

**SPIE.** ADVANCED  
LITHOGRAPHY

CONNECTING MINDS.  
ADVANCING LIGHT.

2016

# ADVANCED LITHOGRAPHY.

TECHNICAL  
PROGRAM

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

Conferences & Courses  
21-25 February 2016

Exhibition  
23-24 February 2016

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

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



## TECHNICAL PROGRAM

### LOCATION

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

### DATES

Conferences & Courses: 21-25 February 2016  
Exhibition: 23-24 February 2016



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## TECHNICAL CONFERENCES

<b>Extreme Ultraviolet (EUV) Lithography VII</b> ( <i>Panning</i> ) .....	18-52
<b>Alternative Lithographic Technologies VIII</b> ( <i>Bencher</i> ) .....	18-50
<b>Metrology, Inspection, and Process Control for Microlithography XXX</b> ( <i>Sanchez</i> ) .....	18-53
<b>Advances in Patterning Materials and Processes XXXIII</b> ( <i>Hohle</i> ) .....	18-51
<b>Optical Microlithography XXIX</b> ( <i>Erdmann</i> ) .....	19-51
<b>Design-Process-Technology Co-optimization for Manufacturability X</b> ( <i>Capodieci</i> ) .....	19-53
<b>Advanced Etch Technology for Nanopatterning V</b> ( <i>Lin</i> ) .....	19-31

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.

Sponsored by

**SPIE.**

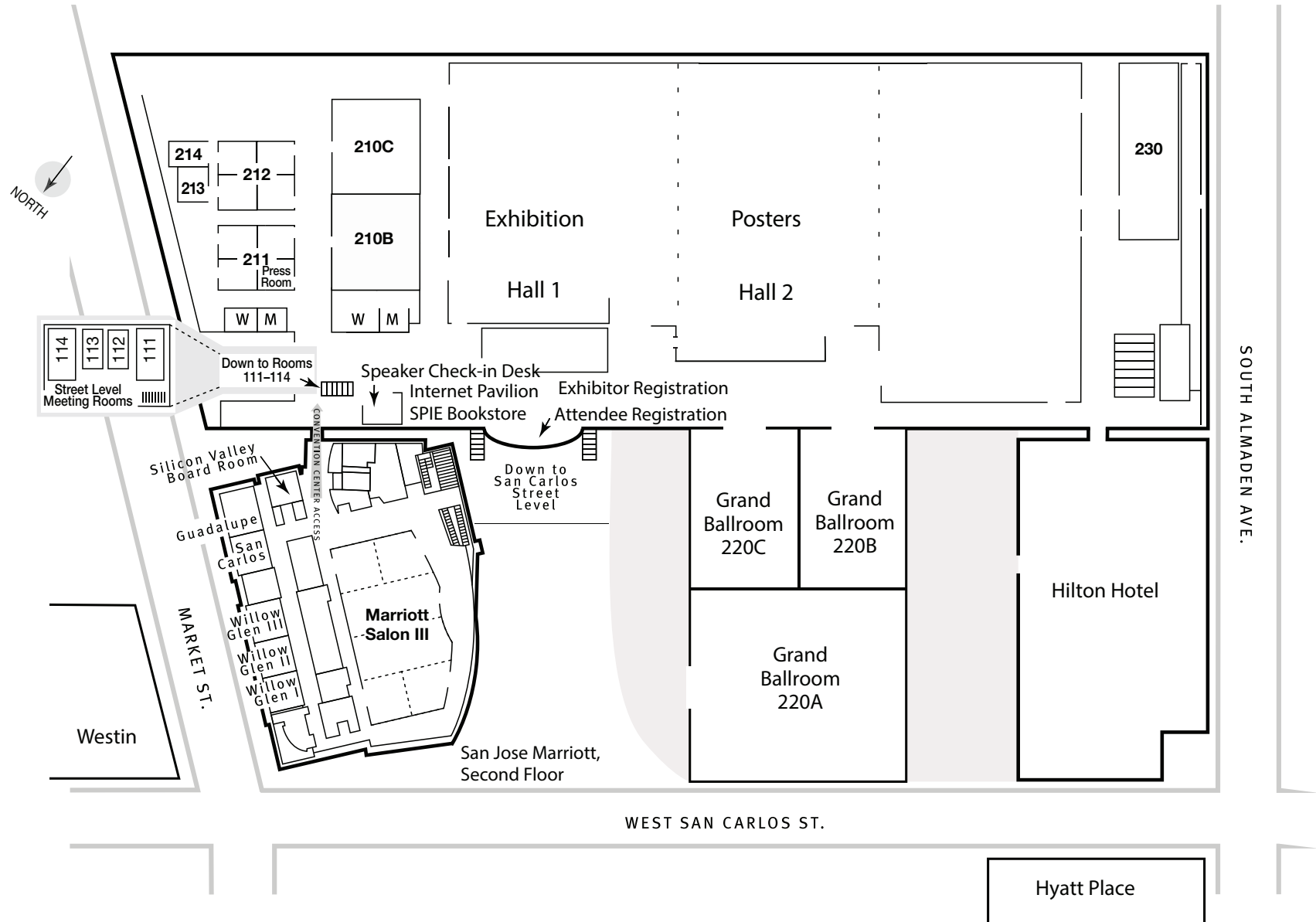
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# Thanks to the following sponsors for their generous support of SPIE Advanced Lithography


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# SAN JOSE CONVENTION CENTER AND MARRIOTT HOTEL 2ND LEVEL



# DAILY SCHEDULE

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
Special Events	<p><b>Welcome and Announcements</b> (Dusa, Smith) 8:00 to 8:30 am, p. 6</p> <p><i>Plenary Presentation: Evolution in the Concentration of Activities in Lithography</i> (Levinson) 8:30 to 9:10 am, p. 6</p> <p><i>Plenary Presentation: Minimizing Process-Induced Variability in Multiple Patterning</i> (Gottscho) 9:10 to 9:50 am, p. 7</p> <p><i>Plenary Presentation: EUV Lithography: From the Very Beginning to the Eve of Manufacturing</i> (Yen) 9:50 to 10:30 am, p. 7</p> <p><b>Award Announcements for Conf. 9778: Presentation of the 2015 Diana Nyyssonen Memorial Award for Best Paper</b>, 11:00 to 11:10 am, p. 9</p> <p><b>Award Announcements for Conf. 9779: Presentation of the 2015 C. Grant Willson Best Paper Award; 2015 Hiroshi Ito Memorial Award for the Best Student Paper; 2016 Jeffrey Byers Memorial Best Poster Award</b>, 11:00 to 11:30 am, p. 9</p> <p><b>SPIE Fellows Luncheon</b>, 12:00 to 1:00 pm, p. 8</p> <p><b>All Symposium Welcome Reception</b>, 5:45 to 7:00 pm, p. 8</p> <p><b>Nanotechnology in Microlithography Panel Discussion: Approaching the Molecular Scale: Rethinking Physical Models and Practices Beyond 7nm</b>, (Barnes, Silver) 7:00 to 8:30 pm, p. 8</p>	<p><b>Metrology, Inspection, and Process Control Conference Celebrates Its 30th Year!</b> (Adan) 5:30 to 6:30 pm, p. 8</p> <p><b>Interactive Poster Session</b>, (Conferences 9776, 9777, 9779, 9780, 9782) 6:00 to 8:00 pm, p. 8</p>	<p><b>Interactive Poster Session</b>, (Conferences 9778, 9781) 6:00 to 8:00 pm, p. 8</p>	<p><b>Award Announcements for Conf. 9778: Presentation of the 2016 Karel Urbanek Best Student Paper Award</b>, 10:30 to 10:40 am, p. 9</p> <p><b>Award Announcement for Conf. 9780: Presentation of the 2016 Best Student Award in Microlithography</b>, 10:30 to 10:35 am, p. 9</p> <p><b>Award Announcement for Conf. 9781: Presentation of the Franco Cerrina Memorial Best Student Paper Award</b>, 3:40 to 3:45 pm, p. 9</p>
		<p><b>EXHIBITION, p. 10</b></p> <p>10:00 am to 5:00 pm</p>		<p>10:00 am to 4:00 pm</p>
				

## Conferences

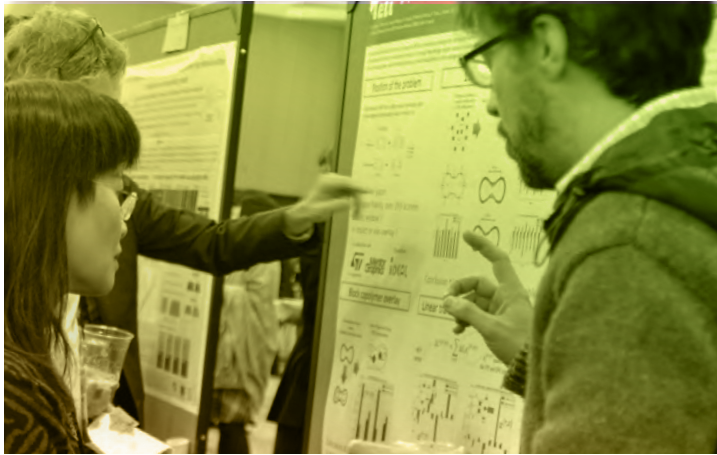
<b>Extreme Ultraviolet (EUV) Lithography VII</b> ( <i>Panning</i> ), p. 18-52
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<b>Design-Process-Technology Co-optimization for Manufacturability X</b> ( <i>Capodieci</i> ), p. 19-53

## Courses

**Sunday and Monday Course schedule**, see pages 15

**See descriptions and register for Courses on site.**





#### *Executive Committee*

**Christopher Bencher**, Applied Materials, Inc.  
**Jason P. Cain**, Advanced Micro Devices, Inc.  
**Luigi Capodiecchi**, KnotPrime Inc.  
**Joy Y. Cheng**, Taiwan Semiconductor Manufacturing Co.  
**Mircea V. Dusa**, ASML US, Inc.  
**Sebastian U. Engelmann**, IBM Thomas J. Watson Research Ctr.  
**Andreas Erdmann**, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB  
**Kenneth A. Goldberg**, Lawrence Berkeley National Lab.  
**Christoph K. Hohle**, Fraunhofer Institute for Photonic Microsystems  
**Jongwook Kye**, GLOBALFOUNDRIES Inc.  
**Qinghuang Lin**, IBM Thomas J. Watson Research Ctr.  
**Eric M. Panning**, Intel Corp.  
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**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  
**Michael T. Postek**, National Institute of Standards and Technology  
**Christopher J. Progler**, Photronics, Inc.  
**C. Grant Willson**, The Univ. of Texas at Austin  
**Anthony Yen**, Taiwan Semiconductor Manufacturing Co. Ltd.

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# Welcome

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Lithography continues to be challenged to extend into ever-shrinking generations, yet remain manufacturable and cost effective. State-of-the-art processes continue with immersion lithography and multiple patterning while EUV lithography moves closer toward production readiness. At the same time, the lithography community aggressively pursues alternative patterning approaches and 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 nanolithography community. The addition of other lithography-related technology over the past several years has sought to address the patterning integration 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.

All conferences are organized by current practitioners of the art, Conference Chairs, working together with organizing committees that are 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 San Jose for SPIE Advanced Lithography's 41st year!

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## 2016 SYMPOSIUM CHAIR

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**Mircea V. Dusa**  
ASML US, Inc.

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## 2016 SYMPOSIUM CO-CHAIR

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**Bruce W. Smith**  
Rochester Institute of Technology

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# SPECIAL EVENTS.

## Plenary Presentations

Monday 22 February · 8:30 to 10:30 AM  
Location: Convention Center, 220A



### Welcome and Announcements

Monday 22 February 2016 · 8:00 to 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

### Advanced Lithography 2016 Special Award

### 13th Frits Zernike Award for Advances in Optical Microlithography

*Zernike Award Sponsored by:*

**ASML**

Plenary Presentations Sponsored by

**ASML**

8:30 to 9:10 AM

### Evolution in the Concentration of Activities in Lithography



#### Harry J. Levinson

Senior Director GLOBALFOUNDRIES Inc.

From a perusal of the proceedings of the SPIE Advanced Lithography Symposium, the progression of new concepts in lithographic technology can be seen. A new idea first appears in a few papers, and over time, there is an increase in the number of papers on the same topic. Eventually the method becomes commonplace, and the number of papers on the topic declines, as the idea becomes part of our industry's working knowledge. For example, one or two papers on resolution enhancement techniques (RETs) appeared in the proceedings of Optical Microlithography in 1989 and 1990. By 1994, the total number of papers had increased to 35. In this way, lithographic technology has evolved, with certain ideas being the focus of attention by R&D engineers during certain periods of time. Early lithographers focused on practical issues, such as adhesion promotion and resist edge bead. The introduction of simulation software brought on the next era of lithography. This was followed by a period of time in which RETs were developed and brought to maturity. In the case of RETs, the concept was introduced much earlier, notably in Marc Levenson's seminal paper on phase-shifting masks, but it took awhile for the idea to gain traction. The introduction of optical proximity corrections (OPC) initiated the next major era of lithography. The traditional path for scaling by using shorter wavelengths, decreasing  $k_1$  and increasing numerical aperture has given way to the current era of optical multiple patterning and lithography-design co-optimization. There has been sufficient activity in EUV lithography R&D to justify a separate EUV Lithography Conference as part of the annual Advanced Lithography Symposium. Each era builds on the cumulative knowledge gained previously.



Over time, there have been parallel developments in optics, exposure tools, resist, metrology and mask technology, many of which were associated with changes in the wavelength of light used for leading-edge lithography. In contrast to the concentration of activities over a few years, there are some ideas that have been topics of discussion repeatedly over decades, most notably the end of optical lithography and its potential successors. The next era may be that of optical lithography's successor.

**Harry J. Levinson** is Sr. Director of GLOBALFOUNDRIES's Technology Research organization and Sr. Fellow. Dr. Levinson spent most of his career working in the field of lithography, starting at AMD. He then spent some time at Sierra Semiconductor and IBM before returning to AMD – now GLOBALFOUNDRIES – in 1994. During the course of his career, Dr. Levinson has applied lithography to many different technologies, including bipolar memories, 64Mb and 256Mb DRAM development, the manufacturing of applications-specific integrated circuits, thin film heads for magnetic recording, flash memories and advanced logic. He was one of the first users of 5× steppers in Silicon Valley and was an early participant in 248 nm and 193 nm lithography. Dr. Levinson also served for several years as the chairman of the USA Lithography Technology Working Group that participates in the generation of the lithography chapter of the International Technology Roadmap for Semiconductors. He has published numerous articles on lithographic science, on topics ranging from thin film optical effects and metrics for imaging, to overlay and process control, and he is the author of two books, *Lithography Process Control* and *Principles of Lithography*. He holds over 60 US patents. Dr. Levinson is an SPIE Fellow, previously chaired the SPIE Publications Committee, and served on SPIE's Board of Directors. He has a BS in engineering from Cornell University and a PhD in Physics from the University of Pennsylvania.

9:10 to 9:50 AM

## Minimizing Process-Induced Variability in Multiple Patterning



**Richard A. Gottscho**

Executive Vice President of Global Products, Lam Research Corp.

Multiple patterning is being implemented to overcome limitations in current lithography. But multiple patterning comes with obvious downsides of added cost and variability; only by reducing both can the benefits of multiple patterning be fully realized. Sources of variability arise from choices in reactor design as well as device architecture and circuit layout. Variability arises from limitations of reactive species transport to the wafer or within the feature. In this talk, I will outline the basic theory behind plasma-induced deposition and etching, used to create and replicate mandrels and spacers for pitch multiplying, to elucidate the relationships between reactor design, layout design, and transport-induced variability. Atomic layer processing will be shown to enable circumvention of these limitations. Other persistent sources of variation stem from line-edge and line-width roughness. In this case, high frequency roughness can be reduced as the sidewalls are smoothed during the mask multiplication process. Multiple patterning is in volume manufacturing now but both the cost and variability of multiply patterned wafers can be reduced further.

**Richard A. Gottscho** is executive vice president of Global Products. He has served at various director and vice presidential levels since joining the Company in January 1996. Prior to joining Lam Research, Dr. Gottscho was a member of Bell Laboratories for 15 years, where he headed research departments in electronics materials, electronics packaging, and flat panel displays. Dr. Gottscho is the author of numerous papers, patents, and lectures in plasma processing and process control. He is a recipient of the American Vacuum Society's Peter Mark Memorial Award and is a fellow of the American Physical and American Vacuum Societies. He has served on numerous editorial boards of refereed technical publications and program committees for major conferences in plasma science and engineering and was vice chair of a National Research Council study on plasma science in the 1980s. Dr. Gottscho earned his Ph.D. and B.S. degrees in physical chemistry from the Massachusetts Institute of Technology and the Pennsylvania State University, respectively.

9:50 to 10:30 AM

## EUV Lithography: From the Very Beginning to the Eve of Manufacturing



**Anthony Yen**

Director, Nanopatterning Technology Infrastructure Division, Taiwan Semiconductor Manufacturing Co. Ltd.

Thirty years have passed since the very first results of EUV imaging were made public by Kinoshita and co-workers of NTT Japan. Why does it take this long for EUV lithography to develop from infancy to near maturity? First, the advent and adoption of several key resolution-enhancing techniques along the way, combined with continual improvements in exposure tools, masks, and materials, greatly extended the life of optical lithography and made the need for EUVL less urgent, until now. Second, technological barriers that must be surmounted in order to put EUVL in manufacturing have indeed been high. In this presentation, I will review the early history of EUVL, point out how its life was extended beyond the initial phase of promising results, and present some most recent progress on the performance of its exposure tools, technology infrastructure, and patterning capability, and hopefully convince the audience that the technology is crossing the threshold to become a mainstream patterning technology for sub-10-nm generations of integrated circuits.

**Anthony Yen** began his study of nanopatterning as a graduate student at MIT under the guidance of Hank Smith. After graduation in 1991, he did R&D work on microlithography at Texas Instruments and, as a TI assignee, at IMEC. Activities there included early work on optical proximity correction which he and his TI colleagues later applied to the manufacturing of Sun microprocessors. He joined Taiwan Semiconductor Manufacturing Company in 1997 to lead its newly formed lithography R&D group. From 2001 to 2003 he was on assignment at SEMATECH where he co-led its lithography division to build infrastructure for next-generation lithography technologies. He then joined Cymer Inc. as senior vice president of marketing but returned to TSMC at the end of 2006. He was put in charge of developing EUV lithography shortly thereafter and is currently director of Nanopatterning Technology Infrastructure Division. Yen received his BSEE degree from Purdue University and his SM, EE, PhD, and MBA degrees from MIT. He has over 80 publications and 40 US patents on nanopatterning. He is a fellow of SPIE and a past chair of its advanced lithography symposia.

Coffee Break 10:30 AM to 11:00 AM

# Technical Events



## SPIE Fellows Luncheon

Monday 22 February · 12:00 pm to 1:00 pm

All Fellows of SPIE are invited to join your colleagues for an SPIE hosted luncheon at Advanced Lithography. Please join us for this informal gathering and a chance to interact with other Fellows.

## All Symposium Welcome Reception

Monday 22 February · 5:45 pm to 7:00 pm  
Location: Convention Center, 230

### New This Year!

Join your colleagues at the new Welcome Reception! Relax, socialize, and enjoy the beverages and hors d'oeuvres on this first night of the conference. All attendees are invited.

Beverage tickets are included with your paid conference registration. Please remember to wear your registration badge. Dress is casual.

Sponsored by



## Nanotechnology in Microlithography Panel Discussion: Approaching the Molecular Scale: Rethinking Physical Models and Practices Beyond 7nm

Monday 22 February · 7:00 pm to 8:30 pm

Location: Convention Center, 220B

Panel Moderators: **Bryan M. Barnes, Richard Silver**, National Institute of Standards and Technology

As the industry approaches 10 nm, looking ahead to the inherent challenges posed by nanostructures at sub-7nm is of critical importance today. How will current approaches to modeling, fabrication, and process control respond given the underlying physics at these dimensions? The panel will explore these fundamental challenges in metrology, lithography, and design as critical dimensions shrink to near-atomic scales.

Sponsored by



## Metrology, Inspection, and Process Control Conference Celebrates Its 30th Year!

Tuesday 23 February · 5:30 pm to 6:30 pm

Location: Convention Center, 220B

Host: **Ofer Adan**, Applied Materials

A chance to test your knowledge of metrology, inspection, and process control state-of-the-art and significant background. State-of-the-art is what happens now—innovations of current and most recent conferences. Significant background is more in the foundations starting 30 years ago.

Sponsored by



## Interactive Poster Sessions

Tuesday 23 February · 6:00 pm to 8:00 pm

(Conferences 9776, 9777, 9779, 9780, 9782)

Tuesday poster reception sponsored by



Wednesday 24 February · 6:00 pm to 8:00 pm

(Conferences 9778, 9781)

Wednesday poster reception sponsored by



Location: Convention Center, Hall 2

Posters will be on display each day 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 and enjoy networking with your friends and 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 9778—Metrology, Inspection, and Process Control for Microlithography**

*Location: Convention Center, 220B  
Monday 22 February · 11:00 AM to 11:10 AM*

### **Presentation of the 2015 Diana Nyysonen Memorial Award for Best Paper**

*Award Sponsored by*  
**HITACHI**  
Inspire the Next

*Thursday 25 February · 10:30 AM to 10:40 AM*

### **Presentation of the 2016 Karel Urbanek Best Student Paper Award**

*Award Sponsored by*  
**KLA Tencor**

## **Award Announcements for Conference 9779—Advances in Patterning Materials and Processes**

*Location: Convention Center, 220C  
Monday 22 February · 11:00 AM to 11:30 AM*

### **Presentation of the 2015 C. Grant Willson Best Paper Award**

### **Presentation of the 2015 Hiroshi Ito Memorial Award for the Best Student Paper**

*The Two Awards Above Sponsored by*



### **Presentation of the 2016 Jeffrey Byers Memorial Best Poster Award in Resist**

*Award Sponsored by*



## **Award Announcement for Conference 9780—Optical Microlithography**

*Location: Convention Center, 210C  
Thursday 25 February · 10:30 AM to 10:35 AM*

### **Presentation of the 2016 Best Student Award in Microlithography**

*Award Sponsored by*  
**CYMER**  
An **ASML** company

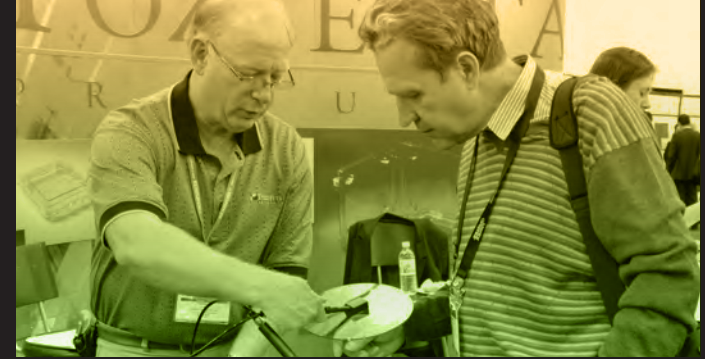
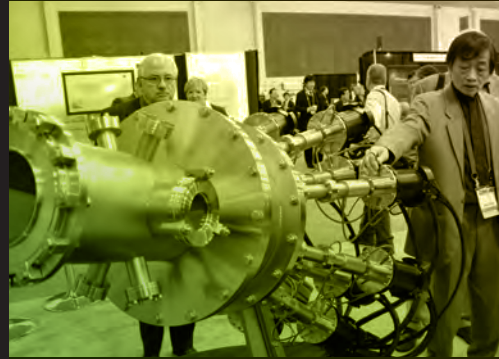
## **Award Announcement for Conference 9781—Design-Process-Technology-Co-optimization for Manufacturability**

*Location: Convention Center, 220C  
Thursday 25 February · 3:40 PM to 3:45 PM*

### **Presentation of the 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 23 February  
10:00 am to 5:00 pm*

*Wednesday 24 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

### Visit these companies (current 1/11/2016)

Abeam Technologies, Inc.  
Amuneal Manufacturing Corp.  
attocube systems Inc.  
Benchmark Technologies  
Berliner Glas KGaA Herbert Kubatz GmbH & Co.  
Brewer Science  
Cadence  
Canon U.S.A., Inc.  
Carl Zeiss SMT GmbH  
Coventor, Inc.  
CyberOptics Corp.  
Energetiq Technology, Inc.  
Fine Semitech Corp.  
GenISys GmbH  
GLOBALFOUNDRIES  
Gudeng Precision Industrial Co., Ltd.  
Halocarbon Products

Heidelberg Instruments Inc.  
ibss Group, Inc.  
Inko Industrial Corp.  
Integrated Micro Materials  
J.A. Woollam Co., Inc.  
JENOPTIK Optical Systems, LLC  
JSR Micro, Inc.  
King Industries Inc.  
LouwersHanique  
Materials Design, Inc.  
Mentor Graphics  
MGM International, Inc.  
Micro Lithography, Inc.  
micro resist technology GmbH  
MicroChem Corp.  
Mitsui Chemicals America, Inc.  
Nano-Master, Inc.  
Pall Corp.

Pozzetta, Inc.  
Qoniac GmbH  
Raith America, Inc.  
RI Research Instruments GmbH  
Rigaku Innovative Technologies, Inc.  
Sage Design Automation, Inc.  
SCREEN SPE USA, LLC  
Shin-Etsu MicroSi, Inc.  
solar-semi GmbH  
Solid State Technology  
SwissLitho AG  
Synopsys, Inc.  
Tokyo Electron Limited  
Tokyo Ohka Kogyo America, Inc. (TOK America, Inc)  
Vermont Photonics Technologies Corp.  
Vistec Electron Beam GmbH  
Zygo Corporation

# GENERAL INFORMATION

## REGISTRATION

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### ONSITE REGISTRATION AND BADGE PICK-UP HOURS

*San Jose Convention Center*

*Sunday 21 February · 7:15 am to 5:00 pm*

*Monday 22 February · 7:15 am to 4:00 pm*

*Tuesday 23 February · 7:30 am to 5:00 pm*

*Wednesday 24 February · 7:30 am to 4:00 pm*

*Thursday 25 February · 7:45 am to 4:00 pm  
(conference reg only)*

### 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.

### 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

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*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 short course, workshop, or special event requiring payment, or have questions regarding your registration, please the SPIE Cashier.

### REFUND INFORMATION

There is a \$50 USD service charge for processing refunds. Requests for refunds must be received by 11 February 2016; 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.



# GENERAL INFORMATION

## Author / Presenter Information

*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 23 February · 10:00 am to 5:00 pm*

*Wednesday 24 February · 10:00 am to 5:00 pm*

Poster authors 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.

## ONSITE SERVICES

### Internet Options

*Location of Internet - Convention Center Ballroom Concourse*

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Monday – Thursday, 7:30 am

Monday and Wednesday Breakfast Breads sponsored by



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Exhibition Hall Concession Stand

Tuesday – Wednesday, 11:00 am – 2:00 pm

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### SPIE Hosted Lunches

Exhibition Hall

Tuesday – Wednesday, 11:30 am to 1:00 pm

Check individual conference listings for exact times

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Wednesday Hosted Lunch sponsored by



### Desserts

Exhibition Hall 1

Tuesday and Wednesday

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## SPIE COURSES

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SUNDAY	MONDAY
SC1099 <b>Chemistry and Lithography</b> (Okoroanyanwu) 8:30 am to 5:30 pm, \$700 / \$810	SC1030 <b>Interaction of Physical Design and Lithography</b> (Yuan) 1:30 pm to 5:30 pm, \$375 / \$430
SC1155 <b>Design Technology Co-Optimization in the Era of Sub-resolution IC Scaling</b> (Liebmann, Vaidyanathan) 8:30 am to 5:30 pm, \$645 / \$755	SC1159 <b>Optimization Methods for Lithographers</b> (Granik) 1:30 pm to 5:30 pm, \$375 / \$430
SC888 <b>EUV Lithography</b> (Bakshi, Ahn, Naulleau) 8:30 am to 5:30 pm, \$830 / \$940	SC1187 <b>Understanding Design-Patterning Interactions for EUV and DSA</b> (Gupta, Torres, Mallik) 1:30 pm to 5:30 pm, \$375 / \$430
SC1173 <b>How and Why: The big ideas in semiconductor lithography</b> (Mack, Petersen) 8:30 am to 5:30 pm, \$685 / \$795	
SC101 <b>Introduction to Microlithography: Theory, Materials, and Processing</b> (Willson, Bowden) 8:30 am to 5:30 pm, \$600 / \$710	
SC992 <b>Lithography Integration for Semiconductor FEOL &amp; BEOL Fabrication</b> (Lin, Zhang) 8:30 am to 5:30 pm, \$600 / \$710	
SC1133 <b>Metrology Toolset Monitoring, Matching, Maintenance and Management</b> (Solecky, Adan) 8:30 am to 12:30 pm, \$375 / \$430	
SC1132 <b>Modeling and Computational Lithography Fundamentals</b> (Lai) 8:30 am to 5:30 pm, \$600 / \$710	
SC885 <b>Principles and Practical Implementation of Multiple Patterning</b> (Dusa, Hsu) 8:30 am to 5:30 pm, \$600 / \$710	
SC1172 <b>Spatial Coherence and Impact on Lithography Simulation and OPC</b> (Kang) 8:30 am to 12:30 pm, \$375 / \$430	
SC1067 <b>Directed Self Assembly and its Application to Nanoscale Fabrication</b> (de Pablo, Nealey, Ruiz) 1:30 pm to 5:30 pm, \$375 / \$430	
SC1158 <b>Metrology of Image Placement</b> (Starikov) 1:30 pm to 5:30 pm, \$380 / \$435	

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- Course topics are continually updated and aligned with current industry needs and trends
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- Money-back guarantee!

### NEW COURSES

- SC1172 Spatial Coherence and Impact on Simulation and OPC
- SC1173 How and Why: The Big Ideas in Semiconductor Lithography
- SC1187 Understanding Design-Patterning interactions for EUV and DSA

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

# SESSION SCHEDULE

	CONFERENCE 9776 Extreme Ultraviolet (EUV) Lithography VII	CONFERENCE 9777 Alternative Lithographic Technologies VIII	CONFERENCE 9778 Metrology, Inspection, and Process Control for Microlithography XXX
Monday 22 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 Materials I: MOx Resists: Joint Session with Conferences 9776 and 9779</b></p> <p><b>Session 3</b> · Mon 4:00 pm to 6:10 pm <b>EUV Materials II: CARs and Novel Approaches: Joint Session with Conferences 9776 and 9779</b></p>	<p><b>Session 1</b> · Mon 3:40 pm to 5:40 pm <b>Keynote Session</b></p>	<p><b>Opening Remarks and Award Announcement</b> 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 1:40 pm to 3:20 pm <b>Optical Metrology I</b></p> <p><b>Session 3</b> · Mon 3:50 pm to 5:30 pm <b>SEM I: Modeling and Simulation</b></p>
Tuesday 23 February	<p><b>Session 4</b> · Tue 8:00 am to 9:50 am <b>EUV Integration</b></p> <p><b>Session 5</b> · Tue 10:40 am to 12:00 pm <b>EUV Mask</b></p> <p><b>Session 6</b> · Tue 1:30 pm to 3:10 pm <b>EUV Source I</b></p> <p><b>Session 7</b> · Tue 3:40 pm to 6:00 pm <b>EUV Source II</b></p>	<p><b>Session 2</b> · Tue 8:00 am to 9:50 am <b>Nanoimprint Lithography Production Readiness</b></p> <p><b>Session 3</b> · Tue 10:20 am to 12:10 pm <b>Nanoimprint Modeling, Processing, and Materials</b></p> <p><b>Session 4</b> · Tue 1:40 pm to 3:40 pm <b>DSA Line-Space Patterning</b></p> <p><b>Session 5</b> · Tue 4:10 pm to 5:50 pm <b>DSA Via Patterning</b></p>	<p><b>Session 4</b> · Tue 8:00 am to 10:10 am <b>New Horizons</b></p> <p><b>Session 5</b> · Tue 10:40 am to 12:00 pm <b>X-ray Methods</b></p> <p><b>Session 6</b> · Tue 1:30 pm to 3:10 pm <b>Inspection</b></p> <p><b>Session 7</b> · Tue 3:40 pm to 5:20 pm <b>Process Control</b></p> <p><b>Metrology, Inspection, and Process Control Conference Celebrates Its 30th Year</b> · 5:30 pm to 6:30 pm</p>
Wednesday 24 February	<p><b>Session 8</b> · Wed 8:00 am to 10:10 am <b>EUV Resist I</b></p> <p><b>Session 9</b> · Wed 10:40 am to 12:00 pm <b>EUV Resist II</b></p> <p><b>Session 10</b> · Wed 1:30 pm to 3:10 pm <b>EUV Mask and Optics</b></p> <p><b>Session 11</b> · Wed 3:40 pm to 6:20 pm <b>EUV Mask Inspection and Imaging</b></p>	<p><b>Session 6</b> · Wed 8:10 am to 10:00 am <b>DSA Process and Integration: Joint Session with Conferences 9777 and 9779</b></p> <p><b>Session 7</b> · Wed 10:30 am to 12:20 pm <b>DSA Materials and Processes: Joint Session with Conferences 9777 and 9779</b></p> <p><b>Session 8</b> · Wed 1:40 pm to 3:30 pm <b>DSA Modeling and Design</b></p> <p><b>Session 9</b> · Wed 4:00 pm to 5:50 pm <b>Direct-Write E-Beam Lithography</b></p>	<p><b>Session 8</b> · Wed 8:00 am to 10:10 am <b>Optical Metrology II</b></p> <p><b>Session 9</b> · Wed 10:40 am to 12:00 pm <b>SEM II</b></p> <p><b>Session 10</b> · Wed 1:30 pm to 3:10 pm <b>AFM</b></p> <p><b>Session 11</b> · Wed 3:40 pm to 6:00 pm <b>Overlay: Metrology Target Design and Optimization</b></p>
Thursday 25 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 Patterning I</b></p> <p><b>Session 14</b> · Thu 1:30 pm to 3:30 pm <b>EUV Patterning II</b></p> <p><b>Session 15</b> · Thu 4:00 pm to 5:50 pm <b>EUV Pellicle</b></p>	<p><b>Session 10</b> · Thu 9:00 am to 10:00 am <b>Novel Lithography and Alternative Patterning I</b></p> <p><b>Session 11</b> · Thu 10:30 am to 12:10 pm <b>Novel Lithography and Alternative Patterning II</b></p>	<p><b>Session 12</b> · Thu 8:10 am to 10:00 am <b>Overlay Optimization: Joint Session with Conferences 9778 and 9780</b></p> <p><b>Karel Urbanek Best Student Paper Award Presentation</b> 10:30 am to 10:40 am</p> <p><b>Session 13</b> · Thu 10:40 am to 11:40 am <b>Mask Inspection</b></p> <p><b>Session 14</b> · Thu 1:50 pm to 3:10 pm <b>Design Interaction with Metrology: Joint Session with Conferences 9778 and 9781</b></p> <p><b>Session 15</b> · Thu 3:40 pm to 5:40 pm <b>Late Breaking News</b></p>



<p><b>CONFERENCE 9779</b>  <b>Advances in Patterning Materials and Processes XXXIII</b></p>	<p><b>CONFERENCE 9780</b>  <b>Optical Microlithography XXIX</b></p>	<p><b>CONFERENCE 9781</b>  <b>Design-Process-Technology Co-optimization for Manufacturability X</b></p>	<p><b>CONFERENCE 9782</b>  <b>Advanced Etch Technology for Nanopatterning V</b></p>
<p><b>Opening Remarks and Award Announcements</b>                      11:00 am to 11:30 am  <b>Session 1</b> · Mon 11:30 am to 12:30 pm  <b>Keynote Session</b>  <b>Session 2</b> · Mon 1:30 pm to 3:30 pm  <b>EUV Materials I: MOx Resists: Joint Session with Conferences 9776 and 9779</b>  <b>Session 3</b> · Mon 4:00 pm to 6:10 pm  <b>EUV Materials II: CARs and Novel Approaches: Joint Session with Conferences 9776 and 9779</b></p>			<p><b>Opening Remarks</b> · 1:20 pm to 1:30 pm  <b>Session 1</b> · Mon 1:30 pm to 3:20 pm  <b>Overviews of Nanopatterning Challenges</b>  <b>Session 2</b> · Mon 3:50 pm to 5:40 pm  <b>New Plasma Sources and New Etching Technologies</b></p>
<p><b>Session 4</b> · Tue 8:00 am to 10:00 am  <b>EUV Materials III: CAR Resists and Fundamentals</b>  <b>Session 5</b> · Tue 10:30 am to 12:10 pm  <b>EUV Materials IV: Metal Oxide Resists</b>  <b>Session 6</b> · Tue 1:20 pm to 3:20 pm  <b>Patterning Materials and Etch: Joint Session with Conferences 9779 and 9782</b>  <b>Session 7</b> · Tue 3:50 pm to 5:30 pm  <b>Negative Tone Materials and Processes: Joint Session with Conferences 9779 and 9780</b></p>	<p><b>Opening Remarks</b> · 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 12:10 pm  <b>Pushing Optical Limit</b>  <b>Session 3</b> · Tue 1:40 pm to 3:20 pm  <b>Image and Process Control</b>  <b>Session 4</b> · Tue 3:50 pm to 5:30 pm  <b>Negative Tone Materials and Processes: Joint Session with Conferences 9779 and 9780</b></p>		<p><b>Session 3</b> · Tue 8:20 am to 10:00 am  <b>Nanopatterning for Advanced Logic and Memory Technology Nodes</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 1:20 pm to 3:20 pm  <b>Patterning Materials and Etch: Joint Session with Conferences 9779 and 9782</b>  <b>Session 6</b> · Tue 4:00 pm to 5:50 pm  <b>Emerging Patterning Technologies (DSA, and other)</b></p>
<p><b>Session 8</b> · Wed 8:10 am to 10:00 am  <b>DSA Process and Integration: Joint Session with Conferences 9777 and 9779</b>  <b>Session 9</b> · Wed 10:30 am to 12:20 pm  <b>DSA Materials and Processes: Joint Session with Conferences 9777 and 9779</b>  <b>Session 10</b> · Wed 1:40 pm to 3:20 pm  <b>Advanced Patterning Process Characterization</b>  <b>Session 11</b> · Wed 3:50 pm to 6:10 pm  <b>DSA Novel Materials</b></p>	<p><b>Session 5</b> · Wed 8:20 am to 10:30 am  <b>Computational Lithography</b>  <b>Session 6</b> · Wed 11:00 am to 12:30 pm  <b>Material and Process Driven Resolution Enhancements</b>  <b>Session 7</b> · Wed 2:00 pm to 3:30 pm  <b>Design and Litho Optimization: Joint Session with Conferences 9780 and 9781</b>  <b>Session 8</b> · Wed 4:00 pm to 5:50 pm  <b>Non-IC Applications</b></p>	<p><b>Session 1</b> · Wed 8:00 am to 10:10 am  <b>Layout Optimization and Design Restrictions</b>  <b>Session 2</b> · Wed 10:40 am to 12:10 pm  <b>Layout Analytics</b>  <b>Session 3</b> · Wed 2:00 pm to 3:30 pm  <b>Design and Litho Optimization: Joint Session with Conferences 9780 and 9781</b>  <b>Session 4</b> · Wed 4:00 pm to 5:20 pm  <b>Circuit Modeling</b></p>	
<p><b>Session 12</b> · Thu 8:00 am to 10:00 am  <b>Process Improvements for Advanced Patterning</b>  <b>Session 13</b> · Thu 10:30 am to 12:10 pm  <b>DSA Materials: Fundamentals and Simulation</b></p>	<p><b>Session 9</b> · Thu 8:10 am to 10:00 am  <b>Overlay Optimization: Joint Session with Conferences 9778 and 9780</b>  <b>Cymer Award</b> · 10:30 am to 10:35 am  <b>Session 10</b> · Thu 10:35 am to 12:35 pm  <b>Toolings</b>  <b>Concluding Remarks</b> · 12:35 pm to 12:40 pm</p>	<p><b>Session 5</b> · Thu 8:10 am to 10:00 am  <b>Hotspot Detection and Removal</b>  <b>Session 6</b> · Thu 10:30 am to 12:00 pm  <b>Multiple Patterning and Directed Self-Assembly</b>  <b>Session 7</b> · Thu 1:50 pm to 3:10 pm  <b>Design Interaction with Metrology: Joint Session with Conferences 9778 and 9781</b>  <b>Franco Cerrina Memorial Best Student Paper Award</b> · 3:40 pm to 3:45 pm  <b>Session 8</b> · Thu 3:45 pm to 4:45 pm  <b>Process and Yield Modeling</b></p>	

## CONFERENCE 9776

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### Extreme Ultraviolet (EUV) Lithography VII

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### Alternative Lithographic Technologies VIII

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

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### Advances in Patterning Materials and Processes XXXIII

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

*Conference Co-Chair:* **Todd R. Younkin**, Intel Corp. (USA)

*Program Committee:* **Robert Allen**, IBM Almaden Research Ctr. (USA); **Ramakrishnan Ayothi**, JSR Micro, Inc. (USA); **Luisa D. Bozano**, IBM Almaden Research Ctr. (USA); **Sean D. Burns**, IBM Corp. (USA); **Ryan Callahan**, FUJIFILM Electronic Materials U.S.A., Inc. (USA); **Ralph R. Dammel**, EMD Performance Materials Corp. (USA); **Chao Fang**, KLA-Tencor Texas (USA); **Roel Gronheid**, IMEC (Belgium); **Douglas Guerrero**, Brewer Science, Inc. (USA); **Clifford L. Henderson**, Georgia Institute of Technology (USA); **Scott W. Jessen**, Texas Instruments Inc. (USA); **Yoshio Kawai**, Shin-Etsu Chemical Co., Ltd. (Japan); **Qinghuang Lin**, IBM Thomas J. Watson Research Ctr. (USA); **Nobuyuki N. Matsuzawa**, Sony Corp. (Japan); **Katsumi Ohmori**, Tokyo Ohka Kogyo Co., Ltd. (Japan); **Daniel P. Sanders**, IBM Almaden Research Ctr. (USA); **Mark H. Somervell**, Tokyo Electron America, Inc. (USA); **Jason K. Stowers**, Inpria (USA); **James W. Thackeray**, Dow Electronic Materials (USA); **Raluca Tiron**, CEA-LETI (France); **Thomas I. Wallow**, ASML Brion Technologies (USA)

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## CONFERENCE 9780

Tuesday–Thursday 23–25  
February 2016 • Proceedings  
of SPIE Vol. 9780

### Optical Microlithography XXIX

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

*Conference Co-Chair:* **Jongwook Kye**,  
GLOBALFOUNDRIES Inc. (USA)

*Program Committee:* **Pary Baluswamy**, Micron  
Technology, 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); **Harsha Grunes**, Intel Corp. (USA);  
**Young Seog Kang**, SAMSUNG Electronics  
Co., Ltd. (Korea, Republic of); **Sachiko  
Kobayashi**, Toshiba Corp. (Japan); **Kafai Lai**,  
IBM Corp. (USA); **Soichi Owa**, Nikon Corp.  
(Japan); **Ryan Pearson**, Synopsys, Inc. (USA);  
**John S. Petersen**, Periodic Structures, Inc.  
(USA); **Mark C. Phillips**, Intel Corp. (USA);  
**Daniel Sarlette**, Infineon Technologies  
Dresden (Germany); **Xuelong Shi**,  
Semiconductor Manufacturing International  
Corp. (China); **Bruce W. Smith**, Rochester  
Institute of Technology (USA); **Kazuhiro  
Takahashi**, Canon Inc. (Japan); **Geert  
Vandenbergh**, imec (Belgium); **Reinhard  
Voelkel**, SUSS MicroOptics SA (Switzerland)

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## CONFERENCE 9781

Wednesday–Thursday 24–25  
February 2016 • Proceedings  
of SPIE Vol. 9781

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

*Conference Chair:* **Luigi Capodieci**, KnotPrime  
Inc.. (USA)

*Conference Co-Chair:* **Jason P. Cain**,  
Advanced Micro Devices, Inc. (USA)

*Program Committee:* **Robert Aitken**, ARM  
Inc. (USA); **Fang-Cheng Chang**, Cadence  
Design Systems, Inc. (USA); **Neal V. Lafferty**,  
Mentor Graphics Corp. (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); **John L. Sturtevant**, Mentor Graphics  
Corp. (USA)

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## CONFERENCE 9782

Monday–Tuesday 22–23  
February 2016 • Proceedings  
of SPIE Vol. 9782

### Advanced Etch Technology for Nanopatterning V

*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:* **Efrain Altamirano-  
Sánchez**, imec (Belgium); **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.  
Oehlein**, Univ. of Maryland, College Park  
(USA); **Erwine Pargon**, CNRS/LTM (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)

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**CONFERENCE 9776**

Extreme Ultraviolet (EUV)  
Lithography VII

**SESSION 1**

**LOCATION: CONVENTION CENTER 220A  
MON 11:00 AM TO 12:00 PM**

**Keynote Session**

Session Chairs: **Anthony Yen**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Kenneth A. Goldberg**, Lawrence Berkeley National Lab. (USA)

11:00 am: **EUV Progress Toward HVM Readiness** (*Keynote Presentation*), Britt Turkot, Intel Corp. (USA) .....[9776-1]

11:30 am: **EUV Lithography: Progress and Perspective** (*Keynote Presentation*), Seong-Sue Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) .....[9776-2]

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

**CONFERENCE 9778**

Metrology, Inspection,  
and Process Control for  
Microlithography XXX

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

**Opening Remarks and Award  
Announcement**

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

**2015 Diana Nyssonen Memorial  
Best Paper Award**

**SESSION 1**

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

**Keynote Session**

Session Chairs: **Martha I. Sanchez**, IBM Research - Almaden (USA); **Vladimir A. Ukrantsev**, Qorvo™ (USA)

11:10 am: **Holistic Lithography and Metrology's Importance in Driving Patterning Fidelity** (*Keynote Presentation*), Martin van den Brink, ASML Netherlands B.V. (Netherlands) ..... [9778-1]

11:40 am: **Smart Metrology for Continuing Moore's Law Scaling** (*Keynote Presentation*), Zhiyong Ma, Intel Corp. (USA) ..... [9778-2]

Lunch Break .....Mon 12:10 pm to 1:40 pm

**CONFERENCE 9779**

Advances in Patterning Materials  
and Processes XXXIII

**LOCATION: CONVENTION CENTER 220C  
11:00 AM TO 11:30 AM**

**Opening Remarks and Award  
Announcements**

Session Chairs: **Christoph K. Hohle**, Fraunhofer Institute Photonic Microsystems (Germany); **Todd R. Younkin**, Intel Corp. (USA)

**SESSION 1**

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

**Keynote Session**

Session Chairs: **Christoph K. Hohle**, Fraunhofer Institute for Photonics Microsystems (Germany); **Todd R. Younkin**, Intel Corp. (USA)

This session dedicated in Memoriam for **Prof. Arnost Reißer** (5 July 1920-4 August 2015)

11:30 am: **Moore or less? The map grows increasingly complex as materials and processes abound** (*Keynote Presentation*), Peter Trefonas III, Dow Electronic Materials (USA) ..... [9779-1]

12:00 pm: **Extending Si, beyond-Si, to beyond-CMOS: Perspectives on logic nano-electronics scaling for the next decade and beyond** (*Keynote Presentation*), Aaron Thean, IMEC (Belgium) [9779-2]

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



**CONFERENCE 9776**

Extreme Ultraviolet (EUV) Lithography VII

**SESSION 2**

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

**EUV Materials I: MOx Resists**

Joint Session with  
Conferences 9776 and 9779

Session Chairs: **Thomas I. Wallow**, ASML Brion (USA); **Florian Gstrein**, Intel Corp. (USA)

1:30 pm: **Metal oxide EUV photoresist performance for N7 relevant patterns and processes**, Jason K. Stowers, Jeremy T. Anderson, Brian Cardineau, Benjamin L. Clark, Peter de Schepper, Joseph Edson, Michael Greer, Kai Jiang, Michael K. Kocsis, Stephen T. Meyers, Alan Telecky, Andrew Grenville, Inpria Corp. (USA); Danilo De Simone, Werner Gillijns, Geert Vandenberghe, IMEC (Belgium) . . . . . [9779-3]

1:50 pm: **Recent progress in nanoparticle photoresists development for EUV lithography**, Kazuki Kasahara, JSR Corp. (Japan) and Cornell Univ. (USA); Vasiliki Kosma, Jeremy Odent, Hong Xu, Mufei Yu, Emmanuel P. Giannelis, Christopher K. Ober, Cornell Univ. (USA) . . . . . [9776-3]

2:10 pm: **Novel ultra-high sensitive 'metal resist' for EUV lithography**, Toru Fujimori, Toru Tsuchihashi, Shinya Minegishi, Takashi Kamizono, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) [9776-4]

2:30 pm: **Positive tone oxide nanoparticle EUV (ONE) photoresists**, Mufei Yu, Emmanuel P. Giannelis, Christopher K Ober, Cornell Univ. (USA) . . . . [9779-4]

2:50 pm: **Characterizing and modeling the electronic response to light in metal-based EUV photoresists**, Alessandro Vaglio Pret, KLA-Tencor/ ICOS Belgium (Belgium); Michael K. Kocsis, Inpria Corp. (USA); Danilo De Simone, Geert Vandenberghe, IMEC (Belgium); Jason K. Stowers, Inpria Corp. (USA); Angelo Giglia, Istituto Officina dei Materiali (Italy); Peter de Schepper, Inpria Corp. (Belgium); Antonio Mani, KLA-Tencor Italy SRL (Italy); John J. Biafore, KLA-Tencor Texas (USA)[9779-5]

3:10 pm: **Novel metal containing resists for EUV lithography extendibility**, Danilo De Simone, IMEC (Belgium); Safak Sayan, Intel Corp. (Belgium); Satoshi Dei, JSR Micro N.V. (Belgium); Ivan Pollentier, IMEC (Belgium); Yuhei Kuwahara, Tokyo Electron Kyushu Ltd. (Netherlands); Geert Vandenberghe, IMEC (Belgium); Kathleen Nafus, Tokyo Electron Europe Ltd. (Netherlands); Motohiro Shiratani, JSR Engineering Co., Ltd. (Japan); Hisashi Nakagawa, Takehiko Naruoka, JSR Corp. (Japan) . . . . . [9776-5]

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

**CONFERENCE 9778**

Metrology, Inspection, and Process Control for Microlithography XXX

**SESSION 2**

**LOCATION: CONVENTION CENTER 220B  
MON 1:40 PM TO 3:20 PM**

**Optical Metrology I**

Session Chairs: **Christopher J. Raymond**, Nanometrics Inc. (USA); **Richard M. Silver**, National Institute of Standards and Technology (USA)

1:40 pm: **Scatterometry modeling for gratings with roughness and irregularities**, Jörg Bischoff, OSIRES (Germany); Karl Hehl, Optimod (Germany) . . . . . [9778-3]

2:00 pm: **Modeling ellipsometric measurement of novel 3D structures with RCWA and FEM simulations**, Samuel O'Mullane, SUNY CNSE/SUNYIT (USA); Nick Keller, Nanometrics (USA); Alain C. Diebold, SUNY CNSE/SUNYIT (USA) . . . [9778-4]

2:20 pm: **Improving optical metrology time to solution using signal response metrology**, Fang Fang, Xiaoxiao Zhang, Alok Vaid, GLOBALFOUNDRIES Inc. (USA); Stilian Pandev, Dimitry Sanko, Vidya Ramanathan, Kartik Venkataraman, Ronny Haupt, KLA-Tencor Corp. (USA) . . . . . [9778-5]

2:40 pm: **Lensless spectromicroscopy with a tabletop extreme-ultraviolet source**, Dennis F. Gardner Jr., JILA (USA); Bosheng Zhang, JILA (USA) and Carl Zeiss X-ray Microscopy, Inc. (USA); Matthew D. Seaberg, JILA (USA) and SLAC National Accelerator Lab. (USA); Elisabeth R. Shanblatt, Christina L. Porter, Robert Karl Jr., Christopher Mancuso, Henry C. Kapteyn, Margaret M. Murnane, Daniel Adams, JILA (USA) . . . . . [9778-15]

3:00 pm: **Innovative scatterometry approach for self-aligned quadruple patterning (SAQP) process control**, Anil Gunay Demirkol, Efrain Altamirano-Sánchez, IMEC (Belgium); Stéphane Heraud, Nova Measuring Instruments GmbH (Germany); Stephane Godny, Anne-Laure Charley, Philippe Leray, IMEC (Belgium); Ronen Urenski, Oded Cohen, Igor Turovets, Shay Wolfing, Nova Measuring Instruments Ltd. (Israel) . . . . . [9778-7]

Coffee Break . . . . . Mon 3:20 pm to 3:50 pm

**CONFERENCE 9779**

Advances in Patterning Materials and Processes XXXIII

**SESSION 2**

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

**EUV Materials I: MOx Resists**

Joint Session with  
Conferences 9776 and 9779

Session Chairs: **Thomas I. Wallow**, ASML Brion (USA); **Florian Gstrein**, Intel Corp. (USA)

1:30 pm: **Metal oxide EUV photoresist performance for N7 relevant patterns and processes**, Jason K. Stowers, Jeremy T. Anderson, Brian Cardineau, Benjamin L. Clark, Peter de Schepper, Joseph Edson, Michael Greer, Kai Jiang, Michael K. Kocsis, Stephen T. Meyers, Alan Telecky, Andrew Grenville, Inpria Corp. (USA); Danilo De Simone, Werner Gillijns, Geert Vandenberghe, IMEC (Belgium) . . . . . [9779-3]

1:50 pm: **Recent progress in nanoparticle photoresists development for EUV lithography**, Kazuki Kasahara, JSR Corp. (Japan) and Cornell Univ. (USA); Vasiliki Kosma, Jeremy Odent, Hong Xu, Mufei Yu, Emmanuel P. Giannelis, Christopher K. Ober, Cornell Univ. (USA) . . . . . [9776-3]

2:10 pm: **Novel ultra-high sensitive 'metal resist' for EUV lithography**, Toru Fujimori, Toru Tsuchihashi, Shinya Minegishi, Takashi Kamizono, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) [9776-4]

2:30 pm: **Positive tone oxide nanoparticle EUV (ONE) photoresists**, Mufei Yu, Emmanuel P. Giannelis, Christopher K Ober, Cornell Univ. (USA) . . . [9779-4]

2:50 pm: **Characterizing and modeling the electronic response to light in metal-based EUV photoresists**, Alessandro Vaglio Pret, KLA-Tencor/ ICOS Belgium (Belgium); Michael K. Kocsis, Inpria Corp. (USA); Danilo De Simone, Geert Vandenberghe, IMEC (Belgium); Jason K. Stowers, Inpria Corp. (USA); Angelo Giglia, Istituto Officina dei Materiali (Italy); Peter de Schepper, Inpria Corp. (Belgium); Antonio Mani, KLA-Tencor Italy SRL (Italy); John J. Biafore, KLA-Tencor Texas (USA)[9779-5]

3:10 pm: **Novel metal containing resists for EUV lithography extendibility**, Danilo De Simone, IMEC (Belgium); Safak Sayan, Intel Corp. (Belgium); Satoshi Dei, JSR Micro N.V. (Belgium); Ivan Pollentier, IMEC (Belgium); Yuhei Kuwahara, Tokyo Electron Kyushu Ltd. (Netherlands); Geert Vandenberghe, IMEC (Belgium); Kathleen Nafus, Tokyo Electron Europe Ltd. (Netherlands); Motohiro Shiratani, JSR Engineering Co., Ltd. (Japan); Hisashi Nakagawa, Takehiko Naruoka, JSR Corp. (Japan) . . . . . [9776-5]

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

**CONFERENCE 9782**

Advanced Etch Technology for Nanopatterning V

**LOCATION: CONVENTION CENTER 210B  
1:20 PM TO 1:30 PM**

**Opening Remarks**

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

**SESSION 1**

**LOCATION: CONVENTION CENTER 210B  
MON 1:30 PM TO 3:20 PM**

**Overviews of Nanopatterning Challenges**

Session Chairs: **Catherine Labelle**, GLOBALFOUNDRIES Inc. (USA); **Robert Turkot**, Intel Corp. (USA); **Richard J. Wise**, Lam Research Corp. (USA)

1:30 pm: **Advanced patterning techniques: Etch opportunities and responsibilities** (*Keynote Presentation*), Richard Schenker, Intel Corp. (USA) . . . . . [9782-1]

2:10 pm: **EUV for sub-10nm logic** (*Keynote Presentation*), Anthony Yen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9782-2]

2:50 pm: **Etch technologies for 7nm and 5nm nodes** (*Invited Paper*), Akihisa Sekiguchi, Tokyo Electron Ltd. (Japan) . . . . . [9782-3]

Coffee Break . . . . . Mon 3:20 pm to 3:50 pm



**CONFERENCE 9776**

Extreme Ultraviolet (EUV)  
Lithography VII

**SESSION 3**

**LOCATION: CONVENTION CENTER 220C  
MON 4:00 PM TO 6:10 PM**

**EUV Materials II: CARs and Novel Approaches**

**Joint Session with Conferences 9776 and 9779**

Session Chairs: **Danilo De Simone**, IMEC (Belgium); **Clifford L. Henderson**, Georgia Institute of Technology (USA)

4:00 pm: **Challenge toward breakage of RLS trade-off by new resists and processes for EUV lithography** (*Invited Paper*), Seiji Nagahara, Tokyo Electron Ltd. (Japan); Michael A. Carcasl, Tokyo Electron America, Inc. (USA); Gosuke Shiraishi, Yuichi Terashita, Yukie Minekawa, Kosuke Yoshihara, Masaru Tomono, Hironori Mizoguchi, Tokyo Electron Kyushu Ltd. (Japan); Hideo Nakashima, Tokyo Electron Ltd. (Japan); Seiichi Tagawa, Akihiro Oshima, Osaka Univ. (Japan); Hisashi Nakagawa, Takehiko Naruoka, Tomoki Nagai, JSR Corp. (Japan); Elizabeth Buitrago, Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland); Oktay Yildirim, Marieke Meeuwissen, Coen Verspaget, Rik Hoefnagels, Gijsbert Rispens, Raymond Maas, ASML Netherlands B.V. (Netherlands) . . . . [9776-6]

4:30 pm: **Fundamental aspects of a new process of high-resist sensitization by the combination lithography of EB/EUV pattern exposure with UV flood exposure of photosensitized CAR and non-CAR**, Seiichi Tagawa, Akihiro Oshima, Cong Que Dinh, Shigehiro Nishijima, Osaka Univ. (Japan) . . . . . [9779-78]

4:50 pm: **Negative-tone single component molecular resist based on cationic polymerization**, Hannah Narcross, Richard A. Lawson, Brandon Sharp, Georgia Institute of Technology (USA); Jun Sung Chun, SEMATECH Inc. (USA); Mark Neisser, SUNY Poly SEMATECH (USA); Laren M. Tolbert, SEMATECH Inc. (USA); Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9779-6]

5:10 pm: **Novel high-sensitivity EUV photoresist for sub-7nm node**, Tomoki Nagai, Hisashi Nakagawa, Takehiko Naruoka, JSR Corp. (Japan); Seiichi Tagawa, Akihiro Oshima, Osaka Univ. (Japan) and The Institute of Scientific and Industrial Research (Japan); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Gosuke Shiraishi, Yukie Minekawa, Yuichi Terashita, Kosuke Yoshihara, Tokyo Electron Kyushu Ltd. (Japan); Elizabeth Buitrago, Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland); Oktay Yildirim, Marieke Meeuwissen, Rik Hoefnagels, Gijsbert Rispens, Coen Verspaget, Raymond Maas, ASML Netherlands B.V. (Netherlands) . . . . . [9779-7]

5:30 pm: **Negative-tone imaging with EUV exposure toward 13nm hp**, Hideaki Tsubaki, Wataru Nihashi, Toru Tsuchihashi, Kei Yamamoto, Takahiro Goto, FUJIFILM Corp. (Japan) . . . . . [9776-8]

5:50 pm: **Approach to hp-10nm resolution by applying dry development rinse materials (DDRP) and materials (DDRM)**, Wataru Shibayama, Shuhei Shigaki, Satoshi Takeda, Ryuji Onishi, Makoto Nakajima, Rikimaru Sakamoto, Nissan Chemical Industries, Ltd. (Japan) . . . . . [9776-9]

**CONFERENCE 9777**

Alternative Lithographic Technologies VIII

**SESSION 1**

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

**Keynote Session**

Session Chairs: **Christopher Bencher**, Applied Materials, Inc. (USA); **Joy Y. Cheng**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

3:40 pm: **Lithography alternatives meet design style reality: How do they "line" up?** (*Keynote Presentation*), Michael C. Smayling, Tela Innovations, Inc. (USA) . . . . . [9777-1]

4:20 pm: **Emerging nanopatterning opportunities in electronics, displays, and healthcare** (*Keynote Presentation*), S. V. Sreenivasan, The Univ. of Texas at Austin (USA) . . . . . [9777-2]

5:00 pm: **Multiple electron-beam direct-write lithography: an overview** (*Keynote Presentation*), Shy-Jay Lin, Jaw-Jung Shin, Jensen Yang, Wen-Chuan Wang, Burn J. Lin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9777-3]

**CONFERENCE 9778**

Metrology, Inspection, and Process Control for Microlithography XXX

**SESSION 3**

**LOCATION: CONVENTION CENTER 220B  
MON 3:50 PM TO 5:30 PM**

**SEM I: Modeling and Simulation**

Session Chairs: **Benjamin D. Bunday**, SUNY Poly SEMATECH (USA); **Shunsuke Koshihara**, Hitachi High-Technologies Corp. (Japan)

3:50 pm: **Virtual rough samples to test 3D nanometer-scale SEM stereo photogrammetry**, John S. Villarrubia, Vipin Tondare, András E. Vladár, National Institute of Standards and Technology (USA) . . . . . [9778-8]

4:10 pm: **Improvements to the analytical linescan model for SEM metrology**, Chris A. Mack, Lithoguru.com (USA); Benjamin D. Bunday, SEMATECH Inc. (USA) . . . . . [9778-9]

4:30 pm: **Gaining insight into effective metrology height through the use of a compact CDSEM model for lithography simulation**, Chao Fang, KLA-Tencor Texas (USA); Alessandro Vaglio Pret, KLA-Tencor/ ICOS Belgium (Belgium); Stewart A. Robertson, Mark D. Smith, KLA-Tencor Texas (USA) . . . . . [9778-10]

4:50 pm: **Electric fields in SEM simulations**, Kerim Tugrul Arat, GenISys GmbH (Germany); Jens Boltzen, AMO GmbH (Germany); Thomas Klimpel, Nezhil Ünal, GenISys GmbH (Germany) . . . . . [9778-11]

5:10 pm: **GPU accelerated Monte-Carlo simulation of SEM images for metrology**, Thomas Verduin, Sebastiaan R. Lokhorst, Cornelis W. Hagen, Pieter Kruit, Technische Univ. Delft (Netherlands). [9778-12]

Monday 22 February

**CONFERENCE 9779**

Advances in Patterning Materials and Processes XXXIII

**SESSION 3**

**LOCATION: CONVENTION CENTER 220C  
MON 4:00 PM TO 6:10 PM**

**EUV Materials II: CARs and Novel Approaches**

Joint Session with Conferences 9776 and 9779

Session Chairs: **Danilo De Simone**, IMEC (Belgium); **Clifford L. Henderson**, Georgia Institute of Technology (USA)

4:00 pm: **Challenge toward breakage of RLS trade-off by new resists and processes for EUV lithography** (*Invited Paper*), Seiji Nagahara, Tokyo Electron Ltd. (Japan); Michael A. Carcasi, Tokyo Electron America, Inc. (USA); Gosuke Shiraishi, Yuichi Terashita, Yukie Minekawa, Kosuke Yoshihara, Masaru Tomono, Hironori Mizoguchi, Tokyo Electron Kyushu Ltd. (Japan); Hideo Nakashima, Tokyo Electron Ltd. (Japan); Seiichi Tagawa, Akihiro Oshima, Osaka Univ. (Japan); Hisashi Nakagawa, Takehiko Naruoka, Tomoki Nagai, JSR Corp. (Japan); Elizabeth Buitrago, Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland); Oktay Yildirim, Marieke Meeuwissen, Coen Verspaget, Rik Hoefnagels, Gijsbert Rispens, Raymond Maas, ASML Netherlands B.V. (Netherlands) . . . . . [9776-6]

4:30 pm: **Fundamental aspects of a new process of high-resist sensitization by the combination lithography of EB/EUV pattern exposure with UV flood exposure of photosensitized CAR and non-CAR**, Seiichi Tagawa, Akihiro Oshima, Cong Que Dinh, Shigehiro Nishijima, Osaka Univ. (Japan) . . . . . [9779-78]

4:50 pm: **Negative-tone single component molecular resist based on cationic polymerization**, Hannah Narcross, Richard A. Lawson, Brandon Sharp, Georgia Institute of Technology (USA); Jun Sung Chun, SEMATECH Inc. (USA); Mark Neisser, SUNY Poly SEMATECH (USA); Laren M. Tolbert, SEMATECH Inc. (USA); Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9779-6]

5:10 pm: **Novel high-sensitivity EUV photoresist for sub-7nm node**, Tomoki Nagai, Hisashi Nakagawa, Takehiko Naruoka, JSR Corp. (Japan); Seiichi Tagawa, Akihiro Oshima, Osaka Univ. (Japan) and The Institute of Scientific and Industrial Research (Japan); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Gosuke Shiraishi, Yukie Minekawa, Yuichi Terashita, Kosuke Yoshihara, Tokyo Electron Kyushu Ltd. (Japan); Elizabeth Buitrago, Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland); Oktay Yildirim, Marieke Meeuwissen, Rik Hoefnagels, Gijsbert Rispens, Coen Verspaget, Raymond Maas, ASML Netherlands B.V. (Netherlands) . . . . . [9779-7]

5:30 pm: **Negative-tone imaging with EUV exposure toward 13nm hp**, Hideaki Tsubaki, Wataru Nihashi, Toru Tsuchihashi, Kei Yamamoto, Takahiro Goto, FUJIFILM Corp. (Japan) . . . . . [9776-8]

5:50 pm: **Approach to hp-10nm resolution by applying dry development rinse materials (DDRP) and materials (DDRM)**, Wataru Shibayama, Shuhei Shigaki, Satoshi Takeda, Ryuji Onishi, Makoto Nakajima, Rikimaru Sakamoto, Nissan Chemical Industries, Ltd. (Japan) . . . . . [9776-9]

**CONFERENCE 9782**

Advanced Etch Technology for Nanopatterning V

**SESSION 2**

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

**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)

3:50 pm: **Atomic layer processing for nanopatterning** (*Invited Paper*), Erwin Kessels, Technische Univ. Eindhoven (Netherlands) . . . . . [9782-4]

4:20 pm: **Paths toward low-damage etching of highly porous organo-silicate low-k dielectrics** (*Invited Paper*), Jean-François de Marneffe, Liping Zhang, Mikhail R. Baklanov, IMEC (Belgium); Koichi Yatsuda, Tokyo Electron Ltd. (Japan); Kaoru Maekawa, TEL Technology Ctr., America, LLC (USA); Mike Cooke, Andy Goodyear, Oxford Instruments Plasma Technology Ltd. (United Kingdom); Christian Dussarrat, Air Liquide Labs. (Japan); Remi Dussart, Thomas Tillocher, Floriane Leroy, Philippe Lefaucheux, Group de Recherches sur l'Énergétique des Milieux Ionisés (France); Mitsuhiro Watanabe, IMEC (Belgium) . . . [9782-5]

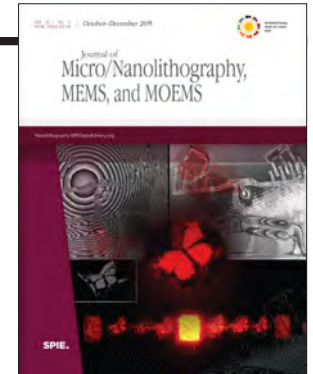
4:50 pm: **Etch transfer of sub-20nm half pitch patterns printed using thermal scanning probe lithography** (*Invited Paper*), Armin W. Knoll, Colin Rawlings, Heiko Wolf, Urs Dürig, IBM Research - Zürich (Switzerland) . . . [9782-6]

5:20 pm: **DC superimposition in CCP etchers for advanced patterning**, Mingmei Wang, Vinayak Rastogi, Hongyun Cottle, Andrew W. Metz, Alok Ranjan, TEL Technology Ctr., America, LLC (USA) . . . . . [9782-7]

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Journal of  
**Micro/Nanolithography,  
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**CONFERENCE 9776**

**Extreme Ultraviolet (EUV) Lithography VII**

**SESSION 4**

**LOCATION: CONVENTION CENTER 220A  
TUE 8:00 AM TO 9:50 AM**

**EUV Integration**

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

8:00 am: **EUV lithography performance for manufacturing: status and outlook** (*Invited Paper*), Alberto Pirati, Rudy Peeters, Daniel A. Smith, Sjoerd Lok, Martijn van Noordenburg, Roderik van Es, Eric Verhoeven, Henk Meijer, Arthur W. E. Minnaert, Jan Willem van der Horst, Hans Meiling, Jörg Mallmann, Christian Wagner, Judon Stoeldraijer, Geert Fisser, Leon Levasier, Jo Finders, Carmen Zoldesi, Uwe Stamm, Herman Boom, David C. Brandt, Daniel J. Brown, Igor V. Fomenkov, ASML Netherlands B.V. (Netherlands) . . . . . [9776-10]

8:30 am: **Demonstration of an N7 integrated fab process for metal oxide EUV photoresist**, Danilo De Simone, Ming Mao, Frederic Lazzarino, Geert Vandenberghe, IMEC (Belgium); Michael K. Kocsis, Peter de Schepper, Jason K. Stowers, Stephen T. Meyers, Benjamin L. Clark, Andrew Grenville, Inpria Corp. (USA); Vinh Luong, TEL Technology Ctr., America, LLC (USA); Fumiko Yamashita, Tokyo Electron Miyagi Ltd. (Japan); Doni Parnell, Tokyo Electron Europe Ltd. (USA) and TEL Technology Ctr., America, LLC (USA) . . . . . [9776-11]

8:50 am: **EUV process establishment through litho and etch for N7 node**, Yuhei Kuwahara, Tokyo Electron Kyushu Ltd. (Belgium); Philippe Foubert, Ming Mao, IMEC (Belgium); Nihar Mohanty, TEL Technology Ctr., America, LLC (USA); Anne-Marie Goethals, IMEC (Belgium); Kathleen Nafus, Koichi Matsunaga, Shinichiro Kawakami, Tokyo Electron Kyushu Ltd. (Japan); Eric Hendrickx, IMEC (Belgium) . . . . . [9776-12]

9:10 am: **Comparison of EUV and 193i based patterning for advanced node integration**, Christopher Wilson, IMEC (Belgium) . . . . . [9776-13]

9:30 am: **Improvement of EUV mix-match overlay for production implementation**, Byongseog Lee, Sarohan Park, Inwhan Lee, Byoung-Hoon Lee, Chang-Moon Lee, Young-Sik Kim, Noh-Jung Kwak, SK Hynix, Inc. (Korea, Republic of) . . . . . [9776-14]

Coffee Break . . . . . Tue 9:50 am to 10:40 am

**CONFERENCE 9777**

**Alternative Lithographic Technologies VIII**

**SESSION 2**

**LOCATION: CONVENTION CENTER 210B  
TUE 8:00 AM TO 9:50 AM**

**Nanoimprint Lithography Production Readiness**

Session Chairs: **Douglas J. Resnick**, Canon Nanotechnologies, Inc. (USA); **John G. Maltabes**, Jordan Valley Semiconductors, Inc. (USA)

8:00 am: **Device fabrication using nanoimprint lithography and challenges in nano-defect management** (*Invited Paper*), Tatsuhiro Higashiki, Toshiba Corp. (Japan) . . . . . [9777-4]

8:30 am: **Nanoimprint system development and status for high-volume semiconductor manufacturing**, Tsuneo Takashima, Yukio Takabayashi, Naosuke Nishimura, Keiji Emoto, Atsushi Kimura, Canon Inc. (Japan); Jin Choi, Philip Schumaker, Canon Nanotechnologies, Inc. (USA); Takahiro Matsumoto, Tatsuya Hayashi, Canon Inc. (Japan) . . . . . [9777-5]

8:50 am: **Improvement of nanoimprint lithography templates toward 1x generation lithography**, Ichimura Koji, Katsutoshi Suzuki, Ryogo Hikichi, Hironori Sasaki, Masaaki Kurihara, Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan) . . . . . [9777-6]

9:10 am: **Design for nanoimprint lithography (NIL): Total layout refinement utilizing NIL process simulation**, Sachiko Kobayashi, Motofumi Komori, Kyoji Yamashita, Akiko Mimotogi, Toshiba Corp. (Japan); Ji-Young Im, SK Hynix, Inc. (Korea, Republic of); Masayuki Hatano, Takuya Kono, Shimon Maeda, Toshiba Corp. (Japan) . . . . . [9777-7]

9:30 am: **200mm wafer scale NIL process assessment for sub-micrometer CD uniformity with the SmartNIL process**, Hubert Teysse, Stefan Landis, CEA Grenoble (France); Christine Thanner, Viktoria Schauer, Laure MARIA, EV Group (Austria); Cyril Vannufel, CEA Grenoble (France); Markus Wimplinger, EV Group (Austria); Laurent Pain, CEA Grenoble (France) . . . . . [9777-8]

Coffee Break . . . . . Tue 9:50 am to 10:20 am

**CONFERENCE 9778**

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

**SESSION 4**

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

**New Horizons**

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

8:00 am: **HVM metrology challenges toward the 5nm node** (*Invited Paper*), Benjamin D. Bunday, SEMATECH Inc. (USA) . . . . . [9778-13]

8:30 am: **Multiple beam ptychography**, Robert Karl Jr., Univ. of Colorado at Boulder (USA); Charles Bevis, JILA (USA); Raymond Lopez-Rios, Univ. of Rochester (USA); Jonathan Reichenadt, Dennis F. Gardner Jr., Christina L. Porter, JILA (USA) and Univ. of Colorado at Boulder (USA); Elisabeth R. Shanblatt, Michael Tanksalvala, Univ. of Colorado at Boulder (USA) and JILA (USA); Giulia Mancini, JILA (USA) and Univ. of Colorado at Boulder (USA); Margaret M. Murnane, Henry C. Kapteyn, Univ. of Colorado at Boulder (USA) and JILA (USA); Daniel Adams, JILA (USA) and Univ. of Colorado at Boulder (USA) . . . . . [9778-14]

8:50 am: **Spectroscopic imaging of buried layers in 2+1D via tabletop ptychography with high-harmonic EUV illumination**, Dennis F. Gardner Jr., Christina L. Porter, JILA (USA) and Univ. of Colorado at Boulder (USA); Elisabeth R. Shanblatt, Giulia Mancini, Robert Karl Jr., Michael Tanksalvala, Charles Bevis, Henry C. Kapteyn, Margaret M. Murnane, Univ. of Colorado at Boulder (USA) and JILA (USA); Daniel Adams, JILA (USA) and Univ. of Colorado at Boulder (USA) . [9778-6]

9:10 am: **Measurement of asymmetric side wall angles by coherent scanning Fourier scatterometry**, Maria Laura Gödecke, Sandy Peterhänsel, Karsten Frenner, Wolfgang Osten, Univ. Stuttgart (Germany) . . . . . [9778-16]

9:30 am: **Non-contact thermal distance sensing and thermal microscopy as a high-resolution inspection and metrology solution**, Roy Bijster, Hamed Sadeghian, Technische Univ. Delft (Netherlands) and TNO (Netherlands); Fred van Keulen, Technische Univ. Delft (Netherlands) . . . . . [9778-17]

9:50 am: **Reliable characterization of materials and nanostructured systems <50nm using coherent EUV beams**, Jorge Nicolas Hernandez-Charpak, Travis Frazer, Joshua Knobloch, Kathleen M. Hoogeboom-Pot, Damiano Nardi, JILA (USA) and Univ. of Colorado at Boulder (USA); Weilun L. Chao, Lawrence Berkeley National Lab. (USA); Lei Jiang, Marie K. Tripp, Sean W. King, Intel Corp. (USA); Margaret M. Murnane, Henry C. Kapteyn, Univ. of Colorado at Boulder (USA) and JILA (USA) . . . . . [9778-18]

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

**CONFERENCE 9779**

**Advances in Patterning Materials and Processes XXXIII**

**SESSION 4**

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

**EUV Materials III: CAR Resists and Fundamentals**

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

8:00 am: **Acid generation efficiency: EUV photons versus photoelectrons**, Dario L. Goldfarb, Ali A. Afzali, Martin Glodde, IBM Thomas J. Watson Research Ctr. (USA) . . . . . [9779-8]

8:20 am: **Investigation of low-energy electron mean free path and energy delivery in EUV resists**, Suchit Bhattarai, Univ. of California, Berkeley (USA); Shaul Aloni, Gong Chen, Andreas Schmid, Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Univ. of California, Berkeley (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA) . . . . . [9779-9]

8:40 am: **Cross sections of EUV PAGs: influence of concentration, electron energy, and structure**, Steven Grzeskowiak, Amrit Narasimhan, Jonathon Schad, SUNY Polytechnic Institute (USA); Mark Neisser, SUNY Poly SEMATECH (USA); Leonidas E. Ocola, Argonne National Lab. (USA); Robert L. Brainard, Gregory Denbeaux, SUNY Polytechnic Institute (USA) . . . . . [9779-10]

9:00 am: **Quantification of the resist dissolution process: an in situ analysis using high-speed atomic force microscopy**, Julius Joseph S. Santillan, Motoharu Shichiri, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9779-11]

9:20 am: **Study on stochastic phenomena induced in chemically amplified poly(4-hydroxystyrene-co-t-butyl methacrylate) resist (high-performance model resist for extreme-ultraviolet lithography)**, Takahiro Kozawa, Osaka Univ. (Japan); Julius J. Santillan, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9779-12]

9:40 am: **Studying electron-PAG interactions using electron-induced fluorescence**, Amrit Narasimhan, Steven Grzeskowiak, Jonathon Schad, SUNY Polytechnic Institute (USA); Mark Neisser, SUNY Poly SEMATECH (USA); Leonidas E. Ocola, Argonne National Lab. (USA); Gregory Denbeaux, Robert L. Brainard, SUNY Polytechnic Institute (USA) [9779-13]

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

**CONFERENCE 9780**  
Optical Microlithography XXIX

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

**Opening Remarks**

Session Chairs: **Andreas Erdmann**,  
Fraunhofer-Institut für Integrierte Systeme  
und Bauelementetechnologie IISB (Germany);  
**Jongwook Kye**, GLOBALFOUNDRIES Inc. (USA)

**SESSION 1**

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

**Keynote Session**

Session Chairs: **Andreas Erdmann**,  
Fraunhofer-Institut für Integrierte Systeme  
und Bauelementetechnologie IISB (Germany);  
**Jongwook Kye**, GLOBALFOUNDRIES Inc. (USA)

8:40 am: **Patterning challenges in the sub-10 nm era** (*Keynote Presentation*), Moshe E. Preil, GLOBALFOUNDRIES Inc. (USA) . . . . . [9780-1]

9:20 am: **Inverse design and implementation of compact and efficient nanophotonic circuits** (*Keynote Presentation*), Jelena Vuckovic, Alexander Piggott, Jesse Lu, Jan Petykiewicz, Stanford Univ. (USA) . . . . . [9780-2]

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

**CONFERENCE 9782**

Advanced Etch Technology for  
Nanopatterning V

**SESSION 3**

**LOCATION: MARRIOTT, SAN JOSE SALON III**  
**TUE 8:20 AM TO 10:00 AM**

**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)

8:20 am: **Patterning challenges in advanced device architectures: FinFET to nanowire** (*Invited Paper*), Naoto Horiguchi, IMEC (Belgium) . . . . . [9782-8]

8:50 am: **193nm trilayer negative-tone development process for patterning magnetic tunneling junctions** (*Invited Paper*), Qinghuang Lin, Sebastian U. Engelmann, Armand Galan, Steve Holmes, Gen Lauer, Nathan Marchack, Janusz J. Nowak, Eugene O'Sullivan, Yu Zhu, Eric A. Joseph, Anthony J. Annunziata, IBM Thomas J. Watson Research Ctr. (USA) . . . . . [9782-9]

9:20 am: **Plasma etch patterning of EUV lithography: balancing roughness and selectivity trade off**, Vinayak Rastogi, TEL Technology Ctr., America, LLC (USA); Genevieve Beique, Lei Sun, GLOBALFOUNDRIES Inc. (USA); Yannick Feurprier, Hongyun Cottle, TEL Technology Ctr., America, LLC (USA); Catherine Labelle, GLOBALFOUNDRIES Inc. (USA); John C. Arnold, Matthew E. Colburn, IBM Corp. (USA); Andrew W. Metz, Kaushik A. Kumar, Alok Ranjan, TEL Technology Ctr., America, LLC (USA) . . . . . [9782-10]

9:40 am: **Plasma etching processes for the integration of III-V materials with Si for CMOS and photonic applications**, Erwine Pargon, Maxime Bizouerne, Guillaume Gay, Camille Petit-Etienne, Laurent Vallier, LTM CNRS (France); Pauline Burtin, Mélisa Brihoum, Sébastien Barnola, CEA-LETI (France) . . . . . [9782-11]

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



**CONFERENCE 9776**

Extreme Ultraviolet (EUV) Lithography VII

**SESSION 5**

**LOCATION: CONVENTION CENTER 220A  
TUE 10:40 AM TO 12:00 PM**

**EUV Mask**

Session Chairs: **Emily E. Gallagher**, IMEC (Belgium); **Bryan S. Kasprovicz**, Photronics, Inc. (USA)

10:40 am: **3D mask effects of absorber geometry and chief ray angles in EUV lithography systems**, Riaz R. Haque, Zac Levinson, Bruce W. Smith, Rochester Institute of Technology (USA) . . . [9776-16]

11:00 am: **Etched multilayer type black border formed on EUV mask: Does it cause image degradation during pattern inspection using EB optics?**, Tsuyoshi Amano, Susumu Iida, Ryoichi Hirano, EUVL Infrastructure Development Ctr., Inc. (Japan); Tsukasa Abe, Dai Nippon Printing Co., Ltd. (Japan); Hidehiro Watanabe, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . [9776-17]

11:20 am: **Aerial imaging study of the mask-induced line-edge roughness of EUV lithography mask**, Antoine J. Wojdyla, Alexander P. Donoghue, Markus P. Benk, Kenneth A. Goldberg, Lawrence Berkeley National Lab. (USA) . . . [9776-18]

11:40 am: **Throughput compensation through optical proximity correction for realization of an extreme-ultraviolet pellicle**, Ki-Ho Ko, Hye-Keun Oh, Soo-Yeon Mo, In-Seon Kim, Hanyang Univ. (Korea, Republic of); Ju-Hwan Kim, Mentor Graphics Corp. (USA) . . . [9776-19]

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

**CONFERENCE 9777**

Alternative Lithographic Technologies VIII

**SESSION 3**

**LOCATION: CONVENTION CENTER 210B  
TUE 10:20 AM TO 12:10 PM**

**Nanoimprint Modeling, Processing, and Materials**

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

10:20 am: **Defectivity prediction for droplet-dispersed UV nanoimprint lithography, enabled by fast simulation of resin flow at feature, droplet, and template scales** (*Invited Paper*), Hayden K. Taylor, Univ. of California, Berkeley (USA) and Simprint Nanotechnologies Ltd. (United Kingdom) . . . [9777-9]

10:50 am: **Jet and flash imprint lithography material development for high-throughput semiconductor memory**, Niyaz Khusnatdinov, Dwayne L. LaBrake, Zhengmao Ye, Tim Stachowiak, J. W. Irving, Whitney Longsine, Matthew C. Traub, Van Truskett, Brian Fletcher, Weijun Liu, S. V. Sreenivasan, Canon Nanotechnologies, Inc. (USA) . . . [9777-10]

11:10 am: **NIL defect performance toward high-volume mass production**, Masayuki Hatano, Hiroyuki Kashiwagi, Kei Kobayashi, Hiroshi Tokue, Takuya Kono, Tetsuro Nakasugi, Toshiba Corp. (Japan); Eun Hyuk Choi, Woo-Yung Jung, SK Hynix, Inc. (Korea, Republic of) . . . [9777-11]

11:30 am: **Improved defectivity and particle for mask life extension, and imprint mask replication for high-volume semiconductor manufacturing**, Keiji Emoto, Fumio M. Sakai, Chiaki Sato, Yukio Takabayashi, Hitoshi Nakano, Tsuneo Takashima, Kiyohito Yamamoto, Tadashi Hattori, Mitsuru Hiura, Toshiaki Ando, Yoshio Kawanobe, Hisanobu Azuma, Takehiko Iwanaga, Canon Inc. (Japan); Jin Choi, Ali Aghili, Brian Fletcher, Zhengmao Ye, J. W. Irving, Canon Nanotechnologies, Inc. (USA) . . . [9777-12]

11:50 am: **Experiments toward establishing of design rules for R2R-UV-NIL with polymer working shims**, Dieter Nees, Stephan Ruttloff, Ursula Palfinger, Barbara Stadlober, JOANNEUM RESEARCH Forschungsgesellschaft mbH (Austria) . . . [9777-13]

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

**CONFERENCE 9778**

Metrology, Inspection, and Process Control for Microlithography XXX

**SESSION 5**

**LOCATION: CONVENTION CENTER 220B  
TUE 10:40 AM TO 12:00 PM**

**X-ray Methods**

Session Chairs: **John A. Allgair**, Nanometrics Inc. (USA); **Christopher J. Raymond**, Nanometrics Inc. (USA)

10:40 am: **High-throughput CDSAXS with compact x-ray sources**, R. Joseph Kline, Daniel Sunday, Donald Windover, National Institute of Standards and Technology (USA) . . . [9778-19]

11:00 am: **Characterization of cross-sectional profile of resist L/S and hole pattern using CD-SAXS**, Yoshiyasu Ito, Akifusa Higuchi, Kazuhiko Omote, Rigaku Corp. (Japan) . . . [9778-20]

11:20 am: **Hybrid enabled x-ray thin film metrology**, Alok Vaid, GLOBALFOUNDRIES Inc. (USA); Cornel Bozdog, Nova Measuring Instruments Inc. (USA); Givantha Iddawela, Sridhar Mahendrakar, Michael Lenahan, Mainul Hossain, Padraig R. Timoney, Abner F. Bello, GLOBALFOUNDRIES Inc. (USA); Heath Pois, GLOBALFOUNDRIES Inc. (USA) and Nova Measuring Instruments Inc. (USA); Wei Ti Lee, Mark Klare, Michael Kwan, Paul K. Isbester, Nova Measuring Instruments Inc. (USA); Matthew J. Sendelbach, GLOBALFOUNDRIES Inc. (USA); Naren Yellai, Tom Larson, Nova Measuring Instruments Inc. (USA) . . . [9778-21]

11:40 am: **XPS-XRF hybrid metrology enabling FDSOI process**, Mainul Hossain, Ganesh Subramanian, Dina Triyoso, Jeremy Wahl, Timothy Mcardle, Alok Vaid, Abner F. Bello, GLOBALFOUNDRIES Inc. (USA); Wei Ti Lee, Mark Klare, Michael Kwan, Heath Pois, Ying Wang, Tom Larson, ReVera, Inc. (USA) . . . [9778-22]

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

**CONFERENCE 9779**

Advances in Patterning Materials and Processes XXXIII

**SESSION 5**

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

**EUV Materials IV: Metal Oxide Resists**

Session Chairs: **Chao Fang**, KLA-Tencor Texas (USA); **Jason K. Stowers**, Inpria Corp. (USA)

10:30 am: **Characterization of metal resist for EUV lithography**, Minoru Toriumi, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) [9779-14]

10:50 am: **Metal containing material processing on coater/developer system**, Shinichiro Kawakami, Hiroshi Mizunoura, Koichi Matsunaga, Tokyo Electron Kyushu Ltd. (Japan); Koichi Hontake, TEL Technology Ctr., America, LLC (USA); Hiroshi Nakamura, Satoru Shimura, Masashi Enomoto, Tokyo Electron Kyushu Ltd. (Japan) . . . [9779-15]

11:10 am: **Characterization of inorganic resists using temperature programmed and electron stimulated desorption**, Gregory S. Herman, Ryan Frederick, Oregon State Univ. (USA); David Marsh, Darren Johnson, Univ. of Oregon (USA); Sumit Saha, Douglas A. Keszler, Oregon State Univ. (USA); Feixiang Luo, Eric Garfunkel, Rutgers, The State Univ. of New Jersey (USA) . . . [9779-16]

11:30 am: **Systematic investigation of the synthesis, characterization and switching mechanism of metal oxide nanoparticle resists**, Meiliana Siauw, Ke Du, David Valade, The Univ. of Queensland (Australia); Peter Trefonas, Jim W. Thackeray, Dow Electronic Materials (USA); Andrew K. Whittaker, Idriss Blakey, The Univ. of Queensland (Australia) . . . [9779-17]

11:50 am: **Comparative study of line roughness metrics of chemically amplified and inorganic resists for EUV**, Roberto Fallica, Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . [9779-18]

Lunch/Exhibition Break . . . Tue 12:10 pm to 1:20 pm



**CONFERENCE 9780**  
Optical Microlithography XXIX

**SESSION 2**

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

**Pushing Optical Limit**

Session Chairs: **Kafai Lai**, IBM Thomas J. Watson Research Ctr. (USA); **Geert Vandenberghe**, IMEC (Belgium)

10:30 am: **Expected innovations of optical lithography in the next 10 years** (*Invited Paper*), Soichi Owa, Noriyuki Hirayanagi, Nikon Corp. (Japan) . . . . . [9780-3]

11:00 am: **Computational process modeling and correction in a multipatterning era** (*Invited Paper*), Chris Spence, ASML Brion (USA) . . . . . [9780-4]

11:30 am: **Lithographic qualification of high-transmission mask blank for 10nm node and beyond**, Yongan Xu, IBM Corp. (USA); Tom B. Faure, Ramya Viswanathan, Granger Lobb, Richard E. Wistrom, GLOBALFOUNDRIES Inc. (USA); Sean D. Burns, IBM Corp. (USA); Lin Hu, GLOBALFOUNDRIES Inc. (USA); Ben Bleiman, IBM Corp. (USA); Daniel S. Fischer, GLOBALFOUNDRIES Inc. (USA); Yann Mignot, IBM Corp. (USA); Yoshifumi Sakamoto, Yusuke Toda, Toppan Printing Co., Ltd. (Japan); Ioana C. Graur, John Bolton, Todd Bailey, GLOBALFOUNDRIES Inc. (USA); Nelson M. Felix, John C. Arnold, Matthew E. Colburn, IBM Corp. (USA) . . . . . [9780-5]

11:50 am: **Ultimate intra-wafer critical dimension uniformity control by using lithography and etch tool corrections**, Michael Kubis, Liesbeth Reijnen, Katja Viatkina, Melisa Luca, Charlotte Chahine, Jan Mulkens, Mircea V. Dusa, ASML Netherlands B.V. (Netherlands); Richard J. Wise, David Hellin, Benjamin Kam, Daniel Sobieski, Johan Vertommen, Girish A. Dixit, Nader Shamma, Lam Research Corp. (USA); Patrick Jaenen, Philippe Leray, IMEC (Belgium); Melisa Luca, Charlotte Chahine, ASML Netherlands B.V. (Netherlands) . . . . . [9780-6]

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

**CONFERENCE 9782**  
Advanced Etch Technology for Nanopatterning V

**SESSION 4**

**LOCATION: MARRIOTT, SAN JOSE**  
**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); **Efrain Altamirano-Sánchez**, IMEC (Belgium)

10:30 am: **Optical metrology for advanced process control: full module metrology solutions** (*Invited Paper*), Cornel Bozdog, Nova Measuring Instruments Inc. (USA); Igor Turovets, Igor Turovets, Igor Turovets, Nova Measuring Instruments Ltd. (Israel) . . . . . [9782-13]

11:00 am: **Self-aligned-quadruple-patterning for N7/N5 silicon fins** (*Invited Paper*), Efrain Altamirano-Sánchez, Tao S. Zheng, Anil Gunay Demirkol, Gian F. Lorusso, Toby Hopf, Jean-Christophe Everat, William Clark, IMEC (Belgium); Daniel Sobieski, Fung-Suong Ou, Lam Research Corp. (United States); David Hellin, Lam Research (Belgium) . . . . . [9782-12]

11:30 am: **Self-aligned quadruple patterning integration using spacer on spacer pitch splitting at the resist level for sub-32nm pitch applications**, Angelique Raley, Sophie Thibaut, Nihar Mohanty, Kal Subhadeep, Akiteru Ko, David O'Meara, Kandabara Tapily, Peter Biolsi, TEL Technology Ctr., America, LLC (USA) . . . . . [9782-14]

11:50 am: **PMMA removal selectivity to PS using dry etch approach: Mechanism understanding and sub-10nm patterning application**, Aurélien Sarrazin, Nicolas Posseme, Patricia Pimenta-Barros, Sébastien Barnola, Ahmed Gharbi, Maxime Argoud, Guillaume Claveau, Raluca Tiron, CEA-LETI (France); Christophe Cardinaud, Institut des Matériaux Jean Rouxel (France) . . . . . [9782-15]

Lunch/Exhibition Break . . . Tue 12:10 pm to 1:20 pm

**CONFERENCE 9776**

Extreme Ultraviolet (EUV) Lithography VII

**SESSION 6**

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

**EUV Source I**

Session Chairs: **Moshe E. Preil**, GLOBALFOUNDRIES Inc. (USA); **Soichi Inoue**, Toshiba Corp. (Japan)

1:30 pm: **Performance of new high-power HVM LPP-EUV source**, Hakan Mizoguchi, Hiroaki Nakarai, Tamotsu Abe, Krzysztof M. Nowak, Yasufumi Kawasuji, Hiroshi Tanaka, Yukio Watanabe, Tsukasa Hori, Takeshi Kodama, Yutaka Shiraishi, Tatsuya Yanagida, Georg Soumagne, Tsuyoshi Yamada, Taku Yamazaki, Takashi Saitou, Gigaphoton Inc. (Japan)[9776-20]

1:50 pm: **Advancements in predictive plasma formation modeling**, David C. Brandt, Michael Purvis, Daniel J. Brown, Igor V. Fomenkov, Alexander Schafgans, Cymer LLC (USA); Harry Krewel, Andrei M. Yakunin, ASML Netherlands B.V. (Netherlands); Steve Langer, Howard A. Scott, Lawrence Livermore National Lab. (USA) ..... [9776-21]

2:10 pm: **High-radiance LDP source: Clean, reliable, and stable EUV source for mask inspection**, Yusuke Teramoto, Bárbara Santos, Guido Mertens, Ralf Kops, Margarete Kops, Ushio Inc. (Germany); Alexander von Wezyk, Klaus Bergmann, Fraunhofer-Institut für Lasertechnik (Germany); Hironobu Yabuta, Akihisa Nagano, Noritaka Ashizawa, Ushio Inc. (Japan); Takahiro Shirai, Kiyotada Nakamura, Kunihiko Kasama, Ushio Opto Semiconductors, Inc. (Japan) ..... [9776-22]

2:30 pm: **Study of Sn removal processes for in-situ collector cleaning**, Daniel T. Elg, Gianluca Panici, Shailendra N. Srivastava, David N. Ruzic, Univ. of Illinois at Urbana-Champaign (USA) ..... [9776-23]

2:50 pm: **Simulation study of impact of collector contamination on imaging quality**, Hoyeon Kim, Jinseok Heo, Insung Kim, Seong-Sue Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) ..... [9776-24]

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

**CONFERENCE 9777**

Alternative Lithographic Technologies VIII

**SESSION 4**

**LOCATION: CONVENTION CENTER 210B  
TUE 1:40 PM TO 3:40 PM**

**DSA Line-Space Patterning**

Session Chairs: **Ricardo Ruiz**, HGST, Inc. (USA); **Chi-Chun Liu**, IBM Corp. (USA)

1:40 pm: **Pattern fidelity improvement of chemo-epitaxy DSA process for high-volume manufacturing**, Makoto Muramatsu, Takatori Nishi, Gen You, Yusuke Saito, Yasuyuki Ido, Tokyo Electron Kyushu Ltd. (Japan); Kiyohito Ito, Toshikatsu Tobana, Masanori Hosoya, Weichien Chen, Tokyo Electron Miyagi Ltd. (Japan); Satoru Nakamura, TEL Technology Ctr., America, LLC (USA); Mark H. Somervell, Tokyo Electron America, Inc. (USA); Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan) . . [9777-14]

2:00 pm: **Block co-polymer contributions to the defectivity and roughness performance of the 14nm half-pitch LiNe flow at IMEC**, Hari Pathangi, Boon Teik Chan, Varun Vaid, Nadia Vandenbroeck, Lieve Van Look, Dieter Van den Heuvel, IMEC (Belgium); Jin Li, Sung Eun Hong, EMD Performance Materials Corp. (Belgium); Jihoon Kim, Baskaran Durairaj, Guanyang Lin, EMD Performance Materials Corp. (USA); Kathleen Nafus, Tokyo Electron America, Inc. (USA); Ryota Harukawa, KLA-Tencor Corp. (USA); Andrew J. Cross, KLA-Tencor England (USA); Lucia D'Urzo, Hareen Bayana, Entegris GmbH (Germany); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) ..... [9777-15]

2:20 pm: **Defect annihilation in DSA: Systematic study of optimal materials selection and processing conditions**, Su-Mi Hur, Chonnam National Univ. (Korea, Republic of); Gurdaman Khaira, Paulina A. Rincon-Delgado, Paul F. Nealey, Juan J. de Pablo, The Univ. of Chicago (USA) ..... [9777-16]

2:40 pm: **Directed self-assembly of silicon-containing block copolymers for 20nm lithography**, Gregory Blachut, C. Grant Willson, The Univ. of Texas at Austin (USA); Stephen Sirard, Lam Research Corp. (USA); Michael J. Maher, Yusuke Asano, Yasunobu Someya, Austin P. Lane, William J. Durand, Christopher J. Ellison, The Univ. of Texas at Austin (USA); Diane Hymes, Lam Research Corp. (USA); Roel Gronheid, IMEC (Belgium) ..... [9777-17]

3:00 pm: **Fabrication of half-pitch sub-15nm metal wire circuits using directed self-assembly of block copolymers with line density multiplication**, Tsukasa Azuma, Yuriko Seino, Hironobu Sato, Yusuke Kasahara, Katsutoshi Kobayashi, Hitoshi Kubota, Hideki Kanai, Katsuyoshi Koderu, Naoko Kihara, Yoshiaki Kawamonzon, Satoshi Nomura, Hitoshi Yamano, Ken Miyagi, Shinya Minegishi, Toshikatsu Tobana, Masayuki Shiraishi, EUVL Infrastructure Development Ctr., Inc. (Japan) ..... [9777-18]

3:20 pm: **Sub-15nm patterning technology using directed self-assembly on nanoimprinting guide**, Seiji Morita, Masahiro Kanno, Ryosuke Yamamoto, Norikatsu Sasao, Shinobu Sugimura, Toshiba Corp. (Japan) ..... [9777-19]

Coffee Break. . . . . Tue 3:40 pm to 4:10 pm

**CONFERENCE 9778**

Metrology, Inspection, and Process Control for Microlithography XXX

**SESSION 6**

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

**Inspection**

Session Chairs: **Timothy F. Crimmins**, Intel Corp. (USA); **Matthew J. Sendelbach**, Nova Measuring Instruments Inc. (USA)

1:30 pm: **High-throughput atomic force microscope for self-assembled monolayers metrology and defect inspection**, Maarten van Es, Rutger Thijssen, TNO (Netherlands); Safak Sayan, IMEC (Belgium); Hamed Sadeghian, TNO (Netherlands); Geert Vandenbergh, IMEC (Belgium) ..... [9778-76]

1:50 pm: **Study of design-based e-beam defect inspection for hotspot detection and process window characterization on 10nm logic device**, Fei Wang, Pengcheng Zhang, Wei Fang, Kevin Liu, Jack Y. Jau, Hermes-Microvision Inc., USA (USA); Philippe Leray, Laith Altimime, Gregory R. McIntyre, IMEC (Belgium) ..... [9778-24]

2:10 pm: **Electromagnetic field modeling for defect detection in 7nm node patterned wafers using the vector boundary element method**, Jinlong Zhu, Lynford L. Goddard, Univ. of Illinois at Urbana-Champaign (USA)[9778-25]

2:30 pm: **Detection of metallic buried void by effective density contrast mode**, Ming Lei, Kevin Wu, GLOBALFOUNDRIES Inc. (USA); Qing Tian, Kewen Gao, Yaqiong Chen, Haokun Hu, Chris Lei, Hermes-Microvision Inc., USA (USA) ..... [9778-26]

2:50 pm: **Critical via hole detection in electron-beam inspection using multi-layer design analysis**, Abhishek Vikram, Anchor Semiconductor, Inc. (USA); Hermes Liu, Semiconductor Manufacturing International Corp. (China); Guojie Chen, Gary Zhang, Anchor Semiconductor, Inc. (China); Khurram Zafar, Anchor Semiconductor, Inc. (USA); Rena Zhai, Ivan Zhen, Semiconductor Manufacturing International Corp. (China) ..... [9778-27]

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

**CONFERENCE 9779**

Advances in Patterning Materials and Processes XXXIII

**SESSION 6**

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

**Patterning Materials and Etch**

**Joint Session with Conferences 9779 and 9782**

Session Chairs: **Douglas Guerrero**, Brewer Science, Inc. (USA); **Qinghuang Lin**, IBM Thomas J. Watson Research Ctr. (USA)

1:20 pm: **Evaluation of ALE processes for patterning (Invited Paper)**, Sebastian U. Engelmann, Robert L. Bruce, Hiroyuki Miyazoe, Nathan Marchack, Eric A. Joseph, IBM Thomas J. Watson Research Ctr. (USA) ..... [9782-16]

1:50 pm: **Edge roughness characterization of advanced patterning processes using power spectral density analysis (PSD) (Invited Paper)**, Shimon Levi, Applied Materials, Ltd. (Israel)[9782-17]

2:20 pm: **Dielectric properties of spin-on metal oxides and their applications for 2D semiconductor devices**, Safak Sayan, Intel Corp. (USA) and IMEC (Belgium); Dennis Lin, Inge Asselberghs, Daniele Chiappe, Surajit Sutar, Iuliana Radu, Aaron Thean, IMEC (Belgium); Salem Mullen, Elizabeth Wolfer, Douglas S. McKenzie, Huirong Yao, M. Dalil Rahmani, JoonYeon Cho, Munirathna Padmanaban, EMD Performance Materials Corp. (USA); Claire Petermann, Sung Eun Hong, IMEC (Belgium) ..... [9779-19]

2:40 pm: **Contact/via placement management for N7 logic and beyond**, Kenichi Oyama, Shohei Yamauchi, Sakurako Natori, Arisa Hara, Masatoshi Yamato, Kyohei Koike, Tokyo Electron AT Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan) ..... [9779-20]

3:00 pm: **3D-ICs created using oblique processing**, D. Bruce Burckel, Paul J. Resnick, Bruce L. Draper, Paul S. Davids, Sandia National Labs. (USA)[9779-21]

Coffee Break. . . . . Tue 3:20 pm to 3:50 pm

**CONFERENCE 9780**  
Optical Microlithography XXIX

**SESSION 3**

**LOCATION: CONVENTION CENTER 210C**  
**TUE 1:40 PM TO 3:20 PM**

**Image and Process Control**

Session Chairs: **Yuri Granik**, Mentor Graphics Corp. (USA); **Kazuhiro Takahashi**, Canon Inc. (Japan)

1:40 pm: **The impact of lower light source bandwidth on patterning performance**, Paolo Alagna, Cymer LLC (Belgium); Gregory A. Rechtsteiner, Will E. Conley, Cymer LLC (USA); Vadim Timoshkov, ASML Netherlands B.V. (Netherlands); Patrick Wong, IMEC (Belgium); Jan Baselmans, ASML Netherlands B.V. (Netherlands) . . . . . [9780-7]

2:00 pm: **Intra-lot wafer by wafer overlay control using integrated and standalone metrology combined sampling**, Young-Sin Choi, Donghan Lee, Jae-il Lee, YoungSun Nam, Young Seog Kang, Se-Yeon Jang, Jeong-Heung Kong, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . [9780-8]

2:20 pm: **Reduction of wafer-edge overlay errors using advanced correction models, optimized for minimal metrology requirements**, Min-Suk Kim, Hwa-Yeon Won, Jong-Mun Jeong, SK Hynix, Inc. (Korea, Republic of); Paul Böcker, Lydia Vergaai-Huizer, Michiel Kupers, Milenko Jovanovic, Kevin Ryan, ASML Netherlands B.V. (Netherlands); Kyu-Tae Sun, Young-Wan Lim, Jin-Moo Byun, Gwang-Gon Kim, Jung-Joon Suh, ASML Korea Co., Ltd. (Korea, Republic of) . . . . . [9780-9]

2:40 pm: **Overcoming low-alignment signal contrast induced alignment failure by alignment signal enhancement**, ByeongSoo Lee, Young Ha Kim, Young Seog Kang, Jeongjin Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Bart Paarhuis, Haico Kok, Roelof F. de Graaf, Stefan Weichselbaum, Richard Droste, Christopher J. Mason, ASML Netherlands B.V. (Netherlands); Jeong-Heung Kong, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9780-10]

3:00 pm: **Pattern edge placement errors at 10nm integrated circuit design node**, Jacek K. Tyminski, Julia A. Sakamoto, Shane R. Palmer, Steven S. Slonaker, Stephen P. Renwick, Nikon Research Corp. of America (USA) . . . . . [9780-11]

Coffee Break . . . . . Tue 3:20 pm to 3:50 pm

**CONFERENCE 9782**  
Advanced Etch Technology for Nanopatterning V

**SESSION 5**

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

**Patterning Materials and Etch**

Joint Session with  
Conferences 9779 and 9782

Session Chairs: **Douglas Guerrero**, Brewer Science, Inc. (USA); **Qinghuang Lin**, IBM Thomas J. Watson Research Ctr. (USA)

1:20 pm: **Evaluation of ALE processes for patterning** (*Invited Paper*), Sebastian U. Engelmann, Robert L. Bruce, Hiroyuki Miyazoe, Nathan Marchack, Eric A. Joseph, IBM Thomas J. Watson Research Ctr. (USA) . . . . . [9782-16]

1:50 pm: **Edge roughness characterization of advanced patterning processes using power spectral density analysis (PSD)** (*Invited Paper*), Shimon Levi, Applied Materials, Ltd. (Israel) [9782-17]

2:20 pm: **Dielectric properties of spin-on metal oxides and their applications for 2D semiconductor devices**, Safak Sayan, Intel Corp. (USA) and IMEC (Belgium); Dennis Lin, Inge Asselberghs, Daniele Chiappe, Surajit Sutar, Iuliana Radu, Aaron Thean, IMEC (Belgium); Salem Mullen, Elizabeth Wolfer, Douglas S. McKenzie, Huirong Yao, M. Dalil Rahman, JoonYeon Cho, Munirathna Padmanaban, EMD Performance Materials Corp. (USA); Claire Petermann, Sung Eun Hong, IMEC (Belgium) . . . . . [9779-19]

2:40 pm: **Contact/via placement management for N7 logic and beyond**, Kenichi Oyama, Shohei Yamauchi, Sakurako Natori, Arisa Hara, Masatoshi Yamato, Kyohei Koike, Tokyo Electron AT Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan) . . . . . [9779-20]

3:00 pm: **3D-ICs created using oblique processing**, D. Bruce Burckel, Paul J. Resnick, Bruce L. Draper, Paul S. Davids, Sandia National Labs. (USA) [9779-21]

Coffee Break . . . . . Tue 3:20 pm to 4:00 pm

**CONFERENCE 9776**

Extreme Ultraviolet (EUV)  
Lithography VII

**SESSION 7**

**LOCATION: CONVENTION CENTER 220A  
TUE 3:40 PM TO 6:00 PM**

**EUV Source II**

Session Chairs: **Patrick P. Naulleau**, Lawrence Berkeley National Lab. (USA); **Bruno La Fontaine**, ASML (USA)

3:40 pm: **Revisiting Li as potential EUV source using dual-laser beam systems**, Tatyana Sizyuk, Ahmed Hassanein, Purdue Univ. (USA) . . . [9776-25]

4:00 pm: **Pulse widths optimization of dual-beam laser systems for high-power EUV sources**, Ahmed Hassanein, Tatyana Sizyuk, Purdue Univ. (USA) . . . [9776-26]

4:20 pm: **Energy effective dual-pulse bispectral laser for EUV lithography**, Aleksandr S. Grishkanich, Aleksandr P. Zhevlyakov, Sergey V. Kascheev, ITMO Univ. (Russian Federation); Ruben P. Seisyan, Ioffe Physical-Technical Institute (Russian Federation); Aleksandr Bagdasarov, S.I. Vavilov State Optical Institute (Russian Federation); Igor S. Sidorov, Univ. of Eastern Finland (Finland) . . . [9776-27]

4:40 pm: **Enabling laboratory EUV research with a compact exposure tool**, Sascha Brose, RWTH Aachen Univ. (Germany) . . . [9776-28]

5:00 pm: **Experimental tests of tin LPP plasma control in the argon cusp source**, Malcolm W. McGeoch, PLEX LLC (USA) . . . [9776-29]

5:20 pm: **Free electron lasers for 13nm EUV lithography: RF design strategies to minimise investment and operational costs**, Simon G. Keens, Marcel Frei, Ampegon AG (Switzerland) . . . [9776-30]

5:40 pm: **Characterization of wavefront and coherence properties of EUV sources**, Klaus Mann, Tobias Mey, Bernd Schäfer, Laser-Lab. Göttingen e.V. (Germany) . . . [9776-31]

**CONFERENCE 9777**

Alternative Lithographic  
Technologies VIII

**SESSION 5**

**LOCATION: CONVENTION CENTER 210B  
TUE 4:10 PM TO 5:50 PM**

**DSA Via Patterning**

Session Chairs: **Todd R. Younkin**, Intel Corp. (USA); **Elizabeth A. Dobisz**, HGST, Inc. (USA)

4:10 pm: **DSA via hole shrink for 7nm node applications**, Cheng Chi, Chi-Chun Liu, Yongan Xu, Luciana Meli, Ekmini Anuja de Silva, IBM Corp. (USA); Kristin Schmidt, Martha I. Sanchez, IBM Research - Almaden (USA); Richard A. Farrell, Hongyun Cottle, TEL Technology Ctr., America, LLC (USA); Daiji Kawamura, Lovejeet Singh, Tsuyoshi Furukawa, JSR Micro, Inc. (USA); Kafai Lai, IBM Thomas J. Watson Research Ctr. (USA); Jed W. Pitera, IBM Research - Almaden (USA); David R. Hetzer, TEL Technology Ctr., America, LLC (USA); Daniel P. Sanders, IBM Research - Almaden (USA) and IBM Corp. (USA); Andrew W. Metz, TEL Technology Ctr., America, LLC (USA); Nelson M. Felix, John C. Arnold, Bassem Hamieh, Matthew E. Colburn, IBM Corp. (USA) . . . [9777-20]

4:30 pm: **New placement estimator for contact hole printed with DSA**, Loic Schneider, Vincent Farys, Emmanuelle Serret, STMicroelectronics (France); Claire Fenouillet-Beranger, CEA LETI (France) . . . [9777-21]

4:50 pm: **Directed self-assembly (DSA) compliant correction flow with immersion lithography**, Yuansheng Ma, Mentor Graphics Corp. (USA); Yan Wang, GLOBALFOUNDRIES Inc. (USA); James Word, Junjiang Lei, Juan Andres Torres, Joydeep Mitra, Mentor Graphics Corp. (USA); Germain L. Fenger, Mentor Graphics Corp. (Belgium); Lei Yuan, Moshe E. Preil, Jongwook Kye, Harry J. Levinson, GLOBALFOUNDRIES Inc. (USA) . . . [9777-22]

5:10 pm: **Investigation of coat-develop track system for placement error of contact hole shrink process**, Masahiko Harumoto, SCREEN Holdings Co., Ltd. (Japan); Harold Stokes, SCREEN SPE Germany GmbH (Germany); Yuji Tanaka, Koji Kaneyama, Charles Pieczulewski, Masaya Asai, SCREEN Holdings Co., Ltd. (Japan); Isabelle Servin, Maxime Argoud, Ahmed Gharbi, CEA-LETI (France); Céline Lapeyre, Commissariat à l'Énergie Atomique (France); Raluca Tiron, CEA-LETI (France); Cedric Monget, STMicroelectronics (France) . . . [9777-23]

5:30 pm: **Manufacturability of dense hole arrays with directed self-assembly using the CHIPS flow**, Arjun Singh, IMEC (Belgium); Jaewoo Nam, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Jongsu Lee, SK Hynix, Inc. (Korea, Republic of); Boon Teik Chan, Hari Pathangi, IMEC (Belgium); Hengpeng Wu, Jian Yin, Yi Cao, EMD Performance Materials Corp. (USA); Roel Gronheid, IMEC (Belgium) . . . [9777-24]

**CONFERENCE 9778**

Metrology, Inspection, and Process  
Control for Microlithography XXX

**SESSION 7**

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

**Process Control**

Session Chairs: **Alok Vaid**, GLOBALFOUNDRIES Inc. (USA); **Eric Solecky**, GLOBALFOUNDRIES Inc. (USA)

3:40 pm: **Focus control enhancement and focus response analysis methodology on product**, Young Ki Kim, Yen-Jen Chen, Xueli Hao, Pavan Samudrala, Juan-Manuel Gomez, GLOBALFOUNDRIES Inc. (USA); Mark O. Mahoney, Ferhad Kamalizadeh, Justin Hanson, ASML (USA); Shawn Lee, ASML (Netherlands); Ye Tian, ASML (USA) . . . [9778-28]

4:00 pm: **Analysis of wafer heating in 14nm DUV layers**, Lokesh Subramany, Woong Jae Chung, Pavan K. Samudrala, Haiyong Gao, Nyan L. Aung, Juan M. Gomez, GLOBALFOUNDRIES Inc. (USA); Blandine Minghetti, ASML US, Inc. (USA); Shawn Lee, ASML Malta (USA) . . . [9778-29]

4:20 pm: **Line-edge roughness accuracy analysis during pattern transfer in self-aligned quadruple patterning process**, Gian F. Lorusso, IMEC (Belgium); Osamu Inoue, Hitachi High-Technologies Corp. (Japan); Takeyoshi Ohashi, Hitachi, Ltd. (Japan); Efrain Altamirano-Sánchez, IMEC (Belgium); Shunsuke Koshihara, Hitachi High-Technologies Corp. (Japan) . . . [9778-30]

4:40 pm: **Design-based metrology: Beyond CD/EPE metrics to evaluate printability performance**, Sandip Halder, Julien Mailfert, Philippe Leray, IMEC (Belgium); Bart Laenens, ASML Brion (USA); David Rio, Jun Chen, ASML Brion (Belgium) . . . [9778-31]

5:00 pm: **A new approach to process control using instability index**, Jeffrey Weintraub, Scott P. Warrick, Cirrus Logic, Inc. (USA) . . . [9778-32]

**LOCATION: CONVENTION CENTER 220B  
5:30 PM TO 6:30 PM**

**Metrology, Inspection, and Process  
Control Conference Celebrates Its  
30th Year!**

A chance to test your knowledge of metrology, inspection, and process control state-of-the art and significant background. State-of-the-art is what happens now; innovations of current and most recent conferences. Significant background is more in the foundations starting 30 years ago.

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**CONFERENCE 9779**

Advances in Patterning Materials and Processes XXXIII

**SESSION 7**

**LOCATION: CONVENTION CENTER 220C  
TUE 3:50 PM TO 5:30 PM**

**Negative Tone Materials and Processes**

Joint Session with  
Conference 9779 and 9780

Session Chairs: **Sean D. Burns**, IBM Corp. (USA); **Carlos Fonseca**, Tokyo Electron America, Inc. (USA)

3:50 pm: **Pattern size based process window variation comparison between NTD and PTD**, Doyoun Kim, SK Hynix, Inc. (Korea, Republic of) ..... [9780-12]

4:10 pm: **Challenges for immersion lithography extension based on negative-tone imaging (NTI) process**, Michihiro Shirakawa, Naoki Inoue, Hajime Furutani, Naohiro Tango, Keita Kato, Kei Yamamoto, Akiyoshi Goto, Mitsuhiro Fujita, FUJIFILM Corp. (Japan)..... [9779-22]

4:30 pm: **Novel DDR process and materials for front-edge NTD process**, Shuhei Shigaki, Wataru Shibayama, Ryuji Onishi, Satoshi Takeda, Makoto Nakajima, Rikimaru Sakamoto, Nissan Chemical Industries, Ltd. (Japan) ..... [9779-23]

4:50 pm: **Ultimate 2D resolution printing with negative-tone development**, Martin Burkhardt, IBM Thomas J. Watson Research Ctr. (USA); Yongan Xu, IBM Corp. (USA); Hsin-yu Tsai, IBM Thomas J. Watson Research Ctr. (USA); Alexander Tritchkov, Joerg Mellmann, Mentor Graphics Corp. (USA)..... [9780-13]

5:10 pm: **Fundamental characterization of shrink techniques on negative-tone development based dense contact holes**, Kaveri Jain, Scott L. Light, Micron Technology, Inc. (USA) ..... [9779-24]

**CONFERENCE 9780**

Optical Microlithography XXIX

**SESSION 4**

**LOCATION: CONVENTION CENTER 220C  
TUE 3:50 PM TO 5:30 PM**

**Negative Tone Materials and Processes**

Joint Session with  
Conference 9779 and 9780

Session Chairs: **Sean D. Burns**, IBM Corp. (USA); **Carlos Fonseca**, Tokyo Electron America, Inc. (USA)

3:50 pm: **Pattern size based process window variation comparison between NTD and PTD**, Doyoun Kim, SK Hynix, Inc. (Korea, Republic of) ..... [9780-12]

4:10 pm: **Challenges for immersion lithography extension based on negative-tone imaging (NTI) process**, Michihiro Shirakawa, Naoki Inoue, Hajime Furutani, Naohiro Tango, Keita Kato, Kei Yamamoto, Akiyoshi Goto, Mitsuhiro Fujita, FUJIFILM Corp. (Japan)..... [9779-22]

4:30 pm: **Novel DDR process and materials for front-edge NTD process**, Shuhei Shigaki, Wataru Shibayama, Ryuji Onishi, Satoshi Takeda, Makoto Nakajima, Rikimaru Sakamoto, Nissan Chemical Industries, Ltd. (Japan) ..... [9779-23]

4:50 pm: **Ultimate 2D resolution printing with negative-tone development**, Martin Burkhardt, IBM Thomas J. Watson Research Ctr. (USA); Yongan Xu, IBM Corp. (USA); Hsin-yu Tsai, IBM Thomas J. Watson Research Ctr. (USA); Alexander Tritchkov, Joerg Mellmann, Mentor Graphics Corp. (USA)..... [9780-13]

5:10 pm: **Fundamental characterization of shrink techniques on negative-tone development based dense contact holes**, Kaveri Jain, Scott L. Light, Micron Technology, Inc. (USA) ..... [9779-24]

**CONFERENCE 9782**

Advanced Etch Technology for Nanopatterning V

**SESSION 6**

**LOCATION: MARRIOTT,  
SAN JOSE SALON III  
TUE 4:00 PM TO 5:50 PM**

**Emerging Patterning Technologies (DSA, and other)**

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

4:00 pm: **Atomic precision etch using a low-electron temperature plasma** (*Invited Paper*), Shahid Rauf, Applied Materials, Inc. (USA) . [9782-18]

4:30 pm: **Interactions between plasma and block copolymers used in directed self-assembly patterning** (*Invited Paper*), Stephen Sirard, Lam Research Corp. (USA); Laurent Azarnouche, Univ. of California, Berkeley (USA); Emir Gurer, Lam Research Corp. (USA); William J. Durand, Michael J. Maher, Kazunori Mori, Gregory Blachut, Dustin Janes, Yusuke Asano, Yasunobu Someya, The Univ. of Texas at Austin (USA); Diane Hymes, Lam Research Corp. (USA); David B. Graves, Univ. of California, Berkeley (USA); Christopher J. Ellison, C. Grant Willson, The Univ. of Texas at Austin (USA) [9782-19]

5:00 pm: **A route for industry compatible DSA on high X PS-PDMS diblock copolymers** (*Invited Paper*), Olivier Joubert, LTM CNRS (France) [9782-20]

5:30 pm: **450mm etch process development and process chamber evaluation using 193i DSA guided pattern**, Wenli Collision, Global 450 Consortium (G450C) (USA) and SUNY Polytechnic Institute (USA); Yii-Cheng Lin, Global 450 Consortium (G450C) (USA) and TSMC (Taiwan); Shannon W. Dunn, Global 450 Consortium (G450C) (USA) and SUNY Polytechnic Institute (USA); Hiroaki Takikawa, Hitachi High-Technologies Corp. (Japan); James Paris, Hitachi High Technologies America, Inc. (USA); Lucy Chen, Troy Detrick, Applied Materials, Inc. (USA); Jun Belen, George Stojakovic, Michael Goss, Lam Research Corp. (USA); Norman Fish, Global 450 Consortium (G450C) (USA) and Intel Corp. (USA); Min-Joon Park, Global 450 Consortium (G450C) (USA) and Samsung Electronics Co., Ltd. (Korea, Republic of); Chih-Ming Sun, Global 450 Consortium (G450C) (USA) and TSMC (Taiwan); Mark Kelling, Global 450 Consortium (G450C) (USA) and GLOBALFOUNDRIES Inc. (USA); Pinyen Lin, Global 450 Consortium (G450C) (USA) and TSMC (Taiwan) ..... [9782-21]

Conference End.



# INTERACTIVE POSTER SESSION

Tuesday 23 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, interact with the poster authors who will be present during the poster session, and enjoy networking with your friends and colleagues.

## CONFERENCE 9776

### Extreme Ultraviolet (EUV) Lithography VII

**Study on RLS trade-off resist upgrade for production ready EUV lithography**, Junghyung Lee, Jieun Kim, Seunguk Jeong, Mi Jung Lim Sunyoung Koo, Chang-Moon Lim, Young Sik Kim, Sk Hynix, Inc. (Korea, Republic of) . . . . . [9776-7]

**Purification solution for EUV pod**, Long Ming Lu, Ming-Chien Chiu, Ruei-Ken Kao, Wei-Yan Chen, Gudeng Precision Industrial Co., Ltd. (Taiwan) . . . . . [9776-76]

**100W EUV light-source key components technology update for HVM**, Tsukasa Hori, Yasufumi Kawasuji, Takeshi Okamoto, Hiroshi Tanaka, Yukio Watanabe, Tamotsu Abe, Takeshi Kodama, Yutaka Shiraiishi, Hiroaki Nakarai, Taku Yamazaki, Shinji Okazaki, Takashi Saitou, Hiratsuka Mizoguchi, Gigaphoton Inc. (Japan) . . . . . [9776-77]

**Stress-induced pellicle analysis for extreme-ultraviolet lithography**, Eun-sang Park, Hye-Keun Oh, Hanyang Univ. (Korea, Republic of) . . . [9776-78]

**Update on EUV radiometry at PTB**, Christian Laubis, Annett Barboutis, Christian Buchholz, Andreas Fischer, Anton Haase, Florian Knorr, Heiko Mentzel, Jana Puls, Anja Schönstedt, Michael Sintschuk, Victor Soltwisch, Christian Stadelhoff, Frank Scholze, Physikalisches Technische Bundesanstalt (Germany) . . . . . [9776-79]

**LWR and defectivity improvement on EUV track system**, Masahiko Harumoto, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Harold Stokes, Yan Thouroude, SCREEN SPE Germany GmbH (Germany); Koji Kaneyama, Charles Pieczulewski, Masaya Asai, SCREEN Semiconductor Solutions Co., Ltd. (Japan) . . . . . [9776-80]

**Fundamental study on dissolution behavior of poly(methyl methacrylate) using by quartz crystal microbalance**, Akihiro Konda, Hiroki Yamamoto, Osaka Univ. (Japan); Shusuke Yoshitake, NuFlare Technology, Inc. (Japan); Takahiro Kozawa, Osaka Univ. (Japan) . . . . . [9776-81]

**Imaging plate analysis of extreme-ultraviolet light from laser-produced plasmas**, Christopher S. A. Musgrave, Takehiro Murakami, Tokyo Institute of Technology (Japan); Tomokazu Iyoda, Tokyo Institute of Technology (Japan) and Japan Science and Technology Agency (Japan); Keiji Nagai, Tokyo Institute of Technology (Japan) . . . . . [9776-82]

**Novel chemically amplified resist development for line-edge roughness reduction using by Monte Carlo simulation in extreme-ultraviolet lithography**, Sung-Gyu Lee, Hyun-Ju Lee, Seon-Young Jeong, Seung-Woo Son, Hanyang Univ. (Korea, Republic of); Hyun-Su Kim, RWTH Aachen Univ. (Germany); Hye-Keun Oh, Hanyang Univ. (Korea, Republic of) . . . . . [9776-83]

**Modeling of initial interaction between the laser pulse and Sn droplet target and pre-plasma formation for the LPP EUV source**, Akira Sasaki, Japan Atomic Energy Agency (Japan); Katsunobu Nishihara, Osaka Univ. (Japan); Atsushi Sunahara, Institute for Laser Technology (Japan); Takeshi Nishikawa, Okayama Univ. (Japan) . . . . . [9776-84]

**Multi-mirror adaptive optics for control of thermal aberrations in extreme-ultraviolet lithography**, Michel Habets, Joni Scholten, Siep Weiland, Technische Univ. Eindhoven (Netherlands); Wim M. J. Coene, Technische Univ. Delft (Netherlands) [9776-85]

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**Investigating the plasma cure on improving LER/LWR of narrow trench for sub-10nm node technology with EUV lithography**, Ming Mao, Frederic Lazzarino, IMEC (Belgium); Nihar Mohanty, TEL Technology Ctr., America, LLC (USA); Jan V. Hermans, Stephane Lariviere, IMEC (Belgium); Doni Parnell, TEL Technology Ctr., America, LLC (USA) . . . . . [9776-87]

**Alternative irradiation scheme for EUV source for inspection applications**, Duane Hudgins, Nadia Gambino, Bob Rollinger, Reza S. Abhari, ETH Zürich (Switzerland) . . . . . [9776-88]

**EUV resist outgassing analysis for the new platform resists at EIDEC**, Eishi Shiobara, Shinji Mikami, Yukiko Kikuchi, Takeshi Sasami, Takashi Kamazono, Shinya Minegishi, Takakazu Kimoto, Toru Fujimori, Satoshi Tanaka, EUVL Infrastructure Development Ctr., Inc. (Japan); Tetsuo Harada, Takeo Watanabe, Hiroo Kinoshita, Univ. of Hyogo (Japan) . . . . . [9776-89]

**Modeling of EUV target irradiated by shaped laser beam**, Majid Masnavi, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA) . . . . . [9776-90]

**High-power EUV irradiation tool setup for resist outgas evaluation in hydrogen**, Shinji Mikami, Eishi Shiobara, Satoshi Tanaka, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9776-91]

**Feasibility of a new absorber material for anamorphic high-NA extreme-ultraviolet lithography**, Ki-Ho Ko, Hye-Keun Oh, Hanyang Univ. (Korea, Republic of) . . . . . [9776-92]

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**Improvement of line-edge roughness through acid diffusion behavior analysis considered stochastic effect for extreme-ultraviolet resist**, Hyun-Ju Lee, Sung-Gyu Lee, Seon-Young Jeong, Seung-Woo Son, Hanyang Univ. (Korea, Republic of); Hyun-Su Kim, RWTH Aachen Univ. (Germany); Hye-Keun Oh, Hanyang Univ. (Korea, Republic of) . . . . . [9776-94]

**An automated image-based tool for pupil plane characterization of EUVL tools**, Zac Levinson, Jack S. Smith, Rochester Institute of Technology (USA); Germain L. Fenger, Mentor Graphics Corp. (Belgium); Bruce W. Smith, Rochester Institute of Technology (USA) . . . . . [9776-95]

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**Non-isotropic shadow effect with various pattern direction in anamorphic high-NA system**, In-Seon Kim, Guk-Jin Kim, Hanyang Univ. (Korea, Republic of); Michael S. Yeung, Fastlitho Inc. (USA); Eytan Barough, Boston Univ. (USA); Hye-Keun Oh, Hanyang Univ. (Korea, Republic of) . . . . . [9776-98]

**An update on Entegris' EUV pellicle compatible EUV inner pod development**, Huaping Wang, Entegris, Inc. (USA) . . . . . [9776-99]

**Emulation of scanner illumination using coherent diffractive imaging**, Patrick Helfenstein, Istvan Mohacsi, Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9776-100]

**Continuing studies focused on high-resolution contact hole printability**, Jun Sung Chun, SUNY Polytechnic Institute (USA) . . . . . [9776-101]

**Potential evaluation of sulfonium functionality bearing non-chemically amplified resists for nanopatterning by helium ion-beam lithography (HIBL)**, Subrata Ghosh, Kenneth E. Gonsalves, Chullikkattil P. Pradeep, Bulti Pramanick, Indian Institute of Technology Mandi (India); Sheng-Wei Chien, Kuen-Yu Tsai, National Taiwan Univ. (Taiwan) . . . . . [9776-102]

**Pattern fidelity optimization focused grating pattern for optical lithography expansion**, Masatoshi Yamato, Noriaki Okabe, Arisa Hara, Sakurako Natori, Shouhei Yamauchi, Kyohei Koike, Kenichi Oyama, Tokyo Electron Yamanashi Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan) . . . . . [9776-103]

**Toward a contamination-tolerant EUV power sensor**, Jacqueline van Veldhoven, Michel vanPutten, Evert Nieuwkoop, Timo Huijser, Diederik J. Maas, Norbert B. Koster, TNO (Netherlands) . . . [9776-104]

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### Alternative Lithographic Technologies VIII

#### NIL

**Nanoimprint lithography using biomass template**, Satoshi Takei, Makoto Hanabata, Kigen Sugahara, Toyama Prefectural Univ. (Japan); Naoto Sugino, Takao Kameda, Sanko Gosei Japan (Japan); Jiro Fukushima, Toyama Prefectural Plastic Industry Association (Japan); Atsushi Sekiguchi, Yoko Matsumoto, Litho Tech Japan Co., Ltd. (Japan).....[9777-52]

**Nano-imprint lithography using poly (methyl methacrylate) (PMMA) and polystyrene (PS) polymers**, Shyi-Long Shy, National Nano Device Labs. (Taiwan).....[9777-53]

**Improvement of sub-20nm pattern quality with dose modulation technique for NIL template production**, Keisuke Yagawa, Kunihiro Ugajin, Machiko Suenaga, Takeharu Motokawa, Kazuki Hagihara, Yukiyasu Arisawa, Sachiko Kobayashi, Masato Saito, Masamitsu Itoh, Toshiba Corp. (Japan).....[9777-54]

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**Resist roughness improvement by a chemical shrink process**, Tatsuro Nagahara, AZ Electronic Materials (Japan) K.K. (Japan); Takashi Sekito, Merck Performance Materials Hong Kong Ltd. (Japan); Yuriko Matsuura, AZ Electronic Materials (Japan) K.K. (Japan).....[9777-55]

**Attaining precision control over carbon nanotube placement on oxide substrates**, Hareem Maune, Charles T. Rettner, Shu-Jen Han, Hoa Truong, Linda K. Sundberg, Leslie Thompson, IBM Research - Almaden (USA); Toan Ta, laure Edoli, San José State Univ. (USA); Brian Lin, The Clorox Co. (USA)[9777-56]

**Nanoscale patterning in ambient conditions using liquid electromigration**, Santanu Talukder, Praveen Kumar, Rudra Pratap, Indian Institute of Science (India).....[9777-57]

**Complex patterns realized by quantum optical lithography**, Eugen Pavel, Storex Technologies Inc. (Romania).....[9777-58]

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**Control of morphological defects at the boundary between the periodic and non-periodic patterns in directed self-assembly process**, Akihisa Yoshida, Kenji Yoshimoto, Masahiro Ohshima, Kyoto Univ. (Japan); Katsuyoshi Kodera, Yoshihiro Naka, Sachiko Kobayashi, Shimon Maeda, Katsutoshi Kobayashi, Hisako Aoyama, Toshiba Corp. (Japan).....[9777-59]

**Directed self-assembly of Si-containing and topcoat free block copolymer**, Tasuku Matsumiya, Takehiro Seshimo, Tsuyoshi Kurosawa, Hitoshi Yamano, Ken Miyagi, Tomotaka Yamada, Katsumi Ohmori, Tokyo Ohka Kogyo Co., Ltd. (Japan).....[9777-60]

**Numerical placement analysis in hole multiplication patterns for directed self-assembly**, Kosuke Yamamoto, Tokyo Electron Yamanashi Ltd. (Japan); Takeo Nakano, Tokyo Electron Ltd. (Japan); Makoto Muramatsu, Hisashi Genjima, Tadatoshi Tomita, Tokyo Electron Kyushu Ltd. (Japan); Kazuyoshi Matsuzaki, Tokyo Electron Ltd. (Japan); Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan).....[9777-61]

**Simulation study of defective states analyzing the polymer chain conformations in direct self-assembly lithography**, Katsuyoshi Kodera, Hideki Kanai, Yuriko Seino, Hironobu Sato, Yusuke Kasahara, Katsutoshi Kobayashi, Hiroshi Kubota, Naoko Kihara, Yoshiaki Kawamonzon, Shinya Minegishi, Ken Miyagi, Hitoshi Yamano, Toshikatsu Tobana, Masayuki Shiraiishi, Satoshi Nomura, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan).....[9777-62]

**Grapho-epitaxial sub-10nm line and space patterning using lamellar-forming Si-containing block copolymer**, Hironobu Sato, Yusuke Kasahara, Naoko Kihara, Yuriko Seino, Ken Miyagi, Shinya Minegishi, Hitoshi Kubota, Katsutoshi Kobayashi, Hideki Kanai, Katsuyoshi Kodera, Yoshiaki Kawamonzon, Masayuki Shiraiishi, Hitoshi Yamano, Satoshi Nomura, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan); Teruaki Hayakawa, Tokyo Institute of Technology (Japan).....[9777-63]

**Sub-10nm lines and spaces patterning using grapho-epitaxial directed self-assembly of lamellar block copolymers**, Yuriko Seino, Hironobu Sato, Yusuke Kasahara, Shinya Minegishi, Ken Miyagi, Hitoshi Kubota, Hideki Kanai, Katsuyoshi Kodera, Masayuki Shiraiishi, Naoko Kihara, Yoshiaki Kawamonzon, Toshikatsu Tobana, Katsutoshi Kobayashi, Hitoshi Yamano, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan).....[9777-64]

**High-chi block copolymers for contact hole shrink DSA**, Kristin Schmidt, IBM Research - Almaden (USA); Hitoshi Osaki, Kouta Nishino, JSR Micro, Inc. (USA); Martha I. Sanchez, IBM Research - Almaden (USA); Eugene A. Delenia, JSR Micro, Inc. (USA) and IBM Research - Almaden (USA); Chi-Chun Liu, Albany NanoTech (USA); Tsuyoshi Furukawa, JSR Micro, Inc. (USA); Cheng Chi, Albany Nanotech (USA); Daniel P. Sanders, IBM Research - Almaden (USA); Nelson M. Felix, Albany NanoTech (USA).....[9777-65]

**Chemoepitaxial guiding underlayers for density asymmetric and energetically asymmetric diblock copolymers**, Benjamin D. Nation, Peter J. Ludovice, Clifford L. Henderson, Georgia Institute of Technology (USA).....[9777-66]

**A route for industry-compatible directed self-assembly of high-chi PS-PDMS block copolymers**, Marc Zelsmann, LTM CNRS (France) and Univ. Grenoble Alpes (France) and CEA-LETI (France); Jérôme Garnier, LTM-CNRS (France) and Univ. Grenoble Alpes (France) and CEA-LETI (France); Cécile Girardot, Javier Arias-Zapata, Sandrine Arnaud, LTM CNRS (France) and Univ. Grenoble Alpes (France) and CEA-LETI (France); Raluca Tiron, CEA-LETI (France) and Univ. Grenoble Alpes (France); Sophie Böhme, LTM CNRS (France) and Univ. Grenoble Alpes (France) and CEA-LETI (France); Denis Buttard, Olivier Marconot, Commissariat à l'Énergie Atomique (France) and Univ. Grenoble Alpes (France).....[9777-67]

**Tunable BCP L0 achievement**, Mary Ann J. Hockey, Brewer Science, Inc. (USA).....[9777-68]

**The effects of surface topography of nanopatterned substrates on the directed self-assembly of block copolymers**, Grant P. Garner, Juan J. de Pablo, The Univ. of Chicago (USA); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA).....[9777-69]

**Improved cost-effectiveness of the block copolymer anneal process for DSA**, Hari Pathangi, IMEC (Belgium); Werner Knaepen, ASM Belgium N.V. (Belgium) and ASM International N.V. (Belgium); Arindam Malik, Boon Teik Chan, Varun Vaid, Nadia Vandembroek, IMEC (Belgium); Jan Willem Maes, ASM International N.V. (Belgium); Roel Gronheid, IMEC (Belgium).....[9777-71]

**Defectivity study for directed self-assembly (DSA) contact hole shrinkage**, Tsung-Han Ko, Kuan Hsin Lo, Chieh-Han Wu, Ching-Yu Chang, Chung-Ju Lee, John Lin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan).....[9777-72]

**An integrated topcoat and pattern transfer approach for sub-10nm directed self-assembly**, Hyo Seon Suh, The Univ. of Chicago (USA) and Argonne National Lab. (USA); Do Han Kim, Massachusetts Institute of Technology (USA); Shisheng Xiong, The Univ. of Chicago (USA) and Argonne National Lab. (USA); Priya Moni, Massachusetts Institute of Technology (USA); Leonidas E. Ocola, Argonne National Lab. (USA); Karen K. Gleason, Massachusetts Institute of Technology (USA); Paul F. Nealey, The Univ. of Chicago (USA) and Argonne National Lab. (USA).....[9777-73]

**Hexagonal dot patterning using colloidal silica grafted with a concentrated polymer brush**, Akira Watanabe, Takeshi Okino, Naoko Kihara, Ryouusuke Yamamoto, Toshiba Corp. (Japan); Kohji Ohno, Kyoto Univ. (Japan).....[9777-74]

**Reversible nano-lithography for commercial approaches**, Hyun Ik Jang, Woo Choong Kim, Chi Won Ahn, Jae Hong Park, National Nanofab Ctr. (Korea, Republic of).....[9777-75]

# INTERACTIVE POSTER SESSION

Tuesday 23 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, interact with the poster authors who will be present during the poster session, and enjoy networking with your friends and colleagues.

## CONFERENCE 9779

### Advances in Patterning Materials and Processes XXXIII

#### Advanced Patterning Materials

**Planarization of topography with spin-on carbon hard mask**, Go Noya, Merck Performance Materials Manufacturing G.K. (Japan); Munirathna Padmanaban, Takanori Kudo, EMD Performance Materials Corp. (USA); Shigemasa Nakasugi, Maki Ishii, Yusuke Hama, Merck Performance Materials Manufacturing G.K. (Japan). . . . . [9779-52]

**Colloidal nanocrystal assemblies based nanolithography without optics**, Santosh Shaw, Kyle J. Miller, Ludovico Cademartiri, Iowa State Univ. of Science and Technology (USA). . . . . [9779-53]

**Development of heat resistant polyphenol compounds applied to the spin-on carbon hardmask**, Junya Horiuchi, Takashi Makinoshima, Naoya Uchiyama, Kana Okada, Yoko Shimizu, Masatoshi Echigo, Mitsubishi Gas Chemical Co., Inc. (Japan). . . . . [9779-54]

**Enhancing the Novolak resin resist resolution by adding phenol to fractionated resin**, Atsushi Sekiguchi, Yoko Matsumoto, Litho Tech Japan Co., Ltd. (Japan); Hatsuyuki Tanaka, Merck Performance Materials Manufacturing G.K. (Japan); Toshiyuki Horiuchi, Tokyo Denki Univ. (Japan); Yoshihisa Sensu, Litho Tech Japan Co., Ltd. (Japan). [9779-55]

**Development of spin-on carbon hardmask materials for planarization coating on topographic substrate**, Koji Inukai, Yoshi Hishiro, JSR Micro, Inc. (USA); Goji Wakamatsu, Tsubasa Abe, JSR Corp. (Japan); Kazunori Sakai, JSR Engineering Co., Ltd. (Japan); Yoshio Takimoto, Tomoki Nagai, Motoyuki Shima, JSR Corp. (Japan); Toru Kimura, JSR Engineering Co., Ltd. (Japan); Gregory Breyta, Noel Arellano, Kumar Virwani, IBM Research - Almaden (USA); Karen E. Petrillo, IBM Corp. (USA); Martin Glodde, IBM Thomas J. Watson Research Ctr. (USA); Ekmini Anuja de Silva, IBM Corp. (USA); Daniel P. Sanders, IBM Research - Almaden (USA). . [9779-56]

**Positive-tone, molecular glass resist based on acid-catalyzed depolymerization**, Brandon Sharp, Richard A. Lawson, Hannah Narcross, Georgia Institute of Technology (USA); Jun Sung Chun, SUNY CENSE/SUNYIT (USA); Mark Neisser, SUNY Poly SEMATECH (USA); Laren M. Tolbert, Clifford L. Henderson, Georgia Institute of Technology (USA). . . . . [9779-57]

**Spin-on metal oxide materials with high etch selectivity and wet strippability**, Huirong Yao, Salem Mullen, Elizabeth Wolfer, Douglas S. McKenzie, M. Dalil Rahman, JoonYeon Cho, Munirathna Padmanaban, EMD Performance Materials Corp. (USA); Claire Petermann, Merck KGaA (Belgium); Sung Eun Hong, EMD Performance Materials Corp. (Belgium). . . . . [9779-58]

**Novel silicon hardmask for collapse margin improvement**, Chen-Yu Liu, Ching-Yu Chang, Cheng-Han Wu, Yao-Ching Ku, John Lin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan). . . . . [9779-59]

**New resist materials based on polyacetal main chain scission**, Theodoros Manouras, Institute of Nanoscience and Nanotechnology (Greece) and Foundation for Research and Technology-Hellas (Greece); Antonis Olziersky, Panagiotis Argitis, Institute of Nanoscience and Nanotechnology (Greece). . . . . [9779-80]

#### Advanced Processing

**Metal reduction at point-of-use filtration**, Toru Umeda, Nihon Pall Ltd. (Japan); Rao Varanasi, Pall Corp. (USA); Shuichi Tsuzuki, Nihon Pall Ltd. (Japan). . . . . [9779-60]

**Integrating nanosphere lithography in device fabrication**, Tod Laurvick, Ronald A. Couto Jr., Air Force Institute of Technology (USA). . . . . [9779-61]

**CD control based on edge placement error analysis**, Shinji Kobayashi, Soichiro Okada, Satoru Shimura, Shinobu Miyazaki, Tokyo Electron Kyushu Ltd. (Japan); Kathleen Nafus, Carlos Fonseca, Tokyo Electron America, Inc. (USA); Serge Biesemans, Tokyo Electron Europe Ltd. (Belgium). . . . [9779-62]

**Considerations for fine hole patterning at 7nm node**, Hidetami Yaegashi, Tokyo Electron Ltd. (Japan); Kenichi Oyama, Shouhei Yamauchi, Arisa Hara, Sakurako Natori, Masatoshi Yamato, Kyohei Koike, Tokyo Electron Yamanashi Ltd. (Japan). . . . . [9779-64]

**Line-space bridge defect reduction via increased contact time at BARC point-of-use filtration**, Michael S. Sevegney, Eric Ellis, Benjamin Kolodzie, Brian Beakley, SAMSUNG Austin Semiconductor LLC (USA); Michael Mesawich, Amarnauth Singh, Rao Varanasi, Pall Corp. (USA). . . . . [9779-65]

**Line-space bridge defect reduction via enhanced filter cleanliness at resist point-of-use filtration**, Michael S. Sevegney, Eric Ellis, Benjamin Kolodzie, Brian Beakley, SAMSUNG Austin Semiconductor LLC (USA); Preston L. Williamson, Annie Xia, Aiwen Wu, Entegris, Inc. (USA). . . . . [9779-66]

**Chemical trimming overcoat: an enhancing composition and process for 193nm lithography**, Cong Liu, Dow Electronic Materials (USA). [9779-67]

## DSA Materials

**Novel neutral underlayer materials to enhance the photolithography performance and defectivity for chemo-epitaxy process**, Ryuta Mizuochi, Hiroyuki Wakayama, Yasunobu Someya, Rikimaru Sakamoto, Nissan Chemical Industries, Ltd. (Japan). . [9779-68]

**Phase field mapping for accurate, ultrafast simulations of directed self-assembly**, Jimmy Liu, Kris T. Delaney, Glenn H. Fredrickson, Univ. of California, Santa Barbara (USA). . . . . [9779-69]

**Filtration on block copolymer solution used in directed self-assembly lithography**, Toru Umeda, Nihon Pall Manufacturing Ltd. (Japan); Shuichi Tsuzuki, Nihon Pall Ltd. (Japan). . . . . [9779-70]

**Contrast enhanced diffusion NMR (CEDOSY): quantifying impurities in block copolymers for DSA**, Rudy Wojtecki, IBM Research - Almaden (USA); Ellie Porath, The Univ. of Chicago (USA); Ankit Vora, Alshakim Nelson, Daniel P. Sanders, IBM Research - Almaden (USA). . . . . [9779-71]

## E-Beam Materials

**Gold-polymethylmethacrylate (Au-PMMA) composite resist system: novel bottom up approach for direct write micro/nano-scale gold structures by electron beam lithography**, Suresh W. Gosavi, Savitribai Phule Pune Univ. (India). . . . . [9779-72]

**Benzophenone doped PDMS composite resist: high-energy pulsed electron-beam lithography application**, Madhushree G. Bute, Sanjay D. Dhole, Vasant N. Bhoraskar, Suresh W. Gosavi, Savitribai Phule Pune Univ. (India). . . . . [9779-73]

**mr-PosEBR: a novel positive-tone resist material for high-resolution electron-beam lithography**, Stefan Pfirrmann, micro resist technology GmbH (Germany); Robert Kirchner, Paul Scherrer Institut (Switzerland); Olga Lohse, Max-Planck-Institut für die Physik des Lichts (Germany); Vitaliy A. Guzenko, Paul Scherrer Institut (Switzerland); Anja Voigt, micro resist technology GmbH (Germany); Irina Harder, Max-Planck-Institut für die Physik des Lichts (Germany); Anett Kolander, micro resist technology GmbH (Germany); Helmut Schiff, Paul Scherrer Institut (Switzerland); Gabi Grützner, micro resist technology GmbH (Germany). . . . . [9779-74]

## EUV Materials

**Process integration of metal oxide based photoresist**, Benjamin L. Clark, Michael K. Kocsis, Sunny Rector, Richard Vachkov, Andrew Grenville, Inpria Corp. (USA); Koichi Hontake, Richard A. Farrell, David R. Hetzer, Andrew W. Metz, Shan Hu, Richard Gaylord, Triantro, Jeffrey T. Smith, TEL Technology Ctr., America, LLC (USA); Koichi Matsunaga, Hiroshi Mizunoura, Shinichiro Kawakami, Masashi Enomoto, Tokyo Electron Kyushu Ltd. (Japan). . . . . [9779-75]

**Spin-on-carbon hard masks utilizing fullerene derivatives**, Andreas Frommhold, The Univ. of Birmingham (United Kingdom); Alan G. Brown, Irresistible Materials Ltd. (United Kingdom); Tom Lada, Nano-C, Inc. (United Kingdom); Alex P. G. Robinson, The Univ. of Birmingham (United Kingdom) [9779-76]

**Helium ion beam lithography using inorganic HafSox resist**, Feixiang Luo, Viacheslav Manichev, Mengjun Li, Boris v. Yakshinskiy, Eric Garfunkel, Rutgers, The State Univ. of New Jersey (USA). . . . . [9779-77]

**EB and EUV lithography using inedible cellulose-based biomass resist material**, Satoshi Takei, Makoto Hanabata, Toyama Prefectural Univ. (Japan); Akihiro Oshima, Miki Kashiwakura, Takahiro Kozawa, Seiichi Tagawa, Osaka Univ. (Japan). . . . [9779-79]

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### Optical Microlithography XXIX

**Sub-100nm periodic structures fabricated by proximity i-line mask-aligner lithography (and self-aligned double patterning)**, Yannick Bourgin, Daniel Voigt, Thomas Kaesbier, Ernst-Bernhard Kley, Friedrich-Schiller-Univ. Jena (Germany); Uwe D. Zeitner, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany). . . . . [9780-38]

**Innovative method to suppress local geometry distortions for fabrication of interdigitated electrode arrays with nano gaps**, Stefan Partel, FH Vorarlberg (Austria) and Univ. of Freiburg (Germany); Gerald A. Urban, Univ. of Freiburg (Germany). . . . . [9780-39]



**Coherence management in lithography printing systems**, Johana Bernasconi, Toralf Scharf, Hans Peter Herzog, Krishnaparvathy Puthankovilakam, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Uwe Vogler, Arianna Bramati, Reinhard Völkel, SUSS MicroOptics SA (Switzerland) [9780-40]

**Fabricate large area and defect free periodic structures with advance achromatic laser interference lithography**, Yin-Kuang Yang, National Tsing Hua Univ. (Taiwan). [9780-41]

**Optimizing the lithography model calibration algorithms for NTD process**, Cheming Hu, Macronix International Co., Ltd. (Taiwan). [9780-42]

**Source mask optimization using 3D mask and compact resist models**, Omar H. El-Sewefy, Mentor Graphics Egypt (Egypt); Ao Chen, GLOBALFOUNDRIES Singapore (Singapore); Neal V. Lafferty, Jason Meiring, Mentor Graphics Corp. (USA); Angeline Chung, Mentor Graphics Corp. (Singapore); Yee Mei Foong, GLOBALFOUNDRIES Singapore (Singapore); Kostas Adam, John L. Sturtevant, Mentor Graphics Corp. (USA). [9780-43]

**Layer aware source-mask-target optimization**, Ao Chen, Yee Mei Foong, GLOBALFOUNDRIES Singapore (Singapore); Jessy Schramm, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Stephen D. Hsu, ASML Brion (USA); James Guerrero, ASML Singapore Pte. Ltd. (Singapore); Fengliang Liu, Joe C. Shaw, ASML Brion (USA). [9780-44]

**Resist profile aware source optimization and application in N28 full chip OPC**, Jun Zhu, State Key Lab. of ASIC & System (China); Zhengkai Yang, Zhifeng Gan, Biquiu Liu, Shirui Yu, Dan Wang, Fang Wei, Chenming Zhang, Han Chen, Daquan He, Lijun Chen, Peng Wu, Haichang Zheng, Shanghai Huali Microelectronics Corp. (China); Yanjun Xiao, Sam Liu, Andy Yang, Frings Liu, Yueliang Yao, ASML Brion (USA); Junwei Lu, ASML Intl. Trading Co., Ltd. (China); Stephen D. Hsu, ASML Brion (USA); Wei D. Zhang, Fudan Univ. (China). [9780-45]

**A novel full chip process window OPC based on matrix retargeting**, Xima Zhang, Tim Yu, Mentor Graphics Corp. (USA); Qingwei Liu, Xuan Shen, Semiconductor Manufacturing International Corp. (China); Liguozhang, Mentor Graphics Shanghai Electronic Technology Co. (China); Le Hong, Vlad Liubich, George Lippincott, Cynthia Zhu, James Word, Mentor Graphics Corp. (USA). [9780-46]

**Model based OPC/ORC accounting for non-planar topography effects in implant layer**, Taehyeong Lee, SK Hynix, Inc. (Korea, Republic of) [9780-47]

**Simple method for decrease of wafer topography effect for implant mask**, Taejun You, SK Hynix, Inc. (Korea, Republic of) [9780-48]

**Native conflict aware layout decomposition in triple patterning using bins based library matching method**, Xianhua Ke, Hao Jiang, Wen Lv, Shiyuan Liu, Huazhong Univ. of Science and Technology (China) [9780-49]

**Means to improve light source productivity: from proof of concept to field implementation**, Emmanuel Rausa, Theodore Cacouris, Will E. Conley, Gregory A. Rechtsteiner, Cymer LLC (USA) [9780-51]

**Neon reduction program on Cymer ArF light sources**, Dinesh Kanawade, Yzzer Roman, Theodore Cacouris, Joshua J. Thornes, Kevin M. O'Brien, Cymer LLC (USA) [9780-52]

**The next-generation ArF excimer laser for multiple-patterning immersion lithography with helium free operation**, Hirotaka Miyamoto, Gigaphoton Inc. (Japan) [9780-54]

**Rare resource supply crisis and solution technology for semiconductor manufacturing**, Hitomi Fukuda, Sophia Hu, Youngsun Yoo, Kenji Takahisa, Tatsuo Enami, Gigaphoton Inc. (Japan) [9780-55]

**Spatial conversion of excimer laser beam**, Alexandr S. Grishkanich, ITMO Univ. (Russian Federation) [9780-56]

**Progress on glass ceramic ZERODUR enabling nanometer precision**, Ralf Jedamzik, Clemens Kunisch, Johannes Nieder, Thomas Westerhoff, SCHOTT AG (Germany) [9780-57]

**Optimal design of wide-view-angle waveplate used for polarimetric diagnosis of lithography system**, Honggang Gu, Hao Jiang, Chuanwei Zhang, Xiuguo Chen, Shiyuan Liu, Huazhong Univ. of Science and Technology (China) [9780-58]

**Confocal position alignment in high-precision wavefront error metrology using Shack-Hartmann wavefront sensor**, Jiani Su, Zengxiong Lu, Yuejing Qi, Guangyi Liu, Qingbin Meng, Academy of Opto-Electronics (China) and Beijing Excimer Laser Technology and Engineering Ctr. (China) [9780-59]

**SEM signal emulation for 2D patterns**, Evgenii Sukhov, Synopsys SPb, LLC (Russian Federation); Thomas Muelders, Ulrich Klostermann, Weimin Gao, Mariya Braylovska, Synopsys GmbH (Germany) [9780-60]

**Source mask optimization study based on latest Nikon immersion scanner**, Jun Zhu, Fudan Univ. (China) and Shanghai Huali Microelectronics Corp. (China); Fang Wei, Lijun Chen, Chenming Zhang, Shanghai Huali Microelectronics Corp. (China); Wei D. Zhang, Fudan Univ. (China); Hisashi Nishinaga, Nikon Corp. (Japan); Omar H. El-Sewefy, Mentor Graphics Egypt (Egypt); Gen-Sheng Gao, Mentor Graphics Shanghai Electronic Technology Co. (China); Neal V. Lafferty, Jason Meiring, Cynthia Zhu, Kostas Adam, John L. Sturtevant, Mentor Graphics Corp. (USA) [9780-61]

**CDU budget breakdown as a diagnostic method for imaging sensitivity in HVM**, Young Ki Kim, Pavan Samudrala, Juan-Manuel Gomez, GLOBALFOUNDRIES Inc. (USA); Peter Nikolsky, Roy Anunciado, Maria Barkelid, ASML Netherlands B.V. (Netherlands); Shawn Lee, ASML (Netherlands); Ye Tian, Justin Hanson, ASML (USA) [9780-62]

**Inverse polarizer on mask**, Minfeng Chen, Shuo-Yen Chou, Chun-Kuang Chen, Ru-Gun Liu, Tsai-Sheng Gau, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) [9780-63]

**Line-edge roughness frequency analysis for SAQP process**, Lei Sun, Xiaoxiao (Michelle) Zhang, GLOBALFOUNDRIES Inc. (USA); Shimon Levi, Applied Materials, Ltd. (Israel); Zhenhua Ge, Hua Zhou, Applied Materials, Inc. (USA); Wenhui Wang, GLOBALFOUNDRIES Inc. (USA); Navaneetha Krishnan, Applied Materials, Inc. (USA); Yulu Chen, Erik Verduijn, Ryoung-Han Kim, GLOBALFOUNDRIES Inc. (USA) [9780-64]

**Fabrication of dual-wavelength diffractive beam splitters using maskless optical lithography based on a digital micromirror device**, Jun Amako, Toyo Univ. (Japan); Shinozaki Yu, Toyo Univ., Kawagoe (Japan) [9780-65]

**OPC for curved designs in application to photonics on silicon**, Bastien Orlando, Vincent Farys, STMicroelectronics (France); Sergei V. Postnikov, Patrick Schiavone, Céline Tranquillin, ASELTA Nanographics (France) [9780-66]

**Pixel-based mask optimization via particle swarm optimization algorithm for inverse lithography**, Lei Wang, Sikun Li, Xiangzhao Wang, Chaoxing Yang, Feng Tang, Shanghai Institute of Optics and Fine Mechanics (China) and Univ. of Chinese Academy of Sciences (China) [9780-67]

**A physical resist shrinkage model for full-chip lithography simulations**, Peng Liu, ASML Brion (USA) [9780-68]

## CONFERENCE 9782

### Advanced Etch Technology for Nanopatterning V

**Predicting LER and LWR in SAQP with 3D virtual fabrication**, Jiangjiang Gu, Dalong Zhao, Vasanth Allampalli, Daniel Faken, Ken Greiner, David M. Fried, Coventor, Inc. (USA) [9782-22]

**Etch proximity correction through machine-learning-driven etch bias model**, Seongbo Shim, Samsung Electronics Co., Ltd. (Korea, Republic of) and KAIST (Korea, Republic of); Youngsoo Shin, KAIST (Korea, Republic of) [9782-23]

**RIE challenge for fabrication of half-pitch sub-10nm lines and spaces pattern using directed self-assembly**, Yusuke Kasahara, Hironobu Sato, Yuriko Seino, Naoko Kihara, Katsutoshi Kobayashi, Hitoshi Kubota, Ken Miyagi, Shinya Minegishi, Toshikatsu Tobana, Hideki Kanai, Katsuyoshi Kodera, Masayuki Shiraishi, Yoshiaki Kawamonzen, Hitoshi Yamano, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan); Teruaki Hayakawa, Tokyo Institute of Technology (Japan) [9782-24]

**LER improvement for sub-32nm pitch self-aligned quadruple patterning (SAQP) at back end of line (BEOL)**, Nihar Mohanty, Richard A. Farrell, Cheryl Periera, Elliott Franke, Jeffrey T. Smith, Akiteru Ko, Anton Devilliers, Peter Biolsi, TEL Technology Ctr., America, LLC (USA); Wenhui Wang, Lei Sun, Ryoung-Han Kim, Genevieve Beique, Catherine Labelle, GLOBALFOUNDRIES Inc. (USA) [9782-25]

**Gate patterning challenges of vertically stacked gate-all-around Si nanowire MOSFET devices for 10nm and beyond nodes**, Lingkuan Meng, Qixia Xu, Xiaobin He, Junjie Li, Yayi Wei, Jiang Yan, Institute of Microelectronics (China) [9782-26]

**CONFERENCE 9776**

**Extreme Ultraviolet (EUV) Lithography VII**

**SESSION 8**

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

**EUV Resist I**

Session Chairs: **Wang Yueh**, Intel Corp. (USA); **Chang-Moon Lim**, SK Hynix, Inc. (Korea, Republic of)

8:00 am: **EUV resists: What's next?** (*Invited Paper*), Anna Lio, Intel Corp. (USA) . . . . . [9776-32]

8:30 am: **Benchmarking study of EUV resists for NXE3300**, Jun Sung Chun, Mac Mellish, Warren Montgomery, SUNY CNSE/SUNYIT (USA); Cecilia A. Montgomery, Yu-Jen Fan, SUNY Poly SEMATECH (USA) . . . . . [9776-33]

8:50 am: **Process development of 'metal resist' for EUV lithography**, Shinya Minegishi, Julius J. S. Santillan, Takashi Kamizono, Toru Fujimori, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9776-34]

9:10 am: **Patterning performance of chemically amplified resist in EUV lithography**, Tatsuya Fujii, Shogo Matsumaru, Tomotaka Yamada, Yoshitaka Komuro, Daisuke Kawana, Katsumi Ohmori, Tokyo Ohka Kogyo Co., Ltd. (Japan) . . . . . [9776-35]

9:30 am: **Sensitivity enhancement of chemically amplified resist and evaluation using EUV interference lithography**, Elizabeth Buitrago, Paul Scherrer Institut (Switzerland); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Oktay Yildirim, ASML Netherlands B.V. (Netherlands); Hisashi Nakagawa, JSR Corp. (Japan); Seiichi Tagawa, Osaka Univ. (Japan); Marieke Meeuwissen, ASML Netherlands B.V. (Netherlands); Tomoki Nagai, Takehiko Naruoka, JSR Corp. (Japan); Coen Verspaget, Rik Hoefnagels, Gijsbert Rispen, ASML Netherlands B.V. (Netherlands); Gosuke Shiraiishi, Yuichi Terashita, Yukie Minekawa, Kosuke Yoshihara, Tokyo Electron Kyushu Ltd. (Japan); Akihiro Oshima, Osaka Univ. (Japan); Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9776-36]

9:50 am: **EUV extendibility via dry development rinse process**, Safak Sayan, Intel Corp. (USA); Danilo De Simone, Tao Sheng Zheng, Geert Vandenberghe, IMEC (Belgium) . . . . . [9776-37]

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

**CONFERENCE 9777**

**Alternative Lithographic Technologies VIII**

**SESSION 6**

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

**DSA Process and Integration**

**Joint Session with Conferences 9777 and 9779**

Session Chairs: **Dan B. Millward**, Dow Chemical Co. (USA); **Mark H. Somervell**, Tokyo Electron America, Inc. (USA)

8:10 am: **Opportunities and challenges for DSA in logic and memory** (*Invited Paper*), Roel Gronheid, IMEC (Belgium); Arjun Singh, IMEC (Belgium) and KU Leuven (Belgium); Jan Doise, KU Leuven (Belgium) and IMEC (Belgium); Carolien Boeckx, Ioannis Karageorgos, IMEC (Belgium) and KU Leuven (Belgium); Julien Ryckaert, Hari Pathangi, IMEC (Belgium); Paulina A. Rincon-Delgadillo, The Univ. of Chicago (Belgium) and IMEC (Belgium); Boon Teik Chan, Geert Vandenberghe, IMEC (Belgium) . . . . . [9777-25]

8:40 am: **DSA patterning options for FinFET formation at 7nm node**, Chi-Chun Liu, IBM Research (USA); Elliott Franke, TEL Technology Ctr., America, LLC (USA); Fee Li Lie, Stuart Sieg, Hsin-yu Tsai, Kafai Lai, IBM Research (USA); Hoa Truong, IBM Research - Almaden (USA); Richard A. Farrell, TEL Technology Ctr., America, LLC (USA); Mark H. Somervell, Tokyo Electron America, Inc. (USA); Bassem Hamieh, IBM Research (USA); Daniel P. Sanders, IBM Research - Almaden (USA); Nelson M. Felix, Michael A. Guillorn, IBM Research (USA); David R. Hetzer, Akiteru Ko, TEL Technology Ctr., America, LLC (USA); Matthew E. Colburn, IBM Research (USA) . . . . . [9777-26]

9:00 am: **Toward sub-20nm pitch FinFET patterning and integration with DSA**, Safak Sayan, Intel Corp. (USA); Taisir Marzook, Intel Corp. (Israel); Boon Teik Chan, Nadia Vandenbroeck, David Laidler, Philippe Leray, Arjun Singh, Paulina A. Rincon-Delgadillo, Roel Gronheid, Efrain Altamirano-Sánchez, Geert Vandenberghe, IMEC (Belgium) . . . [9779-25]

9:20 am: **Defect characterization in templated DSA through electrical measurements**, Paulina A. Rincon-Delgadillo, Boon Teik Chan, Kevin Vandersmissen, IMEC (Belgium); Jan Doise, IMEC (Belgium) and KU Leuven (Belgium); Roel Gronheid, IMEC (Belgium) . . . . . [9777-27]

9:40 am: **Process highlights to enhance DSA contact patterning performances**, Ahmed Gharbi, Raluca Tiron, Maxime Argoud, Gaëlle Chamiot-Maitral, Isabelle Servin, Sandra Bos, Patricia Pimenta-Barros, Aurélien Sarrazin, Antoine Fouquet, Jérôme Hazart, CEA-LETI (France); Xavier Chevalier, Christophe Navarro, Célia Nicolet, Arkema S.A. (France); Céline Lapeyre, Shayma Bouanani, Cedric Monget, STMicroelectronics (France) . . . . . [9777-28]

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

**CONFERENCE 9778**

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

**SESSION 8**

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

**Optical Metrology II**

Session Chairs: **Matthew J. Sendelbach**, Nova Measuring Instruments Inc. (USA); **Alek C. Chen**, ASML (USA)

8:00 am: **Enabling quantitative optical imaging for in-die-capable critical dimension targets** (*Invited Paper*), Bryan M. Barnes, Mark-Alexander Henn, Martin Y. Sohn, Hui Zhou, Richard M. Silver, National Institute of Standards and Technology (USA) . . . . . [9778-33]

8:30 am: **Optical metrology solutions for 10nm films process control challenges**, Sridhar Mahendrakar, Alok Vaid, GLOBALFOUNDRIES Inc. (USA); Kartik Venkataraman, KLA-Tencor Corp. (USA); Michael Lenahan, Steven Seipp, Fang Fang, Shweta Saxena, GLOBALFOUNDRIES Inc. (USA); Dawei Hu, Ming Di, Da Song, KLA-Tencor Corp. (USA) [9778-34]

8:50 am: **Advanced in-line optical metrology of sub-10nm structures for gate all around devices**, Gangadhara Raja Muthinti, IBM Research (USA) and Albany NanoTech (USA); Parker Lund, Aron J. Cepler, Matthew J. Sendelbach, Nova Measuring Instruments Inc. (USA); Oded Cohen, Cornel Bozdog, Nova Measuring Instruments Ltd. (Israel); Mark Klare, ReVera, Inc. (USA); Nicolas Loubet, IBM Research - Almaden (USA) and Albany NanoTech (USA); Robin Chao, IBM Research (USA) and Albany NanoTech (USA); Michael A. Guillorn, Nelson M. Felix, IBM Research (USA) and Albany NanoTech (USA) . . . . . [9778-35]

9:10 am: **Optimizing noise for defect analysis with through-focus scanning optical microscopy**, Ravikiran Attota, John A. Kramar, National Institute of Standards and Technology (USA) . . . . . [9778-36]

9:30 am: **Monitoring of ion implantation in microelectronics production environment using multi-channel reflectometry**, Peter Ebersbach, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Adam Urbanowicz, Nova Measuring Instruments GmbH (Germany); Dmitry Likhachev, Carsten Hartig, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany) . . . . . [9778-37]

9:50 am: **Advanced in-line metrology strategy for self-aligned quadruple patterning**, Robin Chao, IBM Albany NanoTech (USA); Mary A. Breton, Benoit L'Herron, Gangadhara Raja Muthinti, Florence Nelson, Abraham De La Pena, Fee Li Lie, Eric Miller, Stuart Sieg, James Demarest, IBM Albany NanoTech (USA); Peter Gin, Matthew Worthington, Jordan Valley Semiconductors, Inc. (USA); Aron J. Cepler, Cornel Bozdog, Matthew J. Sendelbach, Nova Measuring Instruments Inc. (USA); Shay Wolfing, Nova Measuring Instruments Ltd. (Israel); Sivananda Kanakasabapathy, John Gaudiello, Nelson M. Felix, IBM Albany NanoTech (USA) . . . . . [9778-90]

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



**CONFERENCE 9779**

Advances in Patterning Materials and Processes XXXIII

**SESSION 8**

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

**DSA Process and Integration**

Joint Session with Conferences 9777 and 9779

Session Chairs: **Dan B. Millward**, Dow Chemical Co. (USA); **Mark H. Somervell**, Tokyo Electron America, Inc. (USA)

8:10 am: **Opportunities and challenges for DSA in logic and memory** (*Invited Paper*), Roel Gronheid, IMEC (Belgium); Arjun Singh, IMEC (Belgium) and KU Leuven (Belgium); Jan Doise, KU Leuven (Belgium) and IMEC (Belgium); Carolien Boeckx, Ioannis Karageorgos, IMEC (Belgium) and KU Leuven (Belgium); Julien Ryckaert, Hari Pathangi, IMEC (Belgium); Paulina A. Rincon-Delgadillo, The Univ. of Chicago (Belgium) and IMEC (Belgium); Boon Teik Chan, Geert Vandenbergh, IMEC (Belgium) . . . . . [9777-25]

8:40 am: **DSA patterning options for FinFET formation at 7nm node**, Chi-Chun Liu, IBM Research (USA); Elliott Franke, TEL Technology Ctr., America, LLC (USA); Fee Li Lie, Stuart Sieg, Hsin-yu Tsai, Kafai Lai, IBM Research (USA); Hoa Truong, IBM Research - Almaden (USA); Richard A. Farrell, TEL Technology Ctr., America, LLC (USA); Mark H. Somervell, Tokyo Electron America, Inc. (USA); Bassem Hamieh, IBM Research (USA); Daniel P. Sanders, IBM Research - Almaden (USA); Nelson M. Felix, Michael A. Guillorn, IBM Research (USA); David R. Hetzer, Akiteru Ko, TEL Technology Ctr., America, LLC (USA); Matthew E. Colburn, IBM Research (USA) . . . . . [9777-26]

9:00 am: **Toward sub-20nm pitch FinFET patterning and integration with DSA**, Safak Sayan, Intel Corp. (USA); Taisir Marzook, Intel Corp. (Israel); Boon Teik Chan, Nadia Vandenbroeck, David Laidler, Philippe Leray, Arjun Singh, Paulina A. Rincon-Delgadillo, Roel Gronheid, Efrain Altamirano-Sánchez, Geert Vandenbergh, IMEC (Belgium) . . . [9779-25]

9:20 am: **Defect characterization in templated DSA through electrical measurements**, Paulina A. Rincon-Delgadillo, Boon Teik Chan, Kevin Vandersmissen, IMEC (Belgium); Jan Doise, IMEC (Belgium) and KU Leuven (Belgium); Roel Gronheid, IMEC (Belgium) . . . [9777-27]

9:40 am: **Process highlights to enhance DSA contact patterning performances**, Ahmed Gharbi, Raluca Tiron, Maxime Argoud, Gaëlle Chamiot-Maitral, Isabelle Servin, Sandra Bos, Patricia Pimenta-Barros, Aurélien Sarrazin, Antoine Fouquet, Jérôme Hazart, CEA-LETI (France); Xavier Chevalier, Christophe Navarro, Célia Nicolet, Arkema S.A. (France); Céline Lapeyre, Shayma Bouanani, Cedric Monget, STMicroelectronics (France) . . . . . [9777-28]

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

**CONFERENCE 9780**

Optical Microlithography XXIX

**SESSION 5**

**LOCATION: CONVENTION CENTER 210C  
WED 8:20 AM TO 10:30 AM**

**Computational Lithography**

Session Chairs: **Soichi Owa**, Nikon Corp. (Japan); **John S. Petersen**, Petersen Advanced Lithography, Inc. (USA)

8:20 am: **Chronicles of compact lithographic modeling** (*Invited Paper*), Yuri Granik, Mentor Graphics Corp. (USA) . . . . . [9780-14]

8:50 am: **Effects of lithography model physics on model-based assist feature placement**, Shih-Hsiang Lo, Hsu-Ting Huang, Wen-Chun Huang, Ru-Gun Liu, Tsai-Sheng Gau, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9780-15]

9:10 am: **Machine learning (ML)-guided OPC using basis functions of polar Fourier transform**, Seongbo Shim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) and KAIST (Korea, Republic of); Suhyeong Choi, Youngsoo Shin, KAIST (Korea, Republic of) . . . . . [9780-16]

9:30 am: **Bayesian inference for OPC modeling**, Andrew Burbine, Mentor Graphics Corp. (USA) and Rochester Institute of Technology (USA); David Fryer, John L. Sturtevant, Mentor Graphics Corp. (USA); Bruce W. Smith, Rochester Institute of Technology (USA) . . . [9780-17]

9:50 am: **OPC recipe optimization using genetic algorithm**, Abhishek Asthana, William Wilkinson, Dave Power, GLOBALFOUNDRIES Inc. (USA) . . . . . [9780-18]

10:10 am: **Impact of bandwidth variation on OPC model accuracy**, Will E. Conley, Cymer LLC (USA); Paolo Alagna, Cymer LLC (Belgium); Stephen D. Hsu, ASML Brion (USA) . . . . . [9780-19]

Coffee Break . . . . . Wed 10:30 am to 11:00 am

**CONFERENCE 9781**

Design-Process-Technology  
Co-optimization for Manufacturability X

**SESSION 1**

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

**Layout Optimization and Design Restrictions**

Session Chairs: **Luigi Capodici**, KnotPrime Inc. (USA); **Jason P. Cain**, Advanced Micro Devices, Inc. (USA)

8:00 am: **Toward the 5nm technology: layout optimization and performance benchmark for logic/SRAMs using lateral and vertical GAA FETs** (*Invited Paper*), Trong Huynh-Bao, Julien Ryckaert, Sushil S. Sakhare, Abdelkarim Mercha, Diederik Verkest, Aaron Thean, Piet Wambacq, IMEC (Belgium) . . . . . [9781-1]

8:30 am: **Structural design, layout analysis and routing strategy for constructing IC standard cells using vertical gate-all-around nanowire MOSFETs**, Hongyi Liu, Jun Zhou, Ting Han, Yijian Chen, Peking Univ. (China) . . . . . [9781-2]

8:50 am: **Directed self-assembly aware restricted design rule and its impact on design ability**, Yulu Chen, Ryoung-Han Kim, GLOBALFOUNDRIES Inc. (USA) . . . . . [9781-3]

9:10 am: **Integrated routing and fill for self-aligned double patterning (SADP) using gride-base design**, Youngsoo Song, Jeemyung Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Youngsoo Shin, KAIST (Korea, Republic of) . . . . . [9781-4]

9:30 am: **Integrated layout based Monte Carlo simulation for dense design scaling**, Dongbing Shao, IBM Corp. (USA); Lei Zhuang, GLOBALFOUNDRIES Inc. (USA); Larry Clevenger, IBM Corp. (USA); James A. Culp, GLOBALFOUNDRIES Inc. (USA); Robert Wong, IBM Corp. (USA); Lars Liebmann, GLOBALFOUNDRIES Inc. (USA) . [9781-5]

9:50 am: **Impact of EUV patterning scenarios on different design styles and their design rules for 7nm-node BEOL layers**, Tsann-Bim Chiou, ASML Taiwan Ltd. (Taiwan); Alek C. Chen, Mircea V. Dusa, ASML US, Inc. (USA); Shih En Tseng, ASML Taiwan Ltd. (Taiwan) . . . [9781-6]

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

**CONFERENCE 9776**

**Extreme Ultraviolet (EUV) Lithography VII**

**SESSION 9**

**LOCATION: CONVENTION CENTER 220A  
WED 10:40 AM TO 12:00 PM**

**EUV Resist II**

Session Chairs: **Robert L. Brainard**, SUNY CNSE/SUNYIT (USA);  
**Andrew Grenville**, Inpria Corp. (USA)

10:40 am: **The reaction mechanism and patterning of photosensitized chemically amplified resists**, Seiichi Tagawa, Akihiro Oshima, Cong Que Dinh, Shigehiro Nishijima, Osaka Univ. (Japan); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Michael A. Carcasi, Tokyo Electron America, Inc. (USA); Gosuke Shiraishi, Yuichi Terashita, Yukie Minekawa, Kosuke Yoshihara, Tokyo Electron Kyushu Ltd. (Japan); Hisashi Nakagawa, Takehiko Naruoka, Tomoki Nagai, JSR Corp. (Japan) . . . . . [9776-38]

11:00 am: **Measurement of dynamic absorption coefficients of CAR and non-CAR resists at EUV**, Roberto Fallica, Michaela Vockenhuber, Paul Scherrer Institut (Switzerland); Jason K. Stowers, Andrew Grenville, Inpria Corp. (USA); Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9776-39]

11:20 am: **Effects of acid diffusivity on line-edge roughness in extreme-ultraviolet chemically amplified resist pattern**, Seon-Young Jeong, Youngjin Kim, Sung-Gyu Lee, Hyun-Ju Lee, Hye-Keun Oh, Hanyang Univ. (Korea, Republic of); Hyun-Su Kim, RWTH Aachen Univ. (Germany); Seung-Woo Son, Hanyang Univ. (Korea, Republic of) . . . . . [9776-40]

11:40 am: **Optimization and sensitivity enhancement of high-resolution molecular resist for EUV lithography**, Andreas Frommhold, The Univ. of Birmingham (United Kingdom); Alexandra L. McClelland, Irresistible Materials Ltd. (United Kingdom); John Roth, Nano-C, Inc. (USA); Alex P. G. Robinson, The Univ. of Birmingham (United Kingdom) . . . . . [9776-41]

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

**CONFERENCE 9777**

**Alternative Lithographic Technologies VIII**

**SESSION 7**

**LOCATION: CONVENTION CENTER 210B  
WED 10:30 AM TO 12:20 PM**

**DSA Materials and Processes**

**Joint Session with Conferences 9777 and 9779**

Session Chairs: **Roel Gronheid**, IMEC (Belgium); **Benjamin M. Rathsack**, Tokyo Electron America, Inc. (USA)

10:30 am: **Design and directed self-assembly of Si-containing block copolymers** (*Invited Paper*), C. Grant Willson, The Univ. of Texas at Austin (USA) . . . . . [9777-29]

11:00 am: **Topcoat free orientation control strategies for high- $\gamma$  block copolymers**, Ankit Vora, Anindarupa Chunder, Gabriela Alva, Noel Arellano, Kristin Schmidt, Teddie Magbitang, Melia Tjio, Hoa Troung, Elizabeth M. Lofano, IBM Research - Almaden (USA); Hsinyu Tsai, Hiroyuki Miyazoe, IBM Thomas J. Watson Research Ctr. (USA); Chi-Chun Liu, Albany NanoTech (USA); Joy Cheng, Daniel P. Sanders, IBM Research - Almaden (USA) . . . . . [9777-30]

11:20 am: **Integration of SIS smoothed DSA line patterns: challenges, solutions and impact on defectivity**, Arjun Singh, IMEC (Belgium); Werner Knaepen, ASM Belgium N.V. (Belgium); Ziad el Otell, Boon Teik Chan, IMEC (Belgium); Jan W. Maes, ASM International N.V. (Belgium); Roel Gronheid, IMEC (Belgium) . . . . . [9779-26]

11:40 am: **Directed self-assembly of PS-b-PMMA with ionic liquid addition**, Xuanxuan Chen, The Univ. of Chicago (Belgium) and IMEC (Belgium); Takehito Seo, Tokyo Ohka Kogyo Co., Ltd. (Japan); Paulina A. Rincon-Delgadillo, IMEC (Belgium); Tasuku Matsumiya, Akiya Kawaue, Takaya Maehashi, Takahiro Dazai, Tokyo Ohka Kogyo Co., Ltd. (Japan); Roel Gronheid, IMEC (Belgium); Paul Nealey, The Univ. of Chicago (Belgium) . . . . . [9779-27]

12:00 pm: **Pushing the limit of directed self-assembly and double patterning to 4nm half-pitch and beyond**, Shuaigang Xiao, XiaoMin Yang, Yautzong Hsu, Seagate Technology LLC (USA); Stefano Dallorto, Lawrence Berkeley National Lab. (USA) and The Molecular Foundry (USA); Deirdre L. Olynick, The Molecular Foundry (USA) and Lawrence Berkeley National Lab. (USA); Kim Y. Lee, David Kuo, Seagate Technology LLC (USA) . . . . . [9777-31]

Lunch/Exhibition Break . . . . . Wed 12:20 pm to 1:40 pm

**CONFERENCE 9778**

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

**SESSION 9**

**LOCATION: CONVENTION CENTER 220B  
WED 10:40 AM TO 12:00 PM**

**SEM II**

Session Chairs: **Ofer Adan**, Applied Materials, Ltd. (Israel);  
**Timothy F. Crimmins**, Intel Corp. (USA)

10:40 am: **Process monitor of 3D-device features by using FIB and CD-SEM**, Hiroki Kawada, Masami Ikota, Hideo Sakai, Hitachi High-Technologies Corp. (Japan); Satoshi Tomimatsu, Tsuyoshi Onishi, Hitachi High-Tech Science Corp. (Japan) . . . . . [9778-38]

11:00 am: **Free surface BCP self-assembly process characterization with 3D CDSEM**, Shimon Levi, Applied Materials, Ltd. (Israel)[9778-39]

11:20 am: **Advanced CD-SEM metrology for qualification of DSA patterns using coordinated line epitaxy (COOL) process**, Takeshi Kato, Masami Ikota, Junko Konishi, Satoru Yamaguchi, Hitachi High-Technologies Corp. (Japan); Hironobu Sato, Yuriko Seino, Yusuke Kasahara, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9778-40]

11:40 am: **Identification of multilayer structure using secondary electron yield curves: Effects of native oxide film, material density, and surface contamination**, Susumu Iida, EUVL Infrastructure Development Ctr., Inc. (Japan); Kaoru Ohya, The Univ. of Tokushima (Japan); Ryoichi Hirano, Hidehiro Watanabe, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9778-41]

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

CONFERENCE 9779

Advances in Patterning Materials and Processes XXXIII

SESSION 9

LOCATION: CONVENTION CENTER 210B WED 10:30 AM TO 12:20 PM

DSA Materials and Processes

Joint Session with Conferences 9777 and 9779

Session Chairs: Roel Gronheid, IMEC (Belgium); Benjamin M. Rathsack, Tokyo Electron America, Inc. (USA)

10:30 am: Design and directed self-assembly of Si-containing block copolymers (Invited Paper), C. Grant Willson, The Univ. of Texas at Austin (USA) [9777-29]

11:00 am: Topcoat free orientation control strategies for high-χ block copolymers, Ankit Vora, Anindarupa Chunder, Gabriela Alva, Noel Arellano, Kristin Schmidt, Teddie Magbitang, Melia Tjio, Hoa Troung, Elizabeth M. Lofano, IBM Research - Almaden (USA); Hsinyu Tsai, Hiroyuki Miyazoe, IBM Thomas J. Watson Research Ctr. (USA); Chi-Chun Liu, Albany NanoTech (USA); Joy Cheng, Daniel P. Sanders, IBM Research - Almaden (USA) [9777-30]

11:20 am: Integration of SIS smoothed DSA line patterns: challenges, solutions and impact on defectivity, Arjun Singh, IMEC (Belgium); Werner Knaepen, ASM Belgium N.V. (Belgium); Ziad el Otell, Boon Teik Chan, IMEC (Belgium); Jan W. Maes, ASM International N.V. (Belgium); Roel Gronheid, IMEC (Belgium) [9779-26]

11:40 am: Directed self-assembly of PS-b-PMMA with ionic liquid addition, Xuanxuan Chen, The Univ. of Chicago (Belgium) and IMEC (Belgium); Takehito Seo, Tokyo Ohka Kogyo Co., Ltd. (Japan); Paulina A. Rincon-Delgadillo, IMEC (Belgium); Tasuku Matsumiya, Akiya Kawaue, Takaya Maehashi, Takahiro Dazai, Tokyo Ohka Kogyo Co., Ltd. (Japan); Roel Gronheid, IMEC (Belgium); Paul Nealey, The Univ. of Chicago (Belgium) [9779-27]

12:00 pm: Pushing the limit of directed self-assembly and double patterning to 4nm half-pitch and beyond, Shuaigang Xiao, XiaoMin Yang, Yautzong Hsu, Seagate Technology LLC (USA); Stefano Dallorto, Lawrence Berkeley National Lab. (USA) and The Molecular Foundry (USA); Deirdre L. Olynick, The Molecular Foundry (USA) and Lawrence Berkeley National Lab. (USA); Kim Y. Lee, David Kuo, Seagate Technology LLC (USA) [9777-31]

Lunch/Exhibition Break Wed 12:20 pm to 1:40 pm

CONFERENCE 9780

Optical Microlithography XXIX

SESSION 6

LOCATION: CONVENTION CENTER 210C WED 11:00 AM TO 12:30 PM

Material and Process Driven Resolution Enhancements

Session Chairs: Will E. Conley, Cymer LLC (USA); Harsha Grunes, Intel Corp. (USA)

11:00 am: Design technology co-optimization assessment of directed self-assembly-based lithography (Invited Paper), Kafai Lai, IBM Thomas J. Watson Research Ctr. (USA); Ananthan Raghunathan, GLOBALFOUNDRIES Inc. (USA); Sung Gon Jung, Wooyong Cho, SAMSUNG Electronics Co., Ltd. (USA); Gazi M. Huda, Parul Dhagat, Oseo Park, Lin Hu, GLOBALFOUNDRIES Inc. (USA); Chi-Chun Liu, Yongan Xu, Cheng Chi, IBM Corp. (USA); Hsinyu Tsai, IBM Thomas J. Watson Research Ctr. (USA); Brent Goplen, GLOBALFOUNDRIES Inc. (USA); Jaime D. Morillo, IBM Corp. (USA); Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA); Kristin Schmidt, IBM Corp. (USA); Markus Brink, IBM Thomas J. Watson Research Ctr. (USA); Jed W. Pitera, Daniel P. Sanders, Nelson M. Felix, Matthew E. Colburn, IBM Corp. (USA) [9780-20]

11:30 am: An integrated source/mask/DSA optimization approach, Tim Fühner, Przemyslaw Michalak, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Ulrich Welling, Juan Carlos Orozco Rey, Marcus Müller, Georg-August-Univ. Göttingen (Germany); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) [9780-21]

11:50 am: Multi-layer VEB model: capturing interlayer etch process effects for self-aligned via in multi-patterning process scheme, Lin Hu, GLOBALFOUNDRIES Inc. (USA); Sunwook Jung, Mentor Korea Co., Ltd. (Korea, Republic of); Jianliang Li, Mentor Graphics Corp. (USA); Young Kim, Yuval Bar, Granger Lobb, Jim Liang, Atsushi Ogino, GLOBALFOUNDRIES Inc. (USA); John L. Sturtevant, Mentor Graphics Corp. (USA); Todd Bailey, GLOBALFOUNDRIES Inc. (USA) [9780-22]

12:10 pm: Mask defect printability in the self-aligned quadruple patterning (SAQP) process, Ken Furubayashi, Koutarou Sho, Seiro Miyoshi, Shinji Yamaguchi, Kazunori Iida, Hidefumi Mukai, Naoki Sato, Toshiba Corp. (Japan) [9780-23]

Lunch/Exhibition Break Wed 12:30 pm to 2:00 pm

CONFERENCE 9781

Design-Process-Technology Co-optimization for Manufacturability X

SESSION 2

LOCATION: MARRIOTT, SAN JOSE SALON III WED 10:40 AM TO 12:10 PM

Layout Analytics

Session Chairs: David Z. Pan, The Univ. of Texas at Austin (USA); Luigi Capodiec, KnotPrime Inc. (USA)

10:40 am: Methodology for analyzing and quantifying design style changes and complexity using topological patterns (Invited Paper), Jason P. Cain, Advanced Micro Devices, Inc. (USA); Ya-Chieh Lai, Frank E. Gennari, Jason Sweis, Cadence Design Systems, Inc. (USA) [9781-7]

11:10 am: Methodology to extract, data mine and score geometric constructs from physical design layouts for analysis and applications in semiconductor manufacturing, Piyush Pathak, Karthik N. Krishnamoorthy, GLOBALFOUNDRIES Inc. (USA); Jason Sweis, Frank E. Gennari, Ya-Chieh Lai, Cadence Design Systems, Inc. (USA); Paul Schroeder, Shikha Somani, Fadi Batarseh, Jaime Bravo, GLOBALFOUNDRIES Inc. (USA); Philippe Hurat, Cadence Design Systems, Inc. (USA); Sriram Madhavan, GLOBALFOUNDRIES Inc. (USA) [9781-8]

11:30 am: By using pattern enumeration methodology to accelerate process development and yield ramp up, Yifan Zhang, Cadence Design Systems, Inc. (China); Linda Zhuang, Jenny Pang, Jessy Xu, Semiconductor Manufacturing International Corp. (China); Jason Sweis, Ya-Chieh Lai, Cadence Design Systems, Inc. (USA) [9781-9]

11:50 am: Optimization of self-aligned double patterning (SADP)-compliant layout designs using pattern matching for 10nm technology nodes and beyond, Lynn T. Wang, Paul Schroeder, Youngtag Woo, Jia Zeng, Sriram Madhavan, Luigi Capodiec, GLOBALFOUNDRIES Inc. (USA) [9781-10]

Lunch/Exhibition Break Wed 12:10 pm to 2:00 pm

**CONFERENCE 9776**

**Extreme Ultraviolet (EUV) Lithography VII**

**SESSION 10**

**LOCATION: CONVENTION CENTER 220A  
WED 1:30 PM TO 3:10 PM**

**EUV Mask and Optics**

Session Chairs: **Regina Soufli**, Lawrence Livermore National Lab. (USA); **Markus P. Benk**, Lawrence Berkeley National Lab. (USA)

1:30 pm: **Novel EUV mask black border and its impact on wafer imaging**, Yutaka Kodera, Norihito Fukugami, Toru Komizo, Genta Watanabe, Shin Ito, Itaru Yoshida, Jun Kotani, Toshio Konishi, Takashi Haraguchi, Toppan Printing Co., Ltd. (Japan) . . . . . [9776-42]

1:50 pm: **EUV and optical lithographic pattern shift at the 5nm node**, Deniz E. Civay, Erik R. Hosler, Jason R. Cantone, Sathish Thiruvengadam, Paul Schroeder, GLOBALFOUNDRIES Inc. (USA) . . . . . [9776-43]

2:10 pm: **Polarization aberrations induced by graded multilayer coatings in EUV lithography scanners**, Thiago S. Jota, Russell A. Chipman, The Univ. of Arizona (USA) . . . . . [9776-44]

2:30 pm: **Image-based pupil plane characterization via principal component analysis for EUVL tools**, Zac Levinson, Andrew Burbine, Rochester Institute of Technology (USA); Erik A. Verduijn, Obert R. Wood, Pawitter J. Mangat, GLOBALFOUNDRIES Inc. (USA); Kenneth A. Goldberg, Markus P. Benk, Antoine J. Wojdyla, Lawrence Berkeley National Lab. (USA); Bruce W. Smith, Rochester Institute of Technology (USA) . . . . . [9776-45]

2:50 pm: **Improved Ru/Si multilayer reflective coatings for advanced extreme-ultraviolet lithography photomasks**, Obert R. Wood II, Keith Wong, Valentin Parks, GLOBALFOUNDRIES Inc. (USA); Patrick A. Kearney, SUNY Poly SEMATECH (USA); Eric M. Gullikson, Lawrence Berkeley National Lab. (USA); Vu Luong, Vicky Philippsen, IMEC (Belgium); Mohammad Faheem, Yifan Liang, Ajaykumar Kambham, Esther Chen, Corbin Bennett, Bianzhu Fu, Michael Gribelyuk, Pawitter J. Mangat, Paul Van der Heide, GLOBALFOUNDRIES Inc. (USA) . . . . . [9776-46]

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

**CONFERENCE 9777**

**Alternative Lithographic Technologies VIII**

**SESSION 8**

**LOCATION: CONVENTION CENTER 210B  
WED 1:40 PM TO 3:30 PM**

**DSA Modeling and Design**

Session Chairs: **Michael A. Guillion**, IBM Thomas J. Watson Research Ctr. (USA); **Daniel J. C. Herr**, The Univ. of North Carolina at Greensboro (USA)

1:40 pm: **Directed self-assembly at molecular length scales and the interplay between experiment, theory, and simulation** (*Invited Paper*), Juan J. de Pablo, The Univ. of Chicago (USA) . . . . . [9777-32]

2:10 pm: **Shape optimization for DSA**, Gaddiel Y. Ouaknin, Nabil Laachi, Kris T. Delaney, Glenn H. Fredrickson, Frederic Gibou, Univ. of California, Santa Barbara (USA) . . . . . [9777-33]

2:30 pm: **Modeling and parameter tuning for templated directed self-assembly**, Balint Meliorisz, Thomas Mülders, Hans-Jürgen Stock, Sajan Marokkey, Wolfgang Demmerle, Synopsys GmbH (Germany); Kafai Lai, IBM Thomas J. Watson Research Ctr. (USA); Ananthan Raghunathan, Parul Dhagat, GLOBALFOUNDRIES Inc. (USA) [9777-34]

2:50 pm: **Virtual fabrication using directed self-assembly for process optimization in a 14nm DRAM node**, Mattan Kamon, Mustafa Akbulut, Yiguang Yan, Daniel Faken, Andras Pap, Vasanth Allampalli, Ken Greiner, David M. Fried, Coventor, Inc. (USA) [9777-35]

3:10 pm: **Effect of underlayer on block copolymer defect annihilation kinetics**, Caleb L. Breaux, Benjamin D. Nation, Peter J. Ludovice, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9777-36]

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

**CONFERENCE 9778**

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

**SESSION 10**

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

**AFM**

Session Chairs: **Vladimir A. Ukraintsev**, Qorvo™ (USA); **John A. Allgair**, Nanometrics Inc. (USA)

1:30 pm: **Simultaneous AFM nano-machining and imaging for photomask repair**, Aliasghar Keyvani Janbahan, Mehmet Selman Tamer, Technische Univ. Delft (Netherlands) and TNO (Netherlands); Maarten van Es, Hamed Sadeghian, TNO (Netherlands) . . . [9778-42]

1:50 pm: **Nanoscale chemical and topology imaging of block copolymers assemblies with photo-induced force microscopy**, Derek B. Nowak, William A. Morrison, Molecular Vista, Inc. (USA); Kristin Schmidt, Jane E. Frommer, Daniel P. Sanders, IBM Research - Almaden (USA); Sung I. Park, Molecular Vista, Inc. (USA) . . [9778-43]

2:10 pm: **Device level 3D characterization using peakforce AFM**, Pdraig R. Timoney, Xiaoxiao Zhang, Alok Vaid, GLOBALFOUNDRIES Inc. (USA); Sean Hand, Jason Osborne, Eric Milligan, Adam Feinstein, Bruker Nano Inc. (USA) . . . . . [9778-44]

2:30 pm: **Large dynamic range scanning probe microscope for overlay improvements**, Stefan Kuiper, Erik C. Fritz, Will E. Crowcombe, Thomas Liebig, Geerten Kramer, Tom Duivenvoorde, Ton Overtoom, Erwin J. van Zwet, TNO Technical Sciences (Netherlands); Anton van Dijsseldonk, Arie den Boef, Marcel Beems, Leon Levasier, ASML Netherlands B.V. (Netherlands) . . . . . [9778-45]

2:50 pm: **Parallel, high throughput atomic force metrology and inspection for EUV masks and wafers**, Hamed Sadeghian, Rodolf W. Herfst, Jasper Winters, Tom Bijmagne, Bert Dekker, Ramon Rijnbeek, Nicole Nulkes, TNO (Netherlands) . . . . . [9778-46]

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



**CONFERENCE 9779**

Advances in Patterning Materials and Processes XXXIII

**SESSION 10**

**LOCATION: CONVENTION CENTER 220C  
WED 1:40 PM TO 3:20 PM**

**Advanced Patterning Process Characterization**

Session Chairs: **Yoshio Kawai**, Shin-Etsu Chemical Co., Ltd. (Japan); **Scott W. Jessen**, Texas Instruments Inc. (USA)

1:40 pm: **An improved method for characterizing photoresist lithographic and defectivity performance for sub-20nm node lithography**, Gilles R. Amblard, Sara B. Purdy, Ryan S. Cooper, Marjory C. Hockaday, SAMSUNG Austin Semiconductor LLC (USA) . . . . . [9779-28]

2:00 pm: **Research on topcoat-less photoresist characteristics for high scan speed ArF immersion exposure tool**, Minseok Son, SK Hynix, Inc. (Korea, Republic of) . . . . . [9779-29]

2:20 pm: **CD-bias control on hole pattern**, Kyohei Koike, Kenichi Oyama, Tokyo Electron AT Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan); Noriaki Okabe, Arisa Hara, Sakurako Natori, Shohei Yamauchi, Masatoshi Yamato, Tokyo Electron AT Ltd. (Japan) . . . . . [9779-30]

2:40 pm: **High-speed AFM studies of 193 photoresist during TMAH development**, Johnpeter Ngunjiri, Greg F. Meyers, James F. Cameron, The Dow Chemical Co. (USA); Yasuhiro Suzuki, Dow Chemical Japan Ltd. (Japan); Hyun K. Jeon, Dave Lee, Kwang Mo K. M. Choi, Jung Woo Kim, Kwang-Hwiy Im, Hae-Jin Lim, Dow Chemical Korea Ltd. (Korea, Republic of) . . . . . [9779-31]

3:00 pm: **LER and LWR smoothing by ion implantations from post-litho to post-etch**, Lei Sun, GLOBALFOUNDRIES Inc. (USA); Tristan Y. Ma, Maureen Petterson, Applied Materials, Inc. (USA); Wenhui Wang, Erik A. Verduijn, Yulu Chen, GLOBALFOUNDRIES Inc. (USA); Huixiong Dai, Elly Shi, Pinkesh Shah, Applied Materials, Inc. (USA); Jeric Sarad, Shyam Pal, Ryoung-Han Kim, GLOBALFOUNDRIES Inc. (USA) . . . . . [9779-32]

Coffee Break . . . . . Wed 3:20 pm to 3:50 pm

**CONFERENCE 9780**

Optical Microlithography XXIX

**SESSION 7**

**LOCATION: CONVENTION CENTER 210C  
WED 2:00 PM TO 3:30 PM**

**Design and Litho Optimization**

Joint Session with Conferences 9780 and 9781

Session Chair: **Daniel Sarlette**, Infineon Technologies Dresden (Germany)

2:00 pm: **Standard cell pin access and physical design in advanced lithography** (*Invited Paper*), David Z. Pan, The Univ. of Texas at Austin (USA) . . . . . [9780-24]

2:50 pm: **Hybrid hotspot detection using regression model and SOCS kernels**, Taiki Kimura, Tetsuaki Matsunawa, Shigeki Nojima, Toshiba Corp. (Japan); David Z. Pan, The Univ. of Texas at Austin (USA) . . . . . [9781-12]

3:10 pm: **Incorporating photomask shape uncertainty in computational lithography**, Xiaofei Wu, The Univ. of Hong Kong (Hong Kong, China); Shiyuan Liu, Huazhong Univ. of Science and Technology (China); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementete echnologie IISB (Germany); Edmund Y. Lam, The Univ. of Hong Kong (Hong Kong, China) . . . . . [9780-25]

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

**CONFERENCE 9781**

Design-Process-Technology Co-optimization for Manufacturability X

**SESSION 3**

**LOCATION: CONVENTION CENTER 210C  
WED 2:00 PM TO 3:30 PM**

**Design and Litho Optimization**

Joint Session with Conferences 9780 and 9781

Session Chair: **Daniel Sarlette**, Infineon Technologies Dresden (Germany)

2:00 pm: **Standard cell pin access and physical design in advanced lithography** (*Invited Paper*), David Z. Pan, The Univ. of Texas at Austin (USA) . . . . . [9780-24]

2:50 pm: **Hybrid hotspot detection using regression model and SOCS kernels**, Taiki Kimura, Tetsuaki Matsunawa, Shigeki Nojima, Toshiba Corp. (Japan); David Z. Pan, The Univ. of Texas at Austin (USA) . . . . . [9781-12]

3:10 pm: **Incorporating photomask shape uncertainty in computational lithography**, Xiaofei Wu, The Univ. of Hong Kong (Hong Kong, China); Shiyuan Liu, Huazhong Univ. of Science and Technology (China); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementete echnologie IISB (Germany); Edmund Y. Lam, The Univ. of Hong Kong (Hong Kong, China) . . . . . [9780-25]

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



**CONFERENCE 9776**

**Extreme Ultraviolet (EUV) Lithography VII**

**SESSION 11**

**LOCATION: CONVENTION CENTER 220A  
WED 3:40 PM TO 6:20 PM**

**EUV Mask Inspection and Imaging**

Session Chairs: **Anna Tchikoulaeva**, Lasertec U.S.A., Inc. Zweigniederlassung Deutschland (Germany); **Ted Liang**, Intel Corp. (USA)

3:40 pm: **Actinic review of EUV masks: Performance data and status of the AIMS EUV System**, Dirk Hellweg, Markus R. Weiss, Sascha Perltz, Renzo Capelli, Krister Magnusson, Carl Zeiss SMT GmbH (Germany); Matt Malloy, Stefan Wurm, SUNY Poly SEMATECH (USA) . . . . . [9776-47]

4:00 pm: **Fourier Ptychography imaging for the study of EUV lithography photomasks**, Antoine J. Wojdyla, Markus P. Benk, Kenneth A. Goldberg, Lawrence Berkeley National Lab. (USA) . . . . . [9776-48]

4:20 pm: **EUV mask and wafer defectivity: Strategy and evaluation for full die defect inspection**, Ravi K. Bonam, Luciana Meli, Scott D. Halle, Daniel A. Corliss, Nelson M. Felix, IBM Corp. (USA); Hung-Yu Tien, Acer Chou, Chris Lei, Chiyuan Kuan, Wei Fang, Jack Y. Jau, Hermes-Microvision Inc., USA (USA); Zhengqing John Qi, Karen D. Badger, Christina Turley, Jed H. Rankin, GLOBALFOUNDRIES Inc. (USA) . . . . . [9776-49]

4:40 pm: **Enhancing defect sensitivity by pupil optimization for EUV actinic mask inspection**, Yow-Gwo Wang, Univ. of California, Berkeley (USA) and Lawrence Berkeley National Lab. (USA); Ryan H. Miyakawa, Markus P. Benk, Antoine J. Wojdyla, Kenneth A. Goldberg, Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Univ. of California, Berkeley (USA) and Lawrence Berkeley National Lab. (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA) . . . . . [9776-50]

5:00 pm: **EUV patterned mask inspection performance of an advanced projection electron microscope (PEM) system for 11nm half-pitch (hp) generation**, Ryoichi Hirano, Susumu Iida, Tsuyoshi Amano, Hidehiro Watanabe, EUVL Infrastructure Development Ctr., Inc. (Japan); Masahiro Hatakeyama, Takeshi Murakami, Kenichi Suematsu, Kenji Terao, EBARA Corp. (Japan) . . . . . [9776-51]

5:20 pm: **Scanning coherent diffractive imaging methods for actinic EUV mask metrology**, Patrick Helfenstein, Istvan Mohacsi, Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9776-52]

5:40 pm: **Advances in the detection capability on actinic blank inspection**, Takeshi Yamane, Tsuyoshi Amano, Noriaki Takagi, Hidehiro Watanabe, Ichro Mori, EUVL Infrastructure Development Ctr., Inc. (Japan); Tomohisa Ino, Tomohiro Suzuki, Kiwamu Takehisa, Hiroki Miyai, Haruhiko Kusunose, Lasertec Corp. (Japan) . . . . . [9776-53]

6:00 pm: **Through-pellicle defect inspection of EUV masks using an ArF-based inspection tool**, Dario L. Goldfarb, IBM Thomas J. Watson Research Ctr. (USA); William H. Broadbent, KLA-Tencor Corp. (USA); Nelson M. Felix, Daniel A. Corliss, IBM Corp. (USA) and Albany Nanotech (USA) . . . . . [9776-54]

**CONFERENCE 9777**

**Alternative Lithographic Technologies VIII**

**SESSION 9**

**LOCATION: CONVENTION CENTER 210B  
WED 4:00 PM TO 5:50 PM**

**Direct-Write E-Beam Lithography**

Session Chairs: **Laurent Pain**, CEA-LETI (France); **Moshe E. Preil**, GLOBALFOUNDRIES Inc. (USA)

4:00 pm: **Development of a MEMS electrostatic condenser lens array for nc-Si surface electron emitters of the massive parallel electron-beam direct-write system** (*Invited Paper*), Akira Kojima, Naokatsu Ikegami, Takashi Yoshida, Hiroshi Miyaguchi, Masanori Muroyama, Shinya Yoshida, Kentaro Totsu, Tohoku Univ. (Japan); Nobuyoshi Koshida, Tokyo Univ. of Agriculture and Technology (Japan); Masayoshi Esashi, Tohoku Univ. (Japan) . . . . . [9777-37]

4:30 pm: **Non-CAR resists and advanced materials for massively parallel e-beam direct-write process integration**, Marie-Line Pourteau, Isabelle Servin, Bernard Dal'Zotto, Philippe Essomba, Kevin Lepinay, Jonathan Pradelles, Ludovic Lattard, CEA-LETI (France); Pieter Brandt, Marco Wieland, MAPPER Lithography (Netherlands) . . . . . [9777-38]

4:50 pm: **Complete data preparation flow for massively parallel e-beam lithography on 28nm node full-field design**, Aurélien Fay, CEA-LETI (France); Clyde H. Browning, ASELTA Nanographics (France); Pieter Brandt, MAPPER Lithography (Netherlands); Jacky Chartoire, Sébastien Bérard-Bergery, Jérôme Hazart, CEA-LETI (France); Alexandre Chagoya, Sergei Postnikov, ASELTA Nanographics (France); Ludovic Lattard, CEA-LETI (France); Patrick Schavione, ASELTA Nanographics (France) . . . . . [9777-39]

5:10 pm: **Demonstrating multi-beam lithography for 28nm technology node**, Ludovic Lattard, Jonathan Pradelles, Isabelle Servin, Marie-Line Pourteau, Laurent Pain, CEA-LETI (France); Marco Wieland, Marcel Van Kervick, Guido De Boer, MAPPER Lithography (Netherlands) . . . . . [9777-40]

5:30 pm: **Requirements of the e-beam shot quality for mask patterning of the sub-1X device**, Sinjeung Park, Jongmun Park, Boram Lee, Jin Choi, In Kyun Shin, Chan-Uk Jeon, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9777-41]

**CONFERENCE 9778**

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

**SESSION 11**

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

**Overlay: Metrology Target Design and Optimization**

Session Chairs: **Alexander Starikov**, I&I Consulting (USA); **Byoung-Ho Lee**, Ultratech, Inc. (USA)

3:40 pm: **SEM based overlay measurement between resist and buried patterns**, Philippe Leray, Sandip Halder, IMEC (Belgium); Osamu Inoue, Yutaka Okagawa, Kazuhisa Hasumi, Hitachi High-Technologies Corp. (Japan) . . . . . [9778-47]

4:00 pm: **In depth analysis of sampling plan optimization for overlay and alignment**, Honggoo Lee, Sang-Jun Han, Young-Sik Kim, SK Hynix, Inc. (Korea, Republic of); Boris Habets, Steffen Guhleemann, Enrico Bellmann, Stefan Buhl, Martin Roessiger, Qoniac GmbH (Germany); Seop Kim, Qoniac GmbH (Korea, Republic of) . . . . . [9778-48]

4:20 pm: **Device overlay method for high-volume manufacturing**, John C. Robinson, KLA-Tencor Texas (USA); Honggoo Lee, Sang-Jun Han, Young-Sik Kim, SK Hynix, Inc. (Korea, Republic of); Hoyoung Heo, Sanghuck Jeon, DongSub Choi, KLA-Tencor Texas (USA) . . . . . [9778-49]

4:40 pm: **Eliminating the offset between overlay metrology and device pattern cell using computational target design**, Jianming Zhou, Sarah Wu, Craig Hickman, Micron Technology, Inc. (USA); Ewoud van West, Maurits van der Schaar, ASML Netherlands B.V. (Netherlands); Youping Zhang, Sean Park, Wangshi Zhou, Paul Tuffey, Daniel Ulmer, ASML US, Inc. (USA); Cedric Affentauschegg, Henk Niesing, ASML Netherlands B.V. (Netherlands) . . . . . [9778-50]

5:00 pm: **Accuracy in optical overlay metrology**, Barak Bringoltz, Tal Marciano, Tal Yaziv, Yaron DeLeeuw, Yoel Feler, Ido Adam, Evgeni Gurevich, Noga Sella, Ze'ev Lindenfeld, Tom Leviant, Lilach Saltoun, Eltsafon Island-Ashwal, Dror Alumut, Yuval Lamhot, KLA-Tencor Israel (Israel); Xindong Gao, KLA-Tencor China (China); James R. Manka, Bryan Chen, KLA-Tencor Taiwan (Taiwan); Mark P. Wagner, Dana Klein, KLA-Tencor Israel (Israel) . . . . . [9778-51]

5:20 pm: **A study of swing-curve physics in diffraction-based overlay**, Kaustuve Bhattacharyya, ASML Netherlands B.V. (Netherlands); Chan Hwang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9778-52]

5:40 pm: **Enhancement of intrafield overlay using a design based metrology system**, Kyoyeon Cho, Sunkeun Ji, Shinyoung Kim, Hyungwoo Kang, Minwoo Park, Sangwoo Kim, Jungchan Kim, Hyun-Jo Yang, Donggyu Yim, SK Hynix, Inc. (Korea, Republic of) [9778-53]

CONFERENCE 9779

Advances in Patterning Materials and Processes XXXIII

SESSION 11

LOCATION: CONVENTION CENTER 220C WED 3:50 PM TO 6:10 PM

DSA Novel Materials

Session Chairs: Daniel P. Sanders, IBM Research - Almaden (USA); Ralph R. Dammel, EMD Performance Materials Corp. (USA)

3:50 pm: High-chi block copolymer DSA to improve pattern quality for FinFET device fabrication, Hsinyu Tsai, Hiroyuki Miyazoe, IBM Thomas J. Watson Research Ctr. (USA); Ankit Vora, Teddie Magbitang, IBM Research - Almaden (USA); Chi-Chun Liu, Albany NanoTech (USA); Michael J. Maher, William J. Durand, The Univ. of Texas at Austin (USA); Simon J. Dawes, James J. 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, Albany NanoTech (USA); C. Grant Willson, Christopher J. Ellison, The Univ. of Texas at Austin (USA); Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA). . . . [9779-33]

4:10 pm: High-chi block copolymers based on chemical modification of poly(t-butyl acrylate) containing block copolymers, Sungmin Park, Seongjun Jo, Yonghoon Lee, Yonsei Univ. (Korea, Republic of); Chang Yeol Ryu, Rensselaer Polytechnic Institute (USA); Du Yeol Ryu, Yonsei Univ. (Korea, Republic of); Jun Sung Chun, SUNY CNSE/SUNYIT (USA) . . . . . [9779-34]

4:30 pm: Carbohydrate-based block copolymer self-assemblies: sub-10nm highly nanostructured thin films and DSA patterning, Tiffany Gomez, Issei Otsuka, Ctr. de Recherches sur les Macromolécules Végétales (France) and Ctr. National de la Recherche Scientifique (France) and Univ. Grenoble Alpes (France); Cécile Bouilhac, Institut Charles Gerhardt Montpellier (France); Eric Reynaud, Ctr. de Recherches sur les Macromolécules Végétales (France) and Ctr. National de la Recherche Scientifique (France) and Univ. Grenoble Alpes (France); Wen-Chang Chen, National Taiwan Univ. (Taiwan); Hironobu Sato, Yuriko Seino, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan); Redouane Borsali, Ctr. de Recherches sur les Macromolécules Végétales (France) and Ctr. National de la Recherche Scientifique (France) and Univ. Grenoble Alpes (France). . . . . [9779-35]

4:50 pm: Design of new block-copolymer systems to achieve thick-films with defect-free structures for applications of DSA into lithographic large nodes, Xavier Chevalier, Arkema S.A. (France); Paul Coupillaud, Lab. de Chimie des Polymères Organiques (France); Geoffrey Lombard, Célia Nicolet, Arkema S.A. (France); Guillaume Fleury, Lab. de Chimie des Polymères Organiques (France); Ahmed Gharbi, Raluca Tiron, CEA-LETI (France); Georges Hadziioannou, Lab. de Chimie des Polymères Organiques (France); Christophe Navarro, Ian Cayrefourcq, Arkema S.A. (France) . . . . . [9779-36]

5:10 pm: Directed self-assembly materials for high-resolution beyond PS-b-PMMA, Eri Hirahara, Margareta Paunescu, Orest Polishchuk, EunJeong Jeong, Edward Ng, Jianhui Shan, Jian Yin, Jihoon Kim, Yi Cao, EMD Performance Materials Corp. (USA); Jin Li, Merck Performance Materials Manufacturing G.K. (Japan); Sung Eun Hong, Durairaj Baskaran, Guanyang Lin, EMD Performance Materials Corp. (USA) . . . . . [9779-37]

5:30 pm: Access to 5nm features with DSA topcoat system, Yusuke Asano, Michael J. Maher, Gregory Blachut, The Univ. of Texas at Austin (USA); Stephen Sirard, Lam Research Corp. (USA); Yasunobu Someya, Austin P. Lane, William J. Durand, Christopher J. Ellison, C. Grant Willson, The Univ. of Texas at Austin (USA) . . [9779-38]

5:50 pm: Formation of microphase-separated structure with half-pitch less than 5.0nm formed by multiblock copolymers for nanolithographic application, Terumasa Kosaka, Yukio Kawaguchi, Toshiyuki Himi, Tetsuo Shimizu, HORIBA STEC, Co., Ltd. (Japan); Kazuhiro Hirahara, Yamagata Univ. (Japan); Atsushi Takano, Nagoya Univ. (Japan) . . . . . [9779-39]

CONFERENCE 9780

Optical Microlithography XXIX

SESSION 8

LOCATION: CONVENTION CENTER 210C WED 4:00 PM TO 5:50 PM

Non-IC Applications

Session Chairs: Sachiko Kobayashi, Toshiba Corp. (Japan); Reinhard Völkel, SUSS MicroOptics SA (Switzerland)

4:00 pm: Alternative high-resolution lithographic technologies for optical applications (Invited Paper), Uwe D. Zeitner, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) and Friedrich-Schiller-Univ. Jena (Germany); Tina Weichelt, Yannick Bourgin, Friedrich-Schiller-Univ. Jena (Germany); Robert Kinder, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany). . . . [9780-26]

4:30 pm: Optical lithography on a V-grooved substrate for 3D nanofabrication, Diana A. Grishina, Cornelis A. M. Hartevel, Univ. Twente (Netherlands); Eddy van der Heijden, ASML Netherlands B.V. (Netherlands); Jeroen Bolk, Kevin A. Williams, Meint K. Smit, Technische Univ. Eindhoven (Netherlands); Jo Finders, Arie den Boef, ASML Netherlands B.V. (Netherlands); Willem L. Vos, Univ. Twente (Netherlands) . . . . . [9780-27]

4:50 pm: High dynamic grayscale lithography with an LED based microimage stepper, Hans-Christoph Eckstein, Uwe D. Zeitner, Marko Stumpf, Philipp Schleicher, Andreas Bräuer, Andreas Tünnermann, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) . . . . . [9780-28]

5:10 pm: Firefly: an optical lithographic system for the fabrication of holographic security labels, Jorge A. Calderón M., Oscar J. Rincón Bohorquez, Ricardo Amézquita Orozco, Iván J. Pulido, Luis Romero, Sebastián Amézquita, Andrés Bernal, Viviana Agudelo, Combustion Ingenieros S.A.S. (Colombia) . . . . . [9780-29]

5:30 pm: Phase analysis of binary mask structures, Krishnaparvathy Puthankovilakam, Toralf Scharf, Hans Peter Herzig, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Uwe Vogler, Arianna Bramati, Reinhard Völkel, SUSS MicroOptics SA (Switzerland) . . . . . [9780-30]

CONFERENCE 9781

Design-Process-Technology Co-optimization for Manufacturability X

SESSION 4

LOCATION: MARRIOTT, SAN JOSE SALON III WED 4:00 PM TO 5:20 PM

Circuit Modeling

Session Chairs: Chi-Min Yuan, Freescale Semiconductor, Inc. (USA); Robert Aitken, ARM Inc. (USA)

4:00 pm: Variability-aware compact modeling and statistical circuit validation on SRAM test array, Ying Qiao, Costas J. Spanos, Univ. of California, Berkeley (USA) . . . . . [9781-13]

4:20 pm: Impacts of process variability of alternating-material self-aligned multiple patterning on SRAM circuit performance, Ting Han, Chuyang Hong, Qi Cheng, Yijian Chen, Peking Univ. (China) . . . . . [9781-14]

4:40 pm: Modeling interconnect corners under double patterning misalignment, Daijoon Hyun, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Youngsoo Shin, KAIST (Korea, Republic of) . . . . . [9781-15]

5:00 pm: Model-based CMP aware RC extraction of interconnects in 16nm designs, Yongchan Ban, LG Electronics Inc. (Korea, Republic of); Sang-Min Han, Cadence Design Systems, Inc. (USA); Eun Joo Choi, LG Electronics Inc. (Korea, Republic of); Tamba Gbondo-Tugbawa, Kuang-Han Chen, Cadence Design Systems, Inc. (USA) . . . . . [9781-16]

## CONFERENCE 9778

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

**A novel method to quantify the complex mask patterns.** Yu-Lung Tung, Che-Yuan Sun, Shu-Chuan Chuang, Woei-Bin Luo, Jia-Rui Hu, Hsiang-Lin Chen, Hua-Tai Lin, Chih-Ming Ke, Tsai-Sheng Gau, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9778-60]

**The effect of quantum noise on line-edge roughness.** Thomas Verduin, Sebastiaan R. Lokhorst, Cornelis W. Hagen, Pieter Kruit, Technische Univ. Delft (Netherlands) . . . . . [9778-67]

**Scatterometry-based process control for nanoimprint lithography.** Masafumi Asano, Kazuto Matsuki, Hideaki Abe, Toshiba Corp. (Japan); Woo-Yung Jung, SK Hynix, Inc. (Korea, Republic of) . . . . . [9778-68]

**2D and 3D isolation mounts scatterometry using RCWA and FDTD method.** Hirokimi Shirasaki, Tamagawa Univ. (Japan) . . . . . [9778-69]

**Comparison of left and right side line-edge roughness in lithography.** Lei Sun, Genevieve Beique, Erik A. Verduijn, Wenhui Wang, Yulu Chen, Ryoung-Han Kim, GLOBALFOUNDRIES Inc. (USA) . . . . . [9778-70]

**Generalized measurement configuration optimization for accurate reconstruction of periodic nanostructure using optical scatterometry.** Jinlong Zhu, Univ. of Illinois at Urbana-Champaign (USA); Shiyuan Liu, Huazhong Univ. of Science and Technology (China); Lynford L. Goddard, Univ. of Illinois at Urbana-Champaign (USA) . . . . . [9778-71]

**Hybrid overlay metrology for high-order correction by using CD-SEM.** Philippe Leray, Sandip Halder, IMEC (Belgium); Osamu Inoue, Yutaka Okagawa, Hitachi High-Technologies Corp. (Japan) . . [9778-72]

**Application of overlay modeling and control with Zernike polynomials in an HVM environment.** John C. Robinson, KLA-Tencor Texas (USA); Jae-Wuk Ju, Min-Gyu Kim, Ju-Han Lee, SK Hynix, Inc. (Korea, Republic of); Jeremy Nabeth, Sanghuck Jeon, Hoyoung Heo, Bill Pierson, KLA-Tencor Texas (USA) . . . . . [9778-73]

**Highly sensitive focus monitoring technique based on illumination and target co-optimization.** Myungjun Lee, Mark D. Smith, Ady Levy, KLA-Tencor Corp. (USA) . . . . . [9778-74]

**Scan direction induced charging dynamics and the application for detection of gate to S/D shorts in logic devices.** Ming Lei, GLOBALFOUNDRIES Inc. (USA); Qing Tian, Hermes-Microvision Inc., USA (USA); Kevin Wu, GLOBALFOUNDRIES Inc. (USA); Yan Zhao, Hermes-Microvision Inc., USA (USA) . . . . . [9778-75]

**Image-based overlay (IBO) target segment design on self-aligned patterning process.** Lei Ye, Wei-Ming He, Hua-Yong Hu, Semiconductor Manufacturing International Corp. (China) . [9778-77]

**Improving focus performance at litho using diffraction-based focus metrology, novel calibration methods, interface and control loop.** Kaustuve Bhattacharyya, ASML Netherlands B.V. (Netherlands); Chih-Ming Ke, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9778-78]

**Assistant researchers from Institute of Microelectronics, Chinese Academy of Sciences.** Lisong Dong, Chinese Academy of Sciences (China); Zhiyang Song, Xiaojing Su, Yayi Wei, Institute of Microelectronics (China) . . . . . [9778-79]

**Spacer multi-patterning control strategy with optical CD metrology on device structures.** Jongsu Lee, Byoung-Hoon Lee, Won Kwang Ma, Sang-Jun Han, Young-Sik Kim, Noh-Jung Kwak, SK Hynix, Inc. (Korea, Republic of); Hugo Cramer, Baukje Wisse, Stefan Kruijswijk, Thomas Theeuwes, Yi Song, Wei Guo, Alok Verma, Rui Zhang, Yvon Chai, Sharon Hsu, Giacomo Miceli, ASML Netherlands B.V. (Netherlands); Kyu-Tae Sun, Young-Wan Lim, Jin-Moo Byun, Jung-Joon Suh, Sang-Hoon Jung, ASML Korea Co., Ltd. (Korea, Republic of); Steven Welch, ASML Netherlands B.V. (Netherlands) . . . . [9778-80]

**Study on overlay AEI-ADI shift on contact layer of advanced technology node.** Guogui Deng, Jingan Hao, Lihong Xiao, Bin Xing, Yuntao Jiang, Kaiting He, Qiang Zhang, Wei-Ming He, Chang Liu, Yi-Shih Lin, Qiang Wu, Xuelong Shi, Semiconductor Manufacturing International Corp. (China) . [9778-81]

**Sub-defect reduction of SADP film stack for 80nm flash memory application.** Lihong Xiao, Yongbin Huang, Semiconductor Manufacturing International Corp. (China) . . . . . [9778-82]

**Design-guided data analysis for identifying systematic pattern defects and establishing process window.** Qian Xie, Panneerselvam Venkatachalam, GLOBALFOUNDRIES Inc. (USA); Julie Lee, GLOBALFOUNDRIES, Inc. (USA); Zhijun Chen, Khurram Zafar, Anchor Semiconductor, Inc. (USA) . . . . . [9778-83]

**Mixed-mode, high-order multi-patterning control strategy with small-spot, optical CD metrology on device structures.** Hugo Cramer, Baukje Wisse, Stefan Kruijswijk, Thomas Theeuwes, Yi Song, Wei Guo, Alok Verma, Rui Zhang, Yvon Chai, Sharon Hsu, Giacomo Miceli, ASML Netherlands B.V. (Netherlands); Kyu-Tae Sun, Tae-Gyun Kim, Jin-Moo Byun, ASML Korea Co., Ltd. (Korea, Republic of); Steven Welch, ASML Netherlands B.V. (Netherlands); Moo-Young Seo, Hyun-Sok Kim, Dong-Gyu Park, Jong-Mun Jeong, SK Hynix, Inc. (Korea, Republic of) . . . . . [9778-84]

**Toward a laboratory CD-SAXS solution: An x-ray study.** Assunta Vigliante, Sirius-XRS (Germany); Peter Wochen, Max Planck Institute for Solid State Research (Germany); Roberto Felici, ESRF - The European Synchrotron (France); Benjamin D. Bunday, SUNY Poly SEMATECH (USA) . . . . . [9778-85]

**Overlay optimization for 1x node technology and beyond via rule-based sparse sampling.** Nyan L. Aung, Woong Jae Chung, Lokesh Subramany, Shehzeen Hussain, Pavan K. Samudrala, Haiyong Gao, Xueli Hao, Yen-Jen Chen, Juan M. Gomez, GLOBALFOUNDRIES Inc. (USA) . . . . . [9778-86]

**Monitoring CD-SEM performance using linewidth independent method.** Sergey Babin, Peter Yushmanov, Abeam Technologies, Inc. (USA); Jaffee Huang, SCH Electronics (Taiwan) . . . . . [9778-87]

**Quantitatively measuring nanomechanical, time-varying interaction forces in atomic force microscope imaging.** Mehmet Selman Tamer, Technische Univ. Delft (Netherlands) and TNO (Netherlands); Hamed Sadeghian, TNO (Netherlands) and Technische Univ. Delft (Netherlands); Johannes F. L. Goosen, Fred van Keulen, Technische Univ. Delft (Netherlands) . . . . . [9778-89]

**Overlay metrology performance prediction fidelity: the factors which enable a successful target design cycle.** Inna Tarshish-Shapir, Eitan Hajaj, KLA-Tencor Israel (Israel); Greg Gray, Jeffery Hodges, KLA-Tencor Idaho (USA); Jianming Zhou, Sarah Wu, Sam Moore, Micron Technology, Inc. (USA); Guy Ben Dov, Chen Dror, Ze'ev Lindenfeld, Mark Ghinovker, Michael E. Adel, KLA-Tencor Israel (Israel) . [9778-91]

**Advanced overlay sampling and modeling for optimized run-to-run control.** Lokesh Subramany, Woong Jae Chung, Pavan K. Samudrala, Haiyong Gao, Nyan L. Aung, Juan M. Gomez, Karsten Gutjahr, DeNeil Park, Patrick W. Snow, GLOBALFOUNDRIES Inc. (USA); Miguel Garcia-Medina, Lipkang Yap, Onur N. Demirel, Bill Pierson, John C. Robinson, KLA-Tencor Corp. (USA) . . . . . [9778-92]

**Probe microscopy for metrology of next-generation devices.** Andrew D. L. Humphris, Bin Zhao, David Bastard, Infinitesima Ltd. (United Kingdom); Benjamin D. Bunday, SEMATECH Inc. (USA) . . . . . [9778-93]

**Improving scanner wafer alignment performance using mark optimization.** Christiane Jehoul, Philippe Leray, IMEC (Belgium); Robert J. Socha, Boris Menchtchikov, Eric R. Kent, ASML US, Inc. (USA); Hielke Schoonewelle, ASML Netherlands B.V. (Netherlands); Sudhar Raghunathan, ASML US, Inc. (USA); Patrick Tinnemans, ASML Netherlands B.V. (Netherlands); Paul Tuffly, ASML US, Inc. (USA); Richard J. Wise, Lam Research Corp. (USA) [9778-94]

**New approaches in diffraction based optical metrology.** Martin Ebert, Peter Vanoppen, Martin J. Jak, Gerbrand van der Zouw, Hugo Cramer, Tjitte Nooitgedagt, Hans van der Laan, ASML Netherlands B.V. (Netherlands) . . . . . [9778-95]

**Process window optimizer for pattern-based defect prediction on 28nm metal layer.** Pierre M. Fanton, STMicroelectronics (France); Raphael La Greca, ASML SARL (France); Vivek Jain, ASML US, Inc. (USA); Christopher Prentice, ASML SARL (France); Jean-Gabriel Simiz, STMicroelectronics (France); Stefan Hunsche, ASML US, Inc. (USA); Bertrand Le-Gratiet, STMicroelectronics (France); Laurent Depre, ASML SARL (France) . . . . [9778-96]

**Studying post-etching silicon crystal defects on 300mm wafer by automatic defect review AFM.** Ardavan Zandiatashbar, Park Systems Inc. (USA); Patrick A. Taylor, SunEdison Semiconductor Ltd. (USA); Byong Kim, Young-kook Yoo, Park Systems Inc. (USA) . . . . . [9778-97]

**Comparison study of diffraction-based overlay and image-based overlay measurements on programmed overlay errors.** Haiyong Gao, Woong Jae Chung, Nyan L. Aung, Lokesh Subramany, Pavan K. Samudrala, Juan M. Gomez, GLOBALFOUNDRIES Inc. (USA) . . . . . [9778-98]

**Metrology target design (MTD) solution for diagonally orientated DRAM layer.** Myungjun Lee, Mark D. Smith, Michael E. Adel, KLA-Tencor Corp. (USA); Chia-Hung Chen, Chin-Chang Huang, Hao-Lun Huang, Hsueh-Jen Tsai, I-Lin Wang, Jen-Chou Huang, Jo-Lan Chin, Kuo-Yao Chou, Yuan-Ku Lan, Inotera Memories Inc. (Taiwan); Tal Itzkovich, Chao-Tien H. Huang, Yaniv Abramovitz, KLA-Tencor Corp. (USA); Jinyan Song, Chen Dror, Harvey Cheng, KLA-Tencor Corp. (Taiwan); Ady Levy, KLA-Tencor Corp. (USA) . . . . . [9778-99]

**Electrostatic risks to reticles and damage prevention methodology.** Gavin C. Rider, Microtome Precision, Inc. (USA); Mark J. Hillman, Hillelian Concepts, Inc. (France) . . . . . [9778-100]

**Investigation on the relationship between CD and CDU in memory devices.** Jeong Su Park, Daewoo Kim, Keunjun Kim, Choidong Kim, Sung Koo Lee, Hyeong-Soo Kim, SK Hynix, Inc. (Korea, Republic of) . . . . . [9778-101]



**Triple IBO evaluation and application on advanced node**, En Chuan Lio, Gary Wang, United Microelectronics Corp. (Taiwan) . . . . . [9778-102]

**Applications of on-product diffraction-based focus metrology in logic high-volume manufacturing**, Ben F. Noyes III, Babak Mokaber, David Bolton, Chen Li, SAMSUNG Austin Semiconductor LLC (USA); Ashwin Palande, Marc Noot, Marc Kea, ASML Netherlands B.V. (Netherlands) . . . . . [9778-103]

**Study of correlation between overlay and displacement measured by coherent gradient sensing (CGS) interferometry**, Jeffrey Mileham, Doug Anberg, David M. Owen, Byoung-Ho Lee, Eric Bouche, Ultratech, Inc. (USA); Yasushi Tanaka, Toshiba Corp. (Japan) . . . . . [9778-104]

**Topological study of nanomaterials using surface-enhanced ellipsometric contrast microscopy (SEEC)**, Sylvain G. Muckenhirn, Iris Versicolor Corp. (USA) . . . . . [9778-105]

**Controlling bridging and pinching with pixel-based mask for inverse lithography**, Sergey G. Kobelkov, Mentor Graphics Corp. (Russian Federation); Alexander Tritchkov, JiWan Han, Mentor Graphics Corp. (USA) . . . . . [9778-106]

**An evaluation of edge roll off on 28nm FDSOI (fully depleted silicon on insulator) product**, Bertrand Le-Gratiet, Maxime Gatefait, STMicroelectronics (France); Christopher Prentice, ASML SARL (France); Tanbir Hassan, ASML Netherlands B.V. (Netherlands) . . . . . [9778-108]

**EUV blank defect and particle inspection with high-throughput immersion AFM with 1nm 3D resolution**, Maarten van Es, Hamed Sadeghian, TNO (Netherlands) . . . . . [9778-109]

**Dedication break-up for semi-critical layers to enable efficient product ramp**, Honggoo Lee, Sang-Jun Han, Young-Sik Kim, SK Hynix, Inc. (Korea, Republic of); Boris Habets, Enrico Bellmann, Stefan Buhl, Martin Roessiger, Qoniac GmbH (Germany); Seop Kim, Qoniac GmbH (Korea, Republic of) . . . . . [9778-110]

**Process tool monitoring and matching using interferometry technique**, Doug Anberg, Byoung-Ho Lee, David M. Owen, Jeffrey Mileham, Eric Bouche, Ultratech, Inc. (USA) . . . . . [9778-111]

**Reducing overlay sampling for APC-based correction per exposure by replacing measured data with computational prediction**, Ben F. Noyes III, Babak Mokaber, SAMSUNG Austin Semiconductor LLC (USA); Jong Hun Oh, Hyun Sik Kim, Jun Ha Sung, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Marc Kea, ASML Netherlands B.V. (Netherlands) . . . . . [9778-112]

**Overlay metrology method in nanoscale semiconductor devices using an image processing technique**, ChaeHo Shin, Korea Research Institute of Standards and Science (Korea, Republic of); Jung-Hwan Kim, Korea Basic Science Institute (Korea, Republic of) . . . . . [9778-113]

**Automated klarf-based defect inspection by electron-beam inspection tool: a novel approach to inline monitoring and/or process change validation**, Na Cai, Xuefeng Zeng, Kevin Wu, Ho Young Song, Weihong Gao, GLOBALFOUNDRIES Inc. (USA); Qing Tian, Chris Lei, Kewen Gao, Liuchen Wang, Yan Zhao, Hermes-Microvision Inc., USA (USA) . . . . . [9778-114]

**Sub-20nm particle inspection on EUV mask blanks**, Peter G. W. Bussink, Jean-Baptiste C. G. Volatier, Peter van der Walle, Erik C. Fritz, Jacques C. J. van der Donck, TNO (Netherlands) . . . . [9778-115]

**Next-generation of metrology software platform dedicated to nanopatterns: application to semiconductor industry**, Johann Foucher, Alexandre Derville, Aurelien Labrosse, Yann Zimmermann, POLLEN Metrology (France); Sandip Halder, Arjun Singh, Philippe Leray, Roel Gronheid, IMEC (Belgium) . . . . . [9778-116]

**Root cause analysis of overlay metrology excursions with scatterometry overlay technology (SCOL)**, Vidya Ramanathan, KLA-Tencor New York (USA); Karsten Gutjahr, DeNeil Park, Patrick W. Snow, Richard McGowan, Narae Kang, Yui Zhou, GLOBALFOUNDRIES Inc. (USA); Tal Marciano, Tal Itzkovich, KLA-Tencor Israel (Israel); Janay Camp, KLA-Tencor New York (USA); Michael E. Adel, KLA-Tencor Israel (Israel) . . . . . [9778-117]

**Charging model in a fast analytical simulation of SEM images**, Sergey Babin, Sergey S. Borisov, Vladimir Trifonenkov, Abeam Technologies, Inc. (USA) . . . . . [9778-118]

**Scanner baseliner control monitoring in high-volume manufacturing**, Pavan K. Samudrala, GLOBALFOUNDRIES Inc. (USA) . . . . . [9778-119]

**Efficient electromagnetic field solver for metrology applications**, Sven Burger, Philipp Gutsche, Jan Pomplun, Frank Schmidt, Lin Zschiedrich, JCMwave GmbH (Germany). [9778-120]

**Sensitivity study and parameter optimization of ocd tool for 14nm finfet process**, Zhensheng Zhang, Huiping Chen, Dongmei Sun, Shiqiu Cheng, Kun Huang, Yaoming Shi, Yiping Xu, Raintree Scientific Instruments (Shanghai) Corp. (China) . . . . . [9778-121]

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# INTERACTIVE POSTER SESSION

Wednesday 24 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, interact with the poster authors who will be present during the poster session, and enjoy networking with your friends and colleagues.

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

**Metrology target design simulations for accurate and robust scatterometry overlay measurements**, Guy Ben Dov, Inna Tarshish-Shapir, Mark Ghinovker, Michael E. Adel, KLA-Tencor Israel (Israel); Soonho Oh, DongSub Choi, KLA-Tencor Korea (Korea, Republic of); Eitan Herzal, KLA-Tencor Israel (Israel); Mohamed El Kodadi, KLA-Tencor Korea (Korea, Republic of); Jeongjin Lee, Chan Hwang, Seung Yoon Lee, Jong-Seo Hong, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9778-122]

**An ultrasensitive bio-surrogate for nanoporous filter membrane performance metrology directed toward contamination control in microlithography applications**, Farhan Ahmad, Barbara Mish, Jian Qiu, Amarnauth Singh, Rao Varanasi, Ellidh Bedford, Martin Smith, Pall Corp. (USA) . . . . . [9778-123]

**Co-optimization of RegC® and TWINSCANTM corrections to improve the intra-field on-product overlay performance**, Kujan Gorhad, Ofir Sharoni, Vladimir Dmitriev, Carl Zeiss SMS Ltd. (Israel); Richard J. F. van Haren, Christian Roelofs, Hakki Ergun Cekli, ASML Netherlands B.V. (Netherlands); Emily E. Gallagher, Philippe Leray, IMEC (Belgium); Avi Cohen, Carl Zeiss SMS Ltd. (Israel) . . [9778-124]

**Within-wafer CD variation induced by wafer shape**, Chi-hao Huang, Mars Yang, Elvis Yang, T. H. Yang, K. C. Chen, Macronix International Co., Ltd. (Taiwan) . . . . . [9778-125]

**Process window and defectivity monitoring using high-throughput e-beam hot-spot inspection, guided by a novel, design-aware, scanner control interface**, Fei Wang, Pengcheng Zhang, Wei Fang, Kevin Liu, Jack Y. Jau, Hermes-Microvision Inc., USA (USA); Lester Wang, Alex Wan, Stefan Hunsche, ASML Brion (USA); Sandip Halder, Philippe Leray, IMEC (Belgium) . . . . . [9778-126]

**Holistic, model-based optimization of edge leveling as an enabler for lithographic focus control: Application to a memory use case**, Young Seog Kang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Tanbir Hassan, ASML Netherlands B.V. (Netherlands); Young-Jun Kim, S. J. Park, S. Y. Jang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Kwang-Young Hu, ASML Korea Co., Ltd. (Korea, Republic of); Paul Hinnen, Erik Koop, Maarten A. J. Voncken, ASML Netherlands B.V. (Netherlands) . . . . . [9778-128]

**Study the effect of materials and pore size selection on metals reduction in propylene glycol methyl ether acetate**, Majid Entezarian, Robert Gieger, 3M Purification Inc. (USA) . . . . . [9778-129]

**Electrical defects detection with SEM based review tools in semiconductor production mode manufacturing**, Andrei Miller, Applied Materials, Ltd. (Israel); Haim Pearl, Applied Materials, Inc. (USA); Travis Newell, Brock Tillotson, Microchip Technology, Inc. (USA) . . . . . [9778-130]

**Recipe creation for automated defect classification with a 450mm surface scanning inspection system based on the bidirectional reflectance distribution function and polystyrene latex spheres**, Nithin Yathapu, Global 450 Consortium (G450C) (USA); Steve A. McGarvey, Justin Brown, Hitachi High Technologies America, Inc. (USA); Alexander Zhivotovsky, Intel Corp. (Israel) . . . . . [9778-132]

**Focus measurement method by SEM image analysis of circuit pattern**, Shinichi Shinoda, Hitachi, Ltd. (Japan) . . . . . [9778-135]

**Surface profile measurement of highly reflective silicon wafer using wavelength tuning interferometer**, Yangjin Kim, Naohiko Sugita, Mamoru Mitsuishi, The Univ. of Tokyo (Japan) . . . . . [9778-136]

**Automatic pattern localization across layout database and photolithography mask**, Eric Beisser, Philippe Morey, Frederic Brault, XYALIS (France); Klaus-Dieter Roeth, KLA-Tencor MIE GmbH (Germany); Oliver Ache, KLA-Tencor MIE Germany (Germany) . . . . . [9778-138]

**Prediction of ppm level electrical failure by using physical variation analysis**, Hsin-Ming Hou, Ji-Fu Kung, United Microelectronics Corp. (Taiwan); Chu-en Chen, Kotaro Maruyama, Yuya Toyoshima, NGR Inc. (Japan); Yao-Pi Hsu, United Microelectronics Corp. (Taiwan) . . . . . [9778-139]

**Excursion detection using leveling data**, Min-Gyu Kim, Jae-Wuk Ju, SK Hynix, Inc. (Korea, Republic of); Boris Habets, Georg Erley, Enrico Bellmann, Qoniac GmbH (Germany); Seop Kim, Qoniac Korea Co., Ltd. (Korea, Republic of) . . . . . [9778-140]

**Improving reticle defect disposition via fully automated lithography simulation**, Raunak Mann, Eliot Goodman, Keith Lao, Steven Ha, SAMSUNG Austin Semiconductor LLC (USA); Anthony D. Vacca, Daniel I. Fiekowsky, Peter J. Fiekowsky, AVI-Photomask (USA) . . . . . [9778-142]

**Highly resolved dimensional control of line gratings by ultra-small angle x-ray scattering**, Guillaume Freychet, Univ. Grenoble Alpes (France), CEA-LETI, MINAREC (France); Cecile Cadoux, CEA-LETI (France); Florian Delachat, Univ. de Montreal (Canada), INRS-EMT (Canada); Yoann Blancquaert, CEA-LETI (France); Christophe Constancias, MINATEC (France); Stephane Rey, CEA-LETI, MINATEC (France); Mireille Maret, SIMAP, Grenoble INP, CNRS UJF (France); Patrice Gergaud, CEA-LETI (France) . . . . . [9778-144]

**Best practices for monitoring humidity in emersion scanner reticle environments to reduce reticle haze effects**, Allyn Jackson, CyberOptics Corp. (USA) . . . . . [9778-145]

**Net tracing and classification analysis on e-beam die-to-database inspection**, Weihong Gao, Yan Pan, Na Cai, Peter Lin, Ho Young Song, Hoang Nguyen, GLOBALFOUNDRIES Inc. (USA); Zhijin Chen, Khurram Zafar, Anchor Semiconductor, Inc. (USA) . . . . . [9778-146]

## CONFERENCE 9781

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

**Interlayer design verification methodology using contour image**, Minyoung Shim, Seoksan Kim, Sungmin Park, Seiryung Choi, Namjung Kang, Hyunju Sung, Jin Woo Choi, Jae-Pil Shin, Jai-Kyun Park, Myoungseob Shim, Kyupil Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9781-26]

**Design space exploration for early identification of yield limiting patterns**, Kareem Madkour, Mentor Graphics Egypt (Egypt); Xue Li, Gaorong Li, Sid Hong, ZhengFang Liu, JinYan Wang, Elaine Zou, Semiconductor Manufacturing International Corp. (China); ChunShan Du, Recco Zhang, Mentor Graphics Shanghai Electronic Technology Co. (China); Hussein Ali, Mentor Graphics Egypt (Egypt); Danny Hsu, Mentor Graphics Taiwan, Ltd. (Taiwan); Aliaa Kabeel, Mentor Graphics Egypt (Egypt); Wael ElManhawey, Joe Kwan, Mentor Graphics Corp. (USA) . . . . . [9781-31]

**Design technology co-optimization for 14/10nm metal1 double patterning layer**, Yingli Duan, Xiaojing Su, Ying Chen, Yajuan Su, Yayi Wei, Institute of Microelectronics (China); Feng Shao, Recco Zhang, Junjiang Lei, Minghui Fan, Mentor Graphics Shanghai Electronic Technology Co. (China) . . . . . [9781-32]

**An integrated design-to-manufacturing flow for SADP**, Ahmed Hamed, Rehab Kotb Ali, Omar H. El-Sewefy, Mentor Graphics Egypt (Egypt); Vlad Liubich, James Word, Mentor Graphics Corp. (USA) [9781-33]

**Using pattern analysis methods to do fast detection of manufacturing pattern failures**, Yifan Zhang, Cadence Design Systems, Inc. (China); Evan Zhao, Jessie Wang, Mason Sun, Jeff Wang, Semiconductor Manufacturing International Corp. (China); Jason Sweis, Ya-Chieh Lai, Cadence Design Systems, Inc. (USA) . . . . . [9781-34]

**Electron-beam lithography with character projection exposure for throughput enhancement with line-edge quality optimization**, Rimon Ikeno, Satoshi Maruyama, Yoshio Mita, Makoto Ikeda, Kunihiro Asada, The Univ. of Tokyo (Japan) [9781-35]

**Rapid recipe formulation for plasma etching of new materials**, Meghali J. Chopra, Zizhuo Z. Zhang, John Ekerdt, Roger T. Bonneau, The Univ. of Texas at Austin (USA) . . . . . [9781-36]

**Expanding the printable design space for lithography processes utilizing a cut mask**, Jerome F. Wandell, William Wilkinson, Mohamed Salama, Jui-Hsuan Feng, Mark Curtice, Shao Wen Gao, GLOBALFOUNDRIES Inc. (USA) . . . . . [9781-37]

**Characterization of shallow trench isolation CMP process and its application**, Kuang-Han Chen, Tamba Gbondo-Tugbawa, Hua Ding, Flora Li, Brian Lee, Aaron Gower-Hall, Yang-Chih Chiu, Cadence Design Systems, Inc. (USA); Helen Li, ChunLei Zhang, JinBing Liu, ZhengFang Liu, Semiconductor Manufacturing International Corp. (China) . [9781-38]

**Advanced DFM application for automated bit-line pattern dummy**, TaeHyun Shin, SK Hynix, Inc. (Korea, Republic of); Mohamed Bahr, Mentor Graphics Egypt (Egypt) . . . . . [9781-39]

**Wafer hotspot prevention using etch aware OPC Correction**, Dave Power, Ayman Hamouda, Mohamed Salama, GLOBALFOUNDRIES Inc. (USA); Ao Chen, GLOBALFOUNDRIES Singapore (Singapore) . . . . . [9781-40]

**Building block recipe style recipes for productivity improvement in OPC, RET and ILT flows**, Kevin Lucas, Linghui Wu, Denny Kwa, Matthew M. St. John, Steven Deeth, Thomas Cecil, Brian S. Ward, Synopsys, Inc. (USA) . . . . . [9781-41]

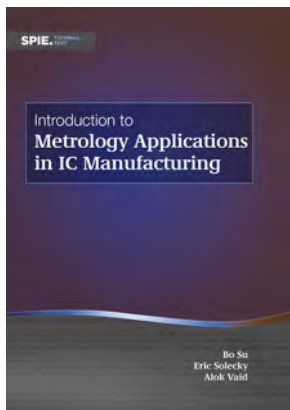
**Hybrid pattern based sub-resolution assist feature**, Ahmed S. Omran, GLOBALFOUNDRIES Inc. (USA); Andrey Lutich, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Paul Schroeder, GLOBALFOUNDRIES Inc. (USA) . . . . . [9781-42]

**Multiple patterning CD bias offset study by overlay**, Chia-Ching Lin, Gary Ch Wang, En Chuan Lio, Howard Chen, United Microelectronics Corp. (Taiwan) . . . . . [9781-43]

**Incorporating effective etch bias model into multipatterning OPC process-window solver**, Carl P. Babcock, Chidam Kallingal, Ayman Hamouda, GLOBALFOUNDRIES Inc. (USA); Jianhong Qiu, Bo Yan, Pengcheng Li, Mu Feng, Joanne Wu, Stanislas Baron, ASML Brion (USA) . . . . . [9781-44]

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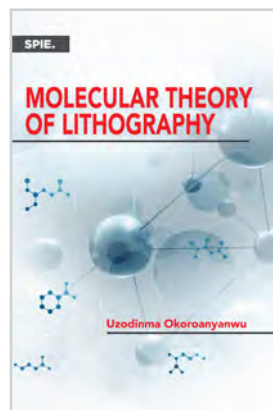


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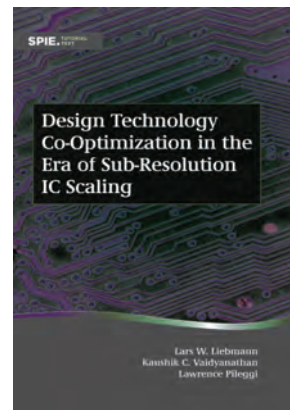


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**CONFERENCE 9776**

**Extreme Ultraviolet (EUV) Lithography VII**

**SESSION 12**

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

**EUV Extension**

Session Chairs: **Obert R. Wood II**, GLOBALFOUNDRIES Inc. (USA); **Thomas I. Wallow**, ASML Brion (USA)

8:00 am: **EUV high-NA scanner and mask optimization for sub-8nm resolution** (*Invited Paper*), Jan van Schoot, Koen van Ingen Schenau, Kars Troost, ASML Netherlands B.V. (Netherlands); John D. Zimmerman, ASML (USA); Sascha Migura, Bernhard Kneer, Jens Timo Neumann, Winfried Kaiser, Carl Zeiss SMT GmbH (Germany) [9776-55]

8:30 am: **Emulation of anamorphic imaging on the SHARP EUV mask microscope**, Markus P. Benk, Antoine J. Wojdyla, Weillun L. Chao, Ryan H. Miyakawa, Patrick P. Naulleau, Kenneth A. Goldberg, Lawrence Berkeley National Lab. (USA) . . . . . [9776-56]

8:50 am: **Influence of anamorphic high-NA for mask defect inspection in EUV lithography**, Guk-Jin Kim, Hye Rim Ji, In-Seon Kim, Hanyang Univ. (Korea, Republic of); Michael S. Yeung, Fastlitho Inc. (USA); Hye-Keun Oh, Hanyang Univ. (Korea, Republic of) . . . [9776-57]

9:10 am: **High-NA EUV projection lens with central obscuration**, Aleksandr S. Grishkanich, Aleksandr P. Zhevnikov, Sergey V. Kascheev, ITMO Univ. (Russian Federation); Ruben P. Seisyan, Ioffe Physical-Technical Institute (Russian Federation); Aleksandr Bagdasarov, S.I. Vavilov State Optical Institute (Russian Federation); Valentin V. Elizarov, ITMO Univ. (Russian Federation); Igor S. Sidorov, Univ. of Eastern Finland (Finland) . . . . . [9776-58]

9:30 am: **Comprehensive characterization of Gd and Tb laser plasma emission near  $\lambda = 6.7\text{nm}$** , Liang Yin, Hanchen Wang, Brendan Reagan, Cory Baumgarten, Vyacheslav N. Shlyaptsev, Colorado State Univ. (USA); Joseph J. Bendik, Dynamic Intelligence (USA); Jorge J. Rocca, Colorado State Univ. (USA). . . . . [9776-59]

9:50 am: **Current development status of HSFET (high-NA small field exposure tool) in EIDEC**, Satoshi Tanaka, Shunko Magoshi, Hidemi Kawai, EUVL Infrastructure Development Ctr., Inc. (Japan); Soichi Inoue, Toshiba Corp. (Japan); Wylie Rosenthal, Luc Girard, Louis A. Marchetti, Robert Kestner, John Kincade, Zygo Corporation (USA) . . . . . [9776-60]

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

**CONFERENCE 9777**

**Alternative Lithographic Technologies VIII**

**SESSION 10**

**LOCATION: CONVENTION CENTER 210B  
THU 9:00 AM TO 10:00 AM**

**Novel Lithography and Alternative Patterning I**

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

9:00 am: **A paradigm shift in patterning foundation from frequency multiplication to edge placement accuracy: A novel processing solution by selective etching and alternating-material self-aligned multiple patterning**, Ting Han, Hongyi Liu, Yijian Chen, Peking Univ. (China) . . . . . [9777-43]

9:20 am: **Contact hole patterning by electric-field assisted assembly of core-shell nanoparticles**, Xuexue Guo, Lan Lin, Theresa S. Mayer, The Pennsylvania State Univ. (USA) . . . [9777-44]

9:40 am: **Single-step patterning on inclined surfaces with ensured alignment for 3D nanofabrication**, Diana A. Grishina, Cornelis A. M. Hartevelde, Léon A. Woldering, Willem L. Vos, Univ. Twente (Netherlands) . . . . . [9777-45]

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

**CONFERENCE 9778**

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

**SESSION 12**

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

**Overlay Optimization**

**Joint Session with Conferences 9778 and 9780**

Session Chairs: **John C. Robinson**, KLA-Tencor Corp. (USA); **Young Seog Kang**, SAMSUNG Electronics Co., Ltd. (Korea, Republic of)

8:10 am: **Patterned wafer geometry (PWG) metrology for improving process-induced overlay and focus problems** (*Invited Paper*), Timothy A. Brunner, Yue Zhou, Cheukwun Wong, Bradley Morgenfeld, Gerald Leino, Sunit Mahajan, GLOBALFOUNDRIES Inc. (USA)[9780-31]

8:40 am: **Proposed approach to drive wafer topography for advanced lithography**, John F. Valley, Andrey Melnikov, John A. Pitney, SunEdison Semiconductor Ltd. (USA) . . . . . [9778-54]

9:00 am: **Assessments of image-based and scatterometry-based overlay targets**, Chiew-Seng Koay, Nelson M. Felix, Bassem Hamieh, Scott D. Halle, Stuart Sieg, IBM Corp. (USA) . . . . . [9778-55]

9:20 am: **Lithography-aware overlay metrology target design method**, Myungjun Lee, Mark D. Smith, KLA-Tencor Corp. (USA); Joon Seuk Lee, Mi-Rim Jung, Honggoo Lee, Young-Sik Kim, Sang-Jun Han, SK Hynix, Inc. (Korea, Republic of); Michael E. Adel, Kangsan Lee, Do-Hwa Lee, DongSub Choi, Zephyr Liu, Tal Itzkovich, Ady Levy, KLA-Tencor Corp. (USA) . . . . . [9778-56]

9:40 am: **Improvement of unbalanced illumination induced telecentricity within the exposure slit**, Jong Hoon Jang, ByeongSoo Lee, Young Seog Kang, Chan Sam Chang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Wim Bouman, Roelof F. de Graaf, Stefan Weichselbaum, Richard Droste, ASML Netherlands B.V. (Netherlands); Jeong-Heung Kong, Young Ha Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9780-32]

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

CONFERENCE 9779

Advances in Patterning Materials and Processes XXXIII

SESSION 12

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

Process Improvements for Advanced Patterning

Session Chairs: Nobuyuki N. Matsuzawa, Sony Corp. (Japan); Ryan Callahan, FUJIFILM Electronic Materials U.S.A., Inc. (USA)

- 8:00 am: Novel pattern trimming and shrink material (PTM (PTD) and PSM (NTI)) for ArF/EUV extension...
8:20 am: Trilayer rework optimization to overcome advanced technologies challenges...
8:40 am: Evaluation of water-based intelligent fluids for resist stripping in single wafer cleaning tools...
9:00 am: Novel ArF immersion extension technology by dry development rinse materials (DDRP) and materials (DDRM)...
9:20 am: Additive chemistry and distributions in photoresist thin films...
9:40 am: PVD prepared molecular glass resists for scanning probe lithography...

CONFERENCE 9780

Optical Microlithography XXIX

SESSION 9

LOCATION: CONVENTION CENTER 220B
THU 8:10 AM TO 10:00 AM

Overlay Optimization

Joint Session with Conferences 9778 and 9780

Session Chairs: John C. Robinson, KLA-Tencor Corp. (USA); Young Seog Kang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of)

- 8:10 am: Patterned wafer geometry (PWG) metrology for improving process-induced overlay and focus problems...
8:40 am: Proposed approach to drive wafer topography for advanced lithography...
9:00 am: Assessments of image-based and scatterometry-based overlay targets...
9:20 am: Lithography-aware overlay metrology target design method...
9:40 am: Improvement of unbalanced illumination induced telecentricity within the exposure slit...

Coffee Break Thu 10:00 am to 10:30 am

CONFERENCE 9781

Design-Process-Technology Co-optimization for Manufacturability X

SESSION 5

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

Hotspot Detection and Removal

Session Chairs: Neal V. Lafferty, Mentor Graphics Corp. (USA); Chul-Hong Park, SAMSUNG Electronics Co., Ltd. (Korea, Republic of)

- 8:10 am: Automatic layout feature extraction for lithography hotspot detection based on deep neural network...
8:40 am: Patterns-based DTCO flow for early estimation of lithographic difficulty using optical image processing techniques...
9:00 am: A random approach of test macro generation for early detection of hotspots...
9:20 am: Hotspot detection and removal flow using multi-level silicon-calibrated CMP models...
9:40 am: Migrating from older to newer technology nodes and discovering the process weak-points...

Coffee Break Thu 10:00 am to 10:30 am



**CONFERENCE 9776**

**Extreme Ultraviolet (EUV) Lithography VII**

**SESSION 13**

**LOCATION: CONVENTION CENTER 220A  
THU 10:40 AM TO 12:00 PM**

**EUV Patterning I**

Session Chairs: **Eric M. Panning**, Intel Corp. (USA); **Kenneth A. Goldberg**, Lawrence Berkeley National Lab. (USA)

10:40 am: **EUV patterning successes and frontiers**, Nelson M. Felix, Daniel A. Corliss, Karen E. Petrillo, Nicole Saulnier, Yongan Xu, Hao Tang, Luciana Meli, Ekmini Anuja de Silva, Bassem Hamieh, Martin Burkhardt, Yann Mignot, Richard Johnson, IBM Corp. (USA); Christopher F. Robinson, GLOBALFOUNDRIES Inc. (USA); Mary A. Breton, IBM Corp. (USA); Genevieve Beique, Andre Labonte, Lei Sun, Geng Han, GLOBALFOUNDRIES Inc. (USA); Eunshoo Han, SAMSUNG (USA); Bong Cheol Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Koichi Hontake, Lior Huli, Corey Lemley, David R. Hetzer, TEL Technology Ctr., America, LLC (USA) . . . . . [9776-61]

11:00 am: **Contrast optimization for 0.33NA EUV lithography**, Jo Finders, Sander F. Wuister, Guido Schiffelers, Friso Wittebrood, Gerardo Bottiglieri, ASML Netherlands B.V. (Netherlands) . . . [9776-62]

11:20 am: **Extension of practical k1 limit in EUV lithography through optimization of illumination modes**, Sarohan Park, Inwhan Lee, Jin-Soo Kim, Chang-Moon Lim, Young-Sik Kim, Noh-Jung Kwak, SK Hynix, Inc. (Korea, Republic of) . . . . . [9776-63]

11:40 am: **Application of EUV resolution enhancement techniques (RET) to optimize and extend single-exposure bi-directional patterning for 7nm and beyond logic designs**, Ryoung-Han Kim, Obert R. Wood, GLOBALFOUNDRIES Inc. (USA); Michael Crouse, ASML Brion (USA); Yulu Chen, GLOBALFOUNDRIES Inc. (USA); Vince Plachecki, Stephen D. Hsu, Keith D. Gronlund, ASML Brion (USA) . . . . . [9776-64]

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

**CONFERENCE 9777**

**Alternative Lithographic Technologies VIII**

**SESSION 11**

**LOCATION: CONVENTION CENTER 210B  
THU 10:30 AM TO 12:10 PM**

**Novel Lithography and Alternative Patterning II**

Session Chairs: **Frank M. Schellenberg**, Consultant (USA); **Helmut Schiff**, Paul Scherrer Institut (Switzerland)

10:30 am: **Enhanced patterning by tilted ion implantation**, Sang Wan Kim, Peng Zheng, Kimihiko Kato, Univ. of California, Berkeley (USA); Leonard Rubin, Axcelsis Technologies, Inc. (USA); Tsu-Jae King Liu, Univ. of California, Berkeley (USA) . . . . . [9777-47]

10:50 am: **Exploring the potential of multiphoton laser ablation lithography (MP-LAL) as a reliable technique for sub-50nm patterning**, Theodoros Manouras, Foundation for Research and Technology-Hellas (Greece) and Opticon Group ABEE (Greece) and Nanotronix USA, Inc. (USA); Vangelis Angelakos, Opticon Group ABEE (Greece) and Nanotronix USA, Inc. (USA); Maria Vamvakaki, Foundation for Research and Technology-Hellas (Greece) and Univ. of Crete (Greece); Panagiotis Argitis, National Ctr. for Scientific Research Demokritos (Greece) . . . . . [9777-48]

11:10 am: **Complementary patterning using plasmon-excited electron beamlets**, Zhidong Du, Luis M. Traverso, Anurup Datta, Chen Chen, Liang Pan, Xianfan Xu, Purdue Univ. (USA) . . . [9777-49]

11:30 am: **Dots-on-the-fly electron beam lithography**, Tero Isotalo, Tapio K. Niemi, Tampere Univ. of Technology (Finland) . . . [9777-50]

11:50 am: **Novel approaches for high-volume conformal replication of advanced 3D patterns for the manufacturing of complex monolithic micro-optical components**, Loic Jacot-Descombes, Arne Schleunitz, Jan J. Klein, Maria M. Russew, micro resist technology GmbH (Germany); Victor J. Cadarso, Helmut Schiff, Paul Scherrer Institut (Switzerland); Gabi Grützner, micro resist technology GmbH (Germany) . . . . . [9777-51]

Conference End.

**CONFERENCE 9778**

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

**LOCATION: CONVENTION CENTER 220B  
10:30 AM TO 10:40 AM**  
**Karel Urbanek Best Student Paper  
Award Presentation**

**SESSION 13**

**LOCATION: CONVENTION CENTER 220B  
THU 10:40 AM TO 11:40 AM**

**Mask Inspection**

Session Chairs: **Eric Solecky**, GLOBALFOUNDRIES Inc. (USA); **Byoung-Ho Lee**, Ultratech (USA)

10:40 am: **Material analysis techniques used to drive down in-situ mask contamination sources**, Harm Dillen, Gerard Rebel, Jennifer Massier, Dominika Grodzinka, Richard J. Bruls, ASML Netherlands B.V. (Netherlands) . . . . . [9778-57]

11:00 am: **Scanning differential-CDI for EUV actinic photomask inspection**, Istvan Mohacsi, Patrick Helfenstein, Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9778-58]

11:20 am: **Simulation of AIMS measurements for ILT masks**, Chih-Shiang Chou, Hsu-Ting Huang, Hsieh-Wei Huang, Yuan-Chih Chu, Yu-Po Tang, Wen-Chun Huang, Ru-Gun Liu, Tsai-Sheng Gau, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9778-59]

Lunch Break . . . . . Thu 11:40 am to 1:30 pm

**CONFERENCE 9779**

Advances in Patterning Materials and Processes XXXIII

**SESSION 13**

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

**DSA Materials: Fundamentals and Simulation**

Session Chairs: **Robert Allen**, IBM Research - Almaden (USA); **James W. Thackeray**, Dow Electronic Materials (USA)

10:30 am: **Molecular simulations and evolutionary computing to reconstruct the block-copolymer morphology from x-ray scattering**, Gurdaman Khaira, The Univ. of Chicago (USA); Manolis Doxastakis, Argonne National Lab. (USA); Jiaxing Ren, The Univ. of Chicago (USA); Daniel Sunday, R. Joseph Kline, National Institute of Standards and Technology (USA); Paul F. Nealey, Juan J. de Pablo, The Univ. of Chicago (USA) and Argonne National Lab. (USA) . . . . . [9779-46]

10:50 am: **Directed self-assembly of diblock copolymers in multi-VIA configurations: effect of chemopatterned substrates on defectivity**, Corinne L. Carpenter, Kris T. Delaney, Glenn H. Fredrickson, Univ. of California, Santa Barbara (USA) . . . . . [9779-47]

11:10 am: **Surface affinity role in directed self-assembly of lamellar block copolymers**, Guillaume Claveau, Patrick Quemere, Maxime Argoud, Jérôme Hazard, Nicolas Posseme, Raluca Tiron, CEA-LETI (France); Xavier Chevalier, Célia Nicolet, Christophe Navarro, Arkema S.A. (France) . . . . . [9779-48]

11:30 am: **Influence of template fill in grapho-epitaxy DSA**, Jan Doise, KU Leuven (Belgium); Joost P. Bekaert, Boon Teik Chan, IMEC (Belgium); Sung Eun Hong, Guanyang Lin, EMD Performance Materials Corp. (USA); Roel Gronheid, IMEC (Belgium) . . . . . [9779-49]

11:50 am: **Application of resonant x-ray scattering to high-chi polymers**, Daniel Sunday, National Institute of Standards and Technology (USA); Jiaxing Ren, Xuanxuan Chen, Paul F. Nealey, Abelardo Ramirez-Hernández, Juan J. de Pablo, The Univ. of Chicago (USA); R. Joseph Kline, National Institute of Standards and Technology (USA) . . . . . [9779-50]

Conference End.

**CONFERENCE 9780**

Optical Microlithography XXIX

**LOCATION: CONVENTION CENTER 210C  
10:30 AM TO 10:35 AM**

**Cymer Award**

**SESSION 10**

**LOCATION: CONVENTION CENTER 210C  
THU 10:35 AM TO 12:35 PM**

**Toolings**

Session Chairs: **Tsai-Sheng Gau**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Bernd Geh**, Carl Zeiss SMT Inc. (USA)

10:35 am: **High-order aberration control during exposure for leading-edge lithography projection optics**, Yasuhiro Ohmura, Yosuke Tsuge, Toru Hirayama, Hironori Ikezawa, Daisuke Inoue, Yasuhiro Kitamura, Yukio Koizumi, Keisuke Hasegawa, Satoshi Ishiyama, Toshiharu Nakashima, Takahisa Kikuchi, Minoru Onda, Yohei Takase, Akimasa Nagahiro, Susumu Isago, Hidetaka Kawahara, Nikon Corp. (Japan) . . . . . [9780-33]

10:55 am: **DUV light source technologies for 10nm and 3D NAND**, Theodore Cacouris, Gregory A. Rechtsteiner, Will E. Conley, Cymer LLC (USA) . . . . . [9780-34]

11:15 am: **The ArF laser for the next-generation multiple-patterning immersion lithography supporting green operations**, Takeshi Ohta, Hiroataka Miyamoto, Keisuke Ishida, Takahito Kumazaki, Hiroaki Tsushima, Akihiko Kurosu, Takashi Matsunaga, Hakaru Mizoguchi, Gigaphoton Inc. (Japan) . . . . . [9780-35]

11:35 am: **NXT:1980Di immersion scanner for 7nm and 5nm production nodes**, Wim P. de Boeij, Roelof F. de Graaf, Stefan Weichselbaum, Richard Droste, Matthew G. McLaren, Bert Koek, ASML Netherlands B.V. (Netherlands) . . . . . [9780-36]

11:55 am: **Next-generation immersion scanner optimizing on-product performance for 7nm node**, Yasushi Yoda, Yusaku Uehara, Yujiro Hikida, Satoshi Ishiyama, Yoichi Tashiro, Toru Hirayama, Yuji Shiba, Kazuo Masaki, Yuichi Shibazaki, Nikon Corp. (Japan)[9780-37]

12:15 pm: **Investigation of systematic CD distribution error on intrafield**, Keunjun Kim, Jung-Hyun Kang, Daewoo Kim, Sung Koo Lee, Hyeong-Soo Kim, SK Hynix, Inc. (Korea, Republic of) . [9780-50]

**LOCATION: CONVENTION CENTER 210C  
12:35 PM TO 12:40 PM**

**Concluding Remarks**

Session Chairs: **Andreas Erdmann**, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); **Jongwook Kye**, GLOBALFOUNDRIES Inc. (USA)

Conference End.

**CONFERENCE 9781**

Design-Process-Technology  
Co-optimization for Manufacturability X

**SESSION 6**

**LOCATION: MARRIOTT, SAN JOSE SALON III  
THU 10:30 AM TO 12:00 PM**

**Multiple Patterning and Directed Self-Assembly**

Session Chairs: **Michael L. Rieger**, Synopsys, Inc. (USA); **Vivek K. Singh**, Intel Corp. (USA)

10:30 am: **Triple/quadruple patterning layout decomposition via novel linear programming and iterative rounding** (*Invited Paper*), Yibo Lin, Xiaoqing Xu, The Univ. of Texas at Austin (USA); Bei Yu, The Chinese Univ. of Hong Kong (China); Ross Baldick, David Z. Pan, The Univ. of Texas at Austin (USA) . . . . . [9781-22]

11:00 am: **Design strategy for integrating DSA via patterning in sub-7nm interconnects**, Ioannis Karageorgos, IMEC (Belgium) and KU Leuven (Belgium); Julien Ryckaert, IMEC (Belgium); Maryann Tung, H. S. P. Wong, Stanford Univ. (USA); Roel Gronheid, Joost P. Bekaert, Kris Croes, IMEC (Belgium); Evangelos Karageorgos, National and Kapodistrian Univ. of Athens (Greece); Geert Vandenberghe, Michele Stucchi, IMEC (Belgium); Wim Dehaene, KU Leuven (Belgium) . . . . . [9781-23]

11:20 am: **Enablement of DSA for VIA layer with a metal SIT process flow**, Loïc Schneider, Vincent Farys, Emmanuelle Serret, STMicroelectronics (France); Claire Fenouillet-Beranger, CEA LETI (France) . . . . . [9781-24]

11:40 am: **Layout decomposition for a modular technology to solve the edge-placement challenges by combining selective etching, direct stitching, and alternating-material self-aligned multiple patterning processes**, Hongyi Liu, Ting Han, Jun Zhou, Yijian Chen, Peking Univ. (China) . . . . . [9781-25]

Lunch Break . . . . . Thu 12:00 pm to 1:50 pm

**CONFERENCE 9776**

**Extreme Ultraviolet (EUV) Lithography VII**

**SESSION 14**

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

**EUV Patterning II**

Session Chairs: **Christopher S. Ngai**, Applied Materials, Inc. (USA); **Sang Hun Lee**, Intel Corp. (USA)

- 1:30 pm: **Assist features: placement, impact, and relevance for EUV imaging**, Iacopo Mochi, Vicky Philipsen, Emily E. Gallagher, Eric Hendrickx, IMEC (Belgium); Kateryna Lyakhova, Friso Wittebrood, Guido Schiffelers, ASML Netherlands B.V. (Netherlands); Bart Laenens, Stephen D. Hsu, Vince Plachecki, James Moon, ASML Brion (USA); Stanislas Baron, ASML US, Inc. (USA) . . . . . [9776-65]
- 1:50 pm: **EUV masks manufacturing: challenges and opportunities**, Bryan S. Kasprovicz, Photronics, Inc. (USA) . . . . . [9776-66]
- 2:10 pm: **EUV implementation of model-based assist features in contact patterns**, Fan Jiang, Mentor Graphics Corp. (USA); Ananthan Raghunathan, GLOBALFOUNDRIES Inc. (USA); Martin Burkhardt, IBM Corp. (USA); Alexander Tritchkov, Srividya Jayaram, Mentor Graphics Corp. (USA); Nicole Saulnier, IBM Corp. (USA); James Word, Mentor Graphics Corp. (USA) . . . . . [9776-67]
- 2:30 pm: **Photolithographic patterning reaches 6nm half-pitch using EUV interference lithography**, Daniel Fan, Yasin Ekinici, Paul Scherrer Institut (Switzerland) . . . . . [9776-68]
- 2:50 pm: **EUV patterned templates with grapho-epitaxy DSA at the N5/N7 logic nodes**, Roel Gronheid, IMEC (Belgium); Carolien Boeckx, Jan Doise, Ioannis Karageorgos, IMEC (Belgium) and KU Leuven (Belgium); Julien Ruckaert, Boon Teik Chan, IMEC (Belgium); Chenxi Lin, Yi Zou, ASML Brion (USA) . . . . . [9776-69]
- 3:10 pm: **Novel detection and process improvement for organic coating-film defect**, Masahiko Harumoto, Yuji Tanaka, Akihiro Hisai, Masaya Asai, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Hideo Ota, Hitachi High-Technologies Corp. (Japan); Fumiaki Endo, Hitachi High-Tech Science Corp. (Japan) . . . . . [9776-70]
- Coffee Break . . . . . Thu 3:30 pm to 4:00 pm

**SESSION 15**

**LOCATION: CONVENTION CENTER 220A  
THU 4:00 PM TO 5:50 PM**

**EUV Pellicle**

Session Chairs: **Jin-ho Ahn**, Hanyang Univ. (Korea, Republic of); **Emily E. Gallagher**, IMEC (Belgium)

- 4:00 pm: **NXE pellicle: offering a EUV pellicle solution to the industry** (*Invited Paper*), Derk Brouns, Eric Casimiri, Dennis De Graaf, Paul Janssen, Ronald Kramer, Matthias Kruizinga, Frits Van Der Meulen, Daniel A. Smith, Beatrijs Verbrugge, David Van De Weg, Noëlie Wojewoda, Carmen Zoldesi, ASML Netherlands B.V. (Netherlands); Peter Delmastro, Aage Bendiksen, Hilary G. Harrold, ASML (USA) . . . . . [9776-71]
- 4:30 pm: **Study of nanometer-thick graphite film for high-power EUVL pellicle**, Mun Ja Kim, Hwan Chul Jeon, Roman Chalykh, Eokbong Kim, Jaehyuck Choi, Byung-Gook Kim, Chan-Uk Jeon, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Seul-Gi Kim, Dong-Wook Shin, Tae Sung Kim, Sooyoung Kim, Jung Hun Lee, Ji-Beom Yoo, Sungkyunkwan Univ. (Korea, Republic of) . . . . . [9776-72]
- 4:50 pm: **EUV lithography imaging using novel pellicle membranes**, Ivan Pollentier, Johannes Vanpaemel, Jae Uk Lee, Christoph Adelman, Houman Zahedmanesh, Cedric Huyghebaert, Emily E. Gallagher, IMEC (Belgium) . . . . . [9776-73]
- 5:10 pm: **Thermomechanical behavior of EUV pellicle under dynamic exposure conditions**, Dario L. Goldfarb, IBM Thomas J. Watson Research Ctr. (USA); Max O. Bloomfield, Rensselaer Polytechnic Institute (USA); Matthew E. Colburn, IBM Corp. (USA) . . . . . [9776-74]
- 5:30 pm: **Inspection of extreme-ultraviolet lithography pellicles using ellipsometry**, Changho Lee, Seulki Kim, Sungmo Park, Eunsung Kim, Hye-Keun Oh, Min-Su Kim, Jin-Goo Park, Jin-ho Ahn, Jung Hwan Kim, Ji Eun Kim, Seong Hoon Jeong, Ilsin An, Hanyang Univ. (Korea, Republic of) . . . . . [9776-75]
- Conference End.

**CONFERENCE 9778**

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

**SESSION 14**

**LOCATION: CONVENTION CENTER 220B  
THU 1:50 PM TO 3:10 PM**

**Design Interaction with Metrology**

**Joint Session with Conferences 9778 and 9781**

- Session Chairs: **Alexander Starikov**, I&I Consulting (USA); **Jason P. Cain**, Advanced Micro Devices, Inc. (USA)
- 1:50 pm: **Modeling metrology for calibration of OPC models**, Chris A. Mack, Lithoguru.com (USA); John L. Sturtevant, Yunfei Deng, Christian D. Zuniga, Kostas Adam, Mentor Graphics Corp. (USA) . . . . . [9778-61]
  - 2:10 pm: **OPC optimization techniques for enabling the reduction of mismatch between overlay metrology and the device pattern cell**, Shinyoung Kim, Chan-Ha Park, Hyun-Jo Yang, Joon Seuk Lee, SK Hynix, Inc. (Korea, Republic of); Sean Park, ASML US, Inc. (USA); Ki-Yeop Park, Seop Kim, Nang-Lyeom Oh, Kyu-Tae Sun, ASML Korea Co., Ltd. (Korea, Republic of); Paul Tuffy, Youping Zhang, ASML US, Inc. (USA); Mi-Rim Jung, SK Hynix, Inc. (Korea, Republic of). [9778-137]
  - 2:30 pm: **The innovative PWQ method for accurate weak point extraction in DRAM**, Daehan Han, JinYoung Kang, Jinman Chang, Tae Heon Kim, Kyusun Lee, Ae-Ran Hong, Yonghyeon Kim  
m, Bumjin Choi, Joo-Sung Lee, Hyoung Jun Kim, KweonJae Lee, Hyeongsun Hong, Gyoyoung Jin, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9781-27]
  - 2:50 pm: **Process window limiting hot spot monitoring for high-volume manufacturing**, Marinus Jochemsen, ASML (USA); Roy Anunciado, Vadim Timoshkov, ASML Netherlands B.V. (Netherlands); Stefan Hunsche, Xinjian Zhou, ASML Brion (USA); Christopher Jones, ASML (USA); Neal Callan, ASML US, Inc. (USA) . . . . . [9778-63]
  - Coffee Break . . . . . Thu 3:10 pm to 3:40 pm

SESSION 15

LOCATION: CONVENTION CENTER 220B  
THU 3:40 PM TO 5:40 PM

Late Breaking News

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

3:40 pm: **Scatterometry-based metrology for SAQP using virtual reference**, Taher Kagalwala, Alok Vaid, Sridhar Mahendrakar, Michael Lenahan, Fang Fang, GLOBALFOUNDRIES Inc. (USA); Paul K. Isbester, Nova Measuring Instruments Inc. (USA); Michael Shifrin, Yoav Etzioni, Nova Measuring Instruments Ltd. (Israel); Aron J. Cepler, Nova Measuring Instruments, Inc. (USA); Prasad Dasari, Nova Measuring Instruments Inc. (USA); Cornel Bozdog, ReVera, A Nova Co. (USA); Naren Yellai, Nova Measuring Instruments Inc. (USA) . . . . . [9778-134]

4:00 pm: **3D-profile measurement of advanced semiconductor features by reference metrology**, Kiyoshi Takamasu, Yuuki Iwaki, Satoru Takahashi, The Univ. of Tokyo (Japan); Hiroki Kawada, Masami Ikota, Hitachi High-Technologies Corp. (Japan); Gian F. Lorusso, Naoto Horiguchi, IMEC (Belgium) . . . . . [9778-64]

4:20 pm: **Resist 3D model based OPC for 28nm metal process window enlargement**, Pierre M. Fanton, Franck Foussadier, Jean-Christophe Le-Denmat, Christian Gardin, Christelle Gardiola, Jonathan Planchot, STMicroelectronics (France); Omar Ndiaje, Nicolas Martin, Laurent Depre, ASML SARL (France); Frederic Robert, STMicroelectronics (France) . . . . . [9778-65]

4:40 pm: **Assessing e-beam direct-write and optical lithography with a multi-beam scanning electron microscope**, Tomasz Garbowski, Friedhelm Panteleit, Carl Zeiss Microscopy GmbH (Germany); Gregor Frank Dellemann, Carl Zeiss SMT GmbH (Germany); Manuela S. Gutsch, Fraunhofer-Ctr. Nanoelektronische Technologien (Germany); Christoph K. Hohle, Fraunhofer-Institut für Photonische Mikrosysteme (Germany); Matthias Rudolph, Katja Steidel, Xaver Thrun, Fraunhofer-Ctr. Nanoelektronische Technologien (Germany); Dirk Zeidler, Carl Zeiss Microscopy GmbH (Germany) . . . . . [9778-66]

5:00 pm: **Challenges in LER/CDU metrology of DSA structures: pitch roughness and cross-line correlations**, Vassilios Constantoudis, National Ctr. for Scientific Research Demokritos (Greece) and Nanometrisis (Greece); Hari Pathangi, Alessandro Vaglio Pret, IMEC (Belgium); Vijaya-Kumar Murugesan Murugesan Kuppuswamy, National Ctr. for Scientific Research Demokritos (Greece); Roel Gronheid, IMEC (Belgium); Evangelos Gogolides, National Ctr. for Scientific Research Demokritos (Greece) and Nanometrisis (Greece) . . . . . [9778-143]

5:20 pm: **Holistic overlay control for multi-patterning process layers at the 10nm and 7nm nodes**, Leon Verstappen, Evert C. Mos, Peter H. Wardenier, Henry Megens, Emil Schmitt-Weaver, Kaustuve Bhattacharyya, Omer Adam, Grzegorz Grzela, Joost van Heijst, Lotte Willems, Jan Mulken, ASML Netherlands B.V. (Netherlands) [9778-141]  
Conference End.

SESSION 7

LOCATION: CONVENTION CENTER 220B  
THU 1:50 PM TO 3:10 PM

Design Interaction with Metrology

Joint Session with Conferences 9778 and 9781

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

1:50 pm: **Modeling metrology for calibration of OPC models**, Chris A. Mack, Lithoguru.com (USA); John L. Sturtevant, Yunfei Deng, Christian D. Zuniga, Kostas Adam, Mentor Graphics Corp. (USA) . . . . . [9778-61]

2:10 pm: **OPC optimization techniques for enabling the reduction of mismatch between overlay metrology and the device pattern cell**, Shinyoung Kim, Chan-Ha Park, Hyun-Jo Yang, Joon Seuk Lee, SK Hynix, Inc. (Korea, Democratic Peoples Republic of); Sean Park, ASML US, Inc. (USA); Ki-Yeop Park, Seop Kim, Nang-Lyeom Oh, Kyu-Tae Sun, ASML Korea Co., Ltd. (Korea, Democratic Peoples Republic of); Paul Tuffy, Youping Zhang, ASML US, Inc. (USA); Mi-Rim Jung, SK Hynix, Inc. (Korea, Republic of) . . . . . [9778-137]

2:30 pm: **The innovative PWQ method for accurate weak point extraction in DRAM**, Daehan Han, JinYoung Kang, Jinman Chang, Tae Heon Kim, Kyusun Lee, Ae-Ran Hong, Yonghyeon Kim, Bumjin Choi, Joo-Sung Lee, Hyoung Jun Kim, KweonJae Lee, Hyeongsun Hong, Gyooyoung Jin, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9781-27]

2:50 pm: **Process window limiting hot spot monitoring for high-volume manufacturing**, Marinus Jochemsen, ASML (USA); Roy Anunciado, Vadim Timoshkov, ASML Netherlands B.V. (Netherlands); Stefan Hunsche, Xinjian Zhou, ASML Brion (USA); Christopher Jones, ASML (USA); Neal Callan, ASML US, Inc. (USA) . . . . . [9778-63]

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

LOCATION: CONVENTION CENTER 220C  
3:40 PM TO 3:45 PM

Franco Cerrina Memorial  
Best Student Paper Award

SESSION 8

LOCATION: CONVENTION CENTER 220C  
THU 3:45 PM TO 4:45 PM

Process and Yield Modeling

Session Chairs: **Shigeki Nojima**, Toshiba Corp. (Japan); **Fang-Cheng Chang**, Cadence Design Systems, Inc. (USA)

3:45 pm: **Verification and application of multi-source focus quantification**, Jean-Gabriel Simiz, STMicroelectronics (France) and Lab. Hubert Curien (France); Tanbir Hasan, Frank Staals, ASML Netherlands B.V. (Netherlands); Bertrand Le-Gratiet, STMicroelectronics (France); Wim T. Tel, ASML Netherlands B.V. (Netherlands); Christopher Prentice, ASML SARL (France); Jan-Willem Gemmink, ASML Netherlands B.V. (Netherlands); Alexandre V. Tishchenko, Lab. Hubert Curien (France) . . . . . [9781-28]

4:05 pm: **A comparative study on the yield performance of via landing and direct stitching processes for 2D pattern connection**, Jun Zhou, Yijian Chen, Peking Univ. (China) . . . . . [9781-29]

4:25 pm: **Estimate design sensitivity to process variation for the 14nm node**, Guillaume Landie, Vincent Farys, STMicroelectronics (France) . . . . . [9781-30]

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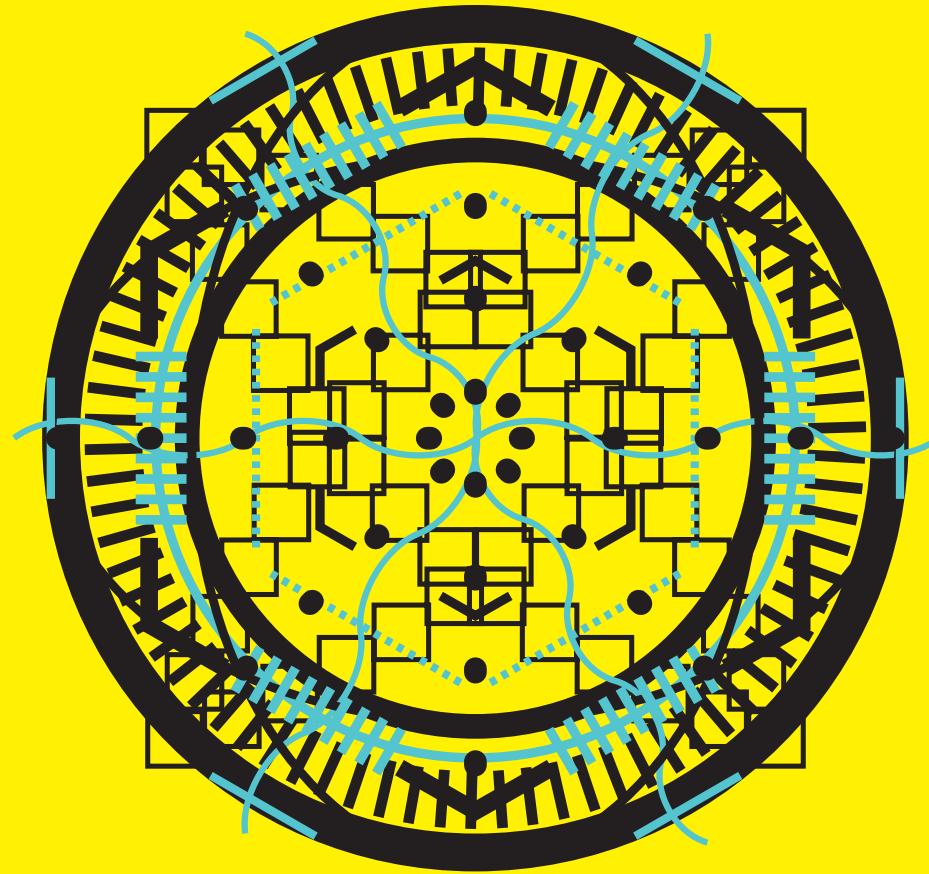
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