

Key Concepts of Design Technology CoOptimization

Metrology of Image Placement

Optimization Methods for Lithographers

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SPIE has been approved as an authorized provider of CEUs by IACET, The International Association for Continuing Education and Training (Provider #1002091). In obtaining this approval, SPIE has demonstrated that it complies with the ANSI/IACET Standards which are widely recognized as standards of good practice.

SPIE reserves the right to cancel a course due to insufficient advance registration.

**SESSION SCHEDULE**

	<b>CONFERENCE 9422</b> Extreme Ultraviolet (EUV) Lithography VI	<b>CONFERENCE 9423</b> Alternative Lithographic Technologies VII	<b>CONFERENCE 9424</b> Metrology, Inspection, and Process Control for Microlithography XXIX
Monday 23 February	<p><b>SESSION 1</b> · MON 11:00 am to 12:00 pm <b>Keynote Session</b></p> <p><b>SESSION 2</b> · MON 1:30 pm to 3:30 pm <b>EUV Resist Extendability: Joint Session with Conferences 9422 and 9425</b></p> <p><b>SESSION 3</b> · MON 4:00 pm to 6:00 pm <b>EUV Resist Mechanistic Studies: Joint Session with Conferences 9422 and 9425</b></p>	<p><b>SESSION 1</b> · MON 3:40 pm to 5:40 pm <b>Keynote Session</b></p>	<p><b>Opening Remarks</b> · MON 11:00 am to 11:10 am</p> <p><b>SESSION 1</b> · MON 11:10 am to 12:10 pm <b>Keynote Session</b></p> <p><b>SESSION 2</b> · MON 1:30 pm to 3:10 pm <b>Characterization of Feature Profile and LER</b></p> <p><b>SESSION 3</b> · MON 3:40 pm to 6:00 pm <b>Overlay Metrology</b></p>
Tuesday 24 February	<p><b>SESSION 4</b> · TUE 8:00 am to 10:10 am <b>EUV Source</b></p> <p><b>SESSION 5</b> · TUE 10:40 am to 12:00 pm <b>EUV Mask Structure</b></p> <p><b>SESSION 6</b> · TUE 1:30 pm to 3:10 pm <b>EUV Resists</b></p> <p><b>SESSION 7</b> · TUE 3:40 pm to 6:00 pm <b>EUV Integration</b></p>	<p><b>SESSION 2</b> · TUE 8:10 am to 10:00 am <b>DSA Process and Integration</b></p> <p><b>SESSION 3</b> · TUE 10:30 am to 12:00 pm <b>UV-NIL for IC Manufacturing</b></p> <p><b>SESSION 4</b> · TUE 1:30 pm to 3:00 pm <b>Scanning Probe Lithography</b></p> <p><b>SESSION 5</b> · TUE 3:30 pm to 4:50 pm <b>Novel Lithography and Applications</b></p> <p><b>SESSION 6</b> · TUE 3:30 pm to 4:50 pm <b>Metrology and Inspection for Directed Self-Assembly: Joint Session with Conferences 9423 and 9424</b></p>	<p><b>SESSION 4</b> · TUE 8:00 am to 10:00 am <b>SEM Metrology and Modeling</b></p> <p><b>SESSION 5</b> · TUE 10:30 am to 11:30 am <b>Wafer Geometry and Topography Effects on Process Control</b></p> <p><b>SESSION 6</b> · TUE 1:20 pm to 3:00 pm <b>AFM</b></p> <p><b>SESSION 7</b> · TUE 3:30 pm to 4:50 pm <b>Metrology and Inspection for Directed Self-Assembly: Joint Session with Conferences 9423 and 9424</b></p>
Wednesday 25 February	<p><b>SESSION 8</b> · WED 8:20 am to 10:00 am <b>Mask Topography: Joint Session with Conferences 9422 and 9426</b></p> <p><b>SESSION 9</b> · WED 10:40 am to 12:00 pm <b>Resist Outgas Testing</b></p> <p><b>SESSION 10</b> · WED 1:30 pm to 3:10 pm <b>EUV Optics and Mask Metrology</b></p> <p><b>SESSION 11</b> · WED 3:40 pm to 5:50 pm <b>EUV Mask Inspection</b></p>	<p><b>SESSION 7</b> · WED 8:00 am to 10:00 am <b>DSA Materials and Processes I: Joint Session with Conferences 9425 and 9423</b></p> <p><b>SESSION 8</b> · WED 10:30 am to 11:50 am <b>DSA Materials and Processes II: Joint Session with Conferences 9425 and 9423</b></p> <p><b>SESSION 9</b> · WED 1:20 pm to 3:10 pm <b>Nanoimprint Lithography: Non-IC Applications</b></p> <p><b>SESSION 10</b> · WED 3:40 pm to 5:50 pm <b>Multibeam Lithography</b></p>	<p><b>SESSION 8</b> · WED 8:00 am to 10:00 am <b>Scatterometry</b></p> <p><b>SESSION 9</b> · WED 10:30 am to 11:50 am <b>Device Overlay</b></p> <p><b>SESSION 10</b> · WED 1:20 pm to 3:00 pm <b>Inspection</b></p> <p><b>SESSION 11</b> · WED 4:00 pm to 5:20 pm <b>Design Interaction with Metrology: Joint Session with Conferences 9424 and 9427</b></p>
Thursday 26 February	<p><b>SESSION 12</b> · THU 8:00 am to 10:10 am <b>EUV Extension</b></p> <p><b>SESSION 13</b> · THU 10:40 am to 12:00 pm <b>EUV Manufacturing</b></p> <p><b>SESSION 14</b> · THU 1:30 pm to 4:40 pm <b>Exposure Tools</b></p>	<p><b>SESSION 11</b> · THU 8:10 am to 10:00 am <b>DSA Line and via Patterning</b></p> <p><b>SESSION 12</b> · THU 10:30 am to 12:20 pm <b>Electron-Beam Applications</b></p> <p><b>SESSION 13</b> · THU 1:45 pm to 3:25 pm <b>DSA Design for Manufacturability Joint Session with Conferences 9423, 9426, and 9427</b></p> <p><b>SESSION 14</b> · THU 4:00 pm to 5:40 pm <b>DSA Modeling</b></p>	<p><b>SESSION 12</b> · THU 8:05 am to 10:05 am <b>Hybrid Metrology and Process Control</b></p> <p><b>Karel Urbaneck Best Student Paper Award</b> · THU 10:35 am to 10:45 am</p> <p><b>SESSION 13</b> · THU 10:45 am to 12:25 pm <b>Overlay Optimization: Joint Session with Conferences 9424 and 9426</b></p> <p><b>SESSION 14</b> · THU 1:55 pm to 3:35 pm <b>X-ray and Novel Optical Methods</b></p> <p><b>SESSION 15</b> · THU 4:05 pm to 4:45 pm <b>Late Breaking News</b></p>

<p><b>CONFERENCE 9425</b>  <b>Advances in Patterning Materials and Processes XXXII</b></p>	<p><b>CONFERENCE 9426</b>  <b>Optical Microlithography XXVIII</b></p>	<p><b>CONFERENCE 9427</b>  <b>Design-Process-Technology Co-optimization for Manufacturability IX</b></p>	<p><b>CONFERENCE 9428</b>  <b>Advanced Etch Technology for Nanopatterning IV</b></p>
<p><b>Welcome and Announcements</b> · MON 11:00 to 11:20 am  <b>SESSION 1</b> · MON 11:20 am to 12:30 pm  <b>Keynote Session</b>  <b>SESSION 2</b> · MON 1:30 pm to 3:30 pm  <b>EUV Resist Extendability: Joint Session with Conferences 9422 and 9425</b>  <b>SESSION 3</b> · MON 4:00 pm to 6:00 pm  <b>EUV Resist Mechanistic Studies: Joint Session with Conferences 9422 and 9425</b></p>			<p><b>SESSION 1</b> · MON 1:30 pm to 3:15 pm  <b>Overviews of Nanopatterning Challenges</b>  <b>SESSION 2</b> · MON 3:45 pm to 5:35 pm  <b>Nanopatterning for Advanced Logic and Memory Technology Nodes</b></p>
<p><b>SESSION 4</b> · TUE 8:20 am to 10:00 am  <b>Negative Tone Materials</b>  <b>SESSION 5</b> · TUE 10:30 am to 12:30 pm  <b>Resist and Process Fundamentals</b>  <b>SESSION 6</b> · TUE 1:30 pm to 3:10 pm  <b>Patterning Materials and Etch: Joint Session with Conferences 9425 and 9428</b>  <b>SESSION 7</b> · TUE 3:40 pm to 5:20 pm  <b>Materials and Etch in Emerging Technologies: Joint Session with Conferences 9425 and 9428</b></p>	<p><b>Opening Remarks</b> · TUE 8:20 am to 8:40 am  <b>SESSION 1</b> · TUE 8:40 am to 10:00 am  <b>Keynote Session</b>  <b>SESSION 2</b> · TUE 10:30 am to 11:50 am  <b>Pushing Optical Limit</b>  <b>SESSION 3</b> · TUE 1:20 pm to 3:00 pm  <b>Image and Process Control</b>  <b>SESSION 4</b> · TUE 3:30 pm to 5:30 pm  <b>Non-IC Applications</b></p>		<p><b>SESSION 3</b> · TUE 8:30 am to 10:00 am  <b>Plasma and Resist Interactions, including Patterning Quality Control for LER, CD Uniformity, etc.</b>  <b>SESSION 4</b> · TUE 10:30 am to 12:10 pm  <b>Patterning Integration Schemes: Multilayer Patterning, Self-Aligned Patterning, etc.</b>  <b>SESSION 5</b> · TUE 1:30 pm to 3:10 pm  <b>Patterning Materials and Etch: Joint Session with Conferences 9425 and 9428</b>  <b>SESSION 6</b> · TUE 3:40 pm to 5:20 pm  <b>Materials and Etch in Emerging Technologies: Joint Session with Conferences 9425 and 9428</b></p>
<p><b>SESSION 8</b> · WED 8:00 am to 10:00 am  <b>DSA Materials and Processes I: Joint Session with Conferences 9425 and 9423</b>  <b>SESSION 9</b> · WED 10:30 am to 11:50 am  <b>DSA Materials and Processes II: Joint Session with Conferences 9425 and 9423</b>  <b>SESSION 10</b> · WED 1:20 pm to 3:00 pm  <b>EUV Resists and Processes</b>  <b>SESSION 11</b> · WED 3:30 pm to 5:30 pm  <b>DSA Materials and New Concepts</b></p>	<p><b>SESSION 5</b> · WED 8:20 am to 10:00 am  <b>Mask Topography: Joint Session with Conferences 9422 and 9426</b>  <b>SESSION 6</b> · WED 10:30 am to 12:10 pm  <b>Multiple Patterning and SMO</b>  <b>SESSION 7</b> · WED 1:30 pm to 3:10 pm  <b>Mask and Wafer Topography Modeling</b>  <b>SESSION 8</b> · WED 3:40 pm to 5:40 pm  <b>OPC and Modeling</b></p>	<p><b>Opening Remarks</b> · WED 8:00 am to 8:10 am  <b>SESSION 1</b> · WED 8:10 am to 8:40 am  <b>Invited Session I</b>  <b>SESSION 2</b> · WED 8:40 am to 10:00 am  <b>Layout Patterns Applications</b>  <b>SESSION 3</b> · WED 10:30 am to 12:10 pm  <b>Multipatterning</b>  <b>SESSION 4</b> · WED 1:40 pm to 2:10 pm  <b>Invited Session II</b>  <b>SESSION 5</b> · WED 2:10 pm to 3:30 pm  <b>Layout Optimization and Verification I</b>  <b>SESSION 6</b> · WED 4:00 pm to 5:20 pm  <b>Design Interaction with Metrology: Joint Session with Conferences 9424 and 9427</b></p>	<p><b>SESSION 7</b> · WED 8:00 am to 9:50 am  <b>New Plasma Sources and New Etching Technologies</b>  <b>SESSION 8</b> · WED 10:30 am to 12:10 pm  <b>Emerging Patterning Technologies in DSA and Others</b></p>
<p><b>SESSION 12</b> · THU 8:00 am to 10:00 am  <b>New Patterning Processes</b>  <b>SESSION 13</b> · THU 10:30 am to 12:30 pm  <b>Materials and Process Engineering</b></p>	<p><b>SESSION 9</b> · THU 8:00 am to 10:10 am  <b>DFM (Design and Litho Optimization): Joint Session with Conferences 9426 and 9427</b>  <b>2015 Best Student Paper Award</b> · THU 10:10 am to 10:15 am  <b>SESSION 10</b> · THU 10:45 am to 12:25 pm  <b>Overlay Optimization: Joint Session with Conferences 9424 and 9426</b>  <b>SESSION 11</b> · THU 1:45 pm to 3:25 pm  <b>DSA Design for Manufacturability: Joint Session with Conferences 9423, 9426, and 9427</b>  <b>SESSION 12</b> · THU 3:55 pm to 5:35 pm · <b>Toolings</b>  <b>Concluding Remarks</b> · THU 5:35 pm to 5:40 pm</p>	<p><b>SESSION 7</b> · THU 8:00 am to 10:10 am  <b>DFM (Design and Litho Optimization): Joint Session with Conferences 9426 and 9427</b>  <b>SESSION 8</b> · THU 10:40 am to 11:10 am  <b>Invited Session III</b>  <b>SESSION 9</b> · THU 11:10 am to 12:10 pm  <b>Circuit Variability</b>  <b>SESSION 10</b> · THU 1:45 pm to 3:25 pm  <b>DSA Design for Manufacturability: Joint Session with Conferences 9423, 9426, and 9427</b>  <b>Luigi Franco Cerrina Memorial Best Student Paper Award</b> · THU 4:00 pm to 4:10 pm  <b>SESSION 11</b> · THU 4:10 pm to 5:30 pm  <b>Layout and Optimization and Verification II</b></p>	

## CONFERENCE 9422

Monday–Thursday  
23–26 February 2015  
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### Extreme Ultraviolet (EUV) Lithography VI

*Conference Chairs:* **Obert R. Wood II**, GLOBALFOUNDRIES Inc. (USA); **Eric M. Panning**, Intel Corp. (USA)

*Program Committee:* **Markus Bender**, Advanced Mask Technology Ctr. GmbH Co. KG (Germany); **Jos P. Benschop**, ASML Netherlands B.V. (Netherlands); **Robert L. Brainard**, College of Nanoscale Science & Engineering, Univ. at Albany (USA); **Li-Jui Chen**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Daniel A. Corliss**, IBM Corp. (USA); **Emily E. Gallagher**, IBM Corp. (USA); **Michael Goldstein**, Intel Corp. (USA); **Frank Goodwin**, SEMATECH Inc. (USA); **Naoya Hayashi**, Dai Nippon Printing Co., Ltd. (Japan); **Soichi Inoue**, EUVL Infrastructure Development Ctr., Inc. (Japan); **Bryan S. Kasprovicz**, Photonics, Inc. (USA); **Insung Kim**, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); **Seong-Sue Kim**, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); **Bruno La Fontaine**, Cymer, Inc. (USA); **Michael J. Lercel**, SEMATECH Inc. (USA); **Ted Liang**, Intel Corp. (USA); **Chang-Moon Lim**, SK Hynix, Inc. (Korea, Republic of); **Anna Lio**, Intel Corp. (USA); **Pawitter J. Mangat**, GLOBALFOUNDRIES Inc. (USA); **Hiroaki Morimoto**, Toppan Printing Co., Ltd. (Japan); **Patrick P. Naulleau**, Lawrence Berkeley National Lab. (USA); **Christopher S. Ngai**, Applied Materials, Inc. (USA); **Shinji Okazaki**, Gigaphoton Inc. (Japan); **Uzodinma Okoroanyanwu**, Consultant (Germany); **Jan Hendrik Peters**, Carl Zeiss SMS GmbH (Germany); **Jorge J. Rocca**, Colorado State Univ. (USA); **Kurt G. Ronse**, IMEC (Belgium); **Tsutomu Shoki**, HOYA Corp. (Japan); **Akiyoshi Suzuki**, Gigaphoton Inc. (Japan); **Anna Tchikoulaeva**, Lasertec U.S.A., Inc. Zweigniederlassung Deutschland (Germany); **Thomas I. Wallow**, ASML Brion Technologies (USA); **Masaki Yoshioka**, Ushio Inc. (Japan); **Wang Yueh**, Intel Corp. (USA)

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23–26 February 2015  
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### Alternative Lithographic Technologies VII

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*Conference Co-Chairs:* **Christopher Bencher**, Applied Materials, Inc. (USA); **Joy Y. Cheng**, IBM Almaden Research Ctr. (USA)

*Program Committee:* **Frank E. Abboud**, Intel Corp. (USA); **Alan D. Brodie**, KLA-Tencor Corp. (USA); **Kenneth R. Carter**, Univ. of Massachusetts Amherst (USA); **Juan J. de Pablo**, The Univ. of Chicago (USA); **Elizabeth A. Dobisz**, HGST (USA); **Michael A. Guillorn**, IBM Thomas J. Watson Research Ctr. (USA); **Naoya Hayashi**, Dai Nippon Printing Co., Ltd. (Japan); **Daniel J. C. Herr**, The Univ. of North Carolina at Greensboro (USA); **Tatsuhiko Higashiki**, Toshiba Corp. (Japan); **James A. Liddle**, National Institute of Standards and Technology (USA); **Shy-Jay Lin**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Hans Loeschner**, IMS Nanofabrication AG (Austria); **John G. Maltabes**, Hewlett-Packard Labs. (USA); **Dan B. Millward**, Micron Technology, Inc. (USA); **Laurent Pain**, CEA-LETI (France); **Ivo W. Rangelow**, Technische Univ. Ilmenau (Germany); **Benjamin M. Rathsack**, Tokyo Electron America, Inc. (USA); **Ricardo Ruiz**, HGST (USA); **Frank M. Schellenberg**, Consultant (USA); **Helmut Schiff**, Paul Scherrer Institut (Switzerland); **Ines A. Stolberg**, Vistec Electron Beam Lithography Group (Germany); **Kevin T. Turner**, Univ. of Pennsylvania (USA); **Marco J. Wieland**, MAPPER Lithography (Netherlands); **Wei Wu**, The Univ. of Southern California (USA); **Todd R. Younkin**, Intel Corp. (USA)

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## CONFERENCE 9424

Monday–Thursday  
23–26 February 2015  
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### Metrology, Inspection, and Process Control for Microlithography XXIX

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*Conference Co-Chair:* **Martha I. Sanchez**, IBM Research - Almaden (USA)

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## CONFERENCE 9425

Monday–Thursday  
23–26 February 2015  
Proceedings of SPIE Vol. 9425

### Advances in Patterning Materials and Processes XXXII

*Conference Chair:* **Thomas I. Wallow**, ASML Brion Technologies (USA)

*Conference Co-Chair:* **Christoph K. Hohle**, Fraunhofer Institute for Photonic Microsystems (Germany)

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## CONFERENCE 9426

Tuesday–Thursday  
24–26 February 2015  
Proceedings of SPIE Vol. 9426

# Optical Microlithography XXVIII

*Conference Chair:* **Kafai Lai**, IBM Corp. (USA)

*Conference Co-Chair:* **Andreas Erdmann**, Fraunhofer-Institut für Integrierte Systeme und Bauelemententechnologie IISB (Germany)

*Program Committee:* **Pary Baluswamy**, Micron Technology, Inc. (USA); **Peter D. Brooker**, Synopsys, Inc. (USA); **Will Conley**, Cymer, Inc. (USA); **Jo Finders**, ASML Netherlands B.V. (Netherlands); **Carlos Fonseca**, Tokyo Electron America, Inc. (USA); **Tsai-Sheng Gau**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Bernd Geh**, Carl Zeiss SMT Inc. (USA); **Yuri Granik**, Mentor Graphics Corp. (USA); **Young Seog Kang**, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); **Sachiko Kobayashi**, Toshiba Corp. (Japan); **Jongwook Kye**, GLOBALFOUNDRIES Inc. (USA); **Soichi Owa**, Nikon Corp. (Japan); **John S. Petersen**, Periodic Structures, Inc. (USA); **Daniel Sarlette**, Infineon Technologies Dresden (Germany); **Xuelong Shi**, Semiconductor Manufacturing International Corp. (China); **Sam Sivakumar**, Intel Corp. (USA); **Bruce W. Smith**, Rochester Institute of Technology (USA); **Kazuhiro Takahashi**, Canon Inc. (Japan); **Geert Vandenberghe**, IMEC (Belgium); **Reinhard Voelkel**, SUSS MicroOptics SA (Switzerland)

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## CONFERENCE 9427

Wednesday–Thursday  
25–26 February 2015  
Proceedings of SPIE Vol. 9427

# Design-Process- Technology Co- optimization for Manufacturability IX

*Conference Chair:* **John L. Sturtevant**, Mentor Graphics Corp. (USA)

*Conference Co-Chair:* **Luigi Capodieci**, GLOBALFOUNDRIES Inc. (USA)

*Program Committee:* **Robert Aitken**, ARM Inc. (USA); **Jason P. Cain**, Advanced Micro Devices, Inc. (USA); **Fang-Cheng Chang**, Cadence Design Systems, Inc. (USA); **Lars W. Liebmann**, IBM Corp. (USA); **Ru-Gun Liu**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Mark E. Mason**, Texas Instruments Inc. (USA); **Andrew R. Neureuther**, Univ. of California, Berkeley (USA); **Shigeki Nojima**, Toshiba Corp. (Japan); **David Z. Pan**, The Univ. of Texas at Austin (USA); **Chul-Hong Park**, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); **Michael L. Rieger**, Synopsys, Inc. (USA); **Vivek K. Singh**, Intel Corp. (USA); **Chi-Min Yuan**, Freescale Semiconductor, Inc. (USA)

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## CONFERENCE 9428

Monday–Wednesday  
23–25 February 2015  
Proceedings of SPIE Vol. 9428

# Advanced Etch Technology for Nanopatterning IV

*Conference Chair:* **Qinghuang Lin**, IBM Thomas J. Watson Research Ctr. (USA)

*Conference Co-Chair:* **Sebastian U. Engelmann**, IBM Thomas J. Watson Research Ctr. (USA)

*Program Committee:* **Julie Bannister**, Tokyo Electron America, Inc. (USA); **Sang-Hoon Cho**, SK Hynix, Inc. (Korea, Republic of); **Maxime Darnon**, LTM CNRS (France); **Eric A. Hudson**, Lam Research Corp. (USA); **Catherine B. Labelle**, GLOBALFOUNDRIES Inc. (USA); **Nae-Eung Lee**, Sungkyunkwan Univ. (Korea, Republic of); **Gottlieb S. Oehrlein**, Univ. of Maryland, College Park (USA); **Erwine Pargon**, LTM CNRS (France); **Nicolas Posseme**, CEA-LETI (France); **Ricardo Ruiz**, HGST (USA); **Seiji Samukawa**, Tohoku Univ. (Japan); **Robert Turkot**, Intel Corp. (USA); **Rich Wise**, Lam Research Corp. (USA); **Jeff Xu**, Qualcomm Technologies Inc. (USA); **Anthony Yen**, TSMC Taiwan (Taiwan); **Ying Zhang**, Applied Materials, Inc. (USA)

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**CONFERENCE 9422**

Extreme Ultraviolet (EUV)  
Lithography VI

**SESSION 1**

**LOCATION: CONVENTION CENTER 210B  
MON 11:00 AM TO 12:00 PM**

**Keynote Session**

Session Chairs: **Jos P. Benschop**, ASML  
Netherlands B.V. (Netherlands); **Shinji Okazaki**,  
Gigaphoton Inc. (Japan)

11:00 am: **EUV for SOC: Does it really help?**  
(*Keynote Presentation*), Greg Yeric, ARM Inc.  
(USA) .....[9422-1]

11:30 am: **Progress and challenges toward EUV  
HVM** (*Keynote Presentation*), Chang-Moon Lim, SK  
Hynix, Inc. (Korea, Republic of) .....[9422-2]

Lunch Break ..... Mon 12:00 pm to 1:30 pm

**CONFERENCE 9424**

Metrology, Inspection,  
and Process Control for  
Microlithography XXIX

**LOCATION: CONVENTION CENTER 220B  
MON 11:00 AM TO 11:10 AM**

**Opening Remarks and Award  
Announcements**

Session Chairs: **Jason P. Cain**, Advanced Micro  
Devices, Inc. (USA); **Martha I. Sanchez**, IBM  
Research - Almaden (USA)

**SESSION 1**

**LOCATION: CONVENTION CENTER 220B  
MON 11:10 AM TO 12:10 PM**

**Keynote Session**

Session Chairs: **Jason P. Cain**, Advanced Micro  
Devices, Inc. (USA); **Martha I. Sanchez**, IBM  
Research - Almaden (USA)

11:10 am: **Tactical and strategic metrology  
perspectives for advanced integrated  
circuit development and manufacturing**  
(*Keynote Presentation*), Eric Solecky, Alok Vaid,  
GLOBALFOUNDRIES Inc. (USA) .....[9424-1]

Lunch Break ..... Mon 12:10 pm to 1:30 pm

**CONFERENCE 9425**

Advances in Patterning Materials  
and Processes XXXII

**LOCATION: CONVENTION CENTER 220C  
MON 11:00 AM TO 11:20 AM**

**Welcome and Award  
Announcements**

Session Chair: **Thomas I. Wallow**, ASML Brion  
Technologies (USA)

**SESSION 1**

**LOCATION: CONVENTION CENTER 220C  
MON 11:20 AM TO 12:30 PM**

**Keynote Session**

Session Chair: **Christoph K. Hohle**, Fraunhofer  
Institute for Photonic Microsystems (Germany)

11:20 am: **Recent progress on multipatterning**  
(*Keynote Presentation*), Hidetami Yaegashi, Tokyo  
Electron Ltd. (Japan); Kenichi Oyama, Shohei  
Yamauchi, Arisa Hara, Sakurako Natori, Masatoshi  
Yamato, Noriaki Okabe, Tokyo Electron AT Ltd.  
(Japan) .....[9425-1]

11:55 am: **Continued CMOS scaling through  
exploratory materials research** (*Keynote  
Presentation*), Todd R. Younkin, Intel Corp.  
(USA) .....[9425-2]

Lunch Break ..... Mon 12:30 pm to 1:30 pm

**CONFERENCE 9422**

Extreme Ultraviolet (EUV)  
Lithography VI

**SESSION 2**

**LOCATION: CONVENTION CENTER 220C  
MON 1:30 PM TO 3:30 PM**

**EUV Resist Extendability**  
Joint Session with Conferences 9422  
and 9425

Session Chairs: **Robert L. Brainard**, SUNY College of Nanoscale Science and Engineering (USA); **James W. Thackeray**, Dow Electronic Materials (USA)

1:30 pm: **Toward 10nm half-pitch in EUV lithography: results on resist screening and pattern collapse mitigation techniques**, Tero S. Kulmala, Michaela Vockenhuber, Paul Scherrer Institut (Switzerland); Michael J. Leeson, Ernisse S. Putna, Intel Corp. (USA); Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9422-3]

1:50 pm: **Extending resolution limits of EUV resist materials**, Marie E. Kryszak, Michael J. Leeson, Ernisse S. Putna, James M. Blackwell, Intel Corp. (USA) . . . . . [9422-4]

2:10 pm: **Relationship between information and energy carried by extreme-ultraviolet photons: consideration from the viewpoint of sensitivity enhancement**, Takahiro Kozawa, Osaka Univ. (Japan); Julius Joseph S. Santillan, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9422-5]

2:30 pm: **New developments in ligand-stabilized metal oxide nanoparticle photoresists for EUV lithography**, Christopher K. Ober, Jing Jiang, Ben Zhang, Li Li, Emmanuel P. Giannelis, Cornell Univ. (USA); Mark Neisser, Jun Sung Chun, SEMATECH Inc. (USA); Reyes Sierra, The Univ. of Arizona (USA) . . . . . [9422-6]

2:50 pm: **Towards 11nm half-pitch resolution for a negative-tone chemically-amplified molecular resist platform for extreme-ultraviolet lithography**, Alex P. Robinson, Andreas Frommhold, The Univ. of Birmingham (United Kingdom); Alexandra L. McClelland, Irresistible Materials Ltd. (United Kingdom); Dong Xu Yang, The Univ. of Birmingham (United Kingdom); John Roth, Nano-C, Inc. (USA); Richard E. Palmer, The Univ. of Birmingham (United Kingdom); Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9425-3]

3:10 pm: **Recent progress of negative-tone imaging with EUV exposure**, Toru Fujimori, EUVL Infrastructure Development Ctr., Inc. (Japan) [9425-4]

Coffee Break . . . . . Mon 3:30 pm to 4:00 pm

**CONFERENCE 9424**

Metrology, Inspection,  
and Process Control for  
Microlithography XXIX

**SESSION 2**

**LOCATION: CONVENTION CENTER 220B  
MON 1:30 PM TO 3:10 PM**

**Characterization of Feature  
Profile and LER**

Session Chairs: **Benjamin D. Bunday**, SEMATECH Inc. (USA); **Ofer Adan**, Applied Materials, Ltd. (Israel)

1:30 pm: **More systematic errors in the measurement of power spectral density**, Chris A Mack, Lithoguru.com (USA) . . . . . [9424-3]

1:50 pm: **Application of frequency domain line-edge roughness characterization methodology in lithography**, Lei Sun, Wenhui Wang, Obert R. Wood II, Ryoung-Han Kim, GLOBALFOUNDRIES Inc. (USA) . . . . . [9424-4]

2:10 pm: **The effect of sidewall roughness on line-edge roughness in top-down scanning electron-microscopy images**, Thomas Verduin, Sebastiaan R. Lokhorst, Cornelis W. Hagen, Pieter Kruit, Technische Univ. Delft (Netherlands) . . [9424-5]

2:30 pm: **Line profile measurement of advanced-FinFET features by reference metrology**, Kiyoshi Takamasu, Yuuki Iwaki, Satoru Takahashi, The Univ. of Tokyo (Japan); Hiroki Kawada, Hitachi High-Tech Science Corp. (Japan); Masami Ikota, Hitachi High-Technologies Taiwan Corp. (Japan); Atsuko Yamaguchi, Hitachi, Ltd. (Japan); Gian F. Lorusso, Naoto Horiguchi, IMEC (Belgium) . . . . . [9424-6]

2:50 pm: **Induced e-beam charge impact on spatial orientation of gate-all-around silicon wires device fabricated on Boron Nitride substrate**, Shimon Levi, Konstantin Chirko, Ofer Adan, Applied Materials, Ltd. (Israel); Guy Choen, IBM Corp. (USA) . . . . . [9424-7]

Coffee Break . . . . . Mon 3:10 pm to 3:40 pm

**CONFERENCE 9425**

Advances in Patterning Materials  
and Processes XXXII

**SESSION 2**

**LOCATION: CONVENTION CENTER 220C  
MON 1:30 PM TO 3:30 PM**

**EUV Resist Extendability**  
Joint Session with Conferences 9422  
and 9425

Session Chairs: **Robert L. Brainard**, SUNY College of Nanoscale Science and Engineering (USA); **James W. Thackeray**, Dow Electronic Materials (USA)

1:30 pm: **Toward 10nm half-pitch in EUV lithography: results on resist screening and pattern collapse mitigation techniques**, Tero S. Kulmala, Michaela Vockenhuber, Paul Scherrer Institut (Switzerland); Michael J. Leeson, Ernisse S. Putna, Intel Corp. (USA); Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9422-3]

1:50 pm: **Extending resolution limits of EUV resist materials**, Marie E. Kryszak, Michael J. Leeson, Ernisse S. Putna, James M. Blackwell, Intel Corp. (USA) . . . . . [9422-4]

2:10 pm: **Relationship between information and energy carried by extreme-ultraviolet photons: consideration from the viewpoint of sensitivity enhancement**, Takahiro Kozawa, Osaka Univ. (Japan); Julius Joseph S. Santillan, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9422-5]

2:30 pm: **New developments in ligand-stabilized metal oxide nanoparticle photoresists for EUV lithography**, Christopher K. Ober, Jing Jiang, Ben Zhang, Li Li, Emmanuel P. Giannelis, Cornell Univ. (USA); Mark Neisser, Jun Sung Chun, SEMATECH Inc. (USA); Reyes Sierra, The Univ. of Arizona (USA) . . . . . [9422-6]

2:50 pm: **Towards 11nm half-pitch resolution for a negative-tone chemically-amplified molecular resist platform for extreme-ultraviolet lithography**, Alex P. Robinson, Andreas Frommhold, The Univ. of Birmingham (United Kingdom); Alexandra L. McClelland, Irresistible Materials Ltd. (United Kingdom); Dong Xu Yang, The Univ. of Birmingham (United Kingdom); John Roth, Nano-C, Inc. (USA); Richard E. Palmer, The Univ. of Birmingham (United Kingdom); Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9425-3]

3:10 pm: **Recent progress of negative-tone imaging with EUV exposure**, Toru Fujimori, EUVL Infrastructure Development Ctr., Inc. (Japan) [9425-4]

Coffee Break . . . . . Mon 3:30 pm to 4:00 pm

**CONFERENCE 9428**

Advanced Etch Technology for  
Nanopatterning IV

**SESSION 1**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
MON 1:30 PM TO 3:15 PM**

**Overviews of Nanopatterning  
Challenges**

Session Chairs: **Catherine Labelle**, GLOBALFOUNDRIES Inc. (USA); **Rich Wise**, Lam Research Corp. (USA)

1:30 pm: **Blazing the trail through industry inflection points: We've done it before - We'll do it again** (*Invited Paper*), George A. Gomba, IBM Corp. (USA) . . . . . [9428-1]

2:05 pm: **Status of EUV lithography** (*Invited Paper*), Anthony Yen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9428-2]

2:40 pm: **Scaling challenges for contact etching in logic devices** (*Invited Paper*), Eric A. Hudson, Lam Research Corp. (USA) . . . . . [9428-3]

Coffee Break . . . . . Mon 3:15 pm to 3:45 pm

**CONFERENCE 9422**

Extreme Ultraviolet (EUV)  
Lithography VI

**SESSION 3**

**LOCATION: CONVENTION CENTER 220C  
MON 4:00 PM TO 6:00 PM**

**EUV Resist Mechanistic Studies**

**Joint Session with Conferences 9422  
and 9425**

Session Chairs: **John J. Biafore**, KLA-Tencor Texas (USA); **Clifford L. Henderson**, Georgia Institute of Technology (USA)

4:00 pm: **Investigating secondary electron behavior in EUV photoresists with experimentation and simulation**, Amrit Narasimhan, Bharath Srivats, Justin Turok, Henry C. Herbol, Liam Wisheart, Eric Tsui, SUNY College of Nanoscale Science and Engineering (USA); Mark Neisser, SEMATECH Inc. (USA); Leonidas E. Ocola, Argonne National Lab. (USA); Gregory Denbeaux, Robert L. Brainard, SUNY College of Nanoscale Science and Engineering (USA) . . . . . [9422-7]

4:20 pm: **The effect of resist dissolution process on pattern formation variability: an in situ analysis using high-speed atomic force microscopy**, Julius Joseph S. Santillan, Motoharu Shichiri, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . [9425-5]

4:40 pm: **XAS photoresists electron/quantum yields study with synchrotron light**, Alessandro Vaglio Pret, KLA-Tencor/ ICOS Belgium (Belgium); Peter de Schepper, Terje Hansen, IMEC (Belgium); Angelo Giglia, Istituto Officina dei Materiali (Italy); Kenji Hoshiko, JSR Micro N.V. (Belgium); John J. Biafore, KLA-Tencor Texas (USA) . . . . . [9425-6]

5:00 pm: **Comparison of shot noise in EUV and e-beam lithography**, Suchit Bhattarai, Univ. of California, Berkeley (USA); Shaul Aloni, Weilun L. Chao, Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Univ. of California, Berkeley (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA) . . . . . [9422-8]

5:20 pm: **Inhomogeneity of PAGs in hybrid-type EUV resist system studied by molecular-dynamics simulations for EUV lithography**, Minoru Toriumi, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9425-7]

5:40 pm: **Low-energy electron (0-100eV) interaction with resists using LEEM**, Aniket Thete, Daniel Geelen, Leiden Univ. (Netherlands); Sander F. Wuister, ASML Netherlands B.V. (Netherlands); Sense Jan van der Molen, Leiden Univ. (Netherlands); Rudolf M. Tromp, IBM Thomas J. Watson Research Ctr. (USA) and Leiden Univ. (Netherlands) . . . . . [9422-9]

**CONFERENCE 9423**

Alternative Lithographic  
Technologies VII

**SESSION 1**

**LOCATION: CONVENTION CENTER 220A  
MON 3:40 PM TO 5:40 PM**

**Keynote Session**

Session Chairs: **Douglas J. Resnick**, Canon Nanotechnologies, Inc. (USA); **Christopher Bencher**, Applied Materials, Inc. (USA)

3:40 pm: **Edge placement: foundation for Moore's Law extension** (*Invited Paper*), Yan A. Borodovsky, Intel Corp. (USA) . . . . . [9423-1]

4:20 pm: **Imprint lithography for high-volume semiconductor manufacturing** (*Keynote Presentation*), Toshiaki Ikoma, Canon Inc. (Japan) . . . . . [9423-2]

5:00 pm: **A direct comparison of directed self-assembly processes to an alternative lithographic process for patterning dense line-space arrays** (*Invited Paper*), Dan B. Millward, Micron Technology, Inc. (USA) . . . . . [9423-3]

**CONFERENCE 9424**

Metrology, Inspection, and Process Control  
for Microlithography XXIX

**SESSION 3**

**LOCATION: CONVENTION CENTER 220B  
MON 3:40 PM TO 6:00 PM**

**Overlay Metrology**

Session Chairs: **Alexander Starikov**, I&I Consulting (USA); **Matthew J. Sendelbach**, Nova Measuring Instruments Inc. (USA)

3:40 pm: **Hybrid overlay metrology with CDSEM in a BEOL patterning scheme**, Philippe J. Leray, IMEC (Belgium); Yutaka Okagawa, Osamu Inoue, Hitachi High-Tech Science Corp. (Japan); David Laidler, Jan V. Hermans, IMEC (Belgium) . . . . . [9424-8]

4:00 pm: **Scatterometry or imaging overlay: a comparative study**, Nuriel Amir, KLA-Tencor Israel (Israel); Simon C. C. Hsu, Yuan Chi Pai, Charlie Chen, Chun Chi Yu, United Microelectronics Corp. (Taiwan); Henry Hsing, Robert H. C. Wu, Kelly T. L. Kuo, KLA-Tencor Taiwan (Taiwan) . . . . . [9424-9]

4:20 pm: **64nm pitch metal1 double-patterning metrology: CD and OVL control by SEMCD, image-based overlay and diffraction-based overlay**, Florent Dettoni, Julien Ducoté, Régis Bouysson, Bertrand Le-Gratiet, STMicroelectronics (France); Damien Carau, STMicroelectronics (France) and LTM CNRS (France); Christophe Dezaudier, STMicroelectronics (France) . . . . . [9424-10]

4:40 pm: **Influence of the process-induced asymmetry on the accuracy of overlay measurements**, Tetyana Shapoval, KLA-Tencor Germany (Germany); Bernd Schulz, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Tal Itzkovich, KLA-Tencor Israel (Israel); Sean Durran, KLA-Tencor Ireland (Ireland); Ronny Haupt, KLA-Tencor Germany (Germany); Agostino Cangiano, KLA-Tencor Italy SRL (Italy); Barak Bringoltz, KLA-Tencor Israel (Israel); Matthias Ruhm, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany); Eric Cotte, Rolf Seltmann, Tino Hertzsch, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Eitan Hajaj, KLA-Tencor Israel (Israel); Carsten Hartig, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Boris Efraty, KLA-Tencor Israel (Israel); Daniel Fischer, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany) . . . . . [9424-11]

5:00 pm: **Overlay accuracy investigation for advanced memory device**, Hong-Goo Lee, Byongseog Lee, Sangjun Han, Myoung Soo Kim, Won-Taik Kwon, Sung-Ki Park, SK Hynix, Inc. (Korea, Republic of); Dong-Sub Choi, Do-Hwa Lee, KLA-Tencor Korea (Korea, Republic of); Sanghuck Jeon, Kangsan Lee, SK Hynix, Inc. (Korea, Republic of); Amnon Manassen, Yuri Paskover, KLA-Tencor Israel (Israel); David C. Tien, KLA-Tencor Corp. (USA); Negri Daria, Tal Itzkovich, David Gready, Eitan Herzal, KLA-Tencor Israel (Israel) . . . . . [9424-12]

5:20 pm: **Stack and topography verification as an enabler for computational metrology target design**, Michael E. Adel, Inna Tarshish-Shapir, David Gready, Mark Ghinovker, KLA-Tencor Israel (Israel); Stephane Godny, IMEC (Belgium) . . . . . [9424-13]

5:40 pm: **Overlay metrology solutions in a triple patterning scheme**, Philippe J. Leray, Ming Mao, Bart Baudemprez, IMEC (Belgium); Nuriel Amir, KLA-Tencor Israel (Israel) . . . . . [9424-14]



**CONFERENCE 9425**

Advances in Patterning Materials and Processes XXXII

**SESSION 3**

**LOCATION: CONVENTION CENTER 220C  
MON 4:00 PM TO 6:00 PM**

**EUV Resist Mechanistic Studies**

Joint Session with Conferences 9422 and 9425

Session Chairs: **John J. Biafore**, KLA-Tencor Texas (USA); **Clifford L. Henderson**, Georgia Institute of Technology (USA)

4:00 pm: **Investigating secondary electron behavior in EUV photoresists with experimentation and simulation**, Amrit Narasimhan, Bharath Srivats, Justin Turok, Henry C. Herbol, Liam Wisehart, Eric Tsui, SUNY College of Nanoscale Science and Engineering (USA); Mark Neisser, SEMATECH Inc. (USA); Leonidas E. Ocola, Argonne National Lab. (USA); Gregory Denbeaux, Robert L. Brainard, SUNY College of Nanoscale Science and Engineering (USA) . . . . . [9422-7]

4:20 pm: **The effect of resist dissolution process on pattern formation variability: an in situ analysis using high-speed atomic force microscopy**, Julius Joseph S. Santillan, Motoharu Shichiri, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9425-5]

4:40 pm: **XAS photoresists electron/quantum yields study with synchrotron light**, Alessandro Vaglio Pret, KLA-Tencor/ ICOS Belgium (Belgium); Peter de Schepper, Terje Hansen, IMEC (Belgium); Angelo Giglia, Istituto Officina dei Materiali (Italy); Kenji Hoshiko, JSR Micro N.V. (Belgium); John J. Biafore, KLA-Tencor Texas (USA) . . . . . [9425-6]

5:00 pm: **Comparison of shot noise in EUV and e-beam lithography**, Suchit Bhattacharai, Univ. of California, Berkeley (USA); Shaul Aloni, Weilin L. Chao, Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Univ. of California, Berkeley (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA) . . . . . [9422-8]

5:20 pm: **Inhomogeneity of PAGs in hybrid-type EUV resist system studied by molecular-dynamics simulations for EUV lithography**, Minoru Toriumi, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9425-7]

5:40 pm: **Low-energy electron (0-100eV) interaction with resists using LEEM**, Aniket Thete, Daniel Geelen, Leiden Univ. (Netherlands); Sander F. Wuister, ASML Netherlands B.V. (Netherlands); Sense Jan van der Molen, Leiden Univ. (Netherlands); Rudolf M. Tromp, IBM Thomas J. Watson Research Ctr. (USA) and Leiden Univ. (Netherlands) . . . . . [9422-9]

**CONFERENCE 9428**

Advanced Etch Technology for Nanopatterning IV

**SESSION 2**

**LOCATION: SAN JOSE MARRIOTT,  
SALON III  
MON 3:45 PM TO 5:35 PM**

**Nanopatterning for Advanced Logic and Memory Technology Nodes**

Session Chairs: **Sang-Hoon Cho**, SK Hynix, Inc. (Korea, Republic of); **Eric A. Hudson**, Lam Research Corp. (USA); **Robert Turkot**, Intel Corp. (USA)

3:45 pm: **Etch patterning for advanced devices (Invited Paper)**, Effendi Leobandung, IBM Thomas J. Watson Research Ctr. (USA) . . . . . [9428-4]

4:15 pm: **Challenges in high-aspect ratio contact (HARC) etching for DRAM capacitor formation (Invited Paper)**, Yongjin Kim, Sangdo Lee, Byoungseok Lee, Sung-Ki Park, SK Hynix, Inc. (Korea, Republic of) . . . . . [9428-5]

4:45 pm: **Dry etch challenges for CD shrinkage in flash memory process (Invited Paper)**, Takaya Matsushita, Takanori Matsumoto, Hidefumi Mukai, Suigen Kyoh, Koji Hashimoto, Toshiba Corp. (Japan) . . . . . [9428-6]

5:15 pm: **Self-limited light ion implantation for nitride spacer etching**, Nicolas Posseme, Olivier Pollet, Fabrice Nemouchi, Sébastien Barnola, CEA-LETI (France) . . . . . [9428-7]



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**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**SESSION 4**

**LOCATION: CONVENTION CENTER 210B  
TUE 8:00 AM TO 10:10 AM**

**EUV Source**

Session Chairs: **Moshe E. Preil**, GLOBALFOUNDRIES Inc. (USA); **Soichi Inoue**, EUVL Infrastructure Development Ctr., Inc. (Japan)

8:00 am: **Performance optimization of MOPA prepulse LPP light source** (*Invited Paper*), Alexander A. Schafgans, ASML (USA); Daniel J. Brown, ASML US, Inc. (USA); Igor V. Fomenkov, Robert J. Rafac, Daniel J. Riggs, Wayne J. Dunstan, Matthew Graham, Yezheng Tao, Nigel R. Farrar, ASML (USA); Hans Meiling, ASML (Netherlands); Christian Wagner, Ron Kool, Alberto Pirati, ASML Netherlands B.V. (Netherlands); David C. Brandt, ASML (USA)[9422-10]

8:30 am: **Performance of one-hundred watt HVM LPP-EUV source**, Hakaru Mizoguchi, Takashi Saitou, Taku Yamazaki, Gigaphoton Inc. (Japan) .[9422-11]

8:50 am: **Considerations for a free-electron laser-based extreme-ultraviolet lithography program**, Erik R. Hosler, Obert R. Wood II, GLOBALFOUNDRIES Inc. (USA); William A. Barletta, Massachusetts Institute of Technology (USA); Pawitner J. Mangat, Moshe E. Preil, GLOBALFOUNDRIES Inc. (USA) . . . . . [9422-12]

9:10 am: **Sub-aperture EUV collector with dual-wavelength spectral purity filter**, Torsten Feigl, Marco Perske, Hagen Pauer, Tobias Fiedler, optiX fab GmbH (Germany); Uwe D. Zeitner, Robert Leitel, Sven Schröder, Marcus Trost, Stefan Risse, Ralf Steinkopf, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); Frank Scholze, Christian Laubis, Physikalisch-Technische Bundesanstalt (Germany) . . . . . [9422-13]

9:30 am: **High-radiance LDP source for mask-inspection application**, Yusuke Teramoto, Bárbara Santos, Guido Mertens, Ralf Kops, Margarete Kops, Ushio Inc. (Germany); Gota Niimi, Hironobu Yabuta, Akihisa Nagano, Noritaka Ashizawa, Ushio Inc. (Japan); Felix Kupper, Fraunhofer-Institut für Lasertechnik (Germany); Kiyotada Nakamura, Kunihiko Kasama, Ushio Inc. (Japan) . . . . . [9422-14]

9:50 am: **Optimum pre-pulsing and target geometry of LPP for efficient EUV and BEUV sources**, Ahmed Hassanein, Tatyana Sizyuk, Purdue Univ. (USA) . . . . . [9422-15]

Coffee Break . . . . . Tue 10:00 am to 10:40 am

**CONFERENCE 9423**

**Alternative Lithographic Technologies VII**

**SESSION 2**

**LOCATION: CONVENTION CENTER 220A  
TUE 8:10 AM TO 10:00 AM**

**DSA Process and Integration**

Session Chairs: **Joy Y. Cheng**, IBM Research - Almaden (USA); **Dan B. Millward**, Micron Technology, Inc. (USA)

8:10 am: **Implementation of templated DSA for via layer patterning at the 7nm node** (*Invited Paper*), Roel Gronheid, Jan Doise, Joost P. Bekaert, Boon Teik Chan, IMEC (Belgium); Germain L. Fenger, Mentor Graphics (Deutschland) GmbH (Belgium); Daisuke Fuchimoto, Hitachi High-Tech Science Corp. (Japan); Guanyang Lin, AZ Electronic Materials USA Corp. (USA); Mark H. Somervell, Tokyo Electron America, Inc. (USA); Julien Ryckaert, Geert Vandenbergh, IMEC (Belgium) . . . . . [9423-4]

8:40 am: **DSA guiding pattern generation with immersion lithography**, Yuansheng Ma, Mentor Graphics Corp. (USA) . . . . . [9423-5]

9:00 am: **Customization and design of directed self-assembly using hybrid prepatters**, Joy Y. Cheng, Melia Tjio, Hoa Truong, IBM Research - Almaden (USA); Hsinyu Tsai, IBM Thomas J. Watson Research Ctr. (USA); Chi-Chun Liu, IBM Corp. (USA); Gurpreet Singh, Gregory S. Doerk, Charles T. Rettner, Markus Brink, Srinivasan Balakrishnan, IBM Research - Almaden (USA); Nelson M. Felix, IBM Corp. (USA) and IBM Research - Almaden (USA); Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA); Daniel P. Sanders, IBM Research - Almaden (USA) . . . . . [9423-6]

9:20 am: **Directed self-assembly on enhanced chemical patterns**, Lei Wan, He Gao, Ricardo Ruiz, Thomas R. Albrecht, HGST (USA) . . . . . [9423-7]

9:40 am: **Understanding of PS-b-PMMA directed self-assembly registration by phase segregation under laser-induced millisecond thermal annealing**, Alan G. Jacobs, Cornell Univ. (USA); Byungki Jung, Intel Corp. (USA); Christopher K. Ober, Michael O. Thompson, Cornell Univ. (USA) . . . . . [9423-8]

Coffee Break . . . . . Tue 10:00 am to 10:30 am

**CONFERENCE 9424**

**Metrology, Inspection, and Process Control for Microlithography XXIX**

**SESSION 4**

**LOCATION: CONVENTION CENTER 220B  
TUE 8:00 AM TO 10:00 AM**

**SEM Metrology and Modeling**

Session Chairs: **Eric Solecky**, IBM Corp. (USA); **Shunsuke Koshihara**, Hitachi High-Tech Science Corp. (Japan)

8:00 am: **Analytical linescan model for SEM metrology**, Chris A. Mack, Lithoguru.com (USA); Benjamin D. Bunday, SEMATECH Inc. (USA) . . . . . [9424-15]

8:20 am: **Solving next-generation (1x node) metrology challenges using advanced CDSEM capabilities: tilt, high energy, and backscatter imaging**, Xiaoxiao Zhang, Alok Vaid, Patrick W. Snow, Eric Solecky, GLOBALFOUNDRIES Inc. (USA); Jessica Zhou, Adam Ge, Shay Yasharzade, Applied Materials, Inc. (USA); Ori Shoval, Ofer Adan, Ishai Schwarzband, Maayan Bar-Zvi, Applied Materials, Ltd. (Israel) . . . . . [9424-16]

8:40 am: **Methodology for determining CD-SEM measurement condition of sub-20nm resist patterns for 0.33NA EUV lithography**, Nobuhiro Okai, Hitachi, Ltd. (Japan); Erin Lavigne, IBM Corp. (USA); Keiichi Hitomi, Hitachi America, Ltd. (USA); Scott D. Halle, IBM Corp. (USA); Shoji Hotta, Hitachi, Ltd. (Japan); Shunsuke Koshihara, Hitachi High-Tech Science Corp. (Japan); Junichi Tanaka, Hitachi, Ltd. (Japan); Todd C. Bailey, IBM Corp. (USA) . [9424-17]

9:00 am: **Fast analytical modeling of SEM images at a high level of accuracy**, Sergey Babin, Sergey S. Borisov, Vladimir Trifonenkov, abeam Technologies, Inc. (USA) . . . . . [9424-18]

9:20 am: **Simulating multi-electron-beam wafer inspection for sub-20nm defects**, Benjamin D. Bunday, SEMATECH Inc. (USA); Brad Thiel, Kathryn W. Quoi, Maseeh Mukhtar, SUNY College of Nanoscale Science and Engineering (USA) [9424-19]

9:40 am: **Investigating SEM metrology effects using a detailed SEM simulation and stochastic resist model**, Richard A. Lawson, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9424-20]

Coffee Break . . . . . Tue 10:00 am to 10:30 am

**CONFERENCE 9425**

**Advances in Patterning Materials and Processes XXXII**

**SESSION 4**

**LOCATION: CONVENTION CENTER 220C  
TUE 8:20 AM TO 10:00 AM**

**Negative Tone Materials**

Session Chairs: **Yoshio Kawai**, Shin-Etsu Chemical Co., Ltd. (Japan); **Nobuyuki N. Matsuzawa**, Sony Corp. (Japan)

8:20 am: **Advanced patterning approaches based on negative-tone development (NTD) process for further extension of 193nm immersion lithography**, Michihiro Shirakawa, Naoki Inoue, Hajime Furutani, Kei Yamamoto, Akiyoshi Goto, Mitsuhiro Fujita, FUJIFILM Corp. (Japan) . . . . . [9425-8]

8:40 am: **Optimizing performance in cross-linking negative-tone molecular resists**, Richard A. Lawson, Hannah Narcross, Brandon Sharp, Georgia Institute of Technology (USA); Jun Sung Chun, SEMATECH Inc. (USA) and SUNY College of Nanoscale Science and Engineering (USA); Mark Neisser, SEMATECH Inc. (USA); Laren M. Tolbert, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9425-9]

9:00 am: **Process variation challenges and resolution in the negative-tone develop double patterning for 20nm and below technology node**, Sohan S. Mehta, Lakshmi K. Ganta, Craig D. Higgins, Vikrant K. Chauhan, Burcin Erenturk, Lokesh Subramany, Chien-Hsien S. Lee, Hui Peng Koh, Paramjit Singh, David R. Cho, GLOBALFOUNDRIES Inc. (USA) . . . . . [9425-10]

9:20 am: **Point-of-use filtration strategy for negative-tone developer in extended immersion and extreme-ultraviolet (EUV) lithography**, Lucia D'Urzo, Entegris GmbH (Germany); Philippe Foubert, IMEC (Belgium); Harold Stokes, Dainippon Screen Deutschland GmbH (Germany); Yan Thouroude, Dainippon Screen Deutschland GmbH (Belgium); Annie Xia, Entegris, Inc. (USA) . . . . . [9425-81]

9:40 am: **Effect of molecular resist structure on glass transition temperature and lithographic performance in epoxide functionalized negative-tone resists**, Hannah Narcross, Richard A. Lawson, Brandon Sharp, Georgia Institute of Technology (USA); Jun Sung Chun, SEMATECH Inc. (USA), SUNY College of Nanoscale Science and Engineering (USA); Mark Neisser, SEMATECH Inc. (USA); Laren M. Tolbert, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9425-12]

Coffee Break . . . . . Tue 10:00 am to 10:30 am

**CONFERENCE 9426**

**Optical Microlithography  
XXVIII**

**LOCATION: CONVENTION CENTER 210C  
TUE 8:20 AM TO 8:40 AM**

**Opening Remarks**

Session Chairs: **Kafai Lai**, IBM Corp. (USA);  
**Andreas Erdmann**, Fraunhofer-Institut  
für Integrierte Systeme und  
Bauelementetechnologie IISB (Germany)

**SESSION 1**

**LOCATION: CONVENTION CENTER 210C  
TUE 8:40 AM TO 10:00 AM**

**Keynote Session**

Session Chairs: **Kafai Lai**, IBM Corp. (USA);  
**Andreas Erdmann**, Fraunhofer-Institut für  
Integrierte Systeme und Bauelementetechnologie  
IISB (Germany)

8:40 am: **Optical lithography with and without  
NGL for single-digit nanometer nodes** (*Keynote  
Presentation*), Burn J. Lin, Taiwan Semiconductor  
Manufacturing Co. Ltd. (Taiwan) . . . . . [9426-1]

9:20 am: **Revolutionizing computing and  
communications with silicon photonics** (*Keynote  
Presentation*), Mario J. Paniccia, Intel Corp.  
(USA) . . . . . [9426-2]

Coffee Break . . . . . Tue 10:00 am to 10:30 am

**CONFERENCE 9428**

**Advanced Etch Technology for  
Nanopatterning IV**

**SESSION 3**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
TUE 8:30 AM TO 10:00 AM**

**Plasma and Resist  
Interactions, including  
Patterning Quality Control  
for LER, CD Uniformity, etc.**

Session Chairs: **Erwine Pargon**, CEA-LETI  
(France); **Sebastian U. Engelmann**, IBM Thomas  
J. Watson Research Ctr. (USA)

8:30 am: **Patterning in the era of atomic scale  
fidelity** (*Invited Paper*), Thorsten B. Lill, Lam  
Research Corp. (USA) . . . . . [9428-8]

9:00 am: **Plasma etch challenges with new EUV  
lithography material introduction for patterning  
for MOL and BEOL**, Phillip A. Friddle, Changwoo  
Lee, Bhaskar Nagabhirava, Michael Goss, Stefan  
Schmitz, Peng Wang, Richard Yang, Jian Wu, Lam  
Research Corp. (USA); Yann Mignot, Nouradine  
Rassoul, Bassem Hamieh, STMicroelectronics (USA);  
Genevieve Beique, Andre Labonte, Catherine Labelle,  
GLOBALFOUNDRIES Inc. (USA); John C. Arnold, IBM  
Corp. (USA) . . . . . [9428-9]

9:20 am: **Spectral analysis of the line-width and  
line-edge roughness transfer during self-aligned  
double patterning approach**, Erwine Pargon,  
Emmanuel Dupuy, CNRS-LTM (France); Marc  
Fouchier, LTM CNRS (France); Jonathan Pradelles,  
Helen Grampeix, Patricia Pimenta Barros, Sébastien  
Barnola, CEA-LETI (France); Maxime Darnon, Olivier  
Joubert, LTM CNRS (France) . . . . . [9428-10]

9:40 am: **Ar and H<sub>2</sub> plasma and neutral/ion-beam  
treatment of EUV resist**, Peter De Schepper, IMEC  
(Belgium) and Katholieke Univ. Leuven (Belgium);  
Daniil Marinov, The Open Univ. (United Kingdom);  
Ziad el Otell, Efrain Altamirano-Sánchez, Jean-  
François G. N. de Marneffe, IMEC (Belgium); Stefan  
De Gendt, IMEC (Belgium) and Katholieke Univ.  
Leuven (Belgium); Nicholas St. J. Braithwaite, The  
Open Univ. (United Kingdom) . . . . . [9428-11]

Coffee Break . . . . . Tue 10:00 am to 10:30 am

**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**SESSION 5**

**LOCATION: CONVENTION CENTER 210B  
TUE 10:40 AM TO 12:00 PM**

**EUV Mask Structure**

Session Chairs: **Frank Goodwin**, SEMATECH Inc. (USA); **Hidehiro Watanabe**, EUVL Infrastructure Development Ctr., Inc. (Japan)

10:40 am: **Magnetron sputtering for the production of EUV mask blanks**, Patrick A. Kearney, Tat Ngai, Anil Karumuri, Jung Yum, SEMATECH Inc. (USA); Hojune Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) and SEMATECH Inc. (USA); David Gilmer, SEMATECH Inc. (USA); Tuan Vo, SUNY College of Nanoscale Science and Engineering (USA); Frank Goodwin, SEMATECH Inc. (USA) . . . [9422-16]

11:00 am: **Alternative materials for high-numerical aperture extreme-ultraviolet lithography mask stacks**, Obert R. Wood II, Sudharshanan Raghunathan, Pawitter J. Mangat, GLOBALFOUNDRIES Inc. (USA); Erik A. Verduijn, GLOBALFOUNDRIES Inc. (Belgium); Patrick A. Kearney, SEMATECH Inc. (USA); Christian Laubis, Victor Soltwisch, Frank Scholze, Physikalisch-Technische Bundesanstalt (Germany) . . . . . [9422-17]

11:20 am: **Understanding EUV mask blank surface roughness induced LER and associated roughness requirement**, Pei-Yang Yan, Guojing Zhang, Intel Corp. (USA); Eric M. Gullikson, Ken A. Goldberg, Markus P. Benk, Lawrence Berkeley National Lab. (USA) . . . . . [9422-18]

11:40 am: **Development and evaluation of interface-stabilized and reactive-sputtered oxide-capped multilayers for EUV lithography**, Michael D. Kriese, Yuriy Y. Platonov, Jim R. Rodriguez, Rigaku Innovative Technologies, Inc. (USA); Charles Tarrio, Steven E. Grantham, Shannon B. Hill, Thomas B. Lucatorto, National Institute of Standards and Technology (USA) . . . . . [9422-19]

Lunch/Exhibition Break . . . Tue 12:00 pm to 1:30 pm

**CONFERENCE 9423**

**Alternative Lithographic Technologies VII**

**SESSION 3**

**LOCATION: CONVENTION CENTER 220A  
TUE 10:30 AM TO 12:00 PM**

**UV-NIL for IC Manufacturing**

Session Chairs: **Naoya Hayashi**, Dai Nippon Printing Co., Ltd. (Japan); **Tatsuhiko Higashiki**, Toshiba Corp. (Japan)

10:30 am: **Device fabrication using nanoimprint lithography (Invited Paper)**, Tatsuhiko Higashiki, Tetsuro Nakasugi, Takuya Kono, Sachiko Kobayashi, Toshiba Corp. (Japan) . . . . . [9423-9]

11:00 am: **Nanoimprint systems for high-volume semiconductor manufacturing**, Kazunori Iwamoto, Canon Inc. (Japan) . [9423-10]

11:20 am: **Status of jet and flash imprint lithography process defects**, S. V. Sreenivasan, Canon Nanotechnologies, Inc. (USA) . . [9423-11]

11:40 am: **HVM readiness of nanoimprint lithography templates: defects, CD, and overlay**, Koji Ichimura, Kouji Yoshida, Saburo Harada, Takaharu Nagai, Masaaki Kurihara, Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan) . . . . . [9423-12]

Lunch/Exhibition Break Tue 12:00 pm to 1:30 pm

**CONFERENCE 9424**

**Metrology, Inspection, and Process Control for Microlithography XXIX**

**SESSION 5**

**LOCATION: CONVENTION CENTER 220B  
TUE 10:30 AM TO 11:30 AM**

**Wafer Geometry and Topography Effects on Process Control**

Session Chairs: **Timothy F. Crimmins**, Intel Corp. (USA); **John A. Allgair**, Nanometrics Inc. (USA)

10:30 am: **Effect of wafer geometry on chucking in advanced lithography processes**, Kevin T. Turner, Univ. of Pennsylvania (USA); Jaydeep K. Sinha, KLA-Tencor Corp. (USA) . . . . . [9424-21]

10:50 am: **Improvement of process control using wafer geometry for enhanced manufacturability of advanced semiconductor devices**, Honggoo Lee, Jongsu Lee, Sang Min Kim, Changhwan Lee, Sangjun Han, Myoung Soo Kim, Wontaik Kwon, Sung-Ki Park, SK Hynix, Inc. (Korea, Republic of); Pradeep Vukkadala, KLA-Tencor Corp. (USA); Amartya Awasthi, KLA-Tencor Corp. (India); J. H. Kim, Sathish Veeraraghavan, KLA-Tencor Corp. (USA); DongSub Choi, KLA-Tencor Korea (Korea, Republic of); Kevin Huang, Prasanna Dighe, KLA-Tencor Corp. (USA); Cheouljung Lee, KLA-Tencor Korea (Korea, Republic of); Soham Dey, Jaydeep K. Sinha, KLA-Tencor Corp. (USA) . . . . . [9424-22]

11:10 am: **Lithography overlay control improvement using patterned wafer geometry for sub-22nm technology nodes**, Jaydeep K. Sinha, KLA-Tencor Corp. (USA); Joel D. Peterson, Gary Rusk, Micron Technology, Inc. (USA); Sathish Veeraraghavan, Kevin Huang, Telly S. Koffas, KLA-Tencor Corp. (USA); Greg Gray, KLA-Tencor Idaho (USA) . . . . . [9424-23]

Lunch/Exhibition Break . . . Tue 11:30 am to 1:20 pm

**CONFERENCE 9425**

**Advances in Patterning Materials and Processes XXXII**

**SESSION 5**

**LOCATION: CONVENTION CENTER 220C  
TUE 10:30 AM TO 12:30 PM**

**Resist and Process Fundamentals**

Session Chairs: **Ralph R. Dammel**, AZ Electronic Materials USA Corp. (USA); **Robert Allen**, IBM Research - Almaden (USA)

10:30 am: **Total fidelity management in self-aligned multiple patterning process**, Masatoshi Yamato, Noriaki Okabe, Arisa Hara, Sakurako Natori, Shouhei Yamauchi, Kenichi Oyama, Tokyo Electron AT Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan) . . . . . [9425-13]

10:50 am: **Tailored molecular glass resists for scanning probe lithography**, Christian Neuber, Hans-Werner Schmidt, Peter Strohrig, Andreas Ringk, Tristan Kolb, Andreas Schedl, Univ. Bayreuth (Germany); Vincent Fokkema, Marijn G. A. van Veghel, VSL Dutch Metrology Institute (Netherlands); Mike Cooke, Oxford Instruments (United Kingdom); Colin Rawlings, Urs Dürig, Armin W. Knoll, IBM Research - Zürich (Switzerland); Jean- François G. N. de Marneffe, Ziad el Otell, IMEC (Belgium); Marcus Kaestner, Yana Krivoschapina, Matthias Budden, Ivo W. Rangelow, Technische Univ. Ilmenau (Germany). [9425-14]

11:10 am: **Effects of the statistical fluctuation of PAG and quencher on LWR of ArF resists**, Mitsuhiro Fujita, Michihiro Shirakawa, Shuhei Yamaguchi, FUJIFILM Corp. (Japan) . . . . . [9425-15]

11:30 am: **Fundamental study of spin-coating using in-situ analysis and simulation**, Masahiko Harumoto, Jun-ichi Yoshida, Dainippon Screen Manufacturing Co., Ltd. (Japan); Harold Stokes, Dainippon Screen Deutschland GmbH (Germany); Yuji Tanaka, Tadashi Miyagi, Koji Kaneyama, Charles Pieczulewski, Masaya Asai, Dainippon Screen Manufacturing Co., Ltd. (Japan) . . . . . [9425-16]

11:50 am: **Contact hole pitch scaling incorporating direct current superposition**, Jeffrey T. Smith, Anton deVilliers, Nihar Mohanty, TEL Technology Ctr., America, LLC (USA); Yuichiro Miyata, Tokyo Electron Kyushu Ltd. (USA); Vinayak Rastogi, Sanjana Das, TEL Technology Ctr., America, LLC (USA) . . . . . [9425-17]

12:10 pm: **Revealing beam-induced chemistry using modulus mapping in negative-tone EUV/e-beam resists with and without cross-linker additives**, Deidre L. Olynick, Prashant K. Kulshreshtha, Dominik Ziegler, Lawrence Berkeley National Lab. (USA); Scott Dhuey, The Molecular Foundry (USA); Ken Maruyama, JSR Micro, Inc. (USA); Paul D. Ashby, Lawrence Berkeley National Lab. (USA) . . . . . [9425-18]

Lunch/Exhibition Break . . . . . Tue 12:30 pm to 1:30 pm

**CONFERENCE 9426**  
Optical Microlithography XXVIII

**SESSION 2**

**LOCATION: CONVENTION CENTER 210C**  
**TUE 10:30 AM TO 11:50 AM**

**Pushing Optical Limit**

Session Chairs: **Bernd Geh**, Carl Zeiss SMT Inc. (USA); **Will Conley**, Cymer LLC (USA)

10:30 am: **Evolving optical lithography without EUV** (*Invited Paper*), Donis G. Flagello, Stephen P. Renwick, Nikon Research Corp. of America (USA) . . . . . [9426-3]

11:00 am: **The impact of mask topography induced phase effects and their mitigation by absorber optimization** (*Invited Paper*), Jo Finders, ASML Netherlands B.V. (Netherlands) . . . . . [9426-4]

11:30 am: **Patterning process exploration of metal 1 and via layers in 7nm node with 3D patterning flow simulations**, Weimin Gao, Synopsys, Inc. (Belgium); Yves Saad, Synopsys Switzerland, LLC (Switzerland); Kevin Lucas, Synopsys, Inc. (USA); Wolfgang Demmerle, Synopsys GmbH (Germany); Ivan Ciofi, Philippe Matagne, Chris Wilson, Werner Gillijns, IMEC (Belgium) . . . . . [9426-5]

Lunch/Exhibition Break . . . Tue 11:50 am to 1:20 pm

**CONFERENCE 9428**  
Advanced Etch Technology for Nanopatterning IV

**SESSION 4**

**LOCATION: SAN JOSE MARRIOTT, SALON III**  
**TUE 10:30 AM TO 12:10 PM**

**Patterning Integration Schemes: Multilayer Patterning, Self-Aligned Patterning, etc.**

Session Chairs: **Maxime Darnon**, LTM CNRS (France); **Nae-Eung Lee**, Sungkyunkwan Univ. (Korea, Republic of)

10:30 am: **DSA patterning for sub-10nm nodes: integration and etch challenges** (*Invited Paper*), Patricia Pimenta Barros, Aurélien Sarrazin, Nicolas Posseme, Sébastien Barnola, Guillaume Claveau, Raluca Tiron, Ahmed Gharbi, Sandra Bos, Maxime Argoud, Isabelle Servin, CEA-LETI (France); Xavier Chevalier, MINATEC (France); Christophe Navarro, Céline Nicolet, Arkema S.A. (France); Céline Lapeyre, Commissariat à l'Énergie Atomique (France); Cedric Monget, STMicroelectronics (France) . . . . . [9428-12]

11:00 am: **Integration of NAND flash memory ISO multilayer etching to improve productivity** (*Invited Paper*), Chang-kwon Oh, SK Hynix, Inc. (Korea, Republic of) . . . . . [9428-13]

11:30 am: **Trench and hole patterning with EUV resists using dual frequency capacitively coupled plasma (CCP)**, Yannick Feurprier, Katie Lutker-Lee, Vinayak Rastogi, Hiroie Matsumoto, Yuki Chiba, Andrew W. Metz, Kaushik Kumar, TEL Technology Ctr., America, LLC (USA); Genevieve Beique, Andre P. Labonte, Cathy Labelle, GLOBALFOUNDRIES Inc. (USA); Yann Mignot, Bassem Hamieh, STMicroelectronics (USA); John Arnold, IBM Corp. (USA) . . . . . [9428-14]

11:50 am: **Challenges and mitigation strategies for resist trim etch in resist-mandrel based SAQP integration scheme**, Nihar Mohanty, Akiteru Ko, Kaushik Kumar, Peter Biolsi, Jefferey T. Smith, David O'Meara, Steven A. Scheer, Anton Devillers, TEL Technology Ctr., America, LLC (USA) . . . . . [9428-15]

Lunch/Exhibition Break . . . Tue 12:10 pm to 1:30 pm

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**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**SESSION 6**

**LOCATION: CONVENTION CENTER 210B  
TUE 1:30 PM TO 3:10 PM**

**EUV Resists**

Session Chairs: **Thomas I. Wallow**, Brion Technologies, Inc. (USA); **Anna Lio**, Intel Corp. (USA)

1:30 pm: **Novel resist approaches to enable EUV lithography in high-volume manufacturing**, Mark Neisser, Kevin D. Cummings, Sean Valente, Cecilia A. Montgomery, Yu-Jen Fan, Ken Matthews, Jun Sung Chun, SEMATECH Inc. (USA) . . . . . [9422-20]

1:50 pm: **Understanding of stochastic noise**, Seo-Min Kim, Chang-Moon Lim, Mi-Rim Jung, Young-Sik Kim, Won-Taik Kwon, SK Hynix, Inc. (Korea, Republic of); Chang-Nam Ahn, Kyu-Tae Sun, ASML Korea (Korea, Republic of); Anita Fumar-Pici, ASML US, Inc. (USA); Alek Chen, ASML Taiwan Ltd. (Taiwan) . . . . . [9422-21]

2:10 pm: **Negative-tone imaging with EUV exposure for 14nm node and beyond**, Hideaki Tsubaki, Wataru Nihashi, Toru Tsuchihashi, Makoto Momota, Takahiro Goto, FUJIFILM Corp. (Japan) . . . . . [9422-22]

2:30 pm: **Acid generation mechanism in anion-bound chemically amplified resists used for extreme-ultraviolet lithography**, Yoshitaka Komuro, Tokyo Ohka Kogyo Co., Ltd. (Japan); Hiroki Yamamoto, Kazuo Kobayashi, The Institute of Scientific and Industrial Research (Japan); Katsumi Ohomori, Tokyo Ohka Kogyo Co., Ltd. (Japan); Takahiro Kozawa, The Institute of Scientific and Industrial Research (Japan) . . . . . [9422-23]

2:50 pm: **Novel EUV resist development for sub-14nm half pitch**, Masafumi Hori, JSR Micro N.V. (Belgium); Takehiko Naruoka, Hisashi Nakagawa, Tomohisa Fujisawa, Takakazu Kimoto, Motohiro Shiratani, Tomoki Nagai, JSR Corp. (Japan); Ramakrishnan Ayothi, Yoshi Hishiro, JSR Micro, Inc. (USA); Kenji Hoshiko, JSR Micro N.V. (Belgium); Toru Kimura, JSR Corp. (Japan) . . . . . [9422-24]

Coffee Break . . . . . Tue 3:10 pm to 3:40 pm

**CONFERENCE 9423**

**Alternative Lithographic Technologies VII**

**SESSION 4**

**LOCATION: CONVENTION CENTER 220A  
TUE 1:30 PM TO 3:00 PM**

**Scanning Probe Lithography**

Session Chairs: **Ivo W. Rangelow**, Technische Univ. Ilmenau (Germany); **Alan D. Brodie**, KLA-Tencor Corp. (USA)

1:30 pm: **Single-digit nanomanufacturing by electric-field scanning probe lithography on molecular resist** (*Invited Paper*), Marcus Kaestner, Yana Krivoschapkina, Matthias Budden, Steve Lenk, Tzvetan Ivanov, Technische Univ. Ilmenau (Germany); Christian Neuber, Hans-Werner Schmidt, Univ. Bayreuth (Germany); Ivo W. Rangelow, Technische Univ. Ilmenau (Germany) . . . . . [9423-13]

2:00 pm: **Optimization of near-field scanning optical lithography**, Ben S. Routley, John L. Holdsworth, Andrew J. Fleming, The Univ. of Newcastle (Australia) . . . . . [9423-14]

2:20 pm: **Progress on thermal scanning probe lithography**, Felix Holzner, Philip Paul, Simon Bonanni, Stefan Weber, Martin Spieser, SwissLitho AG (Switzerland); Colin Rawlings, Heiko Wolf, Ute Drechsler, Urs Duerig, Armin W. Knoll, IBM Research – Zürich (Switzerland) . . . . . [9423-15]

2:40 pm: **Challenges and opportunities of scanning probe lithography for creation of guiding patterns used in directed self-assembly of block copolymers**, Francesc Perez-Murano, Laura Evangelio, Matteo Lorenzoni, Marta Fernandez-Regulez, Ctr. Nacional de Microelectrónica (Spain); Marcus Kaestner, Yana Krivoschapkina, Ivo W. Rangelow, Technische Univ. Ilmenau (Germany) . . . . . [9423-16]

Coffee Break . . . . . Tue 3:00 pm to 3:30 pm

**CONFERENCE 9424**

**Metrology, Inspection, and Process Control for Microlithography XXIX**

**SESSION 6**

**LOCATION: CONVENTION CENTER 220B  
TUE 1:20 PM TO 3:00 PM**

**AFM**

Session Chairs: **Benjamin D. Bunday**, SEMATECH Inc. (USA); **John C. Robinson**, KLA-Tencor Corp. (USA)

1:20 pm: **Demonstration of parallel scanning probe microscope for high-throughput metrology and inspection**, Hamed Sadeghian, Rodolf W. Herfst, Jasper Winters, Tom Bijmagne, Bert Dekker, Alexander Eigenraam, Ramon Rijnbeek, Nicole Nulkes, TNO (Netherlands) . . . . . [9424-24]

1:40 pm: **Self-actuated, self-sensing cantilevers for fast CD measurement**, Ahmad Ahmad, Tzvetan Ivanov, Technische Univ. Ilmenau (Germany); Alexander Reum, nano analytik GmbH (Germany); Elshad Guliyev, Tihomir Angelov, Andreas Schuh, Marcus Kaestner, Technische Univ. Ilmenau (Germany); Manuel Hofer, Mathias Holz, nano analytik GmbH (Germany); Ivo W. Rangelow, Technische Univ. Ilmenau (Germany) . . . . . [9424-25]

2:00 pm: **High-speed AFM for 1x node metrology and inspection: Does it damage the features?**, Hamed Sadeghian, Teun C. van den Dool, TNO (Netherlands); Yoram Uziel, Ron Bar Or, Applied Materials, Ltd. (Israel) . . . . . [9424-26]

2:20 pm: **Multiple height calibration reference for nanometrology**, Marc Christophersen, Bernard F. Philips, Andrew J. Boudreau, Michael K. Yetzbacher, U.S. Naval Research Lab. (USA) . . . . . [9424-27]

2:40 pm: **Development of a comprehensive metrology software platform dedicated to dimensional measurements of CD atomic force microscopy tips**, Johann Foucher, Pollen Technology (France); Sebastian W. Schmidt, nanotools GmbH (Germany); Aurelien Labrosse, Alexandre Derville, Pollen Technology (France); Sandra Bos, CEA-LETI (France); Sebastian Schade, Bernd Irmr, nanotools GmbH (Germany) . . [9424-28]

Coffee Break . . . . . Tue 3:00 pm to 3:30 pm

**CONFERENCE 9425**

**Advances in Patterning Materials and Processes XXXII**

**SESSION 6**

**LOCATION: CONVENTION CENTER 220C  
TUE 1:30 PM TO 3:10 PM**

**Patterning Materials and Etch**

**Joint Session with Conferences 9425 and 9428**

Session Chairs: **Qinghuang Lin**, IBM Thomas J. Watson Research Ctr. (USA); **Thomas I. Wallow**, Brion Technologies, Inc. (USA)

1:30 pm: **Understanding the efficacy of linewidth roughness post processing** (*Invited Paper*), Chris A. Mack, Lithoguru.com (USA) . . . . . [9425-19]

2:00 pm: **Photoresist performance modification through plasma treatment** (*Invited Paper*), Hidetami Yaegashi, Tokyo Electron Ltd. (Japan); Kenichi Oyama, Shohei Yamauchi, Arisa Hara, Sakurako Natori, Masatoshi Yamato, Noriaki Okabe, Tokyo Electron AT Ltd. (Japan) . . . . . [9428-16]

2:30 pm: **Finding practical solution to create phenomenological models that include both photoresist behavior and the etch process effect**, Sunwook Jung, Mentor Korea Co., Ltd. (Korea, Republic of); Thuy Do, John Sturtevant, Mentor Graphics Corp. (USA) . . . . . [9428-17]

2:50 pm: **Molecular glass resist performance for nano-pattern transfer**, Ziad el Otell, IMEC (Belgium); Andreas Ringk, Tristan Kolb, Christian Neuber, Univ. Bayreuth (Germany); Jean-François de Marneffe, IMEC (Belgium) . . . . . [9428-18]

Coffee Break . . . . . Tue 3:10 pm to 3:40 pm

**CONFERENCE 9426**  
**Optical Microlithography XXVIII**

**SESSION 3**

**LOCATION: CONVENTION CENTER 210C**  
**TUE 1:20 PM TO 3:00 PM**

**Image and Process Control**

Session Chairs: **Kazuhiro Takahashi**, Canon Inc. (Japan); **Carlos Fonseca**, Tokyo Electron America, Inc. (USA)

1:20 pm: **Impact of bandwidth on contrast sensitive structures for low-k1 lithography**, Will Conley, Cymer LLC (USA); Simon Hsieh, Cymer Southeast Asia, Ltd. (Taiwan) . . . . . [9426-6]

1:40 pm: **Solution for high-order distortion on extreme illumination condition using computational prediction method**, Young Seog Kang, Hunhwan Ha, Jang-Sun Kim, Ju Hee Shin, Young Ha Kim, Young Sun Nam, Young-Sin Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Cedric Affentauschegg, Rob W. van der Heijden, ASML Netherlands B.V. (Netherlands); Bernd Geh, Carl Zeiss SMT Inc. (USA); Eric Janda, ASML US, Inc. (USA); Jan Baselmans, Stefan van der Sanden, ASML Netherlands B.V. (Netherlands); Oh-Sung Kwon, ASML Korea Co., Ltd. (Korea, Republic of); Mariya Ponomarenko, Daan Slotboom, ASML Netherlands B.V. (Netherlands) . . . . . [9426-7]

2:00 pm: **Optimum ArFi laser bandwidth for 10nm node logic imaging performance**, Paolo Alagna, Cymer LCC (USA); Vadim Timoshkov, ASML Netherlands B.V. (Netherlands); Patrick Wong, IMEC (Belgium); Jan Baselmans, ASML Netherlands B.V. (Netherlands); Gregory Rechtsteiner, Omar Zurita, Cymer LLC (USA) . . . . . [9426-8]

2:20 pm: **Lithographic performance comparison of thin OMOG and attenuated phase-shift masks for 64nm pitch contact holes**, Burcin Erenturk, Sohan Singh S. Mehta, Lakshmi K. Ganta, Yuan Lei, GLOBALFOUNDRIES Inc. (USA) . . . . . [9426-9]

2:40 pm: **Single lithography exposure edge placement model**, Jacek K. Tyminski, Nikon Research Corp. of America (USA) . . . . . [9426-10]

Coffee Break . . . . . Tue 3:00 pm to 3:30 pm

**CONFERENCE 9428**  
**Advanced Etch Technology for Nanopatterning IV**

**SESSION 5**

**LOCATION: CONVENTION CENTER 220C**  
**TUE 1:30 PM TO 3:10 PM**

**Patterning Materials and Etch**

**Joint Session with Conferences 9425 and 9428**

Session Chairs: **Qinghuang Lin**, IBM Thomas J. Watson Research Ctr. (USA); **Thomas I. Wallow**, Brion Technologies, Inc. (USA)

1:30 pm: **Understanding the efficacy of linewidth roughness post processing** (*Invited Paper*), Chris A. Mack, Lithoguru.com (USA) . . . . . [9425-19]

2:00 pm: **Photoresist performance modification through plasma treatment** (*Invited Paper*), Hidetami Yaegashi, Tokyo Electron Ltd. (Japan); Kenichi Oyama, Shohei Yamauchi, Arisa Hara, Sakurako Natori, Masatoshi Yamato, Noriaki Okabe, Tokyo Electron AT Ltd. (Japan) . . . . . [9428-16]

2:30 pm: **Finding practical solution to create phenomenological models that include both photoresist behavior and the etch process effect**, Sunwook Jung, Mentor Korea Co., Ltd. (Korea, Republic of); Thuy Do, John Sturtevant, Mentor Graphics Corp. (USA) . . . . . [9428-17]

2:50 pm: **Molecular glass resist performance for nano-pattern transfer**, Ziad el Otell, IMEC (Belgium); Andreas Ringk, Tristan Kolb, Christian Neuber, Univ. Bayreuth (Germany); Jean-François de Marneffe, IMEC (Belgium) . . . . . [9428-18]

Coffee Break . . . . . Tue 3:10 pm to 3:40 pm

CONFERENCE 9422

Extreme Ultraviolet (EUV) Lithography VI

SESSION 7

LOCATION: CONVENTION CENTER 210B TUE 3:40 PM TO 6:00 PM

EUV Integration

Session Chairs: Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA); Anthony Yen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

3:40 pm: EUV patterning improvement toward high-volume manufacturing, Yuhei Kuwahara, Tokyo Electron Kyushu Ltd. (Belgium); Philippe Foubert, Anne-Marie Goethals, IMEC (Belgium); Kathleen Nafus, Tokyo Electron Kyushu Ltd. (Belgium); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Koichi Matsunaga, Takeshi Shimoaoki, Shinichiro Kawakami, Tokyo Electron Kyushu Ltd. (Japan). . . . . [9422-25]

4:00 pm: Toward production ready processing with a state-of-the-art EUV cluster, Karen E. Petrillo, IBM Corp. (USA) . . . . . [9422-26]

4:20 pm: EUV contact hole patterning with reverse tone imaging process, Sarohan Park, SK Hynix, Inc. (Korea, Republic of) and IMEC (Belgium); Danilo De Simone, Zheng S. Tao, Geert Vandenbergh, IMEC (Belgium); Seo-Min Kim, Chang-Moon Lim, SK Hynix, Inc. (Korea, Republic of) . . . . . [9422-27]

4:40 pm: EUV processing and characterization for BEOL, Nicole Saulnier, Yongan Xu, IBM Corp. (USA); Wenhui Wang, GLOBALFOUNDRIES Inc. (USA); Lin L. Cheong, IBM Corp. (USA); Romain Lallement, STMicroelectronics (USA); Lei Sun, Genevieve Beique, GLOBALFOUNDRIES Inc. (USA); Bassem Hamieh, STMicroelectronics (USA); John C. Arnold, Nelson M. Felix, Matthew E. Colburn, IBM Corp. (USA) [9422-28]

5:00 pm: Implementation of assist features in EUV lithography, Fan Jiang, Mentor Graphics Corp. (USA); Martin Burkhardt, IBM Thomas J. Watson Research Ctr. (USA); James Word, Mentor Graphics Corp. (USA) . . . . . [9422-29]

5:20 pm: Optical proximity effects in 4nm EUV lithography: a rigorous study using a non-conforming mesh PSTD method, Michael S. Yeung, Fastlitho Inc. (USA); Eytan Barouch, Boston Univ. (USA) . . . . . [9422-30]

5:40 pm: Directed self-assembly on resist-limited guiding patterns for hole grapho-epitaxy: Can DSA help lower EUV's source power requirements?, Juan Andres Torres, Fan Jiang, Yuansheng Ma, Joerg Mellman, Mentor Graphics Corp. (USA); Kafai Lai, Ananthan Raghunathan, Yongan Xu, Chi-Chun Liu, IBM Corp. (USA) . . . . . [9422-31]

CONFERENCE 9423

Alternative Lithographic Technologies VII

Sessions 5 and 6 run concurrently.

SESSION 5

LOCATION: CONVENTION CENTER 220A TUE 3:30 PM TO 4:50 PM

Novel Lithography and Applications

Session Chairs: Wei Wu, The Univ. of Southern California (USA); Laurent Pain, CEA-LETI (France)

3:30 pm: Multi-electron-beam-induced deposition of sub-10 nanometer features and their pattern transfer into silicon, Cornelis W. Hagen, Marijke Scotuzzi, Technische Univ. Delft (Netherlands); Martin Kamerbeek, Technische Univ. Delft (Netherlands) and MAPPER Lithography (Netherlands); Andy Goodyear, Oxford Instruments (United Kingdom). [9423-17]

3:50 pm: Sub-5nm patterning using helium ion-beam lithography and nanoimprint lithography, Yuhuan Yao, He Liu, Yifei Wang, The Univ. of Southern California (USA); Wen-Di Li, The Univ. of Hong Kong (Hong Kong, China); Ahmad N. Abbas, Gang Liu, The Univ. of Southern California (USA); R. Stanley Williams, Hewlett-Packard Labs. (USA); Chongwu Zhou, Wei Wu, The Univ. of Southern California (USA) . . . . . [9423-18]

4:10 pm: Fabrication of functional electromechanical nanowire resonators by focused ion-beam (FIB) implantation, Jordi Llobet, Marc Sansa, Ctr. Nacional de Microelectrónica (Spain); Xavier Borrís, Institut Català de Nanociència i Nanotecnologia (ICN2) (Spain); Francesc Pérez-Murano, Ctr. Nacional de Microelectrónica (Spain) . . . . . [9423-19]

4:30 pm: Towards nanostars patterning by three coplanar beam interferential lithography, Joyce Ibrahim, Anna Rumyantseva, Gilles Lerondel, Timothée Toury, Univ. de Technologie Troyes (France) . . . . . [9423-20]

SESSION 6

LOCATION: CONVENTION CENTER 220B TUE 3:30 PM TO 4:50 PM

Metrology and Inspection for Directed Self-Assembly

Joint Session with Conferences 9423 and 9424

Session Chairs: Martha I. Sanchez, IBM Research - Almaden (USA); Daniel J. C. Herr, The Univ. of North Carolina at Greensboro (USA)

3:30 pm: Defect mitigation and root cause studies in IMEC's 14nm half-pitch chemo-epitaxy DSA flow, Hari Pathangi, Boon Teik Chan, Hareem Bayana, Dieter Van Den Heuvel, Lieve Van Look, Paulina A. Rincon-Delgadillo, IMEC (Belgium); Guanyang Lin, Yi Cao, JiHoon Kim, AZ Electronic Materials USA Corp. (USA); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Kathleen Nafus, Tokyo Electron America, Inc. (USA); Ito Chikashi, Venkat R. Nagaswami, KLA-Tencor Corp. (USA); Lucia D'Urzo, Entegris GmbH (Germany); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9423-21]

3:50 pm: Optical CD metrology for directed self-assembly assisted contact hole shrink process, Dhairya J. Dixit, Alain C. Diebold, SUNY College of Nanoscale Science and Engineering (USA); Erik R. Hosler, Moshe E. Preil, GLOBALFOUNDRIES Inc. (USA); Joseph Race, Nick Keller, Nanometrics Inc. (USA); Jun Sung Chun, Michael O'Sullivan, M. Warren Montgomery, SUNY College of Nanoscale Science and Engineering (USA) . . . . . [9424-29]

4:10 pm: Metrology of DSA process using TEM tomography, Tamar Segal-Peretz, Nestor J. Zaluzec, Argonne National Lab. (USA); Jiaying Ren, The Univ. of Chicago (USA); Mahua Biswas, Argonne National Lab. (USA); Jonathan Winterstein, Alexander J. Liddle, National Institute of Standards and Technology (USA); Jeffery W. Elam, Argonne National Lab. (USA); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9424-30]

4:30 pm: Line-edge roughness on directed self-assembly: impact of process conditions, Vijaya-Kumar Murugesan Kuppuswamy, IMEC (Belgium), Katholieke Univ. Leuven (Belgium); Lance D. Williamson, IMEC (Belgium), The Univ. of Chicago (USA); Hari Pathangi, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA); Roel Gronheid, IMEC (Belgium); Guanyang Lin, Yi Cao, AZ Electronic Materials USA Corp. (USA) . [9424-31]

CONFERENCE 9424

Metrology, Inspection, and Process Control for Microlithography XXIX

SESSION 7

LOCATION: CONVENTION CENTER 220B TUE 3:30 PM TO 4:50 PM

Metrology and Inspection for Directed Self-Assembly

Joint Session with Conferences 9423 and 9424

Session Chairs: Martha I. Sanchez, IBM Research - Almaden (USA); Daniel J. C. Herr, The Univ. of North Carolina at Greensboro (USA)

3:30 pm: Defect mitigation and root cause studies in IMEC's 14nm half-pitch chemo-epitaxy DSA flow, Hari Pathangi, Boon Teik Chan, Hareem Bayana, Dieter Van Den Heuvel, Lieve Van Look, Paulina A. Rincon-Delgadillo, IMEC (Belgium); Guanyang Lin, Yi Cao, JiHoon Kim, AZ Electronic Materials USA Corp. (USA); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Kathleen Nafus, Tokyo Electron America, Inc. (USA); Ito Chikashi, Venkat R. Nagaswami, KLA-Tencor Corp. (USA); Lucia D'Urzo, Entegris GmbH (Germany); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9423-21]

3:50 pm: Optical CD metrology for directed self-assembly assisted contact hole shrink process, Dhairya J. Dixit, Alain C. Diebold, SUNY College of Nanoscale Science and Engineering (USA); Erik R. Hosler, Moshe E. Preil, GLOBALFOUNDRIES Inc. (USA); Joseph Race, Nick Keller, Nanometrics Inc. (USA); Jun Sung Chun, Michael O'Sullivan, M. Warren Montgomery, SUNY College of Nanoscale Science and Engineering (USA) . . . . . [9424-29]

4:10 pm: Metrology of DSA process using TEM tomography, Tamar Segal-Peretz, Nestor J. Zaluzec, Argonne National Lab. (USA); Jiaying Ren, The Univ. of Chicago (USA); Mahua Biswas, Argonne National Lab. (USA); Jonathan Winterstein, Alexander J. Liddle, National Institute of Standards and Technology (USA); Jeffery W. Elam, Argonne National Lab. (USA); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9424-30]

4:30 pm: Line-edge roughness on directed self-assembly: impact of process conditions, Vijaya-Kumar Murugesan Kuppuswamy, IMEC (Belgium), Katholieke Univ. Leuven (Belgium); Lance D. Williamson, IMEC (Belgium), The Univ. of Chicago (USA); Hari Pathangi, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA); Roel Gronheid, IMEC (Belgium); Guanyang Lin, Yi Cao, AZ Electronic Materials USA Corp. (USA) . . . . . [9424-31]



**CONFERENCE 9425**

Advances in Patterning Materials and Processes XXXII

**SESSION 7**

**LOCATION: CONVENTION CENTER 220C  
TUE 3:40 PM TO 5:20 PM**

**Materials and Etch in Emerging Technologies**

**Joint Session with Conferences 9425 and 9428**

Session Chairs: **Christoph K. Hohle**, Fraunhofer Institute for Photonic Microsystems (Germany); **Qinghuang Lin**, IBM Thomas J. Watson Research Ctr. (USA)

3:40 pm: **Influence of etch process on contact hole local critical dimension uniformity in extreme-ultraviolet lithography**, Gian F. Lorusso, Ming Mao, IMEC (Belgium); Liesbeth Reijnen, Katja Viatkina, Roel Knops, Timon F. Fliervoet, ASML Netherlands B.V. (Netherlands) . . . . . [9425-20]

4:00 pm: **Investigation of line roughness and undulation during DSA pattern transfer for BEOL applications**, Erik R. Hosler, Xunyu Zhang, Genevieve Beique, Moshe E. Preil, Cathy Labelle, E. Todd Ryan, GLOBALFOUNDRIES Inc. (USA); Vinayak Rastogi, Yannick Feurprier, TEL Technology Ctr., America, LLC (USA); Richard A. Farrell, Tokyo Electron America, Inc. (USA); Kai-Hung Yu, Tokyo Electron America, Inc. (USA); Richard Gaylord, Tokyo Electron America, Inc. (USA); Nihar Mohanty, David Hetzer, Kaushik Kumar, Akitero Ko, TEL Technology Ctr., America, LLC (USA) . . . . . [9428-19]

4:20 pm: **Organic carbon hard masks utilizing fullerene derivatives**, Alex P. Robinson, Andreas Frommhold, The Univ. of Birmingham (United Kingdom); Alan G. Brown, Irresistible Materials Ltd. (United Kingdom); Tom Lada, Nano-C, Inc. (USA) . . . . . [9425-21]

4:40 pm: **Hybrid materials: a bottom-up approach for micro- and nanolithography**, Giovanna Brusatin, Univ. degli Studi di Padova (Italy) . . . . . [9425-22]

5:00 pm: **Enhancing etch selectivity in DSA block copolymer films with sequential infiltration synthesis on 300mm Si substrates**, Arjun Singh, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Safak Sayan, Intel Corp. (USA) and IMEC (Belgium); Ziad el Otell, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Boon Teik Chan, Roel Gronheid, IMEC (Belgium) . . . . . [9425-23]

**CONFERENCE 9426**

Optical Microlithography XXVIII

**SESSION 4**

**LOCATION: CONVENTION CENTER 210C  
TUE 3:30 PM TO 5:30 PM**

**Non-IC Applications**

Session Chairs: **Andreas Erdmann**, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); **Reinhard Völkel**, SUSS MicroOptics SA (Switzerland)

3:30 pm: **Multicolor, visible-light nanolithography (Invited Paper)**, John T. Fourkas, Univ. of Maryland, College Park (USA) . . . . . [9426-11]

4:00 pm: **Progresses in 300mm DUV photolithography for the development of advanced silicon photonic devices (Invited Paper)**, Bertrand Szelag, CEA (France); Charles Baudot, STMicroelectronics (France); Nacima Allouti, Corinne Comboroure, Sébastien Bérard-Bergery, Christian Vizioz, Sébastien Barnola, CEA-LETI (France); Fabien Gays, Denis Mariolle, Commissariat à l'Énergie Atomique (France); Thomas Ferrotti, STMicroelectronics (France) and Commissariat à l'Énergie Atomique (France); Aurélie Souhaité, Stéphane Brisson, CEA-LETI (France); Christophe Kopp, Commissariat à l'Énergie Atomique (France); Frédéric Boeuf, STMicroelectronics (France); Sylvie Menezes, CEA-LETI (France) . . . . . [9426-12]

4:30 pm: **Double-sided diffractive photomask for sub-500nm resolution proximity i-line mask-aligner lithography**, Yannick Bourgin, Thomas Siefke, Thomas Käsebier, Friedrich-Schiller-Univ. Jena (Germany); Uwe D. Zeitner, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) and Friedrich-Schiller-Univ. Jena (Germany); Ernst-Bernhard Kley, Friedrich-Schiller-Univ. Jena (Germany) . . . . . [9426-13]

4:50 pm: **Optimization method for 3D lithography process utilizing DMD-based maskless grayscale photolithography system**, Xiaoxu Ma, Yoshiki Kato, Yoshikazu Hirai, Kyoto Univ. (Japan); Floris van Kempen, Fred van Keulen, Technische Univ. Delft (Netherlands); Toshiyuki Tsuchiya, Osamu Tabata, Kyoto Univ. (Japan) . . . . . [9426-14]

5:10 pm: **Reduced voxel size in two-photon direct laser writing by double exposure**, Carsten Eschenbaum, Uli Lemmer, Karlsruher Institut für Technologie (Germany) . . . . . [9426-15]

**CONFERENCE 9428**

Advanced Etch Technology for Nanopatterning IV

**SESSION 6**

**LOCATION: CONVENTION CENTER 220C  
TUE 3:40 PM TO 5:20 PM**

**Materials and Etch in Emerging Technologies**

**Joint Session with Conferences 9425 and 9428**

Session Chairs: **Christoph K. Hohle**, Fraunhofer Institute for Photonic Microsystems (Germany); **Qinghuang Lin**, IBM Thomas J. Watson Research Ctr. (USA)

3:40 pm: **Influence of etch process on contact hole local critical dimension uniformity in extreme-ultraviolet lithography**, Gian F. Lorusso, Ming Mao, IMEC (Belgium); Liesbeth Reijnen, Katja Viatkina, Roel Knops, Timon F. Fliervoet, ASML Netherlands B.V. (Netherlands) . . . . . [9425-20]

4:00 pm: **Investigation of line roughness and undulation during DSA pattern transfer for BEOL applications**, Erik R. Hosler, Xunyu Zhang, Genevieve Beique, Moshe E. Preil, Cathy Labelle, E. Todd Ryan, GLOBALFOUNDRIES Inc. (USA); Vinayak Rastogi, Yannick Feurprier, TEL Technology Ctr., America, LLC (USA); Richard A. Farrell, Kai-Hung Yu, Richard Gaylord, Tokyo Electron America, Inc. (USA); Nihar Mohanty, David Hetzer, Kaushik Kumar, Akitero Ko, TEL Technology Ctr., America, LLC (USA) . . . . . [9428-19]

4:20 pm: **Organic carbon hard masks utilizing fullerene derivatives**, Alex P. Robinson, Andreas Frommhold, The Univ. of Birmingham (United Kingdom); Alan G. Brown, Irresistible Materials Ltd. (United Kingdom); Tom Lada, Nano-C, Inc. (USA) . . . . . [9425-21]

4:40 pm: **Hybrid materials: a bottom-up approach for micro- and nanolithography**, Giovanna Brusatin, Univ. degli Studi di Padova (Italy) . . . . . [9425-22]

5:00 pm: **Enhancing etch selectivity in DSA block copolymer films with sequential infiltration synthesis on 300mm Si substrates**, Arjun Singh, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Safak Sayan, Intel Corp. (USA) and IMEC (Belgium); Ziad el Otell, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Boon Teik Chan, Roel Gronheid, IMEC (Belgium) . . . . . [9425-23]

Tuesday Poster Reception Sponsor:



**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**Evaluation of surfactant rinse material and process for EUV lithography**, Kazuma Yamamoto, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9422-69]

**Measurement of the phase defect size using scanning probe microscope and at-wavelength inspection tool**, Tsuyoshi Amano, Hidehiro Watanabe, EUVL Infrastructure Development Ctr., Inc. (Japan); Tsukasa Abe, Dai Nippon Printing Co., Ltd. (Japan) . . . . . [9422-70]

**Verification of an effect of phase defect characteristics on scattered light images**, Noriaki Takagi, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9422-71]

**Low-LER tin carboxylate photoresists using EUV**, Ryan Del Re, Miriam Sortland, James Pasarelli, SUNY College of Nanoscale Science and Engineering (USA); Mark Neisser, SEMATECH Inc. (USA); Daniel A. Freedman, State Univ. of New York at New Paltz (USA); Robert L. Brainard, SUNY College of Nanoscale Science and Engineering (USA) [9422-72]

**Systematic study of ligand structures of metal oxide EUV-nanoparticle photoresists**, Jing Jiang, Ben Zhang, Li Li, Cornell Univ. (USA); Mark Neisser, SEMATECH Inc. (USA); Jun Sung Chun, SEMATECH Inc. (USA) and SUNY College of Nanoscale Science and Engineering (USA); Emmanuel P. Giannelis, Christopher K. Ober, Cornell Univ. (USA) . . [9422-73]

**Experimental validation of stochastic: modeling for negative-tone develop EUV resists**, Itaru Kamohara, Synopsys GmbH (Germany); Weimin Gao, Synopsys, Inc. (Belgium); Ulrich Klostermann, Thomas Schmoeller, Wolfgang Demmerle, Synopsys GmbH (Germany); Kevin Lucas, Synopsys, Inc. (USA); Danilo De Simone, Eric Hendrickx, Geert Vandenbergh, IMEC (Belgium) . . . . . [9422-74]

**Study of EUVL patterned mask inspection tool for half-pitch (hp) 16nm-11nm node**, Ryoichi Hirano, Susumu Iida, Tsuyoshi Amano, Hidehiro Watanabe, EUVL Infrastructure Development Ctr., Inc. (Japan); Masahiro Hatakeyama, Takeshi Murakami, Shoji Yoshikawa, Kenichi Suematsu, Kenji Terao, EBARA Corp. (Japan) . . . . . [9422-75]

**Dependence of defect size and shape on detectability for EUV patterned mask inspection**, Susumu Iida, Ryoichi Hirano, Tsuyoshi Amano, Hidehiro Watanabe, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9422-76]

**Performance of actinic EUV mask review using scanning lensless imaging system**, Sangsul Lee, Yasin Ekinici, Paul Scherrer Institut (Switzerland) . . . . . [9422-77]

**Positive-tone resists made from complexes of platinum and palladium**, Miriam Sortland, Ryan Del Re, James Passarelli, SUNY College of Nanoscale Science and Engineering (USA); Mark Neisser, SEMATECH Inc. (USA); Daniel A. Freedman, State Univ. of New York at New Paltz (USA); Robert L. Brainard, SUNY College of Nanoscale Science and Engineering (USA) . . . . . [9422-78]

**Experimental test of an argon cusp plasma for tin LPP power scaling**, Malcolm W. McGeoch, PLEX LLC (USA) . . . . . [9422-79]

**Phase and amplitude defect distinction with an actinic dark-field microscope**, Lukas Bahrenberg, Stefan Herbert, Aleksey Maryasov, Jenny Tempeler, Serhiy Danylyuk, RWTH Aachen (Germany); Rainer Lebert, Bruker ASC GmbH (Germany); Peter Loosen, Larissa Juschkina, RWTH Aachen (Germany) [9422-80]

**Optimizing performance of multilayer mirror optics for EUV and BEUV lithography**, Tatyana Sizyuk, Purdue Univ. (USA) . . . . . [9422-81]

**Alternative irradiation scheme for EUV source for inspection applications**, Duane Hudgins, Nadia Gambino, Bob Rollinger, Reza S. Abhari, ETH Zürich (Switzerland); Fariba Abreau, Adlyte AG (Switzerland) . . . . . [9422-82]

**Improving process and system for EUV coat-develop track**, Masahiko Harumoto, Dainippon Screen Manufacturing Co., Ltd. (Japan); Harold Stokes, Yan Thouroude, Dainippon Screen Deutschland GmbH (Germany); Tadashi Miyagi, Koji Kaneyama, Charles Pieczulewski, Masaya Asai, Dainippon Screen Manufacturing Co., Ltd. (Japan) . . . . . [9422-83]

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**Evaluation of optical properties of EUV resist underlayer**, Jung Sik Kim, Seongchul Hong, Jae Uk Lee, Seung Min Lee, Jinho Ahn, Hanyang Univ. (Korea, Republic of) . . . . . [9422-85]

**New approach to improve LER of EUV resist pattern by chemical and thermal treatment**, Tatsuro Nagahara, Kazuma Yamamoto, Yuriko Matsuura, AZ Electronic Materials (Japan) K.K. (Japan) . . . . . [9422-86]

**Damage simulation of EUV-multilayered mask under-focused ion-beam irradiation**, Kaoru Ohya, Univ. of Tokushima (Japan) . . . . . [9422-87]

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**Simulation study of the impact of post exposure bake parameters on EUV resist LER and CDU**, Suchit Bhattarai, Andrew R. Neureuther, Univ. of California, Berkeley (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA) . . [9422-90]

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**Study of Dill's B parameter measurement of EUV resist**, Atsushi Sekiguchi, Litho Tech Japan Co., Ltd. (Japan) . . . . . [9422-93]

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**Key components technology update of 100W HVM EUV source**, Taku Yamazaki, Hakaru Mizoguchi, Hiroaki Nakarai, Tamotsu Abe, Yasufumi Kawasaki, Takeshi Okamoto, Hiroshi Tanaka, Yukio Watanabe, Tsukasa Hori, Takeshi Kodama, Yutaka Shiraishi, Shinji Okazaki, Takashi Saitou, Gigaphoton Inc. (Japan) . . . . . [9422-98]

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**Fast and thick e-beam resists exposed with multi-beam tool at 5 keV for implants and mature nodes: experimental and simulated model study**, Aurélien Fay, Nideye A. Thiam, CEA-LETI (France); Marie-Laure Cordini, STMicroelectronics (France); Isabelle Servin, Christophe Constancias, Ludovic Lattard, Laurent Pain, CEA-LETI (France) . . . . . [9423-61]

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**Photo-induced large-scale circular surface-relief diffraction gratings on azo-glass**, James Leibold, Ribal Georges Sabat, Royal Military College of Canada (Canada) . . . . . [9423-68]

**Solid immersion optical lithography: tuning the prism/sample interface for improved ultrahigh-NA, high-aspect ration resist patterns over large exposure fields**, Sam D. C. Lowrey, Richard J. Blaikie, Univ. of Otago (New Zealand) . . . . . [9423-69]

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**Block copolymer defect annealing kinetics using a coarse grained molecular dynamics model**, Andrew J. Peters, Richard A. Lawson, Benjamin D. Nation, Peter J. Ludovice, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9423-72]

**Directed self-assembly of diblock copolymers in cylindrical confinement: effect of air-polymer interactions on configurations and defect energies**, Corinne Carpenter, Nabil Laachi, Univ. of California, Santa Barbara (USA); Tatsuhiro Iwama, Univ. of California, Santa Barbara (USA) and Asahi Kasei E-materials Corp. (Japan); David Shykind, Corey J. Weinheimer, Intel Corp. (USA); Glenn H. Fredrickson, Univ. of California, Santa Barbara (USA) . . . . . [9423-73]

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**Mapping self-assembled dots and line arrays by image analysis for quantification of defect density, overlay, and alignment**, Claudia C. Delgado Simão, Institut Català de Nanotecnologia (Spain); Dmitri Tuchapsky, Andreas Amann, Michael A. Morris, Univ. College Cork (Ireland); Clivia M. Sotomayor Torres, Institut Català de Nanotecnologia (Spain) and Institució Catalana de Recerca i Estudis Avançats (Spain) . . . . . [9423-77]

**Density multiplication in directed self-assembly of block co-polymers by chemical surface modification using wide guiding stripes**, Laura Evangelio, Ctr. Nacional de Microelectrónica (Spain); Marta Fernández-Regúlez, Ctr. Nacional de Microelectrónica (Spain) and CEA-LETI (France); Weihua Li, Georg-August-Univ. Göttingen (Germany); Matteo Lorenzoni, Ctr. Nacional de Microelectrónica (Spain); Celia Nicolet, Christophe Navarro, Arkema S.A. (France); Jordi Fraxedas, Institut Català de Nanociència i Nanotecnologia (ICN2) (Spain); Marcus Müller, Georg-August-Univ. Göttingen (Germany); Francesc Pérez-Murano, Ctr. Nacional de Microelectrónica (Spain) . . . . . [9423-78]

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**Nanomechanical properties of solvent cast PS and PMMA polymer blends and block co-polymers**, Matteo Lorenzoni, Francesc Perez Murano, Laura Evangelio, Ctr. Nacional de Microelectrónica (Spain); Christophe Navarro, Celia Nicolet, Arkema S.A. (France) . . . . . [9423-80]

**Creation of guiding patterns for directed self-assembly of block co-polymers by resistless direct e-beam exposure**, Laura Evangelio, Ctr. Nacional de Microelectrónica (Spain); Marta Fernández-Regúlez, Ctr. Nacional de Microelectrónica (Spain) and CEA-LETI (France); Xavier Borrísé, Matteo Lorenzoni, Ctr. Nacional de Microelectrónica (Spain); Jordi Fraxedas, Institut Català de Nanociència i Nanotecnologia (ICN2) (Spain); Francesc Pérez-Murano, Ctr. Nacional de Microelectrónica (Spain) . . . . . [9423-81]

**A simulation study for 3D defects in directed self-assembly lithography**, Hideki Kanai, Katsuyoshi Kodera, Yuriko Seino, Hironobu Sato, Yusuke Kasahara, Katsutoshi Kobayashi, Ken Miyagi, Shinya Minegishi, Naoko Kihara, Yoshiaki Kawamonzon, Tomoharu Fujiwara, Noriyuki Hirayanagi, Toshiakitsu Tobana, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9423-82]

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**Study of DSA interaction range (DSAIR) using Gaussian convolution.** He Yi, Stanford Univ. (USA); Joost P. Bekaert, Roel Gronheid, IMEC (Belgium); Germain L. Fenger, Mentor Graphics (Belgium); Kathleen Nafus, Tokyo Electron America, Inc. (USA); H. S. P. Wong, Stanford Univ. (USA). . . . . [9423-85]

**Surface energy control for contact hole shrinkage using DSA.** Kuan-Hsin Lo, Chieh-Han Wu, Ching-Yu Chang, Chung-Ju Lee, John Lin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan). . . . . [9423-86]

**Barriers to defect melting in chemo-epitaxial directed self-assembly of lamellar-forming diblock copolymer/homopolymer blends.** Kenichi Izumi, JSR Engineering Co., Ltd. (Japan) and The Materials Research Lab. (USA) and Univ. of California, Santa Barbara (USA); Bongkeun Kim, Nabil Laachi, The Materials Research Lab. (USA) and Univ. of California, Santa Barbara (USA); Kris T. Delaney, The Materials Research Lab. (USA); Michael Carilli, Univ. of California, Santa Barbara (USA); Glenn H. Fredrickson, The Materials Research Lab. (USA) and Univ. of California, Santa Barbara (USA). . . [9423-87]

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### Advances in Patterning Materials and Processes XXXII

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**Strategies for enhancing the sensitivity of novel non-chemically amplified (n-CAR) negative tone resists for EUVL.** Vikram Singh, V.S. V. Satyanarayana, Vishwanath Kalyani, Subrata Ghosh, Chullikkattil P. Pradeep, Satinder K. Sharma, Kenneth E. Gonsalves, Indian Institute of Technology Mandi (India). . . . . [9425-53]

**Measurement of lateral diffusion coefficient of single-guest molecules toward evaluation of local inhomogeneity in polymeric materials.** Syoji Ito, Osaka Univ. (Japan); Satoshi Takei, Toyama Prefectural Univ. (Japan); Hiroshi Miyasaka, Osaka Univ. (Japan). . . . . [9425-54]

**Measurement of acid diffusion from PAG in photoresists by using TOF-SIMS with GCIB.** Naoki Man, Toray Research Ctr., Inc. (Japan); Atsushi Sekiguchi, Litho Tech Japan Co., Ltd. (Japan). . . . . [9425-55]

**The effect of resist material composition on development behavior.** Shinya Minegishi, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan). . . . . [9425-56]

#### Posters: New Materials

**Hybrid nanoparticles for EUV lithography.** Ben Zhang, Jing Jiang, Mufei Yu, Cornell Univ. (USA); Jun Sung Chun, SEMATECH Inc. (USA) and SUNY College of Nanoscale Science and Engineering (USA); Mark Neisser, SEMATECH Inc. (USA); Emmanuel P. Giannelis, Christopher K. Ober, Cornell Univ. (USA). . . . . [9425-57]

**Development of new xanthendiol derivatives applied to the negative-tone molecular resists for EB/EUVL.** Takumi Toida, Akihiro Suzuki, Naoya Uchiyama, Takashi Makinoshima, Masaaki Takasuka, Takashi Sato, Masatoshi Echigo, Mitsubishi Gas Chemical Co., Inc. (Japan). . . . . [9425-58]

**Light-scattering thermal cross-linking material using morphology of nanoparticle free polymer blends.** Satoshi Takei, Toyama Prefectural Univ. (Japan). . . . . [9425-59]

**Blending approaches to enhance structural order in block-copolymer's self-assemblies.** Xavier Chevalier, Célia Nicolet, Arkema S.A. (France); Raluca Tiron, Ahmed Gharbi, Patricia Pimenta-Barros, CEA-LETI (France); Guillaume Fleury, Georges Hadzioannou, Lab. de Chimie des Polymères Organiques (France); Ilias Iliopoulos, Christophe Navarro, Arkema S.A. (France). [9425-61]

**Block co-polymer directed self-assembly for sub-10nm patterning.** Kota Nishino, Yoshi Hishiro, JSR Micro, Inc. (USA); Masafumi Hori, JSR Micro N.V. (Belgium); Takehiko Naruoka, Hiroyuki Komatsu, Tomohiro Oda, Tomoki Nagai, Tooru Kimura, JSR Corp. (Japan). . . . . [9425-62]

**High-sensitivity green resist material with organic solvent-free spin-coating and tetramethylammonium hydroxide-free water-developable processes for EB and EUV lithography.** Satoshi Takei, Toyama Prefectural Univ. (Japan); Akihiro Oshima, Osaka Univ. (Japan); Tomoko G. Oyama, Japan Atomic Energy Agency (Japan); Miki Kashiwakura, Takahiro Kozawa, Seiichi Tagawa, Osaka Univ. (Japan); Makoto Hanabata, Osaka Univ. (Japan) and Toyama Prefectural Univ. (Japan). . . . . [9425-63]

**Aromatizing unzipping polyester for EUV photoresist.** Kensuke Matsuzawa, Ryan Mesch, C. Grant Willson, The Univ. of Texas at Austin (USA); Marie Kryszak, Intel Corp. (USA); Mike Olah, Scott Phillips, The Pennsylvania State Univ. (USA). . . . . [9425-64]

**Evaluation of novel lactone derivatives for chemically amplified EUV resists.** Hiroyasu Tanaka, Tetsuhiko Mizusaka, Hiroyuki Tanagi, Kikuo Furukawa, Mitsubishi Gas Chemical Co., Inc. (Japan); Hiroki Yamamoto, Takahiro Kozawa, Osaka Univ. (Japan). . . . . [9425-65]

**Base developable negative-tone molecular resists based on epoxide cross-linking.** Brandon Sharp, Richard A. Lawson, Hannah Narcross, Georgia Institute of Technology (USA); Jun Sung Chun, SEMATECH Inc. (USA) and SUNY College of Nanoscale Science and Engineering (USA); Mark Neisser, SEMATECH Inc. (USA); Laren M. Tolbert, Clifford L. Henderson, Georgia Institute of Technology (USA). . . . . [9425-66]

**Top-coatless 193nm positive-tone development immersion resist for logic application.** Lian Cong Liu, Tsung-Ju Yeh, Yeh Sheng Lin, Yu-Chin Huang, Chien Wen Kuo, Wen Liang Huang, Chia Hung Lin, Chun Chi Yu, United Microelectronics Corp. (Taiwan); Kwang-Hwyi Im, The Dow Chemical Co. (Korea, Republic of); Hae Jin Lim, Hyun K. Jeon, Dow Chemical Co. (Korea, Republic of); Yasuhiro Suzuki, Dow Chemical Co. (Japan); Chengbai Xu, Dow Chemical Co. (USA); Ray Hsu, I-Yuan Wan, Jeff Lin, Dow Chemical Co. (Taiwan). . . . . [9425-67]

**Novel optical resists with high-refractive index for printable photonic devices.** Christophe Peroz, abeam Technologies, Inc. (USA). . . . . [9425-68]

#### Posters: New Patterning Applications

**Nanoimprint lithography for green water-repellent film derived from biomass with high-light transparency.** Satoshi Takei, Makoto Hanabata, Toyama Prefectural Univ. (Japan); C. Grant Willson, The Univ. of Texas at Austin (USA). . . . . [9425-69]

**Realistic scaling solution with spacer patterning towards 5nm node.** Shohei Yamauchi, Sakurako Natori, Arisa Hara, Masatoshi Yamato, Noriaki Okabe, Kenichi Oyama, Tokyo Electron AT Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan). . . . . [9425-71]

**Development of spin-on metal hardmask (SOMHM) for advanced node.** Shintaro Yamada, Deyan Wang, Vivian Chuang, Charlotte A. Cutler, Cong Liu, Sabrina Wong, Dow Electronic Materials (USA); Michael B. Clark, The Dow Chemical Co. (USA); William Williams, Paul Baranowski, Mingqi Li, Joe Mattia, JoAnne M. Leonard, Peter Trefonas, Kathleen M. O'Connell, Chengbai Xu, Dow Electronic Materials (USA). . . . . [9425-72]

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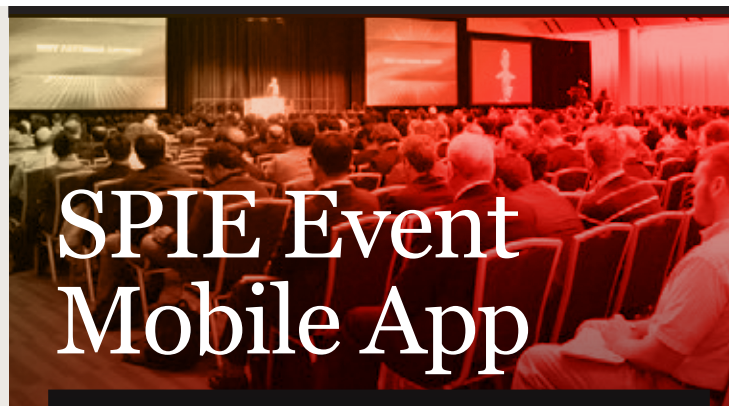
### Posters: Processing

- A comprehensive approach for micro- and multiple-bridges mitigation in immersion photolithography**, Lucia D'Urzo, Entegris GmbH (Germany); Wim Shollaert, JSR Micro N.V. (Belgium); Harold Stokes, Yan Thouroude, Dainippon Screen Deutschland GmbH (Germany) . . . . . [9425-73]
- Thickness optimization for lithography process on silicon substrate**, Xiaojing Su, Yajuan Su, Yansong Liu, Institute of Microelectronics (China); Yayi Wei, Institute of Microelectronics (China); Fong Chen, Zhimin Liu, Wei Zhang, Bifeng Li, Tao Gao, XMC (China) . . . . . [9425-74]
- Advanced chemical shrink material for NTD (negative-tone development) resist**, Yoshihiro Miyamoto, AZ Electronic Materials (Japan) K. K. (Japan) . . . . . [9425-75]
- Microbridge reduction in negative-tone imaging at photoresist point-of-use filtration**, Toru Umeda, Shuichi Tsuzuki, Nihon Pall Ltd. (Japan); Tsukasa Yamanaka, Naoya Iguchi, Mika Hirai, Shiro Gokaichi, FUJIFILM Corp. (Japan) . . . . . [9425-76]
- Novel thin film analysis to investigate actual film formation**, Kenji Mochida, Shinichi Nakamura, Kazunori Sakai, Tooru Kimura, JSR Engineering Co., Ltd. (Japan); Naoki Man, Hirofumi Seiki, Hideki Hashimoto, Toray Research Ctr., Inc. (Japan) . . . . . [9425-77]
- Patterning variability control through the shrink process**, Noriaki Okabe, Tokyo Electron AT Ltd. (Japan) . . . . . [9425-78]
- Cost effective processes by using negative-tone development application**, Keita Kato, Kei Yamamoto, Keiyu Ou, Michihiro Shirakawa, Sou Kamimura, FUJIFILM Corp. (Japan) . . . . . [9425-79]
- Development of planar spin-on carbon hardmask in various patterns**, Jae Baek, Dominea Rathwell, Minsoo Kim, Hyun-ji Song, Hyo-Young Kwon, Yushin Park, Sang-Kyun Kim, SAMSUNG SDI Co., Ltd. (Korea, Republic of) . . . . . [9425-82]

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#### Advanced Etch Technology for Nanopatterning IV

- Magnetic VHF plasma etching process for high-aspect ratio Si structure**, Taku Iwase, Hitachi, Ltd. (Japan); Takao Arase, Akira Hirata, Kenetsu Yokogawa, Masahito Mori, Hitachi High-Technologies Corp. (Japan) . . . . . [9428-28]
- Direct comparison of the performance of commonly used e-beam resists during nanoscale plasma etching of Si, SiO<sub>2</sub>, and Cr**, Andy L. Goodyear, Oxford Instruments (United Kingdom); Monika Boettcher, Ines A. Stolberg, Vistec Electron Beam GmbH (Germany); Mike Cooke, Oxford Instruments (United Kingdom) . . . . . [9428-29]
- Challenges of contact etching for 14nm FDSOI technology**, Mokrane Mebarki, STMicroelectronics (France) and Univ. de Grenoble (France) and LTM CNRS (France); Maxime Darnon, LTM CNRS (France) and Univ. de Grenoble (France); Cécile Jenny, Delia Ristoiu, STMicroelectronics (France); Nicolas Posseme, CEA-LETI (France); Olivier Joubert, LTM CNRS (France) and Univ. de Grenoble (France) . . . . . [9428-30]
- A way to integrate multiple block layers for middle of line contact patterning**, Eddy Kunnen, Steven Demuyck, IMEC (Belgium); Mohand Broui, Lam Research Corp. (Belgium); Jürgen Bömmels, Janko Versluijs, Julien Ryckaert, IMEC (Belgium) . [9428-31]
- Synchronous pulsing plasma utilization in dummy poly gate removal process**, Ruixuan Huang, Semiconductor Manufacturing International Corp. (China) . . . . . [9428-33]
- Characterization of the effect of etch process operating environment on the perfluoroelastomer chamber seal systems**, Barry Kitazumi, Greene, Tweed & Co. Inc. (USA) . . . . . [9428-34]



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**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**SESSION 8**

**LOCATION: CONVENTION CENTER 210C  
WED 8:20 AM TO 10:00 AM**

**Mask Topography**

**Joint Session with Conferences 9422 and 9426**

Session Chairs: **Ted Liang**, Intel Corp. (USA); **Tsai-Sheng Gau**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

8:20 am: **Mask-induced best-focus-shifts in DUV and EUV lithography**, Andreas Erdmann, Peter Evanschitzky, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Jens Timo Neumann, Paul Gräupner, Carl Zeiss SMT GmbH (Germany) ..... [9426-16]

8:40 am: **Intensity and phase fields behind phase-shifting masks studied with high-resolution interference microscopy**, Krishnaparvathy Puthankovilakam, Toralf Scharf, Hans Peter Herzig, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Tina Weichelt, Friedrich-Schiller-Univ. Jena (Germany); Uwe D. Zeitner, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) ..... [9426-17]

9:00 am: **Best focus shift for thick masks**, Martin Burkhardt, IBM Thomas J. Watson Research Ctr. (USA) ..... [9422-32]

9:20 am: **Mitigation of image contrast loss due to mask-side non-telecentricity in an EUVL scanner**, Shinn-Sheng Yu, Chih-Tsung Shih, Yen-Cheng Lu, Jack J. H. Chen, Anthony Yen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) ..... [9422-33]

9:40 am: **EUV telecentricity and shadowing errors in Monte Carlo simulations**, Deniz Civay, Sudharshan Raghunathan, Vikrant Chauhan, Tuhin Guha Neogi, Lesley Smith, Jason Stephens, GLOBALFOUNDRIES Inc. (USA) ..... [9422-34]

Coffee Break ..... Wed 10:10 am to 10:40 am

**CONFERENCE 9423**

**Alternative Lithographic Technologies VII**

**SESSION 7**

**LOCATION: CONVENTION CENTER 220A  
WED 8:00 AM TO 10:00 AM**

**DSA Materials and Processes I**

**Joint Session with Conferences 9425 and 9423**

Session Chairs: **Juan J. de Pablo**, The Univ. of Chicago (USA); **Roel Gronheid**, IMEC (Belgium)

8:00 am: **Material readiness for generation 2 directed self-assembly (DSA) < 24nm pitch**, Eungnak Han, Todd R. Younkin, Manish Chandhok, David Shykind, Alan Myers, Intel Corp. (USA) ..... [9425-24]

8:20 am: **Impact of materials selection on graphoepitaxial directed self-assembly for line-space patterning**, Phillip D. Hustad, Dung Quach, Dow Electronic Materials (USA); Valeriy V. Ginzburg, The Dow Chemical Co. (USA); Mingqi Li, Peter Trefonas III, Dow Electronic Materials (USA); Dan B. Millward, Gurpreet S. Lugani, Scott L. Light, Micron Technology, Inc. (USA) ..... [9423-22]

8:40 am: **Directed self-assembly of topcoat-free, integration-friendly high-X block copolymers**, Eri Hirahara, Margareta Paunesco, Orest Polishchuk, EunJeong Jeong, Edward Ng, Jianhui Shan, JiHoon Kim, SungEun Hong, Durairaj Baskaran, Guanyang Lin, AZ Electronic Materials USA Corp. (USA); Ankit Vora, Melia Tjio, Charles T. Rettner, Elizabeth M. Lofano, Chi-Chun Liu, Hsiinyu Tsai, Anindarupa Chunder, Amy Bowers, Srinivasan Balakrishnan, Joy Y. Cheng, Daniel P. Sanders, IBM Research - Almaden (USA) ..... [9425-25]

9:00 am: **Challenge and opportunity in hexagonal and rectangular bit-patterned media template fabrication**, Shuaigang Xiao, Xiaomin Yang, Yautzong Hsu, Kim Lee, David Kuo, Seagate Technology LLC (USA) ..... [9423-23]

9:20 am: **Directed self-assembly of ABA triblock copolymer on chemical contrast pattern via solvent annealing: molecular architecture, solvent selection, and pattern transfer**, Shisheng Xiong, The Univ. of Chicago (USA); Lei Wan, Yves-Andre Chapuis, Ricardo Ruiz, HGST (USA); Paul F. Nealey, The Univ. of Chicago (USA) ..... [9423-24]

9:40 am: **Selective laser ablation in resists and block copolymers for high-resolution lithographic patterning**, Deirdre L. Olynick, Pradeep N. Perera, Adam M. Schwartzberg, Lawrence Berkeley National Lab. (USA); Nathan D. Jarnagin, Clifford L. Henderson, Georgia Institute of Technology (USA); Zhiwei Sun, Lawrence Berkeley National Lab. (USA) and Univ. of Massachusetts Amherst (USA); Ilja Gunkel, Lawrence Berkeley National Lab. (USA); Thomas P. Russell, Lawrence Berkeley National Lab. (USA) and Univ. of Massachusetts Amherst (USA); Matthias Budden, Ivo W. Rangelow, Technische Univ. Ilmenau (Germany)[9423-25]

Coffee Break ..... Wed 10:00 am to 10:30 am

**CONFERENCE 9424**

**Metrology, Inspection, and Process Control for Microlithography XXIX**

**SESSION 8**

**LOCATION: CONVENTION CENTER 220B  
WED 8:00 AM TO 10:00 AM**

**Scatterometry**

Session Chairs: **Alok Vaid**, GLOBALFOUNDRIES Inc. (USA); **Matthew J. Sendelbach**, Nova Measuring Instruments Inc. (USA)

8:00 am: **Improvements of traceability and tool matching in scatterometry**, Bernd Bodermann, Physikalisch-Technische Bundesanstalt (Germany); Bernd Löchel, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany); Frank Scholze, Hermann A. Gross, Jan Wernecke, Johannes Endres, Physikalisch-Technische Bundesanstalt (Germany); Jürgen Probst, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany); Lars K. Nielsen, Danish Fundamental Metrology Institut (Denmark); Matthias Wurm, Physikalisch-Technische Bundesanstalt (Germany); Mark-Alexander Henn, Physikalisch-Technische Bundesanstalt (Germany) and National Institute of Standards and Technology (USA); Max Schoengen, Michael Krumrey, Physikalisch-Technische Bundesanstalt (Germany); Morten H. Madsen, Dansk Fundamental Metrologi (Denmark); Nitish Kumar, Technische Univ. Delft (Netherlands) and ASML Netherlands B.V. (Netherlands); H. Paul Urbach, Technische Univ. Delft (Netherlands); Peter Petrik, Technische Univ. Delft (Netherlands) and Hungarian Academy of Sciences (Hungary); Petr Klapetek, Czech Metrology Institute (Czech Republic); Poul-Eric Hansen, Danish Fundamental Metrology Institut (Denmark); Sebastian Heidenreich, Physikalisch-Technische Bundesanstalt (Germany); Sven Burger, JCMwave GmbH (Germany); Victor Soltwisch, Physikalisch-Technische Bundesanstalt (Germany) ..... [9424-32]

8:20 am: **Improved scatterometry time-to-solution using virtual reference**, Alok Vaid, GLOBALFOUNDRIES Inc. (USA); Gilad Wainreb, Yinon Katz, Nova Measuring Instruments Ltd. (Israel); Cornel Bodzog, Matthew J. Sendelbach, Nova Measuring Instruments Inc. (USA) ..... [9424-33]

8:40 am: **Data refinement for robust solution to the inverse problem in optical scatterometry**, Jinlong Zhu, Chuanwei Zhang, Xiuguo Chen, Hao Jiang, Shiyuan Liu, Huazhong Univ. of Science and Technology (China) ..... [9424-34]

9:00 am: **Method to simulate light scattering from complex 3D structures**, Sven Burger, Lin Zschiedrich, Jan Pomplun, Frank Schmidt, JCMwave GmbH (Germany) ..... [9424-35]

9:20 am: **Scatterometry-based metrology for the 14nm node double-patterning lithography**, Damien Carau, STMicroelectronics (France) and LTM CNRS (France); Régis Bouyssou, Julien Ducoté, Florent Dettoni, Christophe Dezauzier, Bertrand Le Gratiet, STMicroelectronics (France); Maxime Besacier, LTM CNRS (France); Cécile Gourgon, LTM CNRS (France) ..... [9424-36]

9:40 am: **Designing plasmonic test structures for optical metrology**, Samuel O'Mullane, SUNY College of Nanoscale Science and Engineering (USA); Nick Keller, Joseph Race, Nanometrics Inc. (USA); Alain C. Diebold, SUNY College of Nanoscale Science and Engineering (USA) ..... [9424-37]

Coffee Break ..... Wed 10:00 am to 10:30 am

**CONFERENCE 9425**

Advances in Patterning Materials and Processes XXXII

**SESSION 8**

**LOCATION: CONVENTION CENTER 220A  
WED 8:00 AM TO 10:00 AM**

**DSA Materials and Processes I**

**Joint Session with Conferences 9425 and 9423**

Session Chairs: **Juan J. de Pablo**, The Univ. of Chicago (USA); **Roel Gronheid**, IMEC (Belgium)

8:00 am: **Material readiness for generation 2 directed self-assembly (DSA) < 24nm pitch**, Eungnak Han, Todd R. Younkin, Manish Chandhok, David Shykind, Alan Myers, Intel Corp. (USA) ..... [9425-24]

8:20 am: **Impact of materials selection on graphoeptitaxial directed self-assembly for line-space patterning**, Phillip D. Hustad, Dung Quach, Dow Electronic Materials (USA); Valery V. Ginzburg, The Dow Chemical Co. (USA); Mingqi Li, Peter Trefonas III, Dow Electronic Materials (USA); Dan B. Millward, Gurpreet S. Lugani, Scott L. Light, Micron Technology, Inc. (USA) ..... [9423-22]

8:40 am: **Directed self-assembly of topcoat-free, integration-friendly high-X block copolymers**, Eri Hirahara, Margareta Paunescu, Orest Polishchuk, EunJeong Jeong, Edward Ng, Jianhui Shan, JiHoon Kim, SungEun Hong, Durairaj Baskaran, Guanyang Lin, AZ Electronic Materials USA Corp. (USA); Ankit Vora, Melia Tjio, Charles T. Rettner, Elizabeth M. Lofano, Chi-Chun Liu, Hsinyu Tsai, Anindarupa Chunder, Amy Bowers, Srinivasan Balakrishnan, Joy Y. Cheng, Daniel P. Sanders, IBM Research - Almaden (USA) ..... [9425-25]

9:00 am: **Challenge and opportunity in hexagonal and rectangular bit-patterned media template fabrication**, Shuaigang Xiao, Xiaomin Yang, Yautzong Hsu, Kim Lee, David Kuo, Seagate Technology LLC (USA) ..... [9423-23]

9:20 am: **Directed self-assembly of ABA triblock copolymer on chemical contrast pattern via solvent annealing: molecular architecture, solvent selection, and pattern transfer**, Shisheng Xiong, The Univ. of Chicago (USA); Lei Wan, Yves-Andre Chapuis, Ricardo Ruiz, HGST (USA); Paul F. Nealey, The Univ. of Chicago (USA) ..... [9423-24]

9:40 am: **Selective laser ablation in resists and block copolymers for high-resolution lithographic patterning**, Deirdre L. Olynick, Pradeep N. Perera, Adam M. Schwartzberg, Lawrence Berkeley National Lab. (USA); Nathan D. Jamagin, Clifford L. Henderson, Georgia Institute of Technology (USA); Zhiwei Sun, Lawrence Berkeley National Lab. (USA) and Univ. of Massachusetts Amherst (USA); Ilja Gunkel, Lawrence Berkeley National Lab. (USA); Thomas P. Russell, Lawrence Berkeley National Lab. (USA) and Univ. of Massachusetts Amherst (USA); Matthias Budden, Ivo W. Rangelow, Technische Univ. Ilmenau (Germany) . . . [9423-25]

Coffee Break . . . . . Wed 10:00 am to 10:30 am

**CONFERENCE 9426**

Optical Microlithography XXVIII

**SESSION 5**

**LOCATION: CONVENTION CENTER 210C  
WED 8:20 AM TO 10:00 AM**

**Mask Topography**

**Joint Session with Conferences 9422 and 9426**

Session Chairs: **Ted Liang**, Intel Corp. (USA); **Tsai-Sheng Gau**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

8:20 am: **Mask-induced best-focus-shifts in DUV and EUV lithography**, Andreas Erdmann, Peter Evanschitzky, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Jens Timo Neumann, Paul Gräupner, Carl Zeiss SMT GmbH (Germany) ..... [9426-16]

8:40 am: **Intensity and phase fields behind phase-shifting masks studied with high-resolution interference microscopy**, Krishnaparvathy Puthankovilakam, Toralf Scharf, Hans Peter Herzig, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Tina Weichelt, Friedrich-Schiller-Univ. Jena (Germany); Uwe D. Zeitner, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) ..... [9426-17]

9:00 am: **Best focus shift for thick masks**, Martin Burkhardt, IBM Thomas J. Watson Research Ctr. (USA) ..... [9422-32]

9:20 am: **Mitigation of image contrast loss due to mask-side non-telecetricity in an EUVL scanner**, Shinn-Sheng Yu, Chih-Tsung Shih, Yen-Cheng Lu, Jack J. H. Chen, Anthony Yen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) ..... [9422-33]

9:40 am: **EUV telecentricity and shadowing errors in Monte Carlo simulations**, Deniz Civay, Sudharshan Raghunathan, Vikram Chauhan, Tuhin Guha Neogi, Lesley Smith, Jason Stephens, GLOBALFOUNDRIES Inc. (USA) ..... [9422-34]

Coffee Break . . . . . Wed 10:00 am to 10:30 am

**CONFERENCE 9427**

Design-Process-Technology Co-optimization for Manufacturability IX

**LOCATION: SAN JOSE MARRIOTT, SALON III  
WED 8:00 AM TO 8:10 AM**

**Opening Remarks**

Session Chairs: **John L. Sturtevant**, Mentor Graphics Corp. (USA); **Luigi Capodieci**, GLOBALFOUNDRIES Inc. (USA)

**SESSION 1**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
WED 8:10 AM TO 8:40 AM**

**Invited Session I**

Session Chairs: **John L. Sturtevant**, Mentor Graphics Corp. (USA); **Luigi Capodieci**, GLOBALFOUNDRIES Inc. (USA)

8:10 am: **The daunting complexity of scaling to 7NM without EUV: pushing DTCO to the extreme** (*Invited Paper*), Lars W. Liebmann, IBM Corp. (USA) ..... [9427-1]

**SESSION 2**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
WED 8:40 AM TO 10:00 AM**

**Layout Patterns Applications**

Session Chairs: **John L. Sturtevant**, Mentor Graphics Corp. (USA); **Luigi Capodieci**, GLOBALFOUNDRIES Inc. (USA)

8:40 am: **High-coverage of litho hotspot detection by weak pattern scoring**, Jinho Park, Jae-Hyun Kang, NamJae Kim, Seung Weon Paek, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Marwah Shafee, Kareem Madkour, Mentor Graphics Egypt (Egypt); Wael El-Manhawey, Joe Kwan, Jean-Marie Brunet, Mentor Graphics Corp. (USA) ..... [9427-2]

9:00 am: **A pattern-based methodology for optimizing stitches in double-patterning technology**, Lynn T. Wang, Sriram Madhavan, Vito Dai, Luigi Capodieci, GLOBALFOUNDRIES Inc. (USA) .. [9427-3]

9:20 am: **Fast detection of manufacturing systematic design pattern failures causing device yield loss**, Jean-Christophe Le Denmat, STMicroelectronics (France) ..... [9427-4]

9:40 am: **Topology and context-based pattern extraction using line-segment Voronoi diagram**, Sandeep K. Dey, Panagiotis Cheilaris, Univ. della Svizzera italiana (Switzerland); Nathalie Casati, Maria Gabrani, IBM Research – Zürich (Switzerland); Evanthis Papadopoulos, Univ. della Svizzera italiana (Switzerland) ..... [9427-5]

Coffee Break . . . . . Wed 10:00 am to 10:30 am

**CONFERENCE 9428**

Advanced Etch Technology for Nanopatterning IV

**SESSION 7**

**LOCATION: CONVENTION CENTER 220C  
WED 8:00 AM TO 9:50 AM**

**New Plasma Sources and New Etching Technologies**

Session Chairs: **Seiji Samukawa**, Tohoku Univ. (Japan); **Nicolas Posseme**, CEA-LETI (France); **Julie Bannister**, Tokyo Electron America, Inc. (USA)

8:00 am: **Low-damage cryoetching of low-K materials** (*Invited Paper*), Remi Dussart, Group de Recherches sur l'Energétique des Milieux Ionisés (France) and Ctr. National de la Recherche Scientifique (France) and Univ. d'Orléans (France); Thomas Tillocher, Univ. d'Orléans (France); Floriane Leroy, Philippe Lefaucheur, Group de Recherches sur l'Energétique des Milieux Ionisés (France); Koichi Yatsuda, Tokyo Electron Ltd. (Japan); Kaoru Maekawa, Tokyo Electron Ltd. (USA); Eiichi Nishimura, Tokyo Electron AT Ltd. (Japan); Liping Zhang, Jean-François G. N. de Marneffe, Mikhail R. Baklanov, IMEC (Belgium) ..... [9428-20]

8:30 am: **Low-temperature and damage-free transition metal and magnetic material etching using a new metallic complex reaction** (*Invited Paper*), Toshihisa Nozawa, Tokyo Electron Ltd. (Japan) ..... [9428-21]

9:00 am: **Electron energy distribution control by Fiat: breaking from the conventional flux ratio scaling rules in etch** (*Invited Paper*), Alok Ranjan, Mingmei Wang, TEL Technology Ctr., America, LLC (USA); Peter Ventzek, Tokyo Electron America Inc. (USA) ..... [9428-22]

9:30 am: **Precise etch profile control by multistep cyclic process**, Motohiro Tanaka, Hitachi High-Tech Science Corp. (Japan); Yasushi Sonoda, Yutaka Kozuma, Masahiro Sumiya, Hitachi High-Technologies Corp. (Japan); Naoki Yasui, Hitachi High-Tech Science Corp. (Japan) ..... [9428-23]

Coffee Break . . . . . Wed 9:50 am to 10:30 am

**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**SESSION 9**

**LOCATION: CONVENTION CENTER 210B  
WED 10:40 AM TO 12:00 PM**

**Resist Outgas Testing**

Session Chairs: **Kurt G. Ronse**, IMEC (Belgium); **Michael J. Lercel**, SEMATECH Inc. (USA)

10:40 am: **Analysis of EUV resist outgassing depended on the dosage**, Eishi Shiobara, Isamu Takagi, Yukiko Kikuchi, Takeshi Sasami, Toru Fujimori, Shinya Minegishi, Soichi Inoue, EUVL Infrastructure Development Ctr., Inc. (Japan); Takeo Watanabe, Tetsuo Harada, Hiroo Kinoshita, Univ. of Hyogo (Japan) . . . . . [9422-35]

11:00 am: **First results of outgas resist family test and correlation between outgas specifications and EUV resist development**, Yu-Jen Fan, SEMATECH Inc. (USA); Ken Maruyama, Ramakrishnan Ayothi, Takehiko Naruoka, JSR Micro, Inc. (USA); Tonmoy Chakraborty, Dominic Ashworth, SEMATECH Inc. (USA); Jun Sung Chun, SEMATECH/CNSE (USA); Cecilia A. Montgomery, Shih-Hui Jen, Mark Neisser, Kevin D. Cummings, SEMATECH Inc. (USA) . [9422-36]

11:20 am: **Collaborative work on reducing the inter-site gap of outgassing qualification**, Soichi Inoue, Eishi Shiobara, Takeshi Sasami, Isamu Takagi, Yukiko Kikuchi, Toru Fujimori, Shinya Minegishi, EUVL Infrastructure Development Ctr., Inc. (Japan); Robert F. Berg, Thomas B. Lucatorto, Shannon B. Hill, Charles Tarrio, National Institute of Standards and Technology (USA); Ivan Pollentier, IMEC (Belgium); Yu-Jen Fan, Dominic Ashworth, SEMATECH Inc. (USA) . . . . . [9422-37]

11:40 am: **Polarization resolved measurements with the new EUV ellipsometer of PTB**, Victor Soltwisch, Frank Scholze, Andreas Fischer, Christian Laubis, Christian Stadelhoff, Physikalisch-Technische Bundesanstalt (Germany); Albrecht Ullrich, Advanced Mask Technology Ctr. GmbH Co. KG (Germany) . . . . . [9422-38]

Lunch/Exhibition Break . . . . . Wed 12:00 pm to 1:30 pm

**CONFERENCE 9423**

**Alternative Lithographic Technologies VII**

**SESSION 8**

**LOCATION: CONVENTION CENTER 220A  
WED 10:30 AM TO 11:50 AM**

**DSA Materials and Processes II**

**Joint Session with Conferences 9425 and 9423**

Session Chairs: **Todd R. Younkin**, Intel Corp. (USA); **Sean D. Burns**, IBM Corp. (USA)

10:30 am: **Driving DSA into volume manufacturing**, Mark H. Somervell, Tokyo Electron America, Inc. (USA); Takashi Yamauchi, Soichiro Okada, Tadatoshi Tomita, Takanori Nishi, Shinichiro Kawakami, Makoto Muramatsu, Tokyo Electron Kyushu Ltd. (Japan); Etsuo Iijima, Tokyo Electron Miyagi Ltd. (Japan); Takeo Nakano, Fumiko Iwao, Tokyo Electron AT Ltd. (Japan); Seiji Nagahara, Hiroyuki Iwaki, Makiko Dojun, Koichi Yatsuda, Toshikatsu Tobana, Tokyo Electron Ltd. (Japan); Ainhua Romo Negreira, Doni Parnell, Tokyo Electron Europe Ltd. (Belgium); Ben M. Rathasack, Tokyo Electron America, Inc. (USA); Kathleen Nafus, Tokyo Electron America (Belgium); Jean Luc Peyre, Tokyo Electron Europe Ltd. (Netherlands); Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan) . . . . . [9425-26]

10:50 am: **Toward high-performance quality meeting IC device manufacturing requirements with AZ SMARTTM DSA process**, JiHoon Kim, Jian Yin, Yi Cao, AZ Electronic Materials USA Corp. (USA); YoungJun Her, AZ Electronic Materials (Korea) Ltd. (Korea, Republic of); Hengpeng Wu, Jianhui Shan, Durairaj Baskaran, AZ Electronic Materials USA Corp. (USA); Tomohiko Tsutsumi, AZ Electronic Materials (Japan) K.K. (Japan); Guanyang Lin, AZ Electronic Materials USA Corp. (USA) . . . . . [9423-26]

11:10 am: **Fin formation using graphoepitaxy DSA for SOI FinFET device fabrication**, Chi-Chun Liu, Fee Li Lie, IBM Corp. (USA); Vinayak Rastogi, Nihar Mohanty, TEL Technology Ctr., America, LLC (USA); Hsin-yu Tsai, IBM Thomas J. Watson Research Ctr. (USA); Kafai Lai, Melih Ozlem, IBM Corp. (USA); Wooyong Cho, Sung Gon Jung, SAMSUNG Electronics Co., Ltd. (USA); Jay Strane, IBM Corp. (USA); Mark H. Somervell, Tokyo Electron America, Inc. (USA); Sean D. Burns, Nelson M. Felix, IBM Corp. (USA); Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA); David Hetzer, Akiteru Ko, TEL Technology Ctr., America, LLC (USA); Matthew E. Colburn, IBM Corp. (USA) . . . . . [9423-27]

11:30 am: **Directed self-assembly process integration for sub-10nm fin patterning**, Safak Sayan, Intel Corp. (USA); Boon Teik Chan, Roel Gronheid, Paulina A. Rincon Delgadillo, Arjun Singh, IMEC (Belgium) . . . . . [9425-27]

Lunch/Exhibition Break . . . . . Wed 11:50 am to 1:20 pm

**CONFERENCE 9424**

**Metrology, Inspection, and Process Control for Microlithography XXIX**

**SESSION 9**

**LOCATION: CONVENTION CENTER 220B  
WED 10:30 AM TO 11:50 AM**

**Device Overlay**

Session Chairs: **Richard M. Silver**, National Institute of Standards and Technology (USA); **Masafumi Asano**, Toshiba Corp. (Japan)

10:30 am: **Target design optimization for overlay scatterometry to improve on-product overlay**, Henk-Jan H. Smilde, Richard J. F. van Haren, Willy van Buel, Xing Lan Liu, Jerome Depre, Jan Beltman, ASML Netherlands B.V. (Netherlands); Florent Dettoni, Julien Ducoté, Christophe Dezausier, STMicroelectronics (France); Yoann Blancquaert, CEA-LETI (France) . . . . . [9424-38]

10:50 am: **Overlay improvement by exposure map-based mask registration optimization**, Irene Shi, Eric Guo, Ming Chen, Max Lu, Gordon Li, Rivan Li, Eric M. J. Tian, Semiconductor Manufacturing International Corp. (China) . . . . . [9424-39]

11:10 am: **Improving full-wafer on-product overlay using computationally designed process robust and device-like metrology targets**, Young-Sik Kim, SK Hynix, Inc. (Korea, Republic of); Kevin Ryan, ASML Netherlands B.V. (Netherlands); Young-Sun Hwang, SK Hynix, Inc. (Korea, Republic of); Paul Tuffy, ASML US, Inc. (USA); Mi-Rim Jung, SK Hynix, Inc. (Korea, Republic of); Kyu-Tae Sun, ASML Korea Co., Ltd. (Korea, Republic of); Ji-Hwan Yoo, SK Hynix, Inc. (Korea, Republic of); Jin-Moo Byun, ASML Korea Co., Ltd. (Korea, Republic of); Won-Taik Kwon, SK Hynix, Inc. (Korea, Republic of); Nang-Lyeom Oh, ASML Korea Co., Ltd. (Korea, Republic of); Roy Werkman, Mir Shahrjerdy, ASML Netherlands B.V. (Netherlands); Seung-Hoon Park, Ki-Yeop Chris Park, Youping Zhang, ASML US, Inc. (USA) . . . . . [9424-40]

11:30 am: **Advanced overlay analysis through design-based metrology**, Sunkeun Ji, Gyun Yoo, Gyoyeon Jo, Hyunwoo Kang, Minwoo Park, Jungchan Kim, Chan-Ha Park, Hyun-Jo Yang, DongGyu Yim, SK Hynix, Inc. (Korea, Republic of) . . . . . [9424-41]

Lunch/Exhibition Break . . . . . Wed 11:50 am to 1:20 pm



**CONFERENCE 9425**

Advances in Patterning Materials and Processes XXXII

**SESSION 9**

**LOCATION: CONVENTION CENTER 220A  
WED 10:30 AM TO 11:50 AM**

**DSA Materials and Processes II**

**Joint Session with Conferences 9425 and 9423**

Session Chairs: **Todd R. Younkin**, Intel Corp. (USA); **Sean D. Burns**, IBM Corp. (USA)

10:30 am: **Driving DSA into volume manufacturing**, Mark H. Somervell, Tokyo Electron America, Inc. (USA); Takashi Yamauchi, Soichiro Okada, Tadatoshi Tomita, Takanori Nishi, Shinichiro Kawakami, Makoto Muramatsu, Tokyo Electron Kyushu Ltd. (Japan); Etsuo Iijima, Tokyo Electron Miyagi Ltd. (Japan); Takeo Nakano, Fumiko Iwao, Tokyo Electron AT Ltd. (Japan); Seiji Nagahara, Hiroyuki Iwaki, Makiko Dojun, Koichi Yatsuda, Toshikatsu Tobana, Tokyo Electron Ltd. (Japan); Ainhoa Romo Negreira, Doni Parnell, Tokyo Electron Europe Ltd. (Belgium); Ben M. Rathsack, Tokyo Electron America, Inc. (USA); Kathleen Nafus, Tokyo Electron America (Belgium); Jean Luc Peyre, Tokyo Electron Europe Ltd. (Netherlands); Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan) . . . . . [9425-26]

10:50 am: **Toward high-performance quality meeting IC device manufacturing requirements with AZ SMARTTM DSA process**, JiHoon Kim, Jian Yin, Yi Cao, AZ Electronic Materials USA Corp. (USA); YoungJun Her, AZ Electronic Materials (Korea) Ltd. (Korea, Republic of); Hengpeng Wu, Jianhui Shan, Durairaj Baskaran, AZ Electronic Materials USA Corp. (USA); Tomohiko Tsutsumi, AZ Electronic Materials (Japan) K.K. (Japan); Guanyang Lin, AZ Electronic Materials USA Corp. (USA) . . . . . [9423-26]

11:10 am: **Fin formation using graphoepitaxy DSA for SOI FinFET device fabrication**, Chi-Chun Liu, Fee Li Lie, IBM Corp. (USA); Vinayak Rastogi, Nihar Mohanty, TEL Technology Ctr., America, LLC (USA); Hsinyu Tsai, IBM Thomas J. Watson Research Ctr. (USA); Kafai Lai, Melih Ozlem, IBM Corp. (USA); Wooyong Cho, Sung Gon Jung, SAMSUNG Electronics Co., Ltd. (USA); Jay Strane, IBM Corp. (USA); Mark H. Somervell, Tokyo Electron America, Inc. (USA); Sean D. Burns, Nelson M. Felix, IBM Corp. (USA); Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA); David Hetzer, Akiteru Ko, TEL Technology Ctr., America, LLC (USA); Matthew E. Colburn, IBM Corp. (USA) . . . . . [9423-27]

11:30 am: **Directed self-assembly process integration for sub-10nm fin patterning**, Safak Sayan, Intel Corp. (USA); Boon Teik Chan, Roel Gronheid, Paulina A. Rincon Delgadillo, Arjun Singh, IMEC (Belgium) . . . . . [9425-27]  
Lunch/Exhibition Break. . . . . Wed 11:50 am to 1:20 pm

**CONFERENCE 9426**

Optical Microlithography XXVIII

**SESSION 6**

**LOCATION: CONVENTION CENTER 210C  
WED 10:30 AM TO 12:10 PM**

**Multiple Patterning and SMO**

Session Chairs: **Xuelong Shi**, Semiconductor Manufacturing International Corp. (China); **Geert Vandenberghe**, IMEC (Belgium)

10:30 am: **Study of cut mask lithography options for sub-16nm metal routing**, Yan Wang, Lei Yuan, Chenchen Wang, Jia Zeng, Youngtag Woo, Jongwook Kye, GLOBALFOUNDRIES Inc. (USA) . . . . . [9426-18]

10:50 am: **Inverse lithography using sparse mask representations**, Radu C. Ionescu, EPFL (Switzerland) and IBM Research – Zürich (Switzerland); Paul Hurlley, Stefan Apostol, IBM Research – Zürich (Switzerland) . . . . . [9426-19]

11:10 am: **RET selection on state-of-the-art NAND flash**, Neal V. Lafferty, Yuan He, Mentor Graphics Corp. (USA); Jojo Pei, Semiconductor Manufacturing International Corp. (China); Feng Shao, Mentor Graphics Corp. (China); Qingwei Liu, Xuelong Shi, Semiconductor Manufacturing International Corp. (China); Kostas Adam, John L. Sturtevant, Mentor Graphics Corp. (USA) . . . . . [9426-20]

11:30 am: **Pixel-based ant colony algorithm for source mask optimization**, Hung-Fei Kuo, Wei-Chen Wu, National Taiwan Univ. of Science and Technology (Taiwan) . . . . . [9426-21]

11:50 am: **Low-contrast photoresist development model for OPC application**, Cheng-En R. Wu, Synopsys Taiwan Ltd. (Taiwan); David Wei, Hua Song, Synopsys, Inc. (USA) . . . . . [9426-22]

Lunch/Exhibition Break . . . . . Wed 12:10 to 1:30 pm

**CONFERENCE 9427**

Design-Process-Technology Co-optimization for Manufacturability IX

**SESSION 3**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
WED 10:30 AM TO 12:10 PM**

**Multipatterning**

Session Chairs: **Lars W. Liebmann**, IBM Corp. (USA); **Shigeki Nojima**, Toshiba Corp. (Japan)

10:30 am: **A systematic framework for evaluating standard cell middle-of-line (MOL) robustness for multiple patterning**, Xiaoqing Xu, The Univ. of Texas at Austin (USA); Brian Cline, Greg Yeric, ARM Inc. (USA); Bei Yu, David Z. Pan, The Univ. of Texas at Austin (USA) . . . . . [9427-6]

10:50 am: **Self-aligned quadruple patterning-aware standard cell placement**, Fumiharu Nakajima, Chikaaki Kodama, Koichi Nakayama, Shigeki Nojima, Toshiya Kotani, Toshiba Corp. (Japan) . . . . . [9427-7]

11:10 am: **Impact of a SADP flow on the design and process for N10 M2 layer**, Syed Muhammad Yasser Sherazi, Werner Gillijns, Darko Trivkovic, Boris Vandewalle, Praveen Raghavan, Julien Ryckaert, Diederik Verkest, Kurt G. Ronse, Gregory R. McIntyre, IMEC (Belgium); Vassilios Gerousis, Cadence Design Systems, Inc. (USA) . . . . . [9427-8]

11:30 am: **An efficient auto TPT stitch guidance generation for optimized standard cell design**, Nagaraj C. Samboju, Synopsys (I) Pvt. Ltd. (India); Soo Han Choi, Srinii Arikati, Erdem Cilingir, Synopsys, Inc. (USA) . . . . . [9427-9]

11:50 am: **Yield-aware mask assignment using positive semidefinite relaxation in LELE CUT triple patterning**, Yukihide Kohira, Univ. of Aizu (Japan); Chikaaki Kodama, Toshiba Corp. (Japan); Tomomi Matsui, Atsushi Takahashi, Tokyo Institute of Technology (Japan); Shigeki Nojima, Satoshi Tanaka, Toshiba Corp. (Japan) . . . . . [9427-10]

Lunch/Exhibition Break . . . . . Wed 12:10 pm to 1:40 pm

**CONFERENCE 9428**

Advanced Etch Technology for Nanopatterning IV

**SESSION 8**

**LOCATION: CONVENTION CENTER 220C  
WED 10:30 AM TO 12:10 PM**

**Emerging Patterning Technologies in DSA and Others**

Session Chairs: **Ying Zhang**, Applied Materials, Inc. (USA); **Ricardo Ruiz**, HGST (USA)

10:30 am: **Atomic layer etch (Invited Paper)**, Olivier Joubert, LTM CNRS (France) . . . . . [9428-24]

11:00 am: **Etch aware EPE correction: the critical path toward multipatterning control (Invited Paper)**, Kaidong Xu, IMEC (Belgium) . . . . . [9428-25]

11:30 am: **RIE challenges for sub-15nm lines and spaces patterning using directed self-assembly lithography with coordinated line epitaxy (COOL) process**, Yusuke Kasahara, Yuriko Seino, Hironobu Sato, Hideki Kanai, EUVL Infrastructure Development Ctr., Inc. (Japan); Katsutoshi Kobayashi, EUVL Infrastructure Development Ctr, Inc. (Japan); Toshikatsu Tobana, Ken Miyagi, Shinya Minegishi, Naoko Kihara, Katsuyoshi Kodera, Noriyuki Hirayanagi, Tomoharu Fujiwara, EUVL Infrastructure Development Ctr., Inc. (Japan); Yoshiaki Kawamonzen, EUVL Infrastructure Development Ctr, Inc. (Japan); Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9428-26]

11:50 am: **A facile route for fabricating graphene nanoribbon array transistors using graphoepitaxy of a symmetric block copolymer**, Jonathan Choi, Myungwoong Kim, Nathaniel S. Safron, Michael S. Arnold, Padma Gopalan, Univ. of Wisconsin-Madison (USA) . . . . . [9428-27]

Conference End.

**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**SESSION 10**

**LOCATION: CONVENTION CENTER 210B  
WED 1:30 PM TO 3:10 PM**

**EUV Optics and Mask Metrology**

Session Chairs: **Christopher S. Ngai**, Applied Materials, Inc. (USA); **Jan Hendrik Peters**, Carl Zeiss SMS GmbH (Germany)

1:30 pm: **Measuring aberrations using EUV mask roughness**, Rene A. Claus, Univ. of California, Berkeley (USA); Antoine J. Wojdyla, 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) . . . . . [9422-39]

1:50 pm: **A method of image-based aberration metrology for EUVL tools**, Zac Levinson, Rochester Institute of Technology (USA); Sudharshanan Raghunathan, Erik A. Verduijn, Obert R. Wood II, Pawitter J. Mangat, GLOBALFOUNDRIES Inc. (USA); Kenneth A. Goldberg, Markus P. Benk, Antoine J. Wojdyla, Lawrence Berkeley National Lab. (USA); Vicky Philipsen, Eric Hendrickx, IMEC (Belgium); Bruce W. Smith, Rochester Institute of Technology (USA) . . [9422-40]

2:10 pm: **Correlation of actinic blank inspection and experimental phase defect printability on NXE3x00 EUV scanner**, Rik Jonckheere, IMEC (Belgium); Hidehiro Watanabe, EUVL Infrastructure Development Ctr., Inc. (Japan); Dieter Van den Heuvel, IMEC (Belgium); Osamu Suga, Noriaki Takagi, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9422-41]

2:30 pm: **Phase measurements of EUV mask defects**, Rene A. Claus, Univ. of California, Berkeley (USA); Antoine J. Wojdyla, 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) . . . . . [9422-42]

2:50 pm: **Application of transport of intensity equation in EUV multilayer defect analysis**, Dongbo Xu, Peter Evanschitzky, Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) . . . . . [9422-43]

Coffee Break . . . . . Wed 3:10 pm to 3:40 pm

**CONFERENCE 9423**

**Alternative Lithographic Technologies VII**

**SESSION 9**

**LOCATION: CONVENTION CENTER 220A  
WED 1:20 PM TO 3:10 PM**

**Nanoimprint Lithography: Non-IC Applications**

Session Chairs: **Helmut Schiff**, Paul Scherrer Institut (Switzerland); **Kenneth R. Carter**, Univ. of Massachusetts Amherst (USA)

1:20 pm: **Smart plastic functionalization by nanoimprint and injection molding** (*Invited Paper*), Maksim Zalkovskij, Lasse H. Thamdrup, Kristian Smistrup, Thomas Andén, Alicia C. Johansson, NIL Technology ApS (Denmark); Niels Jørgen Mikkelsen, CemeCon Scandinavia A/S (Denmark); Morten H. Madsen, Jørgen Garnæs, DFM A/S (Denmark); Tommy T. Kristiansen, Mads Diemer, LEGO System A/S (Denmark); Michael Døssing, TOOLpartners® A/S (Denmark); Daniel Minzari, Peter T. Tang, IPU (Denmark); Anders Kristensen, Rafael J. Taboryski, DTU Nanotech (Denmark); Søren Essendrop, SE Design (Denmark); Theodor Nielsen, Brian Bilenberg, NIL Technology ApS (Denmark) . . . . . [9423-28]

1:50 pm: **Development of NIL processes for PV applications**, Hubert Hauser, Nico Tucher, Katharina Tokai, Patrick Schneider, Christine Wellens, Anne-Kristin Volk, Simon Barke, Fraunhofer-Institut für Solare Energiesysteme (Germany); Claas Müller, Univ. of Freiburg (Germany); Thomas Glinsner, Gerald Kreindl, EV Group (Austria); Benedikt Bläsi, Fraunhofer-Institut für Solare Energiesysteme (Germany) . . . . . [9423-29]

2:10 pm: **Line-width tuning and smoothing for periodic grating fabrication in nanoimprint lithography**, Yuhan Yao, He Liu, Yifei Wang, Boxiang Song, Yuanrui Li, Wei Wu, The Univ. of Southern California (USA) . . . . . [9423-30]

2:30 pm: **Shape change of cured 2D and 3D nanostructures from imprint lithography**, Meghali Chopra, Roger T. Bonnecaze, The Univ. of Texas at Austin (USA) . . . . . [9423-88]

2:50 pm: **A nanoimprint lithography based fabrication route to obtain metallic nanoparticle of diverse/tunable shape**, Nerea Alayo, Ctr. Nacional de Microelectrónica (Spain); Ana Conde, Univ. de Barcelona (Spain); Miroslavna Kovylyna, Univ. de Barcelona (Spain) and Univ. of Toronto (Canada); Xavier Borrísé, Institut Català de Nanociència i Nanotecnologia (ICN2) (Spain); Joan Bausells, Ctr. Nacional de Microelectrónica (Spain); Glenn Hibbard, Univ. of Toronto (Canada); Amílcar Labarta, Xavier Batlle, Univ. de Barcelona (Spain); Francesc Perez-Murano, Ctr. Nacional de Microelectrónica (Spain) . . . . . [9423-32]

Coffee Break . . . . . Wed 3:10 pm to 3:40 pm

**CONFERENCE 9424**

**Metrology, Inspection, and Process Control for Microlithography XXIX**

**SESSION 10**

**LOCATION: CONVENTION CENTER 220B  
WED 1:20 PM TO 3:00 PM**

**Inspection**

Session Chairs: **Timothy F. Crimmins**, Intel Corp. (USA); **Byoung-Ho Lee**, Ultratech (USA)

1:20 pm: **9nm node wafer defect inspection using three-dimensional scanning: a 405nm diode laser, and a broadband source**, Renjie Zhou, Christopher A. Edwards, Casey Bryniarski, Gabriel Popescu, Lynford L. Goddard, Univ. of Illinois at Urbana-Champaign (USA) . . . . . [9424-42]

1:40 pm: **Material characterization at sub-50nm dimensions using coherent EUV beams**, Kathleen M. Hoogeboom-Pot, Jorge N. Hernandez-Charpak, Damiano Nardi, Travis Frazer, Emrah Turgut, Univ. of Colorado at Boulder (USA); Erik H. Anderson, Weilun L. Chao, Lawrence Berkeley National Lab. (USA); Justin M. Shaw, National Institute of Standards and Technology (USA); Margaret M. Murnane, Henry C. Kapteyn, Univ. of Colorado at Boulder (USA) . . . . [9424-43]

2:00 pm: **Spectral emission of a tunable LPP light source for inspection applications from the sub-200nm range to the EUV range**, Nadia Gambino, Bob Rolling, Duane Hudgins, Alexander Sanders, Markus Brandstätter, Reza Abhari, ETH Zürich (Switzerland); Fariba Abreau, Adlyte (Switzerland) . . . . . [9424-44]

2:20 pm: **Scatterometry-based defect detection for DSA in-line process control**, Robin Hsin-Kuo Chao, Chi-Chun Liu, IBM Corp. (USA); Cornel Bozdog, Aron J. Cepler, Matthew J. Sendelbach, Oded Cohen, Shay Wolfing, Nova Measuring Instruments Ltd. (Israel); Todd C. Bailey, Nelson M. Felix, IBM Corp. (USA) . . . . . [9424-45]

2:40 pm: **Simulation of AIMS measurements using rigorous mask 3D modeling**, Hsu-Ting Huang, Ru-Gun Liu, Tsai-Sheng Gau, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9424-46]

Coffee Break . . . . . Wed 3:00 pm to 4:00 pm

**CONFERENCE 9425**

Advances in Patterning Materials and Processes XXXII

**SESSION 10**

**LOCATION: CONVENTION CENTER 220C  
WED 1:20 PM TO 3:00 PM**

**EUV Resists and Processes**

Session Chairs: **Katsumi Ohmori**, Tokyo Ohka Kogyo Co., Ltd. (Japan); **Ramakrishnan Ayothi**, JSR Micro, Inc. (USA)

1:20 pm: **Novel processing approaches to enable EUV lithography toward high-volume manufacturing**, Cecilia A. Montgomery, SEMATECH Inc. (USA) . . . . . [9425-28]

1:40 pm: **Integrated fab process for metal oxide EUV photoresist**, Andrew Grenville, Jeremy Anderson, Benjamin L. Clark, Joseph Edson, Michael Greer, Kai Jiang, Michael K. Kocsis, Stephen T. Meyers, Jason K. Stowers, Inpria (USA); Alan Telecky, Inpria (USA); Danilo De Simone, Geert Vandenbergh, IMEC (Belgium) . . [9425-29]

2:00 pm: **High-sensitivity molecular organometallic resist for EUV (MORE)**, James Passarelli, Ryan Del Re, Miriam Sortland, SUNY College of Nanoscale Science and Engineering (USA); Mark Neisser, SEMATECH Inc. (USA); Daniel A. Freedman, State Univ. of New York at New Paltz (USA); Robert L. Brainard, SUNY College of Nanoscale Science and Engineering (USA). . . . . [9425-30]

2:20 pm: **Development of EUV chemically-amplified resist which has novel protecting group**, Shogo Matsumaru, Tatsuya Fujii, Takashi Kamizono, Kenta Suzuki, Hiroto Yamazaki, Masatoshi Arai, Yoshitaka Komuro, Akiya Kawae, Daisuke Kawana, Taku Hirayama, Katsumi Ohmori, Tokyo Ohka Kogyo Co., Ltd. (Japan) . . . . [9425-31]

2:40 pm: **Sensitivity study on the electron affinity of PAG in EUVL**, Changwan Bea, Korea Kumho Petrochemical Co., Ltd. (Korea, Republic of) . . . . . [9425-32]

Coffee Break . . . . .Wed 3:00 pm to 3:30 pm

**CONFERENCE 9426**

Optical Microlithography XXVIII

**SESSION 7**

**LOCATION: CONVENTION CENTER 210C  
WED 1:30 PM TO 3:10 PM**

**Mask and Wafer Topography Modeling**

Session Chairs: **John S. Petersen**, Periodic Structures, Inc. (USA); **Young Seog Kang**, SAMSUNG Electronics Co., Ltd. (Korea, Republic of)

1:30 pm: **Characterizing the dependence of thick-mask edge effects on feature size and illumination angle using AIMS images**, Aamod Shanker, Andrew R. Neureuther, Laura Waller, Univ. of California, Berkeley (USA); Martin Sczyrba, Advanced Mask Technology Ctr. GmbH Co. KG (Germany); Brid Connolly, Toppan Photomasks, Inc. (Germany) . . . . . [9426-23]

1:50 pm: **Accurate, full chip 3D electromagnetic field model for non-Manhattan mask corners**, Michael Lam, Chris H. Clifford, Michael R. Oliver, David Fryer, Edita Tejnli, Kostas Adam, Mentor Graphics Corp. (USA) . . . . . [9426-24]

2:10 pm: **A pattern- and optics-independent compact model of Mask3D under off-axis illumination with significant efficiency and accuracy improvements**, Hongbo Zhang, Qiliang Yan, David Wei, Ebo H. Croffie, Synopsys, Inc. (USA) . . . . . [9426-25]

2:30 pm: **Printing circuits with 4nm feature size: similarities and differences between EUV and optical lithographies**, Michael S. Yeung, Fastlitho Inc. (USA); Eytan Barouch, Boston Univ. (USA) . . . . . [9426-26]

2:50 pm: **Rigorous wafer topography simulation for investigating wafer alignment quality and robustness**, Nicolo Morgana, Infineon Technologies Dresden (Germany); Ulrich Klostermann, Juergen Preuninger, Itaru Kamohara, Synopsys GmbH (Germany); Dmitrii Gavrilin, Synopsys Inc. (Germany); Andreas Greiner, Detlef Hofmann, Holger Moeller, Infineon Technologies Dresden (Germany) . [9426-27]

Coffee Break . . . . .Wed 3:10 pm to 3:40 pm

**CONFERENCE 9427**

Design-Process-Technology Co-optimization for Manufacturability IX

**SESSION 4**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
WED 1:40 PM TO 2:10 PM**

**Invited Session II**

Session Chairs: **Robert Aitken**, ARM Inc. (USA); **Michael L. Rieger**, Synopsys, Inc. (USA)

1:40 pm: **DTCO at N7 and beyond: patterning and electrical compromises and opportunities (Invited Paper)**, Diederik Verkest, Julien Ryckaert, Praveen Raghavan, Arindam Mallik, Sushil S. Sakhare, Bharani Chava, Yasser Sherazi, Philippe Leray, Abdelkarim Mercha, Jürgen Bömmels, IMEC (Belgium); Gregory R. McIntyre, IMEC (USA); Kurt G. Ronse, Aaron Thean, Zsolt Tökei, An Steegen, IMEC (Belgium) . . . . . [9427-11]

**SESSION 5**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
WED 2:10 PM TO 3:30 PM**

**Layout Optimization and Verification I**

Session Chairs: **Robert Aitken**, ARM Inc. (USA); **Michael L. Rieger**, Synopsys, Inc. (USA)

2:10 pm: **Layout optimization with assist features placement by model based rule tables for 2x node random contact**, Jin-Hyuck Jun, Shinyoung Kim, Chan-Ha Park, Hyun-Jo Yang, DongGyu Yim, SK Hynix, Inc. (Korea, Republic of) . . . . . [9427-28]

2:30 pm: **Standard cell design in 7nm node: EUV versus immersion**, Bharani Chava, Peter Debacker, Yasser Sherazi, Praveen Raghavan, Werner Gillijns, IMEC (Belgium); David Rio, ASM Belgium N.V. (Belgium); Ahmad Elsaid, Mircea Dusa, ASML (Belgium); Julien Ryckaert, IMEC (Belgium) . . . . . [9427-13]

2:50 pm: **Layout dependent effects analysis on SMIC 28nm process**, Helen Li, Mealie Zhang, Waisum Wong, Semiconductor Manufacturing International Corp. (China); Huiyuan Song, Wei Xu, Michel L. Cote, Cadence Design Systems, Inc. (USA); Yifan Zhang, Hua Ding, Cadence Design Systems, Inc. (China); Jason Huang, Cadence Design Systems, Inc. (Taiwan); Ya-Chieh Lai, Philippe Hurat, Cadence Design Systems, Inc. (USA) . . . . . [9427-14]

3:10 pm: **Breaking through 1D layout limitations and regaining 2D design freedom-part I: random 2D layout decomposition and stitching techniques for hybrid optical and self-aligned multiple patterning**, Hongyi Liu, Jun Zhou, Yijian Chen, Peking Univ. (China) . . . . . [9427-15]

Coffee Break . . . . .Wed 3:30 pm to 4:00 pm

**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**SESSION 11**

**LOCATION: CONVENTION CENTER 210B  
WED 3:40 PM TO 5:50 PM**

**EUV Mask Inspection**

Session Chairs: **Naoya Hayashi**, Dai Nippon Printing Co., Ltd. (Japan); **Bryan S. Kasprovicz**, Photronics, Inc. (USA)

- 3:40 pm: **Actinic Review of EUV masks: Status and recent results of the AIMSTM EUV system** (*Invited Paper*), Dirk Hellweg, Markus R. Weiss, Carl Zeiss SMT GmbH (Germany); Sascha Perlit, Jan Hendrik Peters, Anthony D. Garetto, Carl Zeiss SMS GmbH (Germany); Vibhu Jindal, SEMATECH Inc. (USA) . . . . . [9422-44]
- 4:10 pm: **New ways of looking at masks with the SHARP EUV microscope**, Kenneth A. Goldberg, Markus P. Benk, Antoine J. Wojdyla, Patrick P. Naulleau, Weilun L. Chao, David G. Johnson, Alexander P. Donoghue, Ryan H. Miyakawa, Yow-Gwo Wang, James B. Macdougall, Lawrence Berkeley National Lab. (USA) . . . [9422-45]
- 4:30 pm: **SEMATECH produces defect-free EUV mask blanks: defect yield and immediate challenges**, Alin O. Antohe, Dave Balachandran, SEMATECH Inc. (USA); Long He, Intel Corp. (USA); Patrick A. Kearney, Anil Karumuri, Frank Goodwin, Kevin D. Cummings, SEMATECH Inc. (USA); Onoue Takahiro, Hoya Japan (Japan); Alan Hayes, Veeco Instruments Inc. (USA) . . . . . [9422-46]
- 4:50 pm: **Demonstration of enhanced defect sensitivity at focus for EUV mask inspection using SHARP EUV microscope**, Yow-Gwo Wang, Lawrence Berkeley National Lab. (USA) and Univ. of California, Berkeley (USA); Ryan Miyakawa, Weilun L. Chao, Markus P. Benk, Antoine J. Wojdyla, Alex P. Donoghue, David G. Johnson, Kenneth Goldberg, Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Lawrence Berkeley National Lab. (USA) and Univ. of California, Berkeley (USA); Ted Liang, Intel Corp. (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA) . . . . . [9422-47]
- 5:10 pm: **Toward defect guard-banding of EUV exposures by full chip optical wafer inspection of EUV mask defect adders**, Scott D. Halle, Luciana Meli, Robert Delancey, IBM Corp. (USA); Kaushik Vemareddy, KLA-Tencor California (USA); Gary Crispo, KLA-Tencor New York (USA); Ravi K. Bonam, Daniel Corliss, IBM Corp. (USA) . . . . . [9422-48]
- 5:30 pm: **Application of differential phase contrast imaging to EUV mask inspection: a numerical study**, Xibin Zhou, Dominic Ashworth, Kevin D. Cummings, SEMATECH Inc. (USA) . . . . . [9422-49]

**CONFERENCE 9423**

**Alternative Lithographic Technologies VII**

**SESSION 10**

**LOCATION: CONVENTION CENTER 220A  
WED 3:40 PM TO 5:50 PM**

**Multibeam Lithography**

Session Chairs: **Hans Loeschner**, IMS Nanofabrication AG (Austria); **Frank E. Abboud**, Intel Corp. (USA)

- 3:40 pm: **Electron multi-beam writer ready for use** (*Invited Paper*), Elmar Platzgummer, IMS Nanofabrication AG (Austria) . . . . [9423-33]
- 4:10 pm: **Performance validation of MAPPER's FLX-1200**, Marco Wieland, Guido de Boer, Michel Dansberg, Remco J. A. Jager, Erwin Slot, Stijn Steenbrink, Jerry J. M. Peijster, MAPPER Lithography (Netherlands); Ludovic Lattard, Laurent Pain, CEA-LETI (France) . . . . . [9423-34]
- 4:30 pm: **Thermal effect induced wafer deformation in high-energy e-beam lithography**, Pei-Shiang Chen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9423-35]
- 4:50 pm: **Comparison between e-beam direct write and immersion lithography for 20nm node**, Pieter Brandt, MAPPER Lithography (Netherlands); Charu Sardana, Dale E. Ibbotson, Altera Corp. (USA); Marco Wieland, MAPPER Lithography (Netherlands); Aurélien Fay, CEA-LETI (France) . . . . . [9423-36]
- 5:10 pm: **Alternative stitching method for massively parallel e-beam lithography**, Pieter Brandt, MAPPER Lithography (Netherlands); Céline Tranquillin, Asetla Nanographics (France); Marco Wieland, MAPPER Lithography (Netherlands); Sébastien Bayle, Matthieu Milléquant, Guillaume Renault, Asetla Nanographics (France) . . . . . [9423-37]
- 5:30 pm: **Development of ballistic hot electron emitter and its applications to parallel processing: active-matrix massive direct-write lithography in vacuum and thin films deposition in solutions**, Nobuyoshi Koshida, Tokyo Univ. of Agriculture and Technology (Japan); Akira Kojima, Naokatsu Ikegami, Takashi Yoshida, Hiroshi Miyaguchi, Masanori Muroyama, Hitoshi Nishino, Shinya Yoshida, Tohoku Univ. (Japan); Masanori Sugata, Crestec Corp. (Japan); Kentaro Totsu, Masayoshi Esashi, Tohoku Univ. (Japan) . . . [9423-38]

**CONFERENCE 9424**

**Metrology, Inspection, and Process Control for Microlithography XXIX**

**SESSION 11**

**LOCATION: CONVENTION CENTER 220B  
WED 4:00 PM TO 5:20 PM**

**Design Interaction with Metrology**

**Joint Session with Conferences 9424 and 9427**

- Session Chairs: **Alexander Starikov**, I&I Consulting (USA); **Jason P. Cain**, Advanced Micro Devices, Inc. (USA)
- 4:00 pm: **Full chip two-layer CD and overlay process window analysis**, Rachit Gupta, John L. Sturtevant, Shumay D. Shang, Mentor Graphics Corp. (USA) . . . . . [9427-16]
  - 4:20 pm: **A new paradigm for in-line detection and control of patterning defects**, Stefan Hunsche, ASML Brion (USA); Marinus Jochemsen, ASML Netherlands B.V. (Netherlands); Vivek Jain, Xinjian Zhou, ASML Brion (USA) . . . . . [9424-47]
  - 4:40 pm: **Predictability and impact of product layout induced-topology on across-field focus control for 28 and 14nm FDSOI technologies**, Jean-Gabriel Simiz, Bertrand Le-Gratiet, Pascal Gilgenkrantz, Alexandre Villaret, François Pasqualini, STMicroelectronics (France); Wim Tel, ASML Netherlands B.V. (Netherlands); Christopher Hugh Angus Prentice, ASML SARL (France) . . . . . [9424-48]
  - 5:00 pm: **The analysis method of the DRAM cell pattern hotspot**, Kyusun Lee, KweonJae Lee, Jinman Chang, Tae Heon Kim, DaeHan Han, Ae-Ran Hong, Yonghyeon Kim, Jinyoung Kang, Bumjin Choi, Joo-Sung Lee, Hyeongsun Hong, Kyupil Lee, Joosun Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9424-49]

**CONFERENCE 9425**

Advances in Patterning Materials and Processes XXXII

**SESSION 11**

**LOCATION: CONVENTION CENTER 220C  
WED 3:30 PM TO 5:30 PM**

**DSA Materials and New Concepts**

Session Chairs: **Mark H. Somervell**, Tokyo Electron America, Inc. (USA); **Daniel P. Sanders**, IBM Research - Almaden (USA)

3:30 pm: **The role of guide stripe chemistry in block copolymer directed self-assembly**, Robert Seidel, Lance D. Williamson, Paul F. Nealey, The Univ. of Chicago (USA); Youngjun Her, AZ Electronic Materials USA Corp. (USA); Roel Gronheid, IMEC (Belgium) [9425-33]

3:50 pm: **Patterning sub-25nm half-pitch hexagonal arrays of contact holes with chemo-epitaxial DSA guided by ArFi pre-patterns**, Arjun Singh, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Boon Teik Chan, IMEC (Belgium); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Hengpeng Wu, Jian Yin, Yi Cao, AZ Electronic Materials USA Corp. (USA); Roel Gronheid, IMEC (Belgium) [9425-34]

4:10 pm: **DSA graphoepitaxy calibrations for CH multiplication**, Stewart A. Robertson, Mark D. Smith, KLA-Tencor Texas (USA); Alessandro Vaglio Pret, KLA-Tencor/ ICOS Belgium (Belgium); Trey Graves, KLA-Tencor Texas (USA); Jan Doise, Joost P. Bekaert, IMEC (Belgium); Roel Gronheid, IMEC (USA) [9425-35]

4:30 pm: **Development and integration of systems with enhanced resolutions based on Si-containing block copolymers for line space applications**, Guillaume Fleury, Karim Aïssou, Muhammad Mumtaz, Univ. Bordeaux 1 (France); Xavier Chevalier, Célia Nicolet, Christophe Navarro, Arkema S.A. (France); Marta Fernandez-Regulez, Patricia Pimenta-Barros, Raluca Tiron, CEA-LETI (France); Cyril Brochon, Eric Cloutet, Georges Hadziioannou, Univ. Bordeaux 1 (France) [9425-36]

4:50 pm: **Analysis of the self-assembling and the defect annihilation processes in DSA using meso-scale simulation**, Hiroshi Morita, Yuki Norioze, National Institute of Advanced Industrial Science and Technology (Japan) [9425-37]

5:10 pm: **Millisecond laser annealing of sub-10nm directed self-assembly of PS-b-PDMS**, Jing Jiang, Brandon M. Wenning, Clemens C. Liedel, Michael O. Thompson, Christopher K. Ober, Cornell Univ. (USA) [9425-38]

**CONFERENCE 9426**

Optical Microlithography XXVIII

**SESSION 8**

**LOCATION: CONVENTION CENTER 210C  
WED 3:40 PM TO 5:40 PM**

**OPC and Modeling**

Session Chairs: **Yuri Granik**, Mentor Graphics Corp. (USA); **Peter D. Brooker**, Synopsys, Inc. (USA)

3:40 pm: **Investigating deprotection-induced shrinkage and retro-grade sidewalls in NTD resists**, Thomas V. Pistor, Panoramic Technology Inc. (USA); Chenchen Wang, Yan Wang, Lei Yuan, Jongwook Kye, Yixu Wu, Paul W. Ackmann, GLOBALFOUNDRIES Inc. (USA) [9426-29]

4:00 pm: **Alternative to ILT method for high-quality full-chip SRAF insertion**, Andrey Lutich, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany) [9426-30]

4:20 pm: **Uncertainty aware site selection method for OPC model calibration**, Tamer H. Coskun, GLOBALFOUNDRIES Inc. (USA) [9426-31]

4:40 pm: **Experiments using automated sample plan selection for OPC modeling**, Ramya Viswanathan, IBM Corp. (USA); Omprakash Jaiswal, IBM Corp. (India); Maria Gabrani, Nathalie Casati, IBM Research – Zürich (Switzerland); Amr Y. Abdo, James Oberschmidt, Josef Watts, IBM Corp. (USA) [9426-32]

5:00 pm: **Optical proximity correction with hierarchical Bayes model**, Tetsuaki Matsunawa, Toshiba Corp. (Japan); Bei Yu, David Z. Pan, The Univ. of Texas at Austin (USA) [9426-33]

5:20 pm: **Application of SEM-based contours for OPC model weighting and sample plan reduction**, Marshal A. Miller, Ioana C. Graur, Scott D. Halle, IBM Corp. (USA); Keiichiro Hitomi, Hitachi America, Ltd. (USA) [9426-34]

**CONFERENCE 9427**

Design-Process-Technology  
Co-optimization for Manufacturability IX

**SESSION 6**

**LOCATION: CONVENTION CENTER 220B  
WED 4:00 PM TO 5:20 PM**

**Design Interaction with Metrology**

**Joint Session with Conferences 9424 and 9427**

Session Chairs: **Alexander Starikov**, I&I Consulting (USA); **Jason P. Cain**, Advanced Micro Devices, Inc. (USA)

4:00 pm: **Full chip two-layer CD and overlay process window analysis**, Rachit Gupta, John L. Sturtevant, Shumay D. Shang, Mentor Graphics Corp. (USA) [9427-16]

4:20 pm: **A new paradigm for in-line detection and control of patterning defects**, Stefan Hunsche, ASML Brion (USA); Marinus Jochemsen, ASML Netherlands B.V. (Netherlands); Vivek Jain, Xinjian Zhou, ASML Brion (USA) [9424-47]

4:40 pm: **Predictability and impact of product layout induced-topology on across-field focus control for 28 and 14nm FDSOI technologies**, Jean-Gabriel Simiz, Bertrand Le-Gratiet, Pascal Gilgenkrantz, Alexandre Villaret, François Pasqualini, STMicroelectronics (France); Wim Tel, ASML Netherlands B.V. (Netherlands); Christopher Hugh Angus Prentice, ASML SARL (France) [9424-48]

5:00 pm: **The analysis method of the DRAM cell pattern hotspot**, Kyusun Lee, KweonJae Lee, Jinman Chang, Tae Heon Kim, DaeHan Han, Ae-Ran Hong, Yonghyeon Kim, Jinyoung Kang, Bumjin Choi, Joo-Sung Lee, Hyeongsun Hong, Kyupil Lee, Joosun Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) [9424-49]

# POSTER RECEPTION - CONVENTION CENTER HALL 2

Wednesday 25 February | 6:00 to 8:00 pm

Wednesday Poster  
Reception Co-Sponsors:



## CONFERENCE 9424

### Metrology, Inspection, and Process Control for Microlithography XXIX

**Metrology of 50 HP wire-grid polarizer: a SEM-scatterometry comparison.** Ruichao Zhu, The Univ. of New Mexico (USA); Sharwan Singhan, The Univ. of Texas at Austin (USA); Alexander R. Munoz, Arizona State Univ. (USA); Srinivasan Sreenivasan, The Univ. of Texas at Austin (USA); Steven R. J. Brueck, The Univ. of New Mexico (USA) . . . . . [9424-65]

**High-throughput automatic defect review for 300mm blank wafers with atomic force microscope.** Ardavan Zandiatashbar, Byong Kim, Young-kook Yoo, Park Systems Inc. (USA); Sang-il Park, Park Systems Corp. (Korea, Republic of) . . . . . [9424-66]

**High-order overlay modeling and APC simulation with Zernike-Legendre polynomials.** Jae-Wuk Ju, Min-Gyu Kim, Ju-Han Lee, SK Hynix, Inc. (Korea, Republic of); Stuart Sherwin, KLA-Tencor Corp. (USA); Choon Hong G. Hoo, KLA-Tencor Texas (USA); Dong-Sub Choi, Do-Hwa Lee, Sanghuck Jeon, Kangsan Lee, KLA-Tencor Korea (Korea, Republic of); David C. Tien, KLA-Tencor Corp. (USA); Bill Pierson, John C. Robinson, Mark D. Smith, KLA-Tencor Texas (USA); Ady Levy, KLA-Tencor Corp. (USA) . [9424-67]

**Continuous tool monitoring by means of product stream data analytics.** Allan Minns, IBM Microelectronics (USA) . . . . . [9424-68]

**Overlay improvement using Legendre/Zernike model-based overlay corrections and monitoring with interpolated metric.** Md Zakir Ullah, Micron Semiconductor Asia Pte. Ltd. (Singapore) . [9424-69]

**2D and 3D isolation mounts scatterometry with RCWA and PML.** Hirokimi Shirasaki, Tamagawa Univ. (Japan) . . . . . [9424-70]

**Novel self-calibration mark for overlay measurement.** Teng-Chin Kuo, United Microelectronics Corp. (Taiwan) . . . . . [9424-71]

**Novel self-calibration mark for overlay accuracy improvement.** Nuriel Amir, KLA-Tencor Israel (Israel); Gary C. H. Wang, Simon C. C. Hsu, En Chuan Lio, Yuan Chi Pai, Sho Shen Lee, Chun Chi Yu, United Microelectronics Corp. (Taiwan); Henry Hsing, KLA-Tencor Taiwan (Taiwan); Tal Itzkovich, KLA-Tencor Israel (Israel) . . . . . [9424-72]

**Overlay target selection for 20nm process on A500 LCM.** Vidya Ramanathan, KLA-Tencor Corp. (USA); Lokesh Subramany, GLOBALFOUNDRIES Inc. (USA); Tal Itzkovich, KLA-Tencor Israel (Israel); Chanseob Cho, GLOBALFOUNDRIES Inc. (USA); Lipkong Yap, KLA-Tencor Corp. (USA); Bill Pierson, KLA-Tencor Corp (USA); Patrick W. Snow, Karsten Gutjhar, GLOBALFOUNDRIES Inc. (USA) . . [9424-73]

**Qmerit-calibrated overlay to improve overlay accuracy and device performance.** Md Zakir Ullah, Micron Semiconductor Asia Pte. Ltd. (Singapore) . . . . . [9424-74]

**Virtual overlay metrology for fault detection supported with inline metrology and machine learning.** Hong-Goo Lee, SK Hynix, Inc. (Korea, Republic of); Emil Schmitt-Weaver, ASML Netherlands B.V. (Netherlands); Min-Suk Kim, Sang-Jun Han, Myoung Soo Kim, Won-Taik Kwon, Sung-Ki Park, SK Hynix, Inc. (Korea, Republic of); Kevin Ryan, Thomas Theeuwes, Kyu-Tae Sun, Young-Wan Lim, Daan Slotboom, Michael Kubis, Jens Staecker, ASML Netherlands B.V. (Netherlands) . . . . . [9424-75]

**A defractometer for quality control in nanofabrication processing based on subwavelength diffraction.** Jordi Gomis-Bresco, Martin Kreuzer, Institut Català de Nanociència i Nanotecnologia (ICN2) (Spain); Clivia M. Sotomayor-Torres, Institut Català de Nanociència i Nanotecnologia (ICN2) (Spain) and ICREA-Institutio Catalana de Recerca i Estudis Avançats (Spain) . . . . . [9424-76]

**High-sensitivity tracking of CD-SEM performance.** Sergey Babin, Peter Yushmanov, Igor Gudich, abeam Technologies, Inc. (USA) . . . . . [9424-77]

**Improvement of depth of focus control using wafer geometry.** Jaydeep K. Sinha, KLA-Tencor Corp. (USA); Honggoo Lee, Jongsu Lee, Sangjun Han, Changhwan Lee, Myoung Soo Kim, Sangmin Kim, Wontaik Kwon, Sung-ki Park, SK Hynix, Inc. (Korea, Republic of); Sathish Veeraraghavan, J. H. Kim, Pradeep Vukkadala, KLA-Tencor Corp. (USA); Junggho Byeon, KLA-Tencor Corp. (Korea, Republic of); Dieter Mueller, KLA-Tencor Corp. (USA) [9424-79]

The following posters will be on display from 10:00 am to 5:00 pm, and from 6:00 pm to 8:00 pm during the poster session. Come and view the high-quality papers that are presented in this alternative format, and interact with the poster authors who will be present during the poster session.

**Through pitch monitoring by optical scatterometry.** Robert Melzer, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany); Carsten Hartig, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Gunter Grasshof, Bjoern Sass, Fernando Koch, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany); Jan Engelmann, KLA-Tencor Germany (Germany); Zhi Qing Xu, Zhenkui Shen, KLA-Tencor China (China) . . . . . [9424-80]

**Understanding CD-SEM artifacts by comparing experiment with simulation.** Alessandro Vaglio Pret, KLA-Tencor/ ICOS Belgium (Belgium); Chao Fang, KLA-Tencor Texas (USA); Joost P. Bekaert, IMEC (Belgium); Stewart A. Robertson, John J. Biafore, Mark D. Smith, KLA-Tencor Texas (USA) . . [9424-81]

**Overlay measurement accuracy enhancement by design and algorithm.** Hong-Goo Lee, Byongseog Lee, Sangjun Han, Myoung Soo Kim, Won-Taik Kwon, Sung-Ki Park, SK Hynix, Inc. (Korea, Republic of); Tal Itzkovich, Yuri Paskover, KLA-Tencor Israel (Israel); Dong-Sub Choi, Do-Hwa Lee, Sanghuck Jeon, Kangsan Lee, KLA-Tencor Korea (Korea, Republic of); Amnon Manassen, KLA-Tencor Israel (Israel); David C. Tien, KLA-Tencor Corp. (USA); Negri Daria, David Greedy, Eitan Herzel, KLA-Tencor Israel (Israel) . . . . . [9424-82]

**Lithography process controllers and photo-resistance monitoring by signal response metrology (SRM).** WeiYuan Chu, KLA-Tencor Corp. (USA); Wei-Jhe Tzai, United Microelectronics Corp. (Taiwan) . . . . . [9424-84]

**Lithography process related electrostatic discharge effect mechanism study.** Xiaosong Yang, Semiconductor Manufacturing International Corp. (China) . . . . . [9424-85]

**Scanner focus metrology for advanced node scanner monitoring and control.** Jimyung Kim, Youngsik Park, Taehwa Jeong, Su Hyun Kim, Kwang-Sub Yoon, Byoung-il Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Vladimir B. Levinski, Daniel Kandel, Yoel Feler, Nadav Gutman, Eltsafon Island-Ashwal, Moshe Cooper, DongSub Choi, Eitan Herzel, Tien David, JungWook Kim, KLA-Tencor Israel (Israel) . . . . . [9424-86]

**The use of eDR-7100 for DSA defect review and automated classification.** Hari Pathangi, Hareem Bayana, Dieter Van Den Heuvel, IMEC (Belgium); Loemba Bouckou, KLA-Tencor France (USA); Jim Brown, KLA-Tencor Corp. (USA); Paolo Parisi, KLA-Tencor Italy SRL (Italy); Roel Gronheid, IMEC (Belgium) . . . . . [9424-87]

**Real-time decision-based multiple mode SEM review imaging solution.** Harsh Sinha, Huina Xu, KLA-Tencor Corp. (USA); Garry Chen, White Pai, United Microelectronics Corp. (Taiwan) . . . [9424-88]

**SEM critical point inspection (CPI) technology using high-resolution SEM images at pre-defined locations on the die and on the wafer for newest technology nodes.** Dominique Sanchez, STMicroelectronics (France); Loemba Bouckou, KLA-Tencor France (France); Remi Le Tiec, Benoit Hinschberger, STMicroelectronics (France); Olivier Moreau, KLA-Tencor Corp. (USA); Paolo Parisi, KLA-Tencor Italy SRL (Italy) . . . . . [9424-89]

**Study on ADI CD bias correlating ABC function.** Guogui Deng, Jingdan Hao, Bin Xing, Yuntao Jiang, Gaorong Li, Qiang Zhang, Liwan Yue, Yanlei Zu, Hua-Yong Hu, Winnie Liu, Manhua Shen, Skin Zhang, Haichao Huang, Wei-Ming He, Deping Kong, Kaiting He, Nannan Zhang, Yi-Shih Lin, Qiang Wu, Xuelong Shi, Semiconductor Manufacturing International Corp. (China) . . . . . [9424-90]

**CD uniformity improvement of dense contact array in negative tone development process.** Fengnien Tsai, Teng-Hao Yeh, Chin-Cheng Yang, Elvis Yang, Ta-Hung Yang, K. C. Chen, Macronix International Co., Ltd. (Taiwan) . . . . . [9424-91]

**Real-time and large-field FF-OCT.** Yue Zhu, Nanjing Univ. of Science and Technology (China) . . [9424-92]

**Improvement of ArF immersion lithography by filtration technology.** Tung-Chang Kuo, Met Yeh, Yeh Sheng Lin, Lian Cong Liu, Wen Liang Huang, Chun Chi Yu, Isaac Chao, Chun-Chung Chuang, Yi Nan Cheng, Will Tseng, United Microelectronics Corp. (Taiwan) . . . . . [9424-93]

**Study on immersion lithography defectivity improvement in memory device manufacturing.** Wei-Ming He, Hua-Yong Hu, Qiang Wu, Semiconductor Manufacturing International Corp. (China) . . . . . [9424-94]

**Carbon dioxide gas purification and analytical measurement for leading edge 193nm lithography.** Sarah Riddle Vogt, Chuck H. Applegarth, Matt Browning, SAES Pure Gas, Inc. (USA); Cristian Landoni, Marco Succi, SAES Getters, S.p.A. (Italy); Simona Pirola, Giorgio Macchi, SAES Getters S.p.A. (Italy) . . . . . [9424-96]

**EUV tools: hydrogen gas purification and recovery strategies.** Sarah Riddle Vogt, Charles H. Applegarth, SAES Pure Gas, Inc. (USA); Cristian Landoni, Marco Succi, SAES Getters S.p.A. (Italy) . . . . . [9424-98]

Enjoy light refreshments while networking with your colleagues.

Full author or technical registration is required for entry to the poster sessions.

Please wear your registration badge.

**Silicon fin line edge roughness determination and sensitivity analysis by Mueller matrix spectroscopic ellipsometry based scatterometry**, Dhairya J. Dixit, Samuel O'Mullane, SUNY College of Nanoscale Science and Engineering (USA); Erik R. Hosler, Vimal K. Kamineni, Moshe E. Preil, GLOBALFOUNDRIES Inc. (USA); Kevin Heidrich, Nick Keller, Joseph Race, Nanometrics Inc. (USA); Gangadhara Raja Muthinti, IBM Semiconductor Research and Development Ctr. (USA); Alain C. Diebold, SUNY College of Nanoscale Science and Engineering (USA) . . . . . [9424-99]

**Transient tip-sample interactions in high-speed AFM imaging of 3D nanostructures**, Aliasghar Keyvani, Hamed Sadeghian, Technische Univ. Delft (Netherlands), TNO (Netherlands); Hans F. L. Goosen, Fred van Keulen, Technische Univ. Delft (Netherlands) . . . . . [9424-100]

## CONFERENCE 9426 Optical Microlithography XXVIII

### Posters: Image and Process Control

**High-contrast imaging at hyper-NA using a fully optimized pupil function and polarization state**, James J. Jacob, Actinix (USA) . . . . . [9426-47]

**Comparing the experimental resist image with image intensity in high-NA projection lens**, Masato Shibuya, Tokyo Polytechnic Univ. (Japan); Akira Takada, Topcon Corp. (Japan); Toshiharu Nakashima, Nikon Corp. (Japan) . . . . . [9426-48]

**Advanced process characterization using light source performance modulation and monitoring**, Paolo Alagna, Omar Zurita, Gregory Rechtsteiner, Cymer LLC (USA) . . . . . [9426-49]

**Analytical analysis for impact of polarization aberration of projection lens on lithographic imaging quality**, Lina Shen, Shanghai Institute of Optics and Fine Mechanics (China) and Xinjiang Normal Univ. (China); Sikun Li, Xiangzhao Wang, Guanyong Yan, Shanghai Institute of Optics and Fine Mechanics (China) . . . . . [9426-80]

**Posters: Mask and Wafer Topography**  
**Reducing the substrate dependent scanner leveling effect in low-k1 contact printing**, Ching Shun Chang, Macronix International Co., Ltd. (Taiwan) . . . . . [9426-50]

**A fast and flexible library-based thick-mask near-field calculation method**, Xu Ma, Jie Gao, Xuanbo Chen, Lisong Dong, Yanqiu Li, Beijing Institute of Technology (China) . . . . . [9426-51]

**Focus shift impacted by mask 3D and comparison between Att. PSM and OMOG**, Yansong Liu, Xiaojing Su, Zhiyang Song, Moran Guo, Yajuan Su, Institute of Microelectronics (China); Yayi Wei, Institute of Microelectronics (China) . . . . . [9426-52]

**UDOF direct improvement by modulating mask absorber thickness**, Enchuan Liu, Dennis Yu, Po Tsang Chen, Chia Hsun Tseng, Kuei-Chun Hung, Charlie Chen, United Microelectronics Corp. (Taiwan) . . . . . [9426-53]

**Posters: Multiple Patterning and SMO**  
**120W ArF laser with high-wavelength stability and efficiency for the next-generation multiple-patterning immersion lithography**, Takeshi Ohta, Gigaphoton Inc. (Japan) . . . . . [9426-54]

**Forbidden pitches: causes, source optimization, and their role in design rules**, Stefan Apostol, Paul Hurley, IBM Research – Zürich (Switzerland) [9426-55]

**Source optimization using particle swarm optimization algorithm in photolithography**, Lei Wang, Sikun Li, Xiangzhao Wang, Guanyong Yan, Chaoxing Yang, Shanghai Institute of Optics and Fine Mechanics (China) . . . . . [9426-79]

### Posters: Non-IC Applications

**Advanced mask aligner lithography (AMALITH)**, Reinhard Völkel, Uwe Vogler, Arianna Bramati, SUSS MicroOptics SA (Switzerland) . . . . . [9426-56]

### Posters: OPC Model

**An improved virtual aberration model to simulate mask 3D and resist effects**, Motokatsu Imai, Reiji Kanaya, Koichi Fujii, Nikon Corp. (Japan); Lin Qun Ying, A\*STAR Institute of Microelectronics (Singapore) . . . . . [9426-58]

**Evaluation of compact models for negative-tone development layers at 20/14nm nodes**, Ao Chen, Yee Mei Foong, GLOBALFOUNDRIES Singapore (Singapore); Dong Qing Zhang, Hongxin Zhang, GLOBALFOUNDRIES Inc. (USA); Angeline Chung, Mentor Graphics Corp. Singapore (Singapore); David Fryer, Yunfei Deng, Dmitry M. Medvedev, Yuri Granik, Mentor Graphics Corp. (USA) . . . . . [9426-59]



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# POSTER RECEPTION - CONVENTION CENTER HALL 2

Wednesday 25 February | 6:00 to 8:00 pm

The following posters will be on display from 10:00 am to 5:00 pm, and from 6:00 pm to 8:00 pm during the poster session. Come and view the high-quality papers that are presented in this alternative format, and interact with the poster authors who will be present during the poster session. Enjoy light refreshments while networking with your colleagues.

Full author or technical registration is required for entry to the poster sessions. Please wear your registration badge.

**Photoresist 3D profile related etch process simulation and its application of full chip etch compact modeling**, Cheng-En R. Wu, Wayne Yang, Synopsys Taiwan Ltd. (Taiwan); Hua Song, Synopsys Inc. (USA) . . . . . [9426-60]

**Resist profile modeling with compact resist model**, Christian D. Zuniga, Yunfei Deng, Yuri Granik, Mentor Graphics Corp. (USA) . . . . . [9426-61]

**Impacts of post OPC shapes on pattern**, Wen-Han Chu, TSMC Taiwan (Taiwan) . . . . . [9426-62]

**Calibrating etch model with SEM contours**, Francois Weisbuch, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Ahmed S. Omran, GLOBALFOUNDRIES Dresden (Germany); Kenneth Jantzen, Mentor Graphics Corp. (USA) . . . . . [9426-78]

**Posters: Optical Proximity Correction 7nm logic optical lithography with OPC-Lite**, Michael C. Smayling, Tela Innovations, Inc. (USA); Koichiro Tsujita, Canon Inc. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan); Valery Axelrad, Sequoia Design Systems, Inc. (USA); Ryo Nakayama, Canon Inc. (Japan); Kenichi Oyama, Tokyo Electron AT Ltd. (Japan); Hiroyuki Ishii, Canon Inc. (Japan); Shohei Yamauchi, Tokyo Electron AT Ltd. (Japan); Koji Mikami, Canon Inc. (Japan) . . . . . [9426-63]

**OPC solution by implementing fast converging methodology**, Eilyn Yang, Yaojun Du, Semiconductor Manufacturing International Corp. (China) . [9426-64]

**The comparison of OPC repair performance with respect to various constraints**, Yaojun Du, Qing Yang, Semiconductor Manufacturing International Corp. (China) . . . . . [9426-65]

**Model-based HSF using by target point control function**, Sungjin Kim, SK Hynix, Inc. (Korea, Republic of); Munhoe Do, Synopsys Korea Inc. (Korea, Republic of); Yongbae Ahn, Jaeseung Choi, Hyun-Jo Yang, DongGyu Yim, SK Hynix, Inc. (Korea, Republic of) . . . . . [9426-66]

**Sub-resolution assist feature (SRAF) printing prediction using logistic regression**, Chin Boon Tan, Kar Kit Koh, GLOBALFOUNDRIES Singapore (Singapore); Dong Qing Zhang, GLOBALFOUNDRIES Inc. (USA); Yee Mei Foong, GLOBALFOUNDRIES Singapore (Singapore) . . . . . [9426-67]

**Accurate and fast computation of transmission cross coefficients**, Stefan Apostol, IBM Research (Switzerland); Paul Hurley, IBM Research – Zürich (Switzerland); Radu C. Ionescu, EPFL (Switzerland) and IBM Research – Zürich (Switzerland) . . [9426-68]

**Model-driven optimization of rule-based OPC fragmentation**, Jingyu Wang, GLOBALFOUNDRIES Inc. (USA); Alexander Wei, Mentor Graphics Corp. (USA); Piyush Verma, William Wilkinson, GLOBALFOUNDRIES Inc. (USA) . . . . . [9426-69]

**The study of lithography conditions to use advanced resist performance properly**, Zhengkai Yang, Wuping Wang, Quan Chen, Shanghai Huali Microelectronics Corp. (China); Hajime Aoyama, Kengo Takemasa, Toshihiko Sei, Tami Miyazawa, Tomoyuki Matsuyama, Nikon Corp. (Japan); Chun Shao, Nikon Precision Shanghai Co., Ltd. (China) . . . . . [9426-70]

**Local printability enhancement technique for hotspot fixer for sub-14nm nodes**, SukYoon Chung, Hyejin Shin, Sejin V. Park, No-Young Chung, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Soung-Su Woo, Sergey Kobelkov, Kyohei Sakajiri, Mentor Graphics Corp. (USA); Jiwan Han, Mentor Graphics Corp. (Korea, Republic of); Sukjoo Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Alexander Trichtkov, Mentor Graphics Corp. (USA); Byoung-il Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9426-71]

## Posters: Toolings

**Modeling and simulation of beam steering unit**, Jiayun Feng, Xiaoping Li, Xin He, Jinchun Wang, Huazhong Univ. of Science and Technology (China) . . . . . [9426-72]

**DUV ArF light-source automated gas optimization for enhanced repeatability and availability**, Tanuj Aggarwal, Kevin O'Brien, Cymer LLC (USA) [9426-73]

**Performance of ETC controller in high-volume production**, Joshua J. Thomas, Kevin O'Brien, Will Conley, Hoang Dao, David Dunlap, Ronnie P. Flores, Matt Lake, Tanuj Aggarwal, Aleks Simic, Brian Wehrung, John Wyman, Cymer LLC (USA) . [9426-74]

**Reduction of helium usage in the XLA and XLR platforms**, Gamaralalage G. Padmabandu, Erich R. Gross, Don Haran, Eric Mason, Richard Ujazdowski, Matt Lake, Cymer LLC (USA) . . . . . [9426-75]

**New robust and highly customizable light source management system**, Yuji Minegishi, Kenji Takahisa, Tatsuo Enami, Hitomi Fukuda, Young Sun Yoo, Hideyuki Ochiai, Takeshi Ohta, Gigaphoton Inc. (Japan) . . . . . [9426-76]

**Extending green technology innovations to enable greener fabs**, Kenji Takahisa, Yuji Minegishi, Tatsuo Enami, Hitomi Fukuda, Young Sun Yoo, Gigaphoton Inc. (Japan) . . . . . [9426-77]

**A complete compact mask 3D model in extreme ultraviolet lithography with high-efficiency and accuracy**, Hongbo Zhang, Qiliang Yan, Xin Zhou, Sajjan Marokkey, Ebo H. Croffie, Synopsys, Inc. (USA) . . . . . [9426-81]

## CONFERENCE 9427 Design-Process-Technology Co-optimization for Manufacturability IX

**20nm CMP model calibration with optimized metrology data and CMP model applications**, Ushasree Katakamsetty, GLOBALFOUNDRIES Singapore (Singapore); Dinesh Koli, GLOBALFOUNDRIES Inc. (USA); Sky Yeo Wee Kwong, Colin C. W. Hui, GLOBALFOUNDRIES Singapore (Singapore); Ruben G. Ghulghazaryan, Mentor Graphics Corp. (Armenia); Burak Aytuna, Jeff S. Wilson, Mentor Graphics Corp. (USA) . . [9427-30]

**Topography-induced DFM rule-based scoring for silicon yield modeling**, Vikas Tripathi, Ushasree Katakamsetty, Wee Kwong Sky Yeo, GLOBALFOUNDRIES Singapore (Singapore) . . . . . [9427-31]

**A compact model to predict pillar-edge-roughness effects on vertical nanowire MOSFETs using the perturbation method**, Pu Wang, Chuyang Hong, Qi Cheng, Yijian Chen, Peking Univ. (China) . . . . . [9427-32]

**Efficient etch bias compensation techniques for accurate on-wafer patterning**, Mohamed Salama, Ayman Hamouda, GLOBALFOUNDRIES Inc. (USA) . . . . . [9427-33]

**An efficient litho hotspot severity analysis method by using Calibre PM and DRC application**, ZeXi Deng, Semiconductor Manufacturing International Corp. (China); ChunShan Du, Mentor Graphics Shanghai Electronic Technology Co. (China); Lin Hong, Semiconductor Manufacturing International Corp. (China); Ligu Zhang, Mentor Graphics Shanghai Electronic Technology Co. (China); JinYan Wang, Semiconductor Manufacturing International Corp. (China) . . . . . [9427-34]

**A holistic methodology to drive process window entitlement, and its application to 20nm logic**, Lalit Shokeen, Ayman Hamouda, Mark Terry, GLOBALFOUNDRIES Inc. (USA); Dan J. Dechene, Stephen D. Hsu, Michael Crouse, Pengcheng Li, Keith D. Gronlund, Gary Guohong Zhang, Brion Technologies, Inc. (USA) . . . . . [9427-35]

**Practical DTCO through design/patterning exploration**, Neal V. Lafferty, Jason Meiring, Dan Schumacher, Mentor Graphics Corp. (USA); James A. Culp, IBM Corp. (USA); Glenn Wawrzynski, Gurpreet S. Lamba, Mohamed S. Bahnas, Joe O'Neill, Kostas Adam, John L. Sturtevant, Chris McGinty, Mentor Graphics Corp. (USA) . . . . . [9427-36]

**Comparison of OPC job prioritization schemes to generate data for mask manufacturing**, Kenneth Jantzen, Mentor Graphics Corp. (USA); Travis Lewis, Vijay Veeraraghavan, Minyoung Park, GLOBALFOUNDRIES Inc. (USA); Stephen H. Kim, Gordon Russell, Mark C. Simmons, Mentor Graphics Corp. (USA) . . . . . [9427-37]

**Design analyzer: A physical design profiling and data mining tool**, Shikha Somani, Piyush Verma, Sriram Madhavan, Fadi Batarseh, Robert C. Pack, Luigi Capodici, GLOBALFOUNDRIES Inc. (USA) . . . . . [9427-38]

**The cell pattern correction through design-based metrology**, Yonghyeon Kim, Kweonjae Lee, Jinman Chang, Taeheon Kim, Daehan Han, Kyusun Lee, Ae-Ran Hong, JinYoung Kang, Bumjin Choi, Joo-Sung Lee, Kyehee Yeom, Hyeongsun Hong, Kyupil Lee, Joosun Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9427-39]

**Breaking through 1D layout limitations and regaining 2D design freedom-part II: stitching yield modeling and optimization**, Jun Zhou, Yijian Chen, Peking Univ. (China) . . . . . [9427-40]

**Automatic DFM methodology for bit line pattern dummy**, Mohamed Bahr, Mentor Graphics Egypt (Egypt) . . . . . [9427-41]



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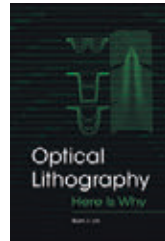


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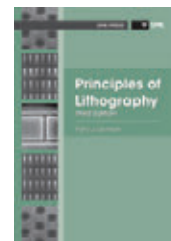


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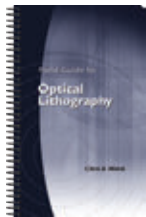


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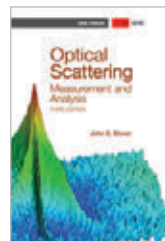


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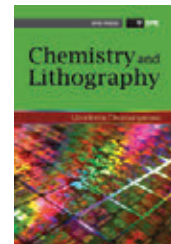


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**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**SESSION 12**

**LOCATION: CONVENTION CENTER 210B  
THU 8:00 AM TO 10:10 AM**

**EUV Extension**

Session Chairs: **Markus Bender**, Advanced Mask Technology Ctr. GmbH Co. KG (Germany); **Pawitter J. Mangat**, GLOBALFOUNDRIES Inc. (USA)

- 8:00 am: **EUV lithography scanner for sub-8nm resolution** (*Invited Paper*), Jan B. P. van Schoot, Koen van Ingen Schenau, ASML Netherlands B.V. (Netherlands); Sascha Migura, Carl Zeiss SMT GmbH (Germany) ..... [9422-50]
- 8:30 am: **EUV lithography optics for sub-9nm resolution**, Bernhard Kneer, Sascha Migura, Jens Timo Neumann, Winfried Kaiser, Carl Zeiss SMT GmbH (Germany); Jan B. P. van Schoot, ASML Netherlands B.V. (Netherlands) ..... [9422-51]
- 8:50 am: **Imaging performance of EUV lithography optics configuration for sub-9nm resolution**, Jens Timo Neumann, Matthias Rösch, Paul Gräupner, Sascha Migura, Bernhard Kneer, Winfried Kaiser, Carl Zeiss SMT GmbH (Germany); Koen van Ingen Schenau, ASML Netherlands B.V. (Netherlands) ..... [9422-52]
- 9:10 am: **EUV resolution enhancement techniques (RET) for k1s below 0.4**, Stephen D. Hsu, Rafael C. Howell, Jianjun Jia, Hua-Yu Liu, Keith Gronlund, ASML Brion (USA); Steve Hansen, ASML US, Inc. (USA); Jörg Zimmermann, Carl Zeiss SMT GmbH (Germany) [9422-53]
- 9:30 am: **Novel interferometric strategies for characterizing high-NA EUV optics**, Ryan H. Miyakawa, Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA) ..... [9422-54]
- 9:50 am: **Advanced coatings for next-generation lithography**, Philipp Naujok, Sergiy Yulin, Norbert Kaiser, Andreas Tünnermann, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) . [9422-55]
- Coffee Break ..... Thu 10:10 am to 10:40 am

**CONFERENCE 9423**

**Alternative Lithographic Technologies VII**

**SESSION 11**

**LOCATION: CONVENTION CENTER 220A  
THU 8:10 AM TO 10:00 AM**

**DSA Line and via Patterning**

Session Chairs: **Ricardo Ruiz**, HGST (USA); **Benjamin M. Rathsack**, Tokyo Electron America, Inc. (USA)

- 8:10 am: **Self-aligned line-space pattern customization with directed self-assembly grapho-epitaxy at 24nm pitch** (*Invited Paper*), Hsinyu Tsai, Hiroyuki Miyazoe, IBM Thomas J. Watson Research Ctr. (USA); Joy Y. Cheng, IBM Research - Almaden (USA); Markus Brink, Simon Dawes, David Klaus, James Buccignano, IBM Thomas J. Watson Research Ctr. (USA); Daniel P. Sanders, IBM Research - Almaden (USA); Eric A. Joseph, IBM Thomas J. Watson Research Ctr. (USA); Matthew E. Colburn, IBM Corp. (USA); Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA) . . . [9423-39]
- 8:40 am: **Impact of BCP asymmetry on DSA patterning performance**, Lance D. Williamson, The Univ. of Chicago (USA) and IMEC (Belgium); JiHoon Kim, Yi Cao, Guanyang Lin, AZ Electronic Materials USA Corp. (USA); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) ..... [9423-40]
- 9:00 am: **Directed self-assembly lithography using coordinated line epitaxy (COOL) process**, Yuriko Seino, Yusuke Kasahara, Ken Miyagi, Shinya Minegishi, Hironobu Sato, Katsutoshi Kobayashi, Hideki Kanai, Katsuyoshi Kodera, Naoko Kihara, Toshikatsu Tobana, Tomoharu Fujiwara, Noriyuki Hirayanagi, Yoshiaki Kawamonzen, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan) ..... [9423-41]
- 9:20 am: **Contact hole shrink and multiplication by directed self-assembly of block copolymers: from materials to integration**, Raluca Tiron, Ahmed Gharbi, MINATEC (France); Patricia Pimenta-Barros, Sandra Bos, Celine Lapeyre, Antoine Fouquet, Jerome Hazart, Sebastien Barnola, Sebastien Berard Bergery, Maxime Argoud, CEA-LETI (France); Shayma Bouanani, Cedric Monget, Vincent Farys, STMicroelectronics (France); Xavier Chevalier, Christophe Navarro, Celia Nicolet, Arkema S.A. (France); Guillaume Fleury, Georges Hadziioannou, Lab. de Chimie des Polymères Organiques (France) ..... [9423-42]
- 9:40 am: **Cross-sectional imaging of directed self-assembly block copolymers**, Kye Okabe, He Yi, Maryann Tung, Richard C. Tiberio, H. S. P. Wong, Stanford Univ. (USA) ..... [9423-43]
- Coffee Break ..... Thu 10:00 am to 10:30 am

**CONFERENCE 9424**

**Metrology, Inspection, and Process Control for Microlithography XXIX**

**SESSION 12**

**LOCATION: CONVENTION CENTER 220B  
THU 8:05 AM TO 10:05 AM**

**Hybrid Metrology and Process Control**

Session Chairs: **Masafumi Asano**, Toshiba Corp. (Japan); **Eric Solecky**, IBM Corp. (USA)

- 8:05 am: **Holistic approach using accuracy of diffraction-based integrated metrology to improve on-product performance, reduce cycle time, and cost at litho**, Kaustave Bhattacharyya, ASML Netherlands B.V. (Netherlands); Chih-Ming Ke, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) ..... [9424-83]
- 8:25 am: **Intra-field patterning control using high-speed and small-target optical metrology of CD and focus**, Hugo Cramer, Stefan Petra, Bastiaan Onne Fagginger Auer, Henk-Jan Smilde, Steven Welch, Baukje Wisse, Stefan Kruijswijk, Frank Staals, Christian Leewis, Paul Hinnen, Stuart Young, Mark Maslow, Michael Kubis, Arie den Boef, ASML Netherlands B.V. (Netherlands) ..... [9424-51]
- 8:45 am: **Comprehensive BEOL control using scatterometry and APC**, Padraig R. Timoney, Sudhir Baral, Laertis Economikos, Jamie Tsai, Alok Vaid, GLOBALFOUNDRIES Inc. (USA); Haibo Lu, Byungcheol Kang, Paul K. Isbester, Prasad Dasari, Naren Yellai, Nova Measuring Instruments Inc. (USA) ..... [9424-52]
- 9:05 am: **Hybrid metrology implementation: server approach**, Alok Vaid, Carmen Osorio, Givantha Iddawela, Jamie Tsai, Florence Nelson, GLOBALFOUNDRIES Inc. (USA); Eyal Grubner, Nova Measuring Instruments Ltd. (Israel); Byungcheol Kang, Paul K. Isbester, Matthew J. Sendelbach, Cornel Bozdog, Nova Measuring Instruments Inc. (USA) ..... [9424-53]
- 9:25 am: **Machine learning and predictive data analytics enabling metrology and process control in IC fabrication**, Narendra Rana, Yunlin Zhang, Todd C. Bailey, IBM Corp. (USA) ..... [9424-54]
- 9:45 am: **Optimizing hybrid metrology: rigorous implementation of Bayesian and parallel regression**, Mark-Alexander Henn, Richard M. Silver, John S. Villarrubia, Nien-Fan Zhang, Hui Zhou, Bryan M. Barnes, Bin Ming, Andrés E. Vladár, National Institute of Standards and Technology (USA) ..... [9424-55]
- Coffee Break ..... Thu 10:05 am to 10:35 am

**CONFERENCE 9425**

Advances in Patterning Materials and Processes XXXII

**SESSION 12**

**LOCATION: CONVENTION CENTER 220C  
THU 8:00 AM TO 10:00 AM**

**New Patterning Processes**

Session Chairs: **Plamen Tzviatkov**, FUJIFILM Electronic Materials U.S.A., Inc. (USA); **Scott W. Jessen**, Texas Instruments Inc. (USA)

8:00 am: **Dry development rinse (DDR) process and material for ArF/EUV extension technique toward 1Xnm hp and beyond**, Shuhei Shigaki, Nissan Chemical Industries, Ltd. (Japan) . . . . . [9425-39]

8:20 am: **Impact of dose optimization on NILS, CD, and CDU for helium-ion lithography on EUV resist**, Diederik J. Maas, Wouter F. W. Mulckhuysse, TNO (Netherlands); Paul F.A. Alkemade, Nima Kalhor, Technische Univ. Delft (Netherlands) . . . . . [9425-40]

8:40 am: **Sustainability and applicability of spacer-related patterning towards 7nm node**, Kenichi Oyama, Shohei Yamauchi, Sakurako Natori, Arisa Hara, Masatoshi Yamato, Noriaki Okabe, Tokyo Electron AT Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan) . . . . . [9425-41]

9:00 am: **Fabrication of micro lens array in Benzophenone doped PDMS by using 6 MeV pulsed electron beam**, Suresh W Gosavi, Madhushree G. Bute, Sanjay D. Dhole, Vasant N. Bhoraskar, Univ. of Pune (India) . . . . . [9425-42]

9:20 am: **Dry development rinse process for ultimate resolution improvement via pattern collapse mitigation**, Safak Sayan, Intel Corp. (USA); Danilo De Simone, Tao Sheng Zheng, Boon Teik Chan, IMEC (Belgium); Michael J. Leeson, Florian Gstrein, Intel Corp. (USA); Geert Vandenberghe, IMEC (Belgium); Yuhei Kuwahara, Kathleen Nafus, Tokyo Electron Kyushu Ltd. (Netherlands) . . . . . [9425-43]

9:40 am: **Block co-polymer approach for CD uniformity and placement error improvement in DSA hole grapho-epitaxy process**, Tasuku Matsumiya, Tsuyoshi Kurosawa, Masahito Yahagi, Hitoshi Yamano, Ken Miyagi, Takaya Maehashi, Issei Suzuki, Akiya Kawauae, Yoshitaka Komuro, Taku Hirayama, Katsumi Ohmori, Tokyo Ohka Kogyo Co., Ltd. (Japan) . . . . . [9425-44]

Coffee Break . . . . . Thu 10:00 am to 10:30 am

**CONFERENCE 9426**

Optical Microlithography XXVIII

**SESSION 9**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
THU 8:00 AM TO 10:10 AM**

**DFM (Design and Litho Optimization)**

**Joint Session with Conferences 9426 and 9427**

Session Chairs: **Jongwook Kye**, GLOBALFOUNDRIES Inc. (USA); **Andrew R. Neureuther**, Univ. of California, Berkeley (USA)

8:00 am: **Layout optimization for the upcoming 10nm and 7nm printability scenarios** (*Invited Paper*), Andrzej J. Strojwas, Carnegie Mellon Univ. (USA) and PDF Solutions, Inc. (USA) . . . . . [9426-35]

8:30 am: **Hot spots prediction after etching process based on defect rate**, Taiki Kimura, Yuki Watanabe, Toshiya Kotani, Toshiba Corp. (Japan) . . . . . [9426-36]

8:50 am: **Hybrid OPC flow with pattern search and replacement**, Piyush Verma, Shikha Somani, Yang Y. Ping, Piyush Pathak, Rani S. Ghaida, Carl P. Babcock, Fadi Batarseh, Jingyu Wang, Sriram Madhavan, Sarah McGowan, GLOBALFOUNDRIES Inc. (USA) . . . . . [9426-37]

9:10 am: **Quantitative evaluation of manufacturability and performance for ILT produced mask shapes using a single-objective function**, Heon J. Choi, Wei-Long Wang, Chidam G. Kallingal, GLOBALFOUNDRIES Inc. (USA) . . . . . [9427-18]

9:30 am: **Akaike information criterion to select well-fit resist models**, Andrew Burbine, David Fryer, John L. Sturtevant, Mentor Graphics Corp. (USA) . . . . . [9427-19]

9:50 am: **Fast source optimization by clustering algorithm based on lithography properties**, Masashi Tawada, Waseda Univ. (Japan); Takaki Hashimoto, Keishi Sakanushi, Shigeki Nojima, Toshiya Kotani, Toshiba Corp. (Japan); Masao Yanagisawa, Nozomu Togawa, Waseda Univ. (Japan) . . . . . [9427-20]

**LOCATION: SAN JOSE MARRIOTT, SALON III  
THU 10:10 AM TO 10:15 AM**

**2015 Best Student Paper Award**

Session Chairs: **Kafai Lai**, IBM Corp. (USA); **Will Conley**, Cymer LLC (USA)

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Coffee Break . . . . . Thu 10:15 am to 10:45 am

**CONFERENCE 9427**

Design-Process-Technology Co-optimization for Manufacturability IX

**SESSION 7**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
THU 8:00 AM TO 10:10 AM**

**DFM (Design and Litho Optimization)**

**Joint Session with Conferences 9426 and 9427**

Session Chairs: **Jongwook Kye**, GLOBALFOUNDRIES Inc. (USA); **Andrew R. Neureuther**, Univ. of California, Berkeley (USA)

8:00 am: **Layout optimization for the upcoming 10nm and 7nm printability scenarios** (*Invited Paper*), Andrzej J. Strojwas, Carnegie Mellon Univ. (USA) and PDF Solutions, Inc. (USA) . . . . . [9426-35]

8:30 am: **Hot spots prediction after etching process based on defect rate**, Taiki Kimura, Yuki Watanabe, Toshiya Kotani, Toshiba Corp. (Japan) . . . . . [9426-36]

8:50 am: **Hybrid OPC flow with pattern search and replacement**, Piyush Verma, Shikha Somani, Yang Y. Ping, Piyush Pathak, Rani S. Ghaida, Carl P. Babcock, Fadi Batarseh, Jingyu Wang, Sriram Madhavan, Sarah McGowan, GLOBALFOUNDRIES Inc. (USA) . . . . . [9426-37]

9:10 am: **Quantitative evaluation of manufacturability and performance for ILT produced mask shapes using a single-objective function**, Heon J. Choi, Wei-Long Wang, Chidam G. Kallingal, GLOBALFOUNDRIES Inc. (USA) . . . . . [9427-18]

9:30 am: **Akaike information criterion to select well-fit resist models**, Andrew Burbine, David Fryer, John L. Sturtevant, Mentor Graphics Corp. (USA) . . . . . [9427-19]

9:50 am: **Fast source optimization by clustering algorithm based on lithography properties**, Masashi Tawada, Waseda Univ. (Japan); Takaki Hashimoto, Keishi Sakanushi, Shigeki Nojima, Toshiya Kotani, Toshiba Corp. (Japan); Masao Yanagisawa, Nozomu Togawa, Waseda Univ. (Japan) . . . . . [9427-20]

Coffee Break . . . . . Thu 10:10 am to 10:40 am

**CONFERENCE 9422**

**Extreme Ultraviolet (EUV) Lithography VI**

**SESSION 13**

**LOCATION: CONVENTION CENTER 210B  
THU 10:40 AM TO 12:00 PM**

**EUV Manufacturing**

Session Chairs: **Sang Hun Lee**, Intel Corp. (USA); **Eric Hendrickx**, IMEC (Belgium)

10:40 am: **The Patterning Center of Excellence (CoE): an evolving lithographic enablement model**, M. Warren Montgomery, Jun Sung Chun, SUNY College of Nanoscale Science and Engineering (USA); Michael Liehr, Univ. at Albany (USA); Michael D. Tittnich, Albany NanoTech (USA) . . . . . [9422-56]

11:00 am: **EUV mask cleans comparison of frontside and dual-sided concurrent cleaning**, Lin L. Cheong, Daniel Corliss, IBM Corp. (USA); Dusty Leonard, John M. Boyle, Applied Materials, Inc. (USA); Christopher F. Robinson, Louis M. Kindt, IBM Corp. (USA) . . . [9422-57]

11:20 am: **No more of Moore's Law: the high cost for dimensional scaling**, Arindam Mallik, Julien Ryckaert, Abdelkarim Mercha, Diederik Verkest, Kurt G. Ronse, Aaron Thean, IMEC (Belgium) . . . . . [9422-58]

11:40 am: **Multi-stack extreme-ultraviolet pellicle with out-of-band reduction**, Sung-Gyu Lee, Guk-Jin Kim, In-Seon Kim, Jinho Ahn, Jingu Park, Hye-Keun Oh, Hanyang Univ. (Korea, Republic of) [9422-59]

Lunch Break . . . . . Thu 12:00 pm to 1:30 pm

**CONFERENCE 9423**

**Alternative Lithographic Technologies VII**

**SESSION 12**

**LOCATION: CONVENTION CENTER 220A  
THU 10:30 AM TO 12:20 PM**

**Electron-Beam Applications**

Session Chairs: **Shy-Jay Lin**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Ines A. Stolberg**, Vistec Electron Beam GmbH (Germany)

10:30 am: **High-speed e-beam defect inspection: enabling next-generation patterned defect inspection technology for high-volume manufacturing** (*Invited Paper*), Matt Malloy, SEMATECH Inc. (USA); Brad Thiel, SUNY College of Nanoscale Science and Engineering (USA); Benjamin D. Bunday, Michael J. Lercel, SEMATECH Inc. (USA); Kathy Quoi, Maseeh Mukhtar, SUNY College of Nanoscale Science and Engineering (USA); Stefan Wurm, Kevin D. Cummings, SEMATECH Inc. (USA) . . . . . [9423-44]

11:00 am: **Fabrication of NIL templates and diffractive optical elements using the new Vistec SB4050 VSB e-beam writer**, Mathias Irmscher, Jörg Butschke, Stephan Martens, Holger Sailer, Institut für Mikroelektronik Stuttgart (Germany); Bernd Schnabel, Vistec Electron Beam GmbH (Germany); Corinna Köpernik, Institut für Mikroelektronik Stuttgart (Germany) . . . . . [9423-45]

11:20 am: **Integration of e-beam direct write in BEOL processes of 28nm SRAM technology using mix and match**, Christoph K. Hohle, Fraunhofer-Institut für Photonische Mikrosysteme (Germany); Kang-Hoon Choi, Manuela S. Gutsch, Norbert Hanisch, Fraunhofer-Ctr. Nanoelektronische Technologien (Germany); Robert Seidel, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany); Katja Steidel, Xaver Thrun, Fraunhofer-Ctr. Nanoelektronische Technologien (Germany); Thomas Werner, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany) . . . . . [9423-46]

11:40 am: **Ready for multi-beam exposure at 5kV on MAPPER tool: Lithographic and process integration performances of advanced resists/stack**, Ndeye A. Thiam, Patricia Pimenta-Barros, CEA-LETI (France); Marie-Laure Cordini, STMicroelectronics (France); Isabelle Servin, Marie-Line Pourteau, Armel-Petit Mebiene, Julien Jussot, Jonathan Pradelles, Philippe Essomba, Ludovic Lattard, CEA-LETI (France); Pieter Brandt, Marco Wieland, MAPPER Lithography (Netherlands) . . . . . [9423-47]

12:00 pm: **A contour-based kernel modeling and verification approach to electron-beam lithography**, Jan-Wen You, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9423-48]

Lunch Break . . . . . Thu 12:20 pm to 1:45 pm

**CONFERENCE 9424**

**Metrology, Inspection, and Process Control for Microlithography XXIX**

**LOCATION: CONVENTION CENTER 220B  
THU 10:35 AM TO 10:45 AM**

**Karel Urbanek Best Student Paper Award**

**SESSION 13**

**LOCATION: CONVENTION CENTER 220B  
THU 10:45 AM TO 12:25 PM**

**Overlay Optimization**

**Joint Session with Conferences 9424 and 9426**

Session Chairs: **Pary Baluswamy**, Micron Technology, Inc. (USA); **John C. Robinson**, KLA-Tencor Corp. (USA)

10:45 am: **Overlay improvement methods with DBO and IM**, YoungSun Nam, Jang-Sun Kim, Ju Hee Shin, Young-Sin Choi, Sang Ho Yun, Young-Hoon Kim, Si Woo Shin, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Jeong-Heung Kong, Samsung Electro-Mechanics (Korea, Republic of); Young Seog Kang, Hunhwan Ha, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9426-38]

11:05 am: **Intra-field overlay correction for illumination based distortion**, Michael B. Pike, Timothy A. Brunner, Timothy J. Wiltshire, Bradley Morgenfeld, Nick Jing, IBM Corp. (USA) . . . . . [9426-39]

11:25 am: **Wafer to wafer overlay control algorithm implementation based on statistics**, ByeongSoo Lee, Young Seog Kang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Jeong-Heung Kong, Samsung Electro-Mechanics (Korea, Republic of); Hyunwoo Hwang, Myeong Gyu Song, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9426-40]

11:45 am: **Intra-field on-product overlay improvement by application of RegC® and TWINSCANTM corrections**, Ofir Sharoni, Carl Zeiss SMS Ltd. (Israel) . . . . . [9424-56]

12:05 pm: **Pattern recognition and data mining techniques to identify factors in wafer processing and control determining overlay error**, Auguste Lam, STMicroelectronics (France); Alexander Ypma, ASML Netherlands B.V. (Netherlands); Maxime Gatefait, STMicroelectronics (France); David Deckers, Arne Koopman, Richard J. F. van Haren, Jan Beltman, ASML Netherlands B.V. (Netherlands) . . . . . [9424-57]

Lunch Break . . . . . Thu 12:25 pm to 1:55 pm

**CONFERENCE 9425**

Advances in Patterning Materials and Processes XXXII

**SESSION 13**

**LOCATION: CONVENTION CENTER 220C  
THU 10:30 AM TO 12:30 PM**

**Materials and Process Engineering**

Session Chairs: **Douglas Guerrero**, Brewer Science, Inc. (USA); **Luisa D. Bozano**, IBM Research - Almaden (USA)

10:30 am: **Progress in spin-on metal oxide hardmask materials for filling applications**, Huirong Yao, Alberto Dioses, Salem Mullen, Elizabeth Wolfer, Douglas S. McKenzie, Dalil Rahman, JoonYeon Cho, Munirathna Padmanaban, AZ Electronic Materials USA Corp. (USA) ..... [9425-45]

10:50 am: **Aqueous-based thick photoresist removal for bumping applications**, John C. Moore, Jared M. Pettit, Alex J. Brewer, Alman Law, DAETEC, LLC (USA) ..... [9425-46]

11:10 am: **Coater/developer process integration of metal-oxide based photoresist**, Benjamin L. Clark, Michael K. Kocsis, Michael Greer, Andrew Grenville, Inpria (USA); Takashi Saito, Lior Huli, Richard A. Farrell, David Hetzer, Hiroie Matsumoto, Andrew Metz, Shan Hu, Richard Gaylord, Jeffrey T. Smith, TEL Technology Ctr., America, LLC (USA); Shinchiro Kawakami, Masashi Enomoto, Tokyo Electron Kyushu Ltd. (Japan) ..... [9425-47]

11:30 am: **BARC/SOC planarization beyond 10nm**, Po Tsang Chen, Lian Cong Liu, Jimmy Wu, Kuan Ying Lai, Lucas Chao, Chen Jui Chen, Chia Hsun Tseng, United Microelectronics Corp. (Taiwan) . [9425-48]

11:50 am: **Enablement of resist core self-aligned multiple patterning**, Jeffrey T. Smith, Nihar Mohanty, David O'Meara, Vinayak Ragosti, Dave Hetzer, Anton deVilliers, TEL Technology Ctr., America, LLC (USA) ..... [9425-49]

12:10 pm: **Directly patternable dielectric based on fluorinated polyimide for use in chip packaging**, Andrew R. Dick, William K. Bell, Brendan L. Luke, The Univ. of Texas at Austin (USA); Brennan K. Mueller, Georgia Institute of Technology (USA); Brandon M. Rawlings, Intel Corp. (USA); C. Grant Willson, The Univ. of Texas at Austin (USA) ..... [9425-50]

Conference End.

**CONFERENCE 9426**

Optical Microlithography XXVIII

**SESSION 10**

**LOCATION: CONVENTION CENTER 220B  
THU 10:45 AM TO 12:25 PM**

**Overlay Optimization**

**Joint Session with Conferences 9424 and 9426**

Session Chairs: **Pary Baluswamy**, Micron Technology, Inc. (USA); **John C. Robinson**, KLA-Tencor Corp. (USA)

10:45 am: **Overlay improvement methods with DBO and IM**, YoungSun Nam, Jang-Sun Kim, Ju Hee Shin, Young-Sin Choi, Sang Ho Yun, Young-Hoon Kim, Si Woo Shin, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Jeong-Heung Kong, Samsung Electro-Mechanics (Korea, Republic of); Young Seog Kang, Hunhwan Ha, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) ..... [9426-38]

11:05 am: **Intra-field overlay correction for illumination based distortion**, Michael B. Pike, Timothy A. Brunner, Timothy J. Wiltshire, Bradley Morgenfeld, Nick Jing, IBM Corp. (USA) ..... [9426-39]

11:25 am: **Wafer to wafer overlay control algorithm implementation based on statistics**, ByeongSoo Lee, Young Seog Kang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Jeong-Heung Kong, Samsung Electro-Mechanics (Korea, Republic of); Hyunwoo Hwang, Myeong Gyu Song, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) ..... [9426-40]

11:45 am: **Intra-field on-product overlay improvement by application of RegC® and TWINSCANTM corrections**, Ofir Sharoni, Carl Zeiss SMS Ltd. (Israel) ..... [9424-56]

12:05 pm: **Pattern recognition and data mining techniques to identify factors in wafer processing and control determining overlay error**, Auguste Lam, STMicroelectronics (France); Alexander Ypma, ASML Netherlands B.V. (Netherlands); Maxime Gatafait, STMicroelectronics (France); David Deckers, Arne Koopman, Richard J. F. van Haren, Jan Beltman, ASML Netherlands B.V. (Netherlands) ..... [9424-57]

Lunch Break ..... Thu 12:25 pm to 1:45 pm

**CONFERENCE 9427**

Design-Process-Technology Co-optimization for Manufacturability IX

**SESSION 8**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
THU 10:40 AM TO 11:10 AM**

**Invited Session III**

Session Chairs: **Chi-Min Yuan**, Freescale Semiconductor, Inc. (USA); **Ru-Gun Liu**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

10:40 am: **Deploying DFM in an age of design restrictions: A foundry perspective (Invited Paper)**, Cyrus E. Tabery, Intel Corp. (USA) ..... [9427-21]

**SESSION 9**

**LOCATION: SAN JOSE MARRIOTT, SALON III  
THU 11:10 AM TO 12:10 PM**

**Circuit Variability**

Session Chairs: **Chi-Min Yuan**, Freescale Semiconductor, Inc. (USA); **Ru-Gun Liu**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

11:10 am: **Statistical modeling of intra-cell and inter-die SRAM circuit variability**, Qi Cheng, Yijian Chen, Peking Univ. (China) ..... [9427-22]

11:30 am: **Variability-aware compact modeling and statistical circuit validation on SRAM test array**, Ying Qiao, Costas J. Spanos, Univ. of California, Berkeley (USA) ..... [9427-23]

11:50 am: **Layout optimization and trade-off between 193i and EUV-based patterning for SRAM cells to improve performance and process variability at 7nm technology node**, Sushil S. Sakhare, Darko Trivkovic, Julien Ryckaert, Abdelkarim Mercha, Diederik Verkest, Aaron Thean, IMEC (Belgium); Mircea V. Dusa, ASML Leuven (Belgium) ..... [9427-24]

Lunch Break ..... Thu 12:10 pm to 1:45 pm

CONFERENCE 9422

Extreme Ultraviolet (EUV) Lithography VI

SESSION 14

LOCATION: CONVENTION CENTER 210B
THU 1:30 PM TO 4:40 PM

Exposure Tools

Session Chairs: Seong-Sue Kim, SAMSUNG Electronics Co. (Korea, Republic of); Daniel Corliss, IBM Corp. (USA)

1:30 pm: Performance overview and outlook of EUV lithography systems, Alberto Pirati, Rudy Peeters, Daniel A. Smith, Sjoerd Lok, Arthur W. E. Minnaert, Martijn van Noordenburg, Jörg Mallmann, ASML Netherlands B.V. (Netherlands); Noreen Harned, ASML (USA); Judon Stoeldraijer, Christian Wagner, ASML Netherlands B.V. (Netherlands); David C. Brandt, ASML (USA); Nigel R. Farrar, ASML (USA); Daniel J. Brown, ASML (USA); Herman Boom, Hans Meiling, Ron Kool, ASML Netherlands B.V. (Netherlands) [9422-60]

1:50 pm: Overlay and edge placement control strategies for the 7nm node using EUV and ArF lithography, Jan Mulkens, Daan Slotboom, Henry Megens, Michael Hanna, Richard J. F. van Haren, ASML Netherlands B.V. (Netherlands) [9422-61]

2:10 pm: Development of a high-numerical aperture EUV lithography tool: the SEMATECH Berkeley MET5 Platform, Patrick P. Naulleau, Arnaud P. Allezy, Christopher Neil Anderson, Carl W. Cork, Paul E. Denham, Michael R. Dickinson, Geoff Gains, Eric M. Gullikson, Ryan H. Miyakawa, Senajith B. Rekawa, Will Thur, Daniel J. Zehm, Lawrence Berkeley National Lab. (USA); Regina Soufli, Lawrence Livermore National Lab. (USA); Matt Bjork, Mark Bremer, Luc Girard, Robert Kestner, John Kincade, Louis A. Marchetti, Zygo Corporation (USA); Russell Hudyma, Hyperion Development LLC (USA); Dominic Ashworth, Kevin D. Cummings, SEMATECH Inc. (USA) [9422-62]

2:30 pm: Evaluation of EUV resist performance using interference lithography, Elizabeth Buitrago, Paul Scherrer Institut (Switzerland); Oktay Yildirim, ASML Netherlands B.V. (Netherlands); Michaela Vockenhuber, Paul Scherrer Institut (Switzerland); Coen Verspagnet, Naoko Tsugama, Rik Hoefnagels, Gijsbert Respens, ASML Netherlands B.V. (Netherlands); Yasin Ekinci, Paul Scherrer Institut (Switzerland) [9422-63]

2:50 pm: Method of accurately characterizing out-of-band light in an EUVL scanner, Shinn-Sheng Yu, Yen-Cheng Lu, Chih-Tsung Shih, Shang-Chieh Chien, Shu-Hao Chang, Hsiang-Yu Chou, Jui-Ching Wu, Tao-Ming Huang, Jack J. H. Chen, Anthony Yen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) [9422-64]

Coffee Break Thu 3:10 pm to 3:40 pm

3:40 pm: EUV mask particle adders during scanner exposure, Yoonsuk Hyun, SK Hynix, Inc. (Korea, Republic of) [9422-65]

4:00 pm: Debris monitoring and minimization system for EUV sources, Arjen de Jong, Rene Jilisen, Mark A. van de Kerkhof, Arnold van Putten, ASML Netherlands B.V. (Netherlands) [9422-66]

4:20 pm: Feasibility study on the impact of higher power EUV irradiation on key lithographic elements, Soichi Inoue, Shinji Mikami, Eishi Shiobara, Isamu Takagi, Hiroyuki Tanaka, EUVL Infrastructure Development Ctr., Inc. (Japan) [9422-67]

Conference End.

CONFERENCE 9423

Alternative Lithographic Technologies VII

SESSION 13

LOCATION: CONVENTION CENTER 210C
THU 1:45 PM TO 3:25 PM

DSA Design for Manufacturability

Joint Session with Conferences 9423, 9426, and 9427

Session Chairs: Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA); Sachiko Kobayashi, Toshiba Corp. (Japan); Vivek K. Singh, Intel Corp. (USA)

1:45 pm: Verification of directed self-assembly (DSA) guide patterns through machine learning, Seong-Bo Shim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) and KAIST (Korea, Republic of); Siboo Cai, Samsung Electronics (Korea, Republic of); Seung-Hune Yang, Jungdal Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Youngsoo Shin, KAIST (Korea, Republic of) [9423-49]

2:05 pm: Experimental study of sub-DSA resolution assist features (SDRAF), He Yi, Stanford Univ. (USA); Joost P. Bekaert, Roel Gronheid, Geert Vandenberghe, IMEC (Belgium); Kathleen Nafus, Tokyo Electron America, Inc. (USA); H. S. P. Wong, Stanford Univ. (USA) [9423-50]

2:25 pm: Incorporating DSA in multipatterning semiconductor manufacturing technologies, Juan Andres Torres, Mentor Graphics Corp. (USA); Yasmine A. Badr, Univ. of California, Los Angeles (USA); Yuansheng Ma, Joydeep Mitra, Mentor Graphics Corp. (USA); Puneet Gupta, Univ. of California, Los Angeles (USA) [9427-25]

2:45 pm: DSA-aware assist features, Azat M. Latypov, Tamer H Coskun, GLOBALFOUNDRIES Inc. (USA) [9423-51]

3:05 pm: Computational approaches to DSA-assisted lithography applications, Tim Fühner, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Ulrich Welling, Georg-August-Univ. Göttingen (Germany); Przemyslaw Michalak, Fraunhofer IISB (Germany); Juan Carlos Orozco Rey, Weihua Li, Marcus Müller, Georg-August-Univ. Göttingen (Germany); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) [9426-41]

Coffee Break Thu 3:25 pm to 4:00 pm

CONFERENCE 9424

Metrology, Inspection, and Process Control for Microlithography XXIX

SESSION 14

LOCATION: CONVENTION CENTER 220B
THU 1:55 PM TO 3:35 PM

X-ray and Novel Optical Methods

Session Chairs: Richard M. Silver, National Institute of Standards and Technology (USA); Christopher J. Raymond, Nanometrics Inc. (USA)

1:55 pm: Hybridization of XRF XPS and scatterometry for in-line FinFET process control beyond 10nm, Benoit L'Herron, STMicroelectronics (USA); Robin Hsin-Kuo Chao, IBM Corp. (USA); Kwanghoon Kim, Samsung (France); Bartlet Deprospro, Muthumanickam Sankarapandian, IBM Corp. (USA); Wei Ti Lee, ReVera, Inc. (USA) [9424-58]

2:15 pm: Grazing-incidence small angle x-ray scattering studies of nanoscale polymer gratings, Manolis Doxastakis, Hyo Seon Suh, Argonne National Lab. (USA) and The Univ. of Chicago (USA); Xuanxuan Chen, The Univ. of Chicago (USA); Paulina A. Rincon Delgado, The Univ. of Chicago (USA) and IMEC (Belgium); Lingshu Wan, The Univ. of Chicago (USA); Lance D. Williamson, The Univ. of Chicago (USA) and IMEC (Belgium); Zhang Jiang, Joseph Strzalka, Jin Wang, Argonne National Lab. (USA); Wei Chen, Nicola Ferrier, Abelardo Ramirez-Hernandez, Argonne National Lab. (USA) and The Univ. of Chicago (USA); Juan J. de Pablo, The Univ. of Chicago (USA) and Argonne National Lab. (USA); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) and Argonne National Lab. (USA) [9424-59]

2:35 pm: Evaluation of laboratory x-ray sources for high-throughput CD-SAXS, Daniel F. Sunday, Donald Windover, Wen-li Wu, R. Joseph Kline, National Institute of Standards and Technology (USA) [9424-60]

2:55 pm: Signal response metrology (SRM): a new approach for lithography metrology, Stilian Pandev, KLA-Tencor Corp. (USA); Fang Fang, Young Ki Kim, Jamie Tsai, Alok Vaid, Lokesh Subramany, Chen Li, GLOBALFOUNDRIES Inc. (USA); Dmitry Sanko, Vidya Ramanathan, Ren Zhou, Kartik Venkataraman, KLA-Tencor Corp. (USA); Ronny Haupt, KLA-Tencor Germany (Germany); Lester Wang, GLOBALFOUNDRIES (USA) [9424-61]

3:15 pm: A parametric study of TSOM method, Ravikiran Attota, HyeongGon Kang, National Institute of Standards and Technology (USA) [9424-62]

Coffee Break Thu 3:35 pm to 4:05 pm

**CONFERENCE 9426**  
Optical Microlithography XXVIII

**SESSION 11**

**LOCATION: CONVENTION CENTER 210C**  
**THU 1:45 PM TO 3:25 PM**

**DSA Design for Manufacturability**

**Joint Session with Conferences 9423, 9426, and 9427**

Session Chairs: **Michael A. Guillorn**, IBM Thomas J. Watson Research Ctr. (USA); **Sachiko Kobayashi**, Toshiba Corp. (Japan); **Vivek K. Singh**, Intel Corp. (USA)

1:45 pm: **Verification of directed self-assembly (DSA) guide patterns through machine learning**, Seong-Bo Shim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) and KAIST (Korea, Republic of); Sib0 Cai, Samsung Electronics (Korea, Republic of); Seung-Hune Yang, Jungdal Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Youngsoo Shin, KAIST (Korea, Republic of) . . . . . [9423-49]

2:05 pm: **Experimental study of sub-DSA resolution assist features (SDRAF)**, He Yi, Stanford Univ. (USA); Joost P. Bekaert, Roel Gronheid, Geert Vandenberghe, IMEC (Belgium); Kathleen Nafus, Tokyo Electron America, Inc. (USA); H. S. P. Wong, Stanford Univ. (USA) . . . [9423-50]

2:25 pm: **Incorporating DSA in multipatterning semiconductor manufacturing technologies**, Juan Andres Torres, Mentor Graphics Corp. (USA); Yasmine A. Badr, Univ. of California, Los Angeles (USA); Yuansheng Ma, Joydeep Mitra, Mentor Graphics Corp. (USA); Puneet Gupta, Univ. of California, Los Angeles (USA) . . . . . [9427-25]

2:45 pm: **DSA-aware assist features**, Azat M. Latypov, Tamer H Coskun, GLOBALFOUNDRIES Inc. (USA). . . . . [9423-51]

3:05 pm: **Computational approaches to DSA-assisted lithography applications**, Tim Fühner, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Ulrich Welling, Georg-August-Univ. Göttingen (Germany); Przemyslaw Michalak, Fraunhofer IISB (Germany); Juan Carlos Orozco Rey, Weihua Li, Marcus Müller, Georg-August-Univ. Göttingen (Germany); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) . . . . . [9426-41]

Coffee Break . . . . . Thu 3:25 pm to 3:55 pm

**CONFERENCE 9427**  
Design-Process-Technology  
Co-optimization for Manufacturability IX

**SESSION 10**

**LOCATION: CONVENTION CENTER 210C**  
**THU 1:45 PM TO 3:25 PM**

**DSA Design for Manufacturability**

**Joint Session with Conferences 9423, 9426, and 9427**

Session Chairs: **Michael A. Guillorn**, IBM Thomas J. Watson Research Ctr. (USA); **Sachiko Kobayashi**, Toshiba Corp. (Japan); **Vivek K. Singh**, Intel Corp. (USA)

1:45 pm: **Verification of directed self-assembly (DSA) guide patterns through machine learning**, Seong-Bo Shim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) and KAIST (Korea, Republic of); Sib0 Cai, Samsung Electronics (Korea, Republic of); Seung-Hune Yang, Jungdal Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Youngsoo Shin, KAIST (Korea, Republic of) . . . . . [9423-49]

2:05 pm: **Experimental study of sub-DSA resolution assist features (SDRAF)**, He Yi, Stanford Univ. (USA); Joost P. Bekaert, Roel Gronheid, Geert Vandenberghe, IMEC (Belgium); Kathleen Nafus, Tokyo Electron America, Inc. (USA); H. S. P. Wong, Stanford Univ. (USA) . . . [9423-50]

2:25 pm: **Incorporating DSA in multipatterning semiconductor manufacturing technologies**, Juan Andres Torres, Mentor Graphics Corp. (USA); Yasmine A. Badr, Univ. of California, Los Angeles (USA); Yuansheng Ma, Joydeep Mitra, Mentor Graphics Corp. (USA); Puneet Gupta, Univ. of California, Los Angeles (USA) . . . . . [9427-25]

2:45 pm: **DSA-aware assist features**, Azat M. Latypov, Tamer H Coskun, GLOBALFOUNDRIES Inc. (USA). . . . . [9423-51]

3:05 pm: **Computational approaches to DSA-assisted lithography applications**, Tim Fühner, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Ulrich Welling, Georg-August-Univ. Göttingen (Germany); Przemyslaw Michalak, Fraunhofer IISB (Germany); Juan Carlos Orozco Rey, Weihua Li, Marcus Müller, Georg-August-Univ. Göttingen (Germany); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) . . . . . [9426-41]

Coffee Break . . . . . Thu 3:25 pm to 4:00 pm

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## CONFERENCE 9423 Alternative Lithographic Technologies VII

### SESSION 14

LOCATION: CONVENTION CENTER 220A  
THU 4:00 PM TO 5:40 PM

#### DSA Modeling

Session Chairs: **Frank M. Schellenberg**, Consultant (USA);  
**Elizabeth A. Dobisz**, HGST (USA)

4:00 pm: **Directed self-assembly of blends of block copolymers from different architectures in confinement: trends in morphology and defectivity**, Bongkeun Kim, Univ. of California, Santa Barbara (USA); Peter Trefonas, The Dow Chemical Co. (USA); Kris T. Delaney, The Materials Research Lab. (USA); Glenn H Fredrickson, The Materials Research Lab. (USA) and Univ. of California, Santa Barbara (USA) . . . . . [9423-52]

4:20 pm: **Advantages and limitations of density functional theory in lithographic design**, Jimmy Liu, Nabil Laachi, Kris T. Delaney, Glenn H. Fredrickson, Univ. of California, Santa Barbara (USA) . . . [9423-53]

4:40 pm: **Effect of chemoepitaxial guiding underlayer design on the pattern quality and shape of aligned lamellae for fabrication of line-space patterns**, Benjamin D. Nation, Andrew J. Peters, Richard A. Lawson, Peter J. Ludovice, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9423-54]

5:00 pm: **The effects of geometry and chemistry of nanopatterned substrates on the directed self-assembly of block-copolymer blends**, Grant P. Garner, The Univ. of Chicago (USA); Paulina A. Rincon Delgadillo, IMEC (Belgium); Lance D. Williamson, The Univ. of Chicago (USA); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, Juan J. de Pablo, The Univ. of Chicago (USA) . . . . . [9423-55]

5:20 pm: **Effect of  $\gamma$ N and underlayer composition on self-assembly of thin films of block copolymers with energy asymmetric block**, Richard A. Lawson, Andrew J. Peters, Benjamin D. Nation, Peter J. Ludovice, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9423-56]

Conference End.

## CONFERENCE 9424 Metrology, Inspection, and Process Control for Microlithography XXIX

### SESSION 15

LOCATION: CONVENTION CENTER 220B  
THU 4:05 PM TO 4:45 PM

#### Late Breaking News

Session Chairs: **Jason P. Cain**, Advanced Micro Devices, Inc. (USA); **Chih-Ming Ke**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

4:05 pm: **The development and advantages of helium ion microscopy for the study of block copolymer nanopatterns**, Alan P. Bell, Trinity College Dublin (Ireland); Ramsankar Sentharamaikannan, Tandra Ghoshal, Atul B. Chaudhari, Michael A. Morris, Univ. College Cork (Ireland) . . . . . [9424-63]

4:25 pm: **Potential application of tip-enhanced Raman spectroscopy (TERS) for metrology applications in semiconductor manufacturing**, P. Y. Hung, SEMATECH Inc. (USA); Thomas O'Loughlin, Texas A&M Univ. (USA); Martin Samayoa, SEMATECH Inc. (USA); Sarbajit Banerjee, Texas A&M Univ. (USA); Erin Wood, Angela R. Hight-Walker, National Institute of Standards and Technology (USA) . . . . . [9424-64]

Conference End.



**CONFERENCE 9426**  
Optical Microlithography XXVIII

**SESSION 12**

**LOCATION: CONVENTION CENTER 210C**  
**THU 3:55 PM TO 5:35 PM**

**Toolings**

Session Chairs: **Soichi Owa**, Nikon Corp. (Japan); **Daniel Sarlette**, Infineon Technologies Dresden (Germany)

3:55 pm: **Immersion and dry scanner extensions for sub-10nm production nodes**, Stefan Weichselbaum, ASML Netherlands B.V. (Netherlands) . . . . . [9426-46]

4:15 pm: **Latest performance of ArF immersion scanner NSR-S630D for high-volume manufacturing for 7nm node**, Takayuki Funatsu, Yusaku Uehara, Yujiro Hikida, Akira Hayakawa, Satoshi Ishiyama, Hiroataka Kono, Katsushi Nakano, Yosuke Shirata, Yuichi Shibazaki, Nikon Corp. (Japan) . . . . . [9426-42]

4:35 pm: **Wavelength metrology and control improvements to enable light source extensions to 10nm**, Russell Burdt, Thomas P. Duffey, Rahul Ahlawat, John T. Melchior, Joshua J. Thomes, David Dunlap, Ronnie P. Flores, Thomas Bibby, Kevin O'Brien, Will Conley, Mary Haviland, Daniel J. Brown, Cymer LLC (USA) . . . . . [9426-43]

4:55 pm: **Total lithography system based on a new application software platform enabling smart scanner management**, Hiroataka Kono, Kazuo Masaki, Tomoyuki Matsuyama, Shinji Wakamoto, Seemoon Park, Taro Sugihara, Yuichi Shibazaki, Nikon Corp. (Japan) . . . . . [9426-44]

5:15 pm: **Green solution: 120W ArF immersion light source supporting the next-generation multiple-patterning lithography**, Takahito Kumazaki, Takeshi Ohta, Keisuke Ishida, Hiroaki Tsushima, Akihiko Kurosu, Kouji Kakizaki, Takashi Matsunaga, Hakaru Mizoguchi, Gigaphoton Inc. (Japan) . . . . . [9426-45]

**LOCATION: CONVENTION CENTER 210C**  
**THU 5:35 PM TO 5:40 PM**

**Concluding Remarks**

Session Chairs: **Kafai Lai**, IBM Corp. (USA); **Andreas Erdmann**, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany)

Conference End.

**CONFERENCE 9427**

Design-Process-Technology  
Co-optimization for Manufacturability IX

**LOCATION: SAN JOSE MARRIOTT, SALON III**  
**THU 4:00 PM TO 4:10 PM**

**Luigi Franco Cerrina Memorial**  
**Best Student Paper Award**

Session Chair: **John L. Sturtevant**, Mentor Graphics Corp. (USA)

**The Franco Cerrina Memorial Best Student Paper Award**, which will be inaugurated in 2015, recognizes the best technical contribution by students to the Design-Process Technology Co-Optimization Conference, celebrating the legacy of one of the most prominent research pioneer, scholar, entrepreneur and mentor in the fields of semiconductor processing and nano-scale lithography.

Professor Cerrina's technical vision continues to inform virtually every research area in advanced lithography, both through his scientific achievements and today through the hundreds of students, colleagues and collaborators who had the fortune of studying and working with him, learning by his example how to trace a path from science to technological innovation.

The award wants to be a tangible sign and an encouragement to a new generation of researcher to follow suit with curiosity, dedication and a generous sense of community.

**SESSION 11**

**LOCATION: SAN JOSE MARRIOTT, SALON III**  
**THU 4:10 PM TO 5:30 PM**

**Layout and Optimization and Verification II**

Session Chairs: **Luigi Capodieci**, GLOBALFOUNDRIES Inc. (USA); **Chul-Hong Park**, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); **David Z. Pan**, The Univ. of Texas at Austin (USA)

4:10 pm: **Design layout analysis and DFM optimization using topological patterns**, Ji Xu, Karthik N. Krishnamoorthya, Edward Teoh, Vito Dai, Luigi Capodieci, GLOBALFOUNDRIES Inc. (USA); Jason Sweis, Ya-Chieh Lai, Cadence Design Systems, Inc. (USA) . . . . . [9427-26]

4:30 pm: **Automation for pattern library creation and in-design optimization**, Rock Deng, Sid Hone, JinYan Wang, Semiconductor Manufacturing International Corp. (China); Yifan Zhang, Cadence Design Systems, Inc. (China); Jason Sweis, Ya-Chieh Lai, Cadence Design Systems, Inc. (USA); Hua Ding, Cadence Design Systems, Inc. (China); Jason Huang, Cadence Design Systems, Inc. (Taiwan); Elaine Zou, Semiconductor Manufacturing International Corp. (China) . . [9427-27]

4:50 pm: **A new lithography hotspot detection framework based on AdaBoost classifier and simplified feature extraction**, Tetsuaki Matsunawa, Toshiba Corp. (Japan); Jih-Rong Gao, Bei Yu, David Z. Pan, The Univ. of Texas at Austin (USA) . . . . . [9427-12]

5:10 pm: **A methodology to optimize design pattern context size for higher sensitivity to hotspot detection using pattern association tree (PAT)**, Shikha Somani, Piyush Verma, Piyush Pathak, Sriram Madhavan, Luigi Capodieci, GLOBALFOUNDRIES Inc. (USA) . . . . . [9427-29]

Conference End.

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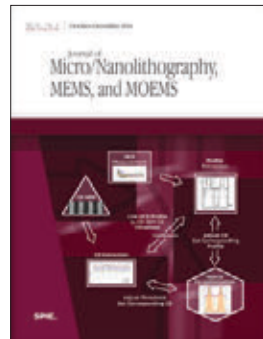
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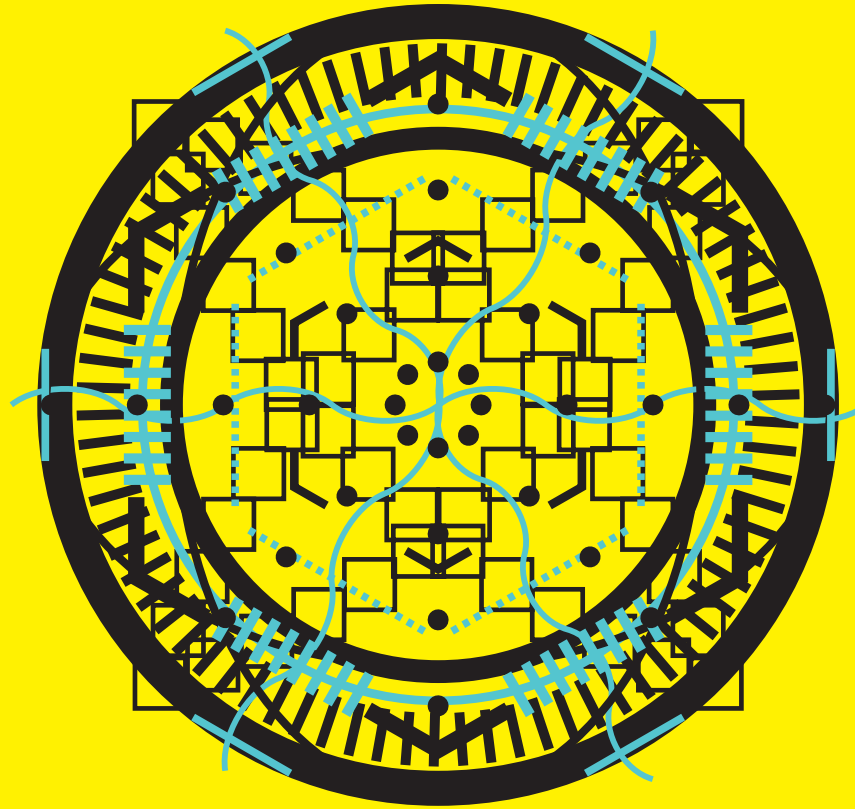
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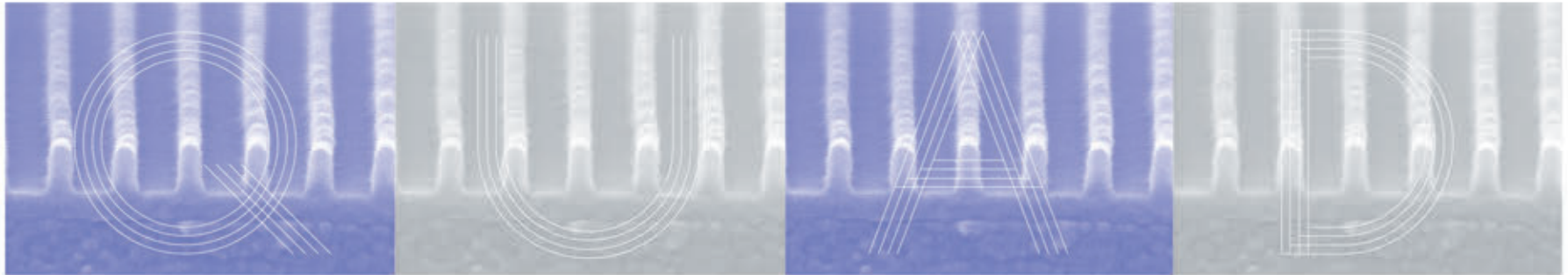


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