SPIE®

2014 Advanced Lithography

Technical Program

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Conference & Courses
23–27 February 2014

Exhibition
25–26 February 2014

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

Welcome

Your attendance at SPIE Advanced Lithography increases your company's success in the lithography industry through access to the latest research, networking opportunities, and industry directions.

Technologies

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

SPIE Advanced Lithography

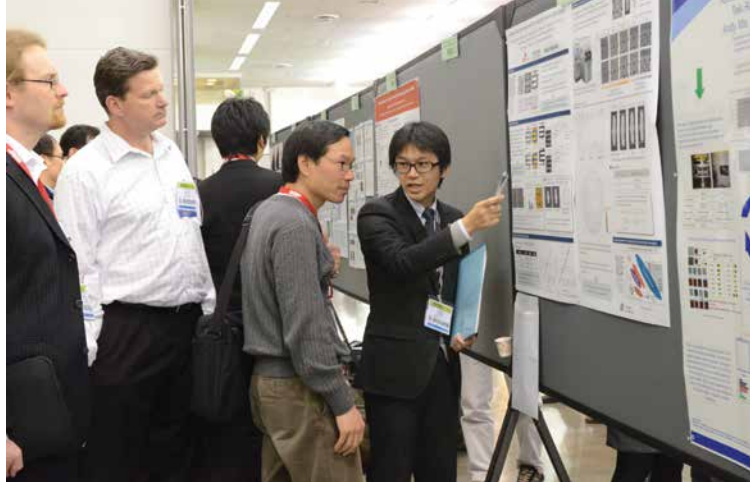
Technical Program

Conferences and Courses: 23–27 February 2014 · Exhibition: 25–26 February 2014

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

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

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



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Advances in Patterning Materials and Processes XXXI *(Wallow, Hohle)* 18–55

Optical Microlithography XXVII *(Lai, Erdmann)* 19–57

Design-Process-Technology Co-optimization for Manufacturability VIII *(Sturtevant, Capodieci)* 19–57

Advanced Etch Technology for Nanopatterning III *(Oehrlein, Lin)* 19–31

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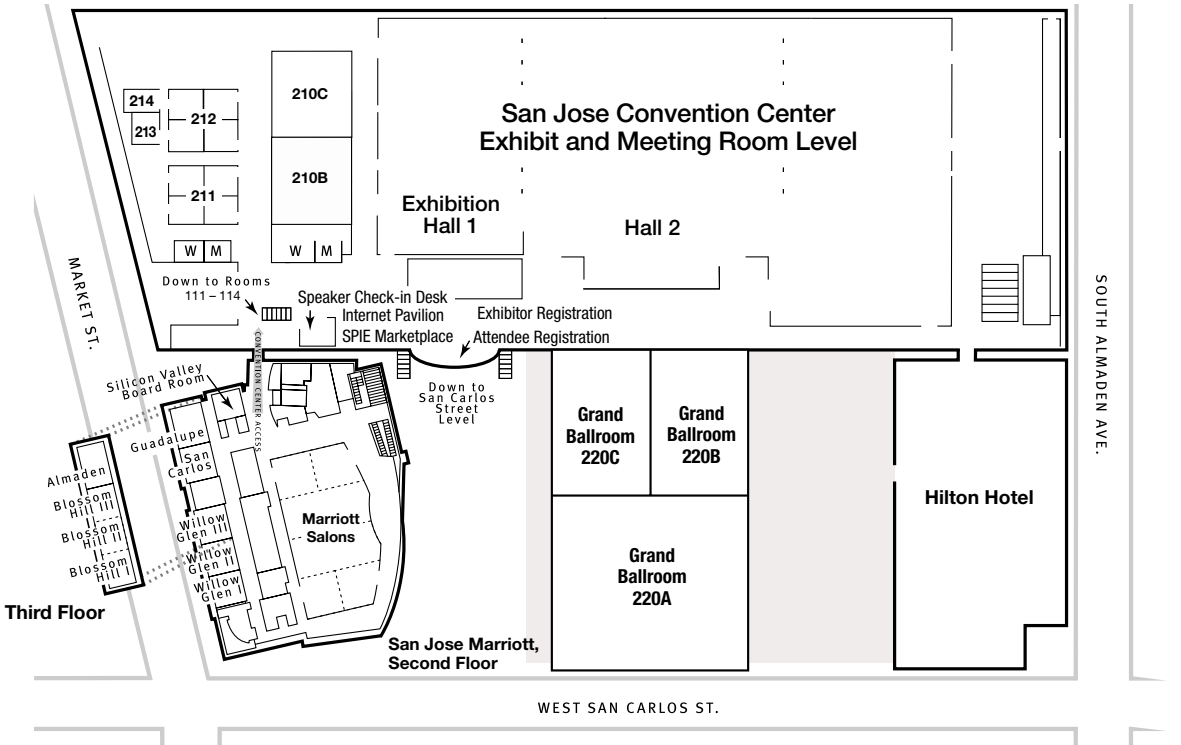

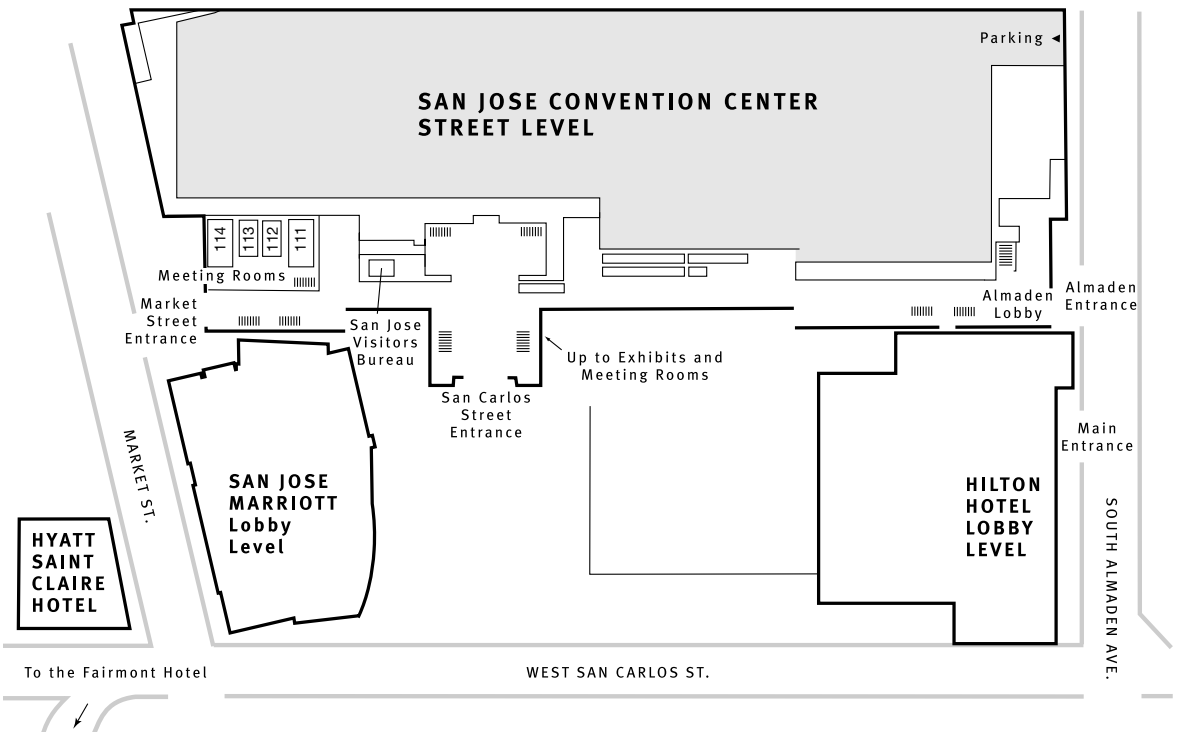

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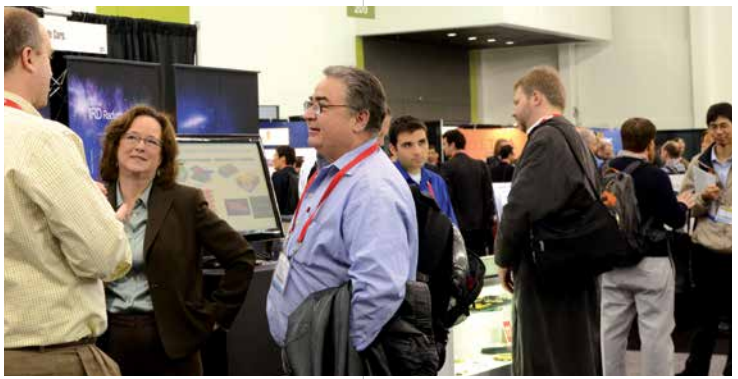
Daily Schedule

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
Special Events	**Welcome and Announcements** (Levinson), 8:00 to 8:30 am, p. 6	**Panel Discussion on Alternative Forms of Scaling,** 5:15 to 7:00 pm, p. 8	**Poster Reception** (Conferences 9050, 9051, 9053), 6:00 to 8:00 pm, p. 8	**Award Announcements for Conference 9052-Optical Microlithography,** 10:20 to 10:25 am, p. 9
	Plenary presentation: **My Year as SPIE President: What Does the Society Do and Who Makes it Happen?** (Arnold) 8:30 to 9:10 am, p. 6	**Poster Reception** (Conferences 9048, 9049, 9052, 9054), 6:00 to 8:00 pm, p. 8		**Award Announcements for Conference 9050-Metrology, Inspection, and Process Control for Microlithography,** 10:30 to 10:40 am, p. 9
	Plenary presentation: **Making the Impossible: Dealing with Patterns Throughout the Design and Manufacturing Flow** (Sawicki) 9:10 to 9:50 am, p. 7	**Joint Panel Discussion on The Battle for the 7nm Node: What are the Non-EUV Solutions?** *(Conley, Lai),* 7:45 to 9:00 pm, p. 8		
	Plenary presentation: **Beyond Scaling: Opportunities and Approaches** (Sekiguchi) 9:50 to 10:30 am, p. 7	**EXHIBITION,** p. 10 10:00 am to 5:00 pm; 6:00 to 8:00 pm	10:00 am to 4:00 pm	
	Award Announcements for Conference 9050-Metrology, Inspection, and Process Control for Microlithography, 11:00 to 11:20 am, p. 9			
	Award Announcements for Conference 9051-Advances in Patterning Materials and Processes, 11:00 to 11:20 am, p. 9			
	Nanotechnology in Microlithography Panel Discussion *(Silver, Barnes),* 6:00 to 7:30 pm, p. 8			
	BACUS Panel Discussion on Managing EUV Masks in Wafer Fab *(Progler),* 7:00 to 8:30 pm, p. 8			
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		Optical Microlithography XXVII *(Lai, Erdmann),* p. 18–57		
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Courses				
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See Course schedule page 15.
Review course descriptions and register for courses at the SPIE Cashier Desk.

2014 Advanced Lithography

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Luc Van den hove, IMEC
C. Grant Willson, The Univ. of Texas at Austin
Anthony Yen, Taiwan Semiconductor Manufacturing Co., Ltd.

Welcome!

The continuation of lithography-enabled Moore's Law scaling is being challenged as never before. While solving the technical problems associated with extending immersion lithography and bringing EUV lithography and other new technologies to production readiness, lithographers are increasingly challenged with finding solutions that are cost-effective. Success will demand unprecedented ingenuity, cost efficiency and communication within the lithography community and across interdisciplinary lines.

For the past 38 years, the SPIE Advanced Lithography Symposium has played a key role in bringing the lithography and broader patterning community together to solve challenges required by the semiconductor industry. Symposium participants come from an extensive array of backgrounds to share and learn about state-of-the-art lithographic tools, resists, metrology, processes, and design and process integration. Through a series of provocative panel discussions and seminars, the symposium further probes current issues to be faced as we extend these technologies or try to switch to alternative technologies.

The symposium is organized into seven conferences:

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

All conferences are organized by current practitioners of the art, and numerous short courses are taught by recognized industry experts. In keeping with the interdisciplinary nature of lithography, there are several joint sessions which cover topics relevant to multiple conferences. Additional information is available from the many manufacturers' exhibits, which allow tool makers, EDA suppliers, and material suppliers to showcase new products while interacting one-on-one with customers.

We welcome you to the San Jose Convention Center, San Jose, California for the SPIE Advanced Lithography's 39th year.

Harry J. Levinson
GLOBALFOUNDRIES, Inc.
2014 Symposium Chair

Mircea Dusa
ASML US, Inc.
2014 Symposium Co-Chair

Special Events

Welcome and Announcements

Convention Center 220A

Monday 24 February . . . . . 8:00 to 8:30 am
Symposium Chair: **Harry J. Levinson,** GLOBALFOUNDRIES

Introduction of New SPIE Fellows

Award Presentations

11th Frits Zernike Award for Advances in Optical Microlithography

Zernike Award Sponsored by:

ASML

2013 Harold E. Edgerton Award

Award presented to **Martin Richardson,**
by **William H. Arnold**

PLENARY PRESENTATIONS · *Convention Center 220A*

8:30 to 9:10 am

My Year as SPIE President: What Does the Society Do and Who Makes It Happen?

William H. Arnold
Chief Scientist, ASML
2013 SPIE President

I served as SPIE President in 2013, the first lithographer to hold this office. The Society of Photo-Optical Instrumentation Engineers has a unique membership and history, going back almost sixty years. The original meetings were organized by engineers trying to improve photography of rockets being fired into space from the plains of West Texas, to determine range and maximum altitude. Today the society has more than 17000 members, working in all fields of optical science and engineering. Major symposia in lasers and optical design, biomedical optics and medical imaging, nanotechnology and solar power, astronomy and remote sensing are the premiere venues in these fields, as Advanced Lithography is in ours. Proceedings of these conferences include some of the most cited papers in the world, figuring especially strongly in US Patents. The society also organizes major industry exhibitions such as Photonics West, the world's biggest trade show in optical and photonic products, held annually in San Francisco. At its core, SPIE is an educational not-for-profit organization, donating more than $3.2 million in altruistic giving in 2013, more than $190 per member, to various charitable activities such as scholarships, student travel grants and awards, and educational outreach to the developing world.

In this talk I will give a snapshot of what I did as President in the last year and the interesting people I met and worked with. I will highlight the opportunities people in our community have to use the resources of the society to their best advantage and to contribute themselves to the wider world of optical sciences and photonics, beyond lithography.

Bill Arnold has worked in lithography for 34 years, starting as a stepper engineer at Advanced Micro Devices in Sunnyvale, CA in 1980. He wrote his first paper for this conference in 1982. After serving in various author, session chair, and conference chair roles, he served as Symposium Chair in 1994 and 1995. He has been the Senior Editor for Lithography for the SPIE journal JM3 since 2002. He chaired the SPIE Publications Committee from 2004 to 2008. He was elected Vice President of the Society for 2011 and served as President in 2013.

Bill worked as a chipmaker for AMD from 1980 to 1998 where he was a Senior Fellow and Director of Process Development. In 1998 he moved to Veldhoven, the Netherlands, to become the Chief Scientist of ASML, now the world's leading lithography equipment manufacturer. In 2001, he moved back to the US, to head the ASML Technology Development Center in Tempe, AZ, where he is the Senior Vice President. Arnold has a B.A. in Physics from Hampshire College and an M.S. in Physics from the University of Chicago. He is a Fellow of SPIE.

9:10 to 9:50 am

Making the Impossible: Dealing with Patterns Throughout the Design and Manufacturing Flow

Joseph Sawicki
Vice President and General Manager,
Design-to-Silicon Division
Mentor Graphics Corp.

We have always described a semiconductor process node by aspects of pitch. Whether it is a minimum channel length, metal spacing, or as seems more common now, a number driven by the marketing department's target message, everything came down to widths and spaces. Regardless as to how we got there, this matched well with both design and manufacturing views up though about 130nm. For designers, smaller transistors, and smaller interconnect pitches mapped to faster, smaller, and cheaper designs. For the fab, the widths and spaces mapped directly onto particle defect densities and defined their yield challenge.

The world started to change somewhere in the 130nm to 90nm timeframe. Driven by the well-known difficulties involved in lithography and exacerbated by increased sensitivity in processes like CMP, design style-based or systematic defects became the major challenge to yield-ramp, adding to the basic process ramp. Because of its involvement in the design, manufacturing, and test; EDA is in a unique position to contribute towards controlling, if not solving, the problem. We'll look at:

- Solutions in the DFT space that let us identify pattern failures hiding in yield loss
- New methods in OPC that allow for process window expansion of problematic hot spots
- Upcoming modeling technologies that target new pattern failure mechanisms in emerging nodes
- New tools in the design spaces that can give designers visibility into the risks of production.

The goal is a pattern aware EDA flow that minimizes risk, enhances manufacturing and quickly finds issues when they occur.

Joseph Sawicki is the Vice President and General Manager of the Design-to-Silicon division. An expert in IC nanometer design and manufacturing challenges, Sawicki is responsible for Mentor's industry-leading design-to-silicon products, including the Calibre physical verification and DFM platform and Mentor's Tessent design-for-test product line. Sawicki joined Mentor Graphics in 1990 and has held previous positions in applications engineering, sales, marketing and management. He holds a BSEE from the University of Rochester, an MBA from Northeastern University's High Technology Program, and has completed the Harvard Business School Advanced Management Program.

9:50 to 10:30 am

Beyond Scaling: Opportunities and Approaches

Akihisa Sekiguchi
Corporate VP and Deputy General Manager,
SPE Marketing and Process Development,
Tokyo Electron Ltd.

We have experienced a staggering revolution in IC manufacturing, which has equipped us with ubiquitous portable devices that boast computing capabilities exponentially greater than the room-sized mainframes from a few decades ago. Ingenuity and innovation have steadily scaled devices to today's levels. And as we look ahead, we are faced with the uncertainty of how much longer we can depend on historical scaling advances to guide us forward.

Maintaining the cadence of recent node scaling has come at a significant cost. Achieving the necessary process controls and low defectivity levels requires advanced equipment, including lithography and metrology tools, for cost effective manufacturing. Innovations such as double / multiple patterning, gridded design rules, computational methods, and source-mask optimization extend lithography beyond what was considered feasible just a few years ago. All of these components together introduce complexity and cost into current leading-edge manufacturing.

With EUVL and complementary techniques, such as DSA unproven for high volume manufacturing, a patterning path to future nodes is not clear. Are we up against a roadblock or a fork in the road? As we explore options, a number of uncertainties unfold. Can we overcome device level limitations by employing new materials, design architectures and process technologies? Will industry be able to contain escalating R&D expenditures in pursuit of scaling? And will we have a sustainable infrastructure that fosters collaborative ingenuity and innovation to ensure steady progress? During the course of my presentation, I will explore viable paths and highlight some of the essential elements necessary to propel the industry forward.

Akihisa Sekiguchi is currently Corporate Vice President and Deputy General Manager of Semiconductor Production Equipment (SPE) Marketing and Process Development at Tokyo Electron Limited. He is responsible for defining and driving internal and external corporate R&D strategies, mergers and acquisitions, corporate technology marketing, 450mm development and consortia programs.

Since joining TEL in 2007, Dr. Sekiguchi has served as senior technologist for key accounts and consortia. Additionally, he has been responsible for developing and implementing corporate R&D strategies, and merger and acquisition strategies.

He started his career at IBM in 1991, initially working on early stage development of Cu-based BEOL processes. Subsequently, he managed IBM's Cell Processor process technology, FEOL Unit/Module process development and 90nm/65nm/early 45nm SOI based process technologies.

Dr. Sekiguchi holds a B.S. and M. Eng. in Applied and Engineering Physics from Cornell University, an M.B.A in Finance from New York University Stern School of Business, and a Ph.D. in Applied Physics from Columbia University.

Having lived in Honduras and Brazil, Dr. Sekiguchi speaks Spanish and Portuguese in addition to Japanese and English. He devotes his free time to his marriage, two children and tennis.

He holds several patents and is a member of IEEE and SEMI.

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

Nanotechnology in Microlithography Panel Discussion: Extending the End of CMOS Through Nanotechnology

Convention Center 220B

Monday 24 February . . . . . 6:00 to 7:30 pm

Chairs: **Richard Silver, Bryan Barnes,** and **Joseph Kline,** National Institute of Standards and Technology

Delaying the preordained "End of CMOS" will require innovations based in nanotechnology. Similar to optical lithography, the end of CMOS has been predicted for some time, but new solutions continue to give life to CMOS and its extensive manufacturing infrastructure. There are a wealth of new advances in nanotechnology that have or are likely to extend the viability of CMOS, such as directed self-assembly, strain engineering, composition tuning, and geometrical spacers for pitch quartering. What new tools and advances in nanotechnology can be harnessed to enable down-scaling, overcoming device level limitations, and new scalable architectures, and can they be integrated with the existing manufacturing infrastructure? We have assembled a panel of experts that will share their insights on the industry's prospects to use nanotechnology to prolong CMOS as we know it. The panel will evaluate potential materials solutions such as directed self-assembly and block copolymers, III-V materials and Ge, and atomic layer deposition to address known gaps. Process advances such as precision etch for fin formation or spacer techniques that rely on nanometer scale three-dimensional geometries present substantial metrology and manufacturing challenges. The panel will identify key areas of nanotechnology that have the potential to provide solutions for critical gaps in lithography, materials, and device designs.

BACUS Panel Discussion on Managing EUV Masks in Wafer Fab

Convention Center 220C

Monday 24 February . . . . . 7:00 to 8:30 pm

Sponsored by KLA Tencor

Moderator: **Christopher J. Progler,** Photronics, Inc.

Wafer fabs have developed various approaches to manage, monitor and extend the lifecycle of advanced optical masks. An effective wafer fab management system for masks considers each step from shipping to receiving, incoming qualification, storage, use monitoring, recertification and occasional reprocessing. Certain steps, such as re-pellicle and cleaning, may involve a shipment of the mask from wafer fab to mask operation and back. In the case of the EUV mask, it is conceivable a very different mask management flow may be necessary and this panel is designed to highlight the unique requirements of managing production level EUV masks in the wafer fab in order to assess critical infrastructure gaps in the process flow.

Panelists will explore certain, relevant fab management best practices for optical masks to assess what might be applicable in the EUV case. Specific challenges for implementing an EUV mask management system will be highlighted with emphasis on issues such as mask process capability needed within the fab to enable reliable EUV lithography, end to end fab management of the EUV mask from shipping to validation and recertification, anticipated wafer fab lifetime issues with EUV masks, impact of pellicles on the fab management strategy and the critical interaction points between the wafer fab and mask operation to maintain a reliable EUV mask management strategy.

Poster Receptions

Convention Center Hall 2

Tuesday 25 February . . . . . 6:00 to 8:00 pm

(Conferences 9048, 9049, 9052, 9054)

Tuesday Poster Sponsor: AZ ELECTRONIC MATERIALS

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

Wednesday 26 February. . . . . 6:00 to 8:00 pm

(Conferences 9050, 9051, 9053)

Wednesday Poster Sponsor: tok

All registered attendees are invited to attend the poster sessions. Come view the high-quality papers that are presented in this alternative format, and interact with the poster authors who will be available for discussion. Enjoy light refreshments while networking with colleagues in your field.

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

Joint Panel Discussion on The Battle for the 7nm Node: What are the Non-EUV Solutions?

Convention Center 220A

Tuesday 25 February . . . . . 7:45 to 9:00 pm

Sponsored by KLA Tencor

Moderator: **Will Conley,** Cymer, Inc.; **Kafai Lai,** IBM Corp.

Joint Panel with conferences 9050, 9051, 9052, 9053, 9054

Panel Discussion on Alternative Forms of Scaling

Convention Center 220A

Tuesday 25 February . . . . . 5:15 to 7:00 pm

Conf. 9049

Moderators: **Christopher Bencher,** Applied Materials, Inc.; **H.-S. Philip Wong,** Stanford Univ.

Panelists: **Johann Alsmeier,** SanDisk Corp.; **Liam Madden,** Xilinx Inc.; **Kunal Parekh,** Micron Technology, Inc.; **Michael Van Buskirk,** Adesto Technologies, Inc.

The options for next generation lithography and alternative patterning techniques have been thoroughly debated within our lithography conferences and communities. Orthogonal to these 2D scaling efforts, several new device architectures have been developed which offer the potential to supplement planar scaling using 3D methods.

3D NAND is coming to market as an alternative to planar NAND and potentially displace quad-patterning requirements in one market segment. Re-RAM is another developing 3D-compatible memory device with potential to affect patterning requirements further upstream in the memory hierarchy. DRAM has seen the emergence of 3D die-stacking as a means to supplement planar scaling in high performance DRAM applications. FPGA makers have come-to-market with heterogeneous 2.5D and 3D solutions for high performance programmable logic applications.

This panel is assembled to discuss the technical and economic merits of these new device architectures, and their potential influence to the needs and requirements for alternative lithography.

Award Announcements for Conference 9050—Metrology, Inspection, and Process Control for Microlithography

Monday 24 February . . . . . 11:00 to 11:20 am

Presentation of the 2013 Diana Nyyssonen Memorial Award for Best Paper

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Thursday 27 February . . . . . 10:30 to 10:40 am

Presentation of the 2014 Karel Urbanek Best Student Paper Award

Award Sponsored by

KLA Tencor

Award Announcements for Conference 9051—Advances in Patterning Materials and Processes

Monday 24 February . . . . . .11:00 to 11:20 am

Presentation of the 2013 C. Grant Willson Best Paper Award

Presentation of the 2013 Hiroshi Ito Memorial Award for the Best Student Paper

These Two Awards Sponsored by

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Presentation of the 2014 Jeffrey Byers Memorial Best Poster Award

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Award Announcement for Conference 9052—Optical Microlithography

Thursday 27 February . . . . . .10:20 to 10:25 am

Presentation of the 2014 Best Student Award in Microlithography

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Visit the exhibition

Convention Center Hall 1

Tuesday 25 February
10:00 am to 5:00 pm; 6:00 to 8:00 pm Poster Session

Wednesday 26 February
10:00 am to 4:00 pm

Exhibition Technologies

Lithography: immersion, double patterning, e-beam, EUV, optical/laser, and RET

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Design and manufacturing software

Materials and chemicals

Imaging equipment

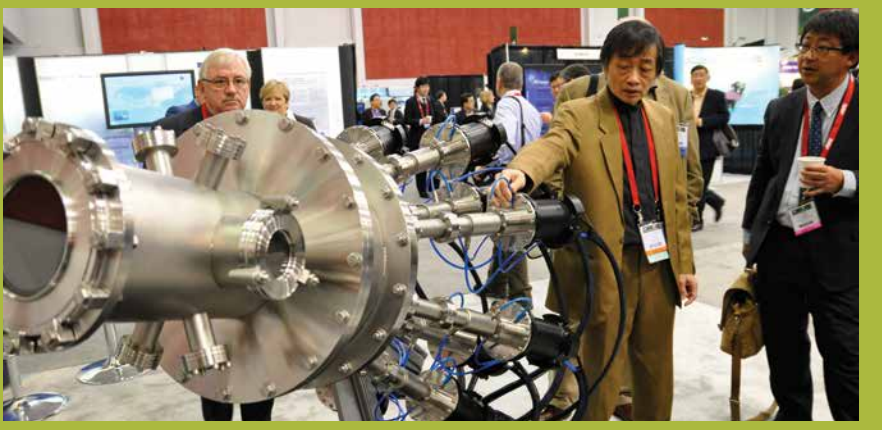
Lasers

Resist materials and processing

Nano-imprint

IC and chip fabrication

Nanoscale imaging



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SwissOptic AG
Synopsys Inc.
Tokyo Electron Limited
Tokyo Ohka Kogyo America, Inc. (TOK America)
TRIOPTICS GmbH
Vistec Electron Beam GmbH
XEI Scientific, Inc.
Zygo Corporation

Registration

Onsite Registration/Badge Pick-Up Hours

San Jose Convention Center

Sunday 23 February . . . . . 7:00 am to 5:00 pm
Monday 24 February . . . . . 7:00 am to 4:00 pm
Tuesday 25 February. . . . . 7:30 am to 5:00 pm
Wednesday 26 February . . . . . 7:30 am to 4:00 pm
Thursday 27 February . . . . . 7:30 am to 4:00 pm

Conference Registration

Includes admission to all conference sessions, plenaries, panels, technical group meetings, and poster sessions; Admission to the Exhibition; Lunches and dessert snacks on Tuesday and Wednesday; Breakfast breads; Coffee Breaks; A choice of proceedings, print or CD (excluding students).

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.

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.

SPIE Cashier

Registration Area - Open during registration hours

- Registration Payments

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

- Receipts and Certificate of Attendance

Preregistered attendees who did not receive a receipt may obtain one at Badge Corrections and Receipts. Attendees who need a Certificate of Attendance may obtain it from the SPIE Cashier.

- Badge Corrections

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

- Refund Information

There is a US$50 service charge for processing refunds. Requests for refunds must be received by 13 February 2014; all registration fees will be forfeited after this date. Membership dues, SPIE Digital Library subscriptions, and Special Events 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.

Author / Presenter Information

Speaker Check-In and Preview Station

Convention Center, Ballroom Concourse

Sunday . . . . . 2:00 to 5:00 pm
Monday through Thursday . . . . . 7:00 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

Convention Center Hall 2

Tuesday 25 February. . . . . 6:00 to 8:00 pm
Wednesday 26 February . . . . . 6:00 to 8:00 pm

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

- Poster authors may set up their posters after 10:00 am on the day of their poster session. Paper numbers will be posted on the poster boards in numerical order. Poster supplies (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.
- It is the authors’ responsibility to remove their posters and all other materials at the conclusion of the poster reception for that day. Posters and all 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 reception.

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

General Information

Onsite Services

Internet Access

Location of Internet - *Convention Center Ballroom Concourse*

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

Internet Pavilion sponsored by JEOL

WiFi – *Convention Center Upper Level Concourse*

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

WiFi sponsored by

TOKYO ELECTRON and HITACHI Inspire the Next

SPIE Conference App

On your Smart Phone (iPhone, Android)

Search and browse the program, special events, participants, exhibitors, courses, and more. See p. 9.

Sponsored by TOKYO ELECTRON

SPIE Bookstore

Convention Center Lobby near Registration

The SPIE Bookstore is your source for the latest SPIE Books, Proceedings, and Education and Professional Development materials. Become an SPIE Member, explore the Digital Library, take home a free SPIE poster, or buy a souvenir (tie, t-shirt, educational toys, and more).

SPIE Education Services

Located near SPIE Registration

Open during registration hours

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

SPIE Press Room

Marriott Think Tank Room

Open during registration hours. For Registered Press only. The Press Room provides meeting space, refreshments, access to exhibitor press releases, and Internet connections. Press are urged to register before the meeting by emailing name, contact information, and name of publication to media@spie.org. Preregistration closes approximately 10 days before the start of the event.

Child Care Services

Bay Area 2nd MOM Inc.
Toll Free Phone: 1-888-926-3666, or 650-858-2469, or 650-787-6518.
Email: uday@2ndmom.com
Website: www.2ndmom.com

Sitters Unlimited
Toll Free Phone: 408-452-0225,
Email: info@bayareasittersunlimited.com
Website: www.bayareasittersunlimited.com

Urgent Message Line

SPIE has an urgent message line available during registration hours Sunday through Thursday: 408-271-6279.

Lost and Found

SPIE Cashier

During Registration Hours

Found items will be kept at SPIE Registration Cashier. At the end of the meeting, all found items will be turned over to The San Jose Convention Center Security: 408-271-6279.

Food and Beverage Services

Coffee Breaks

Served daily - 7:30 am, 10:00 am, and 3:00 pm

Check individual conference listings for exact times and locations.

Sponsored by ASML and NuFlare

Breakfast Breads

Convention Center, Ballroom Concourse

Monday – Thursday, 7:30 am

Sponsored by KLA-Tencor

Food and Refreshments for Purchase

Exhibition Hall Concession Stand

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

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

SPIE-Hosted Lunches

Exhibition Hall

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

Check individual conference listings for exact times

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

Tuesday Lunch sponsored by DOW

Desserts

Exhibition Hall

Tuesday – Wednesday, 3:00 to 4:00 pm

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

Sponsored by ASML and KLA-Tencor

Travel to San Jose

Car Rental

Hertz Car Rental is the official car rental agency for this Symposium. To reserve a car, identify yourself as an Advanced Lithography conference attendee using the Hertz Meeting Code CV# 029B0019.

In the United States call 1-800-654-2240.

For complete travel information check the SPIE website www.spie.org/x27428.xml

Policies

Acceptance of Policies and Registration Conditions
The following Policies and Conditions apply to all SPIE Events. As a condition of registration, you will be required to acknowledge and accept the SPIE Registration Policies and Conditions contained herein.

Granting Attendee Registration and Admission

SPIE, or their officially designated event management, in their sole discretion, reserves the right to accept or decline an individual's registration for an event. Further, SPIE, or event management, reserves the right to prohibit entry or remove any individual whether registered or not, be they attendees, exhibitors, representatives, or vendors, who in their sole opinion are not, or whose conduct is not, in keeping with the character and purpose of the event. Without limiting the foregoing, SPIE and event management reserve the right to remove or refuse entry to any attendee, exhibitor, representative, or vendor who has registered or gained access under false pretenses, provided false information, or for any other reason whatsoever that they deem is cause under the circumstances.

Misconduct Policy

SPIE is a professional, not-for-profit society committed to providing valuable conference and exhibition experiences. SPIE is dedicated to equal opportunity and treatment for all its members and meeting attendees. Attendees are expected to be respectful to other attendees, SPIE staff, and contractors. Harassment and other misconduct will not be tolerated; violators will be asked to leave the event.

Identification

To verify registered participants and provide a measure of security, SPIE will ask attendees to present a government-issued Photo ID at registration to collect registration materials.

Individuals are not allowed to pick up badges for attendees other than themselves. Further, attendees may not have some other person participate in their place at any conference-related activity. Such other individuals will be required to register on their own behalf to participate.

Capture and Use of a Person's Image

By registering for this event, I grant full permission to SPIE to capture, store, use, and/or reproduce my image or likeness by any audio and/or visual recording technique (including electronic/digital photographs or videos), and create derivative works of these images and recordings in any SPIE media now known or later developed, for any legitimate SPIE marketing or promotional purpose.

By registering for this event, I waive any right to inspect or approve the use of the images or recordings or of any written copy. I also waive any right to royalties or other compensation arising from or related to the use of the images, recordings, or materials. By registering, I release, defend, indemnify and hold harmless SPIE from and against any claims, damages or liability arising from or related to the use of the images, recordings or materials, including but not limited to claims of defamation, invasion of privacy, or rights of publicity or copyright infringement, or any misuse, distortion, blurring, alteration, optical illusion or use in composite form that may occur or be produced in taking, processing, reduction or production of the finished product, its publication or distribution.

Payment Method

Registrants for paid elements of the event, who do not provide a method of payment, will not be able to complete their registration. Individuals with incomplete registrations will not be able to attend the conference until payment has been made. SPIE accepts VISA, MasterCard, American Express, Discover, Diner's Club, checks and wire transfers. Onsite registrations can also pay with Cash.

Authors/Coauthors

By submitting an abstract, you agree to the following conditions:

- An author or coauthor (including keynote, invited, and solicited speakers) will register at the author registration rate, attend the meeting, and make the presentation as scheduled.
- A full-length manuscript (6-page minimum) for any accepted oral or poster presentation will be submitted for publication in the SPIE Digital Library, printed conference Proceedings, and CD. (Some SPIE events have other requirements that the author is made aware of at the time of submission.)
- Only papers presented at the conference and received according to publication guidelines and timelines will be published in the conference Proceedings and SPIE Digital Library (or via the requirements of that event).

Audio, Video, Digital Recording Policy

Conferences, courses, and poster sessions: For copyright reasons, recordings of any kind are prohibited without prior written consent of the presenter or instructor. Attendees may not capture or use the materials presented in any meeting/course room, or in course notes on display without written permission. Consent forms for material presented in meeting rooms are available at Speaker Check-In. Individuals not complying with this policy will be asked to leave a given session and/or asked to surrender their recording media.

Exhibition Hall: For security and courtesy reasons, recordings of any kind are prohibited unless one has explicit permission from on-site company representatives. Individuals not complying with this policy will be asked to surrender their recording media and to leave the exhibition hall.

Your registration signifies your agreement to be photographed or videotaped by SPIE in the course of normal business. Such photos and video may be used in SPIE marketing materials or other SPIE promotional items.

Laser Pointer Safety Information/Policy

SPIE supplies tested and safety-approved laser pointers for all conference meeting rooms. For safety reasons, SPIE requests that presenters use provided laser pointers.

Use of a personal laser pointer represents user's acceptance of liability for use of a non-SPIE-supplied laser pointer. If you choose to use your own laser pointer, it must be tested to ensure <5 mW power output. Laser pointers in Class II and IIIa (<5 mW) are eye safe if power output is correct, but output must be verified because manufacturer labeling may not match actual output. Come to Speaker Check-In and test your laser pointer on our power meter. You are required to sign a waiver releasing SPIE of any liability for use of potentially non-safe, personal laser pointers. Misuse of any laser pointer can lead to eye damage.

Access to Technical and Networking Events

Persons under the age of 18 including babies, carried or in strollers, and toddlers are not allowed in technical or networking events. Anyone 18 or older must register as an attendee. All technical and networking events require a valid conference badge for admission.

General Information

Underage Persons on Exhibition Floor Policy

For safety and insurance reasons:

- No persons under the age of 18 will be allowed in the exhibition area during move-in and move-out.
- Children 14 and older, accompanied by an adult, will be allowed in the exhibition area during open exhibition hours only.
- All children younger than 14, including babies in strollers and toddlers, are not allowed in the exhibition area at any time.

Unauthorized Solicitation Policy

Unauthorized solicitation in the Exhibition Hall is prohibited. Any non-exhibiting manufacturer or supplier observed to be distributing information or soliciting business in the aisles, or in another company's booth, will be asked to leave immediately.

Unsecured Items Policy

Personal belongings should not be left unattended in meeting rooms or public areas. Unattended items are subject to removal by security. SPIE is not responsible for items left unattended.

Wireless Internet Service Policy

At SPIE events where wireless is included with your registration, SPIE provides wireless access for attendees during the conference and exhibition but cannot guarantee full coverage in all locations, all of the time. Please be respectful of your time and usage so that all attendees are able to access the internet.

Excessive usage (e.g., streaming video, gaming, multiple devices) reduces bandwidth and increases cost for all attendees. No routers may be attached to the network. Properly secure your computer before accessing the public wireless network. Failure to do so may allow unauthorized access to your laptop as well as potentially introduce viruses to your computer and/or presentation. SPIE is not responsible for computer viruses or other computer damage.

Mobile Phones and Related Devices Policy

Mobile phones, tablets, laptops, pagers, and any similar electronic devices should be silenced during conference sessions. Please exit the conference room before answering or beginning a phone conversation.

Smoking

For the health and consideration of all attendees, smoking is not permitted at any event elements, such as but not limited to: plenaries, conferences, workshops, courses, poster sessions, hosted meal functions, receptions, and in the exhibit hall. Most facilities also prohibit smoking in all or specific areas. Attendees should obey any signs preventing or authorizing smoking in specified locations.

Hold Harmless

Attendee agrees to release and hold harmless SPIE from any and all claims, demands, and causes of action arising out of or relating to your participation in the event you are registering to participate in and use of any associated facilities or hotels.

Event Cancellation

If for some unforeseen reason SPIE should have to cancel the event, registration fees processed will be refunded to registrants. Registrants will be responsible for cancellation of travel arrangements or housing reservations and the applicable fees.

Confidential Reporting of Unethical or Inappropriate Behavior

SPIE is an organization with strong values of responsibility and integrity. Our Ethics Statement and Code of Professional Conduct contain general guidelines for conducting business with the highest standards of ethics. SPIE has established a confidential reporting system for staff & other stakeholders to raise concerns about possible unethical or inappropriate behavior within our community. Complaints may be filed by phone or through the website, and, if preferred, may be made anonymously. The web address is www.SPIE.ethicspoint.com and the toll free hotline number is 1-888-818-6898.

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Go above and beyond
- Set up job alerts, access career-related articles and more

SPIE Career Center

SPIE

Contact Sara Liebert:
+1 360 685 5600
info@spiecareercenter.org

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Relevant training | Proven instructors | Education you need to stay competitive in today's job market

- Choose from 13 courses and learn current approaches in EUV lithography, DSA, optical lithography, FEOL/MOL/BEOL lithography, and more
- SPIE Student Members receive 50% off course registration
- New courses in 2014 include Metrology Toolset Monitoring, Matching, Maintenance and Management, and Modeling and Computational Lithography Fundamentals
- Earn CEUs to fulfill continuing professional education requirements

www.spie.org/education

SUNDAY	MONDAY	THURSDAY
SC1099 **Chemistry and Lithography** (Okoroanyanwu) 8:30 am to 5:30 pm, $600 / $710	SC1030 **Interaction of Physical Design and Lithography** (Yuan) 1:30 to 5:30 pm, $375 / $430	SC616 **Practical Photoresist Processing** (Dammel) 8:30 am to 12:30 pm, $375 / $430
SC1009 **Electron Beam Inspection - Principles and Applications in IC and Mask Manufacturing** (Xiao) 8:30 am to 12:30 pm, $375 / $430		
SC888 **EUV Lithography** (Bakshi, Ahn, Naulleau) 8:30 am to 5:30 pm, $830 / $940		
SC101 **Introduction to Microlithography: Theory, Materials, and Processing** (Willson, Bowden) 8:30 am to 5:30 pm, $600 / $710		
SC116 **Lithographic Optimization: A Theoretical Approach** (Mack) 8:30 am to 5:30 pm, $650 / $760		
SC992 **Lithography Integration for Semiconductor FEOL & BEOL Fabrication** (Lin, Zhang) 8:30 am to 5:30 pm, $600 / $710		
NEW SC1133 **Metrology Toolset Monitoring, Matching, Maintenance and Management** (Solecky, Adan) 8:30 am to 12:30 pm, $375 / $430		
NEW SC1132 **Modeling and Computational Lithography Fundamentals** (Lai) 8:30 am to 5:30 pm, $600 / $710		
SC885 **Principles and Practical Implementation of Multiple Patterning** (Dusa, Hsu) 8:30 am to 5:30 pm, $600 / $710		
SC1067 **Directed Self Assembly and its Application to Nanoscale Fabrication** (de Pablo, Nealey, Ruiz) 1:30 to 5:30 pm, $375 / $430		
SC1100 **Scatterometry in Profile, Overlay and Focus Process Control** (Cramer, Turovets) 1:30 to 5:30 pm, $375 / $430		

Register now for courses at the SPIE Cashier Desk.

Money-back Guarantee

We are confident that once you experience an SPIE course for yourself you will look to us for your future education needs. However, if for any reason you are dissatisfied, we will gladly refund your money. We just ask that you tell us what you did not like; suggestions for improvement are always welcome.

AUTHORIZED IACET PROVIDER

Continuing Education Units

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

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

SPIE

Technical Conference Session Schedule

	Conference 9048 Extreme Ultraviolet (EUV) Lithography V	Conference 9049 Alternative Lithographic Technologies VI	Conference 9050 Metrology, Inspection, and Process Control for Microlithography XXVIII
Monday 24 February	Session 1 · Mon 11:00 am to 12:00 pm Invited Session Session 2 · Mon 1:30 pm to 3:30 pm New EUV Resist Materials: Joint Session with Conferences 9048 and 9051 Session 3 · Mon 4:00 pm to 6:00 pm Stochastics and EUV Process Improvements: Joint Session with Conferences 9048 and 9051	Session 1 · Mon 3:40 pm to 5:40 pm Alternative Lithography Keynote Session	Opening Remarks and Award Presentation · 11:00 to 11:20 am Session 1 · Mon 11:20 am to 12:20 pm Keynote Session Session 2 · Mon 1:30 pm to 3:30 pm Hybrid and Virtual Metrology Techniques Session 3 · Mon 4:00 pm to 6:00 pm Metrology of 3D Structures
Tuesday 25 February	Session 4 · Tue 8:00 am to 10:10 am EUV Source Session 5 · Tue 10:40 am to 12:00 pm EUV Mask I Session 6 · Tue 1:30 pm to 3:10 pm EUV Mask II Session 7 · Tue 3:40 pm to 6:00 pm EUV Integration	Session 2 · Tue 8:10 am to 10:10 am DSA Process and Integration Session 3 · Tue 10:40 am to 12:10 pm Novel Nanolithography Session 4 · Tue 1:30 pm to 3:10 pm Roll to Roll UV Nanoimprint Lithography Session 5 · Tue 1:20 pm to 3:10 pm Metrology and Inspection for Directed Self-Assembly: Joint Session with Conferences 9049 and 9050 Session 6 · Tue 3:40 pm to 5:00 pm Beam Lithography	Session 4 · Tue 8:00 am to 10:00 am SEM Simulation and Emulation I: Joint Session with Conferences 9050 and 9051 Session 5 · Tue 10:30 am to 11:50 am SEM Simulation and Emulation II: Joint Session with Conferences 9050 and 9051 Session 6 · Tue 1:20 pm to 3:10 pm Metrology and Inspection for Directed Self-Assembly: Joint Session with Conferences 9049 and 9050 Session 7 · Tue 3:40 pm to 5:00 pm Metrology for Process Control
Wednesday 26 February	Session 8 · Wed 8:00 am to 10:10 am EUV Mask Metrology Session 9 · Wed 10:40 am to 12:00 pm Metrology Sources and Modeling Session 10 · Wed 1:30 pm to 3:10 pm EUV Resist Outgas Testing Session 11 · Wed 3:40 pm to 6:00 pm EUV Resist I	Session 7 · Wed 8:00 am to 10:10 am DSA Materials and Processes I: Joint Session with Conferences 9049 and 9051 Session 8 · Wed 10:40 am to 12:00 pm DSA Materials and Processes II: Joint Session with 9049 and 9051 Session 9 · Wed 1:30 pm to 3:20 pm Step and Repeat UV Nanoimprint Lithography Session 10 · Wed 3:50 pm to 5:50 pm Multiple Electron Beam Direct Write Lithography	Session 8 · Wed 8:00 am to10:00 am SEM, AFM, and SPM Session 9 · Wed 10:30 am to 11:50 am X-Ray Scattering Methods Session 10 · Wed 1:20 pm to 3:00 pm Overlay Measurement and Control: Joint Session with Conferences 9050 and 9052 Session 11 · Wed 3:30 pm to 6:10 pm Inspection
Thursday 27 February	Session 12 · Thu 8:00 am to 10:10 am Exposure Tools and Extendibility Session 13 · Thu 10:40 am to 12:00 pm EUV Manufacturing	Session 11 · Thu 8:20 am to 10:00 am DSA Line Patterning Session 12 · Thu 10:30 am to 12:20 pm Nanodevice Fabrication Session 13 · Thu 1:35 pm to 3:35 pm DSA Design for Manufacturability: Joint Session with Conferences 9049, 9052, and 9053 Session 14 · Thu 4:05 pm to 5:45 pm DSA Via Patterning	Session 12 · Thu 8:00 am to 9:40 am Scatterometry and Optical Methods Award Announcement · 10:30 to 10:40 am Session 13 · Thu 10:40 am to 11:40 am Reference Metrology, Accuracy, Standards Session 14 · Thu 1:00 pm to 2:20 pm Overlay Session 15 · Thu 2:20 pm to 3:00 pm Late Breaking News

Conference 9051 Advances in Patterning Materials and Processes XXXI	Conference 9052 Optical Microlithography XXVII	Conference 9053 Design-Process-Technology Co-optimization for Manufacturability VIII	Conference 9054 Advanced Etch Technology for Nanopatterning III
Welcome and Award Announcements · 11:00 to 11:10 am Session 1 · Mon 11:10 am to 12:20 pm Keynote Session Session 2 · Mon 1:30 pm to 3:30 pm New EUV Resist Materials: Joint Session with Conferences 9048 and 9051 Session 3 · Mon 4:00 pm to 6:00 pm Stochastics and EUV Process Improvements: Joint Session with Conferences 9048 and 9051			Session 1 · Mon 1:30 pm to 3:20 pm Reviews and Overviews of Nanopatterning Challenges Session 2 · Mon 3:50 pm to 5:30 pm Nanopatterning for Advanced Logic and Memory Technology Nodes
Session 4 · Tue 8:00 am to 10:00 am SEM Simulation and Emulation I: Joint Session with Conferences 9050 and 9051 Session 5 · Tue 10:30 am to 11:50 am SEM Simulation and Emulation II: Joint Session with Conferences 9050 and 9051 Session 6 · Tue 1:40 pm to 3:40 pm New Materials and Processes Session 7 · Tue 4:10 pm to 5:50 pm DSA Materials I	Opening Remarks · 8:20 to 8:40 am Session 1 · Tue 8:40 am to 10:00 am Keynote Session Session 2 · Tue 10:30 am to 12:00 pm Optics and Beyond Session 3 · Tue 1:30 pm to 3:30 pm Image and Process Control Session 4 · Tue 4:00 pm to 6:00 pm Non-IC Applications		Session 3 · Tue 8:30 am to 10:10 am Plasma and Resist Interactions, Including Patterning Quality Control (LER, CD Uniformity, etc.) Session 4 · Tue 10:40 am to 12:00 pm Patterning Integration Schemes (multilayer patterning, self-aligned patterning, etc.) Session 5 · Tue 1:30 pm to 3:10 pm New Plasma Sources and New Etching Technologies Session 6 · Tue 3:40 pm to 5:30 pm Emerging Patterning Technologies (DSA and others)
Session 8 · Wed 8:00 am to 10:10 am DSA Materials and Processes I: Joint Session with Conferences 9049 and 9051 Session 9 · Wed 10:40 am to 12:00 pm DSA Materials and Processes II: Joint Session with 9049 and 9051 Session 10 · Wed 1:30 pm to 3:30 pm Materials and Process Fundamentals Session 11 · Wed 4:00 pm to 5:40 pm Advanced Patterning Processes	Session 5 · Wed 8:20 am to 10:00 am OPC Algorithms Session 6 · Wed 10:20 am to 12:20 pm Multiple Patterning and SMO Session 7 · Wed 1:20 pm to 3:00 pm Overlay Measurement and Control: Joint Session with Conferences 9050 and 9052 Session 8 · Wed 3:30 pm to 5:10 pm OPC Modeling	Session 1 · Wed 8:00 am to 10:10 am Patterns in DTCO Session 2 · Wed 10:30 am to 12:20 pm Multipatterning Session 3 · Wed 1:30 pm to 3:20 pm Hotspots Session 4 · Wed 3:50 pm to 5:10 pm Design Optimization I	
Session 12 · Thu 8:20 am to 10:00 am DSA Materials II Session 13 · Thu 10:30 am to 12:40 pm Underlayers and Spin-on Materials Processing Session 14 · Thu 1:40 pm to 3:20 pm EUV Materials	Session 9 · Thu 8:20 am to 10:00 am Pattern-Aware Techniques: Joint Session with Conferences 9052 and 9053 Award Announcement · 10:20 to 10:25 am Session 10 · Thu 10:25 am to 12:25 pm Mask Topography Modeling Session 11 · Thu 1:35 pm to 3:35 pm DSA Design for Manufacturability: Joint Session with Conferences 9049, 9052, and 9053 Session 12 · Thu 4:05 pm to 5:45 pm Toolings	Session 5 · Thu 8:20 am to 10:00 am Pattern-Aware Techniques: Joint Session with Conferences 9052 and 9053 Session 6 · Thu 10:30 am to 12:00 pm Design Optimization II Session 7 · Thu 1:35 pm to 3:35 pm DSA Design for Manufacturability: Joint Session with Conferences 9049, 9052, and 9053 Session 8 · Thu 4:05 pm to 5:25 pm Design Optimization III	

Conference 9048

Monday–Thursday
24–27 February 2014
Proceedings of SPIE Vol. 9048

Extreme Ultraviolet (EUV) Lithography V

Conference Chair: **Obert R. Wood II,** GLOBALFOUNDRIES Inc. (USA)

Conference Co-Chair: **Eric M. Panning,** Intel Corp. (USA)

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

Conference sponsor:

Rigaku

Conference 9049

Monday–Thursday
24–27 February 2014
Proceedings of SPIE Vol. 9049

Alternative Lithographic Technologies VI

Conference Chair: **Douglas J. Resnick,** Molecular Imprints, Inc. (USA)

Conference Co-Chair: **Christopher Bencher,** Applied Materials, Inc. (USA)

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Conference 9050

Monday–Thursday
24–27 February 2014
Proceedings of SPIE Vol. 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

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

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

Program Committee: **Ofer Adan,** Applied Materials (Israel); **John A. Allgair,** GLOBALFOUNDRIES Inc. (USA); **Masafumi Asano,** Toshiba Corp. (Japan); **Benjamin D. Bunday,** SEMATECH Inc. (USA); **Alek C. Chen,** ASML Taiwan Ltd. (Taiwan); **Timothy F. Crimmins,** Intel Corp. (USA); **Daniel J. C. Herr,** The Univ. of North Carolina at Greensboro (USA); **Chih-Ming Ke,** Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Shunsuke Koshihara,** Hitachi High-Technologies Corp. (Japan); **Yi-Sha Ku,** Industrial Technology Research Institute (Taiwan); **Byoung-Ho Lee,** Ultratech (USA); **Christopher J. Raymond,** Nanometrics Inc. (USA); **John C. Robinson,** KLA-Tencor Corp. (USA); **Matthew J. Sendelbach,** Nova Measuring Instruments Inc. (USA); **Richard Silver,** National Institute of Standards and Technology (USA); **Eric Solecky,** IBM Corp. (USA); **Costas J. Spanos,** Univ. of California, Berkeley (USA); **Alexander Starikov,** I&I Consulting (USA); **Vladimir A. Ukraintsev,** Nanometrology International, Inc. (USA); **Alok Vaid,** GLOBALFOUNDRIES Inc. (USA)

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Conference 9051

Monday–Thursday
24–27 February 2014
Proceedings of SPIE Vol. 9051

Advances in Patterning Materials and Processes XXXI

Conference Chairs: **Thomas I. Wallow,** GLOBALFOUNDRIES Inc. (USA)

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

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); **Ralph R. Dammel,** AZ Electronic Materials USA Corp. (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); **Dah-Chung Owe-Yang,** Shin-Etsu MicroSi, Inc. (USA); **Daniel P. Sanders,** IBM Almaden Research Ctr. (USA); **Mark H. Somervell,** Tokyo Electron America, Inc. (USA); **James W. Thackeray,** Dow Electronic Materials (USA); **Plamen Tzviatkov,** FUJIFILM Electronic Materials U.S.A., Inc. (USA); **Todd R. Younkin,** Intel Corp. (Belgium)

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Conference 9052

Tuesday–Thursday
25–27 February 2014
Proceedings of SPIE Vol. 9052

Optical Microlithography XXVII

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

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

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

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Conference 9053

Wednesday–Thursday
26–27 February 2014
Proceedings of SPIE Vol. 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

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

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

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

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Conference 9054

Monday–Tuesday
24–25 February 2014
Proceedings of SPIE Vol. 9054

Advanced Etch Technology for Nanopatterning III

Conference Chair: **Gottlieb S. Oehrlein,** Univ. of Maryland, College Park (USA)

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

Program Committee: **Julie Bannister,** Tokyo Electron America, Inc. (USA); **Charles T. Black,** Brookhaven National Lab. (USA); **Maxime Darnon,** LTM CNRS (France); **Sebastian U. Engelmann,** IBM Thomas J. Watson Research Ctr. (USA); **Eric A. Hudson,** Lam Research Corp. (USA); **Catherine B. Labelle,** GLOBALFOUNDRIES Inc. (USA); **Nae-Eung Lee,** Sungkyunkwan Univ. (Korea, Republic of); **Erwine Pargon,** LTM CNRS (France); **Ricardo Ruiz,** HGST (USA); **Seiji Samukawa,** Tohoku Univ. (Japan); **Denis Shamiryan,** MAPPER Lithography B.V. (Netherlands); **Rich Wise,** IBM Corp. (USA); **Anthony Yen,** TSMC Taiwan (Taiwan); **Ying Zhang,** Applied Materials, Inc. (USA); **Jeff Xu,** Qualcomm Technologies Inc. (USA)

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Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 1
Location: Conv. Ctr. 210B
Mon 11:00 am to 12:00 pm

Invited Session

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

11:00 am: **Progress and challenges of EUV lithography for high-volume manufacturing** *(Invited Paper)*, Anthony Yen, Jack Jenghorng Chen, TSMC Taiwan (Taiwan) . . . . . [9048-1]

11:30 am: **Challenges of EUV/193i complementary lithography** *(Invited Paper)*, Mark C. Phillips, Intel Corp. (USA) . . . . . [9048-2]

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

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Location: Conv. Ctr. 220B
11:00 am to 11:20 am

Opening Remarks and Award Presentation

Session Chair: **Jason P. Cain,** Advanced Micro Devices, Inc. (USA)

Presentation of the **Diana Nyyssonen Memorial Award for Best Paper**

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Session 1
Location: Conv. Ctr. 220B
Mon 11:20 am to 12:20 pm

Keynote Session

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

11:20 am: **CDSEM: Past, present, and future: from metrology to patterning diagnosis** *(Keynote Presentation)*, Hiroshi Fukuda, Hitachi High-Technologies Corp. (Japan) . . . . . [9050-1]

11:50 am: **Addressing emerging challenges in advanced patterning, interconnect, and 3D device integration** *(Keynote Presentation)*, Ofer Adan, Applied Materials, Inc. (Israel) . . . . . [9050-2]

Lunch Break . . . . . .Mon 12:20 pm to 1:30 pm

Conference 9051

Advances in Patterning Materials and Processes XXXI

Location: Conv. Ctr. 220C
11:00 am to 11:10 am

Welcome and Award Announcements

Session Chair: **Thomas I. Wallow,** GLOBALFOUNDRIES Inc. (USA)

Award Presentations

Presentation of the **2013 C. Grant Willson Best Paper Award**

Presentation of the **2013 Hiroshi Ito Memorial Best Student Paper Award**

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Presentation of the **2014 Jeffrey Byers Memorial Award for Best Poster**

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Session 1
Location: Conv. Ctr. 220C
Mon 11:10 am to 12:20 pm

Keynote Session

Session Chairs: **Thomas I. Wallow,** GLOBALFOUNDRIES Inc. (USA); **Christoph K. Hohle,** Fraunhofer Institute for Photonics Microsystems IPMS (Germany)

11:10 am: **Directed self-assembly (DSA) of block polymers: past, present, and future** *(Keynote Presentation)*, Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9051-1]

11:45 am: **Resist materials in the limits of nanopatterning: New physics, new chemistry, and new opportunities?** *(Keynote Presentation)*, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9051-2]

Lunch Break . . . . . .Mon 12:20 pm to 1:30 pm

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 2
Location: Conv. Ctr. 220C
Mon 1:30 pm to 3:30 pm

New EUV Resist Materials: Joint Session with Conferences 9048 and 9051

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

1:30 pm: **EUV resists toward 11nm half-pitch**, Yasin Ekinci, Michaela Vockenhuber, Nassireddin M. Mojarad, Daniel Fan, Paul Scherrer Institut (Switzerland) . [9048-3]

1:50 pm: **Process-stable EUV patternable metal oxide hardmask**, Andrew Grenville, Jeremy T. Anderson, Benjamin L. Clark, Michael Greer, Kai Jiang, Michael K. Kocsis, Stephen T. Meyers, Jason K. Stowers, Alan Telecky, Richard Vachkov, Douglas A. Keszler, Inpria (USA); William D. Hinsberg, Columbia Technical Consulting, Inc. (USA) . . . . . [9051-3]

2:10 pm: **A molecular inorganic approach to EUV photoresists**, Miles Marnell, State Univ. of New York at New Paltz (USA); Brian Cardineau, SUNY College of Nanoscale Science & Engineering (USA); Hashim Al-Mashat, Kara Heard, Amber Aslam, State Univ. of New York at New Paltz (USA); Ryan Del Re, SUNY College of Nanoscale Science & Engineering (USA); Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland); Daniel A. Freedman, State Univ. of New York at New Paltz (USA); Robert L. Brainard, College of Nanoscale Science & Engineering, Univ. at Albany (USA) . . . . . [9051-4]

2:30 pm: **Novel nonchemically amplified (n-CARs) negative resists for EUVL**, Vikram Singh, V. S. V. Satynarayana, Satinder K. Sharma, Subrata Ghosh, Indian Institute of Technology Mandi (India); Kenneth E. Gonsalves, Indian Institute of Technology Mandi (India) and The Univ. of North Carolina at Charlotte (USA) . . . . . [9051-5]

2:50 pm: **Evaluation of vacancies in positive tone nonchemically and chemically-amplified EUV/EB resists: Relationship between free volume and LER**, Akihiro Oshima, Osaka Univ. (Japan); Toru Hinata, Hirotaka Nakamura, Waseda Univ. (Japan); Toshitaka Oka, Tohoku Univ. (Japan); Vrian E. O'Rourke, Ryoichi Suzuki, Nagayasu Oshima, National Institute of Advanced Industrial Science and Technology (Japan); Masakazu Washio, Waseda Univ. (Japan); Seiichi Tagawa, Osaka Univ. (Japan) . . . . . [9051-6]

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 2
Location: Conv. Ctr. 220B
Mon 1:30 pm to 3:30 pm

Hybrid and Virtual Metrology Techniques

Session Chairs: **John C. Robinson,** KLA-Tencor Corp. (USA); **Matthew J. Sendelbach,** Nova Measuring Instruments Inc. (USA)

1:30 pm: **Optimizing hybrid metrology through a consistent multi-tool parameter set and uncertainty model**, Richard M. Silver, Bryan M. Barnes, Nien-Fan Zhang, Hui Zhou, András E. Vladar, John S. Villarrubia, R. Joseph Kline, Daniel F. Sunday, National Institute of Standards and Technology (USA) . . . . .[9050-3]

1:50 pm: **Leveraging data analytics, patterning simulations, and metrology models to enable accurate CD metrology and patterning**, Narender Rana, Yunlin Zhang, Taher Kagalwala, Todd C. Bailey, Lin Hu, Mohamed Talbi, IBM Corp. (USA) . . . . .[9050-4]

2:10 pm: **New techniques in large-scale metrology toolset data mining to accelerate integrated chip technology development and increase manufacturing efficiencies**, Eric Solecky, Narender Rana, Carol Gustafson, Allan Minns, IBM Corp. (USA); Paul A. Llanos, Roger Cornell, Applied Materials, Inc. (USA) . .[9050-5]

2:30 pm: **Data fusion paradigms for next-generation CD metrology**, Johann Foucher, Jérome Hazart, Guillaume Evin, Nicolas Chesneau, Axel Largent, Thomas Janvier, Alexandre Derville, Romain Thérèse, CEA-LETI (France) . . . . . .[9050-6]

2:50 pm: **CD-SEM AFM hybrid metrology for the characterization of gate-all-around silicon nanowires**, Shimon Levi, Applied Materials, Inc. (Israel); Sean Hand, Bruker Nano Inc. (USA); Guy M. Cohen, IBM Thomas J. Watson Research Ctr. (USA) . . . . . .[9050-7]

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 2
Location: Conv. Ctr. 220C
Mon 1:30 pm to 3:30 pm

New EUV Resist Materials: Joint Session with Conferences 9048 and 9051

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

1:30 pm: **EUV resists toward 11nm half-pitch**, Yasin Ekinci, Michaela Vockenhuber, Nassireddin M. Mojarad, Daniel Fan, Paul Scherrer Institut (Switzerland) . [9048-3]

1:50 pm: **Process-stable EUV patternable metal oxide hardmask**, Andrew Grenville, Jeremy T. Anderson, Benjamin L. Clark, Michael Greer, Kai Jiang, Michael K. Kocsis, Stephen T. Meyers, Jason K. Stowers, Alan Telecky, Richard Vachkov, Douglas A. Keszler, Inpria (USA); William D. Hinsberg, Columbia Technical Consulting, Inc. (USA) . . . . . [9051-3]

2:10 pm: **A molecular inorganic approach to EUV photoresists**, Miles Marnell, State Univ. of New York at New Paltz (USA); Brian Cardineau, SUNY College of Nanoscale Science & Engineering (USA); Hashim Al-Mashat, Kara Heard, Amber Aslam, State Univ. of New York at New Paltz (USA); Ryan Del Re, SUNY College of Nanoscale Science & Engineering (USA); Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland); Daniel A. Freedman, State Univ. of New York at New Paltz (USA); Robert L. Brainard, College of Nanoscale Science & Engineering, Univ. at Albany (USA) . . . . . [9051-4]

2:30 pm: **Novel nonchemically amplified (n-CARs) negative resists for EUVL**, Vikram Singh, V. S. V. Satynarayana, Satinder K. Sharma, Subrata Ghosh, Indian Institute of Technology Mandi (India); Kenneth E. Gonsalves, Indian Institute of Technology Mandi (India) and The Univ. of North Carolina at Charlotte (USA) . . . . . [9051-5]

2:50 pm: **Evaluation of vacancies in positive tone nonchemically and chemically-amplified EUV/EB resists: Relationship between free volume and LER**, Akihiro Oshima, Osaka Univ. (Japan); Toru Hinata, Hirotaka Nakamura, Waseda Univ. (Japan); Toshitaka Oka, Tohoku Univ. (Japan); Vrian E. O'Rourke, Ryoichi Suzuki, Nagayasu Oshima, National Institute of Advanced Industrial Science and Technology (Japan); Masakazu Washio, Waseda Univ. (Japan); Seiichi Tagawa, Osaka Univ. (Japan) . . . . . [9051-6]

Conference 9054

Advanced Etch Technology for Nanopatterning III

Session 1
Location: San Jose Marriott Salon III
Mon 1:30 pm to 3:20 pm

Reviews and Overviews of Nanopatterning Challenges

Session Chairs: **Cathy Labelle,** GLOBALFOUNDRIES Inc. (USA); **Rich Wise,** IBM Corp. (USA)

1:30 pm: **Model-aided plasma process development: met, unmet and to be made promises** *(Keynote Presentation)*, Mark J. Kushner, Univ. of Michigan (USA) . . . [9054-1]

2:10 pm: **Where is plasma patterning going from here?** *(Keynote Presentation)*, Ying Zhang, Applied Materials, Inc. (Taiwan)[9054-2]

2:50 pm: **Fabrication challenges in patterning of 12nm half-pitch ultralow-k dual damascene copper interconnects** *(Invited Paper)*, Jasmeet S. Chawla, Alan Myers, Richard Schenker, Kanwal Jit Singh, Robert Turkot, Hui Jae Yoo, Intel Corp. (USA) . . . . . [9054-3]

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

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

3:10 pm: **Investigation of novel inorganic resist materials for EUV lithography**, Marie E. Krysak, James M. Blackwell, Intel Corp. (USA); Todd R. Younkin, Intel Corp. (Belgium); Steve E. Putna, Michael J. Leeson, Intel Corp. (USA) [9048-4]

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

Session 3
Location: Conv. Ctr. 220C
Mon 4:00 pm to 6:00 pm

Stochastics and EUV Process Improvements: Joint Session with Conferences 9048 and 9051

Session Chairs: **Roel Gronheid,** IMEC (Belgium); **Uzodinma Okoroanyanwu,** GLOBALFOUNDRIES Inc. (Germany)

4:00 pm: **Stochastic effects in fabrication of 11nm line-and-space patterns using extreme-ultraviolet lithography**, Takahiro Kozawa, Osaka Univ. (Japan); Julius Joseph S. Santillan, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9048-5]

4:20 pm: **Understanding EUV resist mottling leading to better resolution and linewidth roughness**, James W. Thackeray, James F. Cameron, Vipul Jain, Paul LaBeaume, Owendi Ongayi, Suzanne M. Coley, Michael Wagner, Dow Electronic Materials (USA). . . . . [9048-6]

4:40 pm: **Comparison of EUV patterning between PTD and NTD for 1Xnm DRAM**, Chang-Il Oh, SK Hynix, Inc. (Korea, Republic of). . . . . [9048-7]

5:00 pm: **Impact of stochastic effects on EUV printability limits**, Peter De Bisschop, Jeroen Van de Kerkhove, Julien Mailfert, IMEC (Belgium); Alessandro Vaglio Pret, KLA-Tencor/ ICOS Belgium (Belgium); John J. Biafore, KLA-Tencor Texas (USA). . . . . [9048-8]

5:20 pm: **Manufacturability improvements in EUV resist processing**, Yuhei Kuwahara, Koichi Matsunaga, Takeshi Shimoaoki, Kathleen Nafus, Tokyo Electron Kyushu Ltd. (Japan); Philippe Foubert, Anne-Marie Goethals, Efrain Altamirano-Sánchez, IMEC (Belgium); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Shigeru Tahara, Tokyo Electron Miyagi Ltd. (Japan); Satoru Shimura, Tokyo Electron Kyushu Ltd. (Japan). . . . . [9051-7]

5:40 pm: **EUV stochastic noise analysis and LCDU mitigation by etching on dense contact-hole array patterns**, Seo Min Kim, SK Hynix, Inc. (Korea, Republic of); Chang-Nam Ahn, ASML US, Inc. (USA); Sunyoung Koo, Hynix Semiconductor Inc. (Korea, Republic of); Jun-Taek Park, Chang-Moon Lim, Myoung Soo Kim, SK Hynix, Inc. (Korea, Republic of); Anita Fumar-Pici, ASML US, Inc. (USA); Alek C. Chen, ASML Taiwan Ltd. (Taiwan) . . . . . [9048-9]

Conference 9049

Alternative Lithographic Technologies VI

Session 1
Location: Conv. Ctr. 220A
Mon 3:40 pm to 5:40 pm

Alternative Lithography Keynote Session

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

3:40 pm: **Forced evolution: the increasingly symbiotic relationship of future device, circuit, and patterning technology** *(Keynote Presentation)*, Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA) . . . . . [9049-1]

4:20 pm: **Nanomanufacturing: Is there life beyond silicon?** *(Keynote Presentation)*, James A. Liddle, National Institute of Standards and Technology (USA) . . . . . [9049-2]

5:00 pm: **E-beam lithography: The real case for manufacturing** *(Keynote Presentation)*, Timothy R. Groves, Univ. at Albany (USA). . . . . [9049-3]

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

3:10 pm: **Hybrid metrology universal engine: co-optimization**, Alok Vaid, Carmen Osorio, Jamie Tsai, GLOBALFOUNDRIES Inc. (USA); Cornel Bozdog, Matthew J. Sendelbach, Nova Measuring Instruments Inc. (USA); Eyal Grubner, Roy Koret, Shay Wolfing, Nova Measuring Instruments Ltd. (Israel). . . . . .[9050-8]

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

Session 3
Location: Conv. Ctr. 220B
Mon 4:00 pm to 6:00 pm

Metrology of 3D Structures

Session Chairs: **Masafumi Asano,** Toshiba Corp. (Japan); **Alok Vaid,** GLOBALFOUNDRIES Inc. (USA)

4:00 pm: **10nm three-dimensional CD-SEM metrology**, András E. Vladár, John S. Villarrubia, Bin Ming, R. Joseph Kline, National Institute of Standards and Technology (USA) . . . . . .[9050-9]

4:20 pm: **Metrology for FinFET sidewall roughness: A study of H2 anneal smoothening for mobility enhancement**, Abner F. Bello, Abhijeet Paul, GLOBALFOUNDRIES Inc. (USA); Chun-Chen Yeh, Huiming Bu, Mukesh Khare, IBM Corp. (USA) . . . . . .[9050-10]

4:40 pm: **Addressing FinFET challenges in 1Xnode by image-based 3D metrology using CD-SEM tilt beam**, Xiaoxiao Zhang, Alok Vaid, Deepasree Konduparthi, Carmen Osorio, GLOBALFOUNDRIES Inc. (USA); Hua Zhou, Zhenhua Ge, Applied Materials, Inc. (USA); Stefano Ventola, Applied Materials GmbH (USA); Roi Meir, Ori Shoval, Roman Kris, Ofer Adan, Maayan Bar-Zvi, Applied Materials, Inc. (Israel). . . . . .[9050-11]

5:00 pm: **Novel three-dimensional (3D) CD-SEM profile measurements**, Wataru Ito, Advantest Corp. (Japan); Benjamin D. Bunday, SEMATECH Inc. (USA); Sumito Harada, Advantest Corp. (Japan); Aaron Cordes, SEMATECH Inc. (USA); Tsutomu Murakawa, Advantest Corp. (Japan); Abraham Arceo, SEMATECH Inc. (USA); Makoto Yoshikawa, Soichi Shida, Masayuki Yamagata, Jun Matsumoto, Takayuki Nakamura, Advantest Corp. (Japan) . . . . . .[9050-12]

5:20 pm: **Metrology and 3D shape process monitoring of HAR features using TSOM method**, Ravikiran Attota, HyeongGon Kang, John A. Kramar, National Institute of Standards and Technology (USA); Benjamin D. Bunday, Victor H. Vartanian, SEMATECH Inc. (USA) . . . . . .[9050-13]

5:40 pm: **Metrology of white-light interferometer for TSV processing**, Padraig R. Timoney, Yeong-Uk Ko, Daniel Fisher, Cheng-Kuan Lu, Yudesh Ramnath, Alok Vaid, Sarasvathi Thangaraju, Daniel Smith, Himani S. Kamineni, Dingyou Zhang, GLOBALFOUNDRIES Inc. (USA); Hemant Amin, Jonathan Peak, Holly Edmunson, Joseph Race, Timothy A. Johnson, Nanometrics Inc. (USA). . . . . .[9050-14]

Conference 9051

Advances in Patterning Materials and Processes XXXI

3:10 pm: **Investigation of novel inorganic resist materials for EUV lithography**, Marie E. Krysak, James M. Blackwell, Intel Corp. (USA); Todd R. Younkin, Intel Corp. (Belgium); Steve E. Putna, Michael J. Leeson, Intel Corp. (USA) . . . . . [9048-4]

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

Session 3
Location: Conv. Ctr. 220C
Mon 4:00 pm to 6:00 pm

Stochastics and EUV Process Improvements: Joint Session with Conferences 9048 and 9051

Session Chairs: **Roel Gronheid,** IMEC (Belgium); **Uzodinma Okoroanyanwu,** GLOBALFOUNDRIES Inc. (Germany)

4:00 pm: **Stochastic effects in fabrication of 11nm line-and-space patterns using extreme-ultraviolet lithography**, Takahiro Kozawa, Osaka Univ. (Japan); Julius Joseph S. Santillan, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan) . . . . . [9048-5]

4:20 pm: **Understanding EUV resist mottling leading to better resolution and linewidth roughness**, James W. Thackeray, James F. Cameron, Vipul Jain, Paul LaBeaume, Owendi Ongayi, Suzanne M. Coley, Michael Wagner, Dow Electronic Materials (USA) . . . . . [9048-6]

4:40 pm: **Comparison of EUV patterning between PTD and NTD for 1Xnm DRAM**, Chang-Il Oh, SK Hynix, Inc. (Korea, Republic of). . . . . [9048-7]

5:00 pm: **Impact of stochastic effects on EUV printability limits**, Peter De Bisschop, Jeroen Van de Kerkhove, Julien Mailfert, IMEC (Belgium); Alessandro Vaglio Pret, KLA-Tencor/ICOS Belgium (Belgium); John J. Biafore, KLA-Tencor Texas (USA) . . . . . [9048-8]

5:20 pm: **Manufacturability improvements in EUV resist processing**, Yuhei Kuwahara, Koichi Matsunaga, Takeshi Shimoaoki, Kathleen Nafus, Tokyo Electron Kyushu Ltd. (Japan); Philippe Foubert, Anne-Marie Goethals, Efrain Altamirano-Sánchez, IMEC (Belgium); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Shigeru Tahara, Tokyo Electron Miyagi Ltd. (Japan); Satoru Shimura, Tokyo Electron Kyushu Ltd. (Japan) . . . . . [9051-7]

5:40 pm: **EUV stochastic noise analysis and LCDU mitigation by etching on dense contact-hole array patterns**, Seo Min Kim, SK Hynix, Inc. (Korea, Republic of); Chang-Nam Ahn, ASML US, Inc. (USA); Sunyoung Koo, Hynix Semiconductor Inc. (Korea, Republic of); Jun-Taek Park, Chang-Moon Lim, Myoung Soo Kim, SK Hynix, Inc. (Korea, Republic of); Anita Fumar-Pici, ASML US, Inc. (USA); Alek C. Chen, ASML Taiwan Ltd. (Taiwan) . . . . . [9048-9]

Conference 9054

Advanced Etch Technology for Nanopatterning III

Session 2
Location: San Jose Marriott Salon III
Mon 3:50 pm to 5:30 pm

Nanopatterning for Advanced Logic and Memory Technology Nodes

Session Chairs: **Denis Shamiryan,** MAPPER Lithography (Netherlands); **Eric A. Hudson,** Lam Research Corp. (USA)

3:50 pm: **Line-width roughness reduction strategies for patterns exposed via electron-beam lithography**, Julien Jussot, Univ. Joseph Fourier (France); Erwine Pargon, LTM CNRS (France); Béatrice Icard, CEA-LETI-Minatec (France); Jessy Bustos, STMicroelectronics (France); Laurent Pain, CEA-LETI (France) . . . . . [9054-26]

4:10 pm: **Effect of etch pattern transfer on local overlay margin in 28nm GATE integration**, Onintza Ros, Pascal Gouraud, Bertrand Le-Gratiet, STMicroelectronics (France); Erwine Pargon, Lab. des Technologies de la Microélectronique (France); Christian Gardin, Julien Ducoté, STMicroelectronics (France) . . . . . [9054-5]

4:30 pm: **Gate double-patterning strategies for 1Xnm node FinFET devices**, Hubert Hody, IMEC (Belgium); Vasile Paraschiv, SC Etch Tech Solutions (Romania); David Hellin, Lam Research Corp. (Belgium); Tom Vandeweyer, Guillaume Boccardi, Kaidong Xu, IMEC (Belgium) . . . . . [9054-6]

4:50 pm: **28nm FDSOI high-k metal gate CD variability investigation**, Latifa Desvoivres, CEA-LETI-Minatec (France) and STMicroelectronics (France); Pascal Gouraud, Bertrand Le-Gratiet, Régis Bouyssou, Rossella Ranica, Benjamin Dumont, STMicroelectronics (France). . . . . [9054-7]

5:10 pm: **Highly-selective etch gas chemistry design for precise DSAL dry development process**, Mitsuhiro Omura, Tsubasa Imamura, Hiroshi Yamamoto, Toshiba Materials Co., Ltd. (Japan); Itsuko Sakai, Toshiba Corp. (Japan); Hisataka Hayashi, Toshiba Corp. (Japan) . [9054-8]

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- Emerging Mask Technologies
- Mask Application
- Mask Business

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 4
Location: Conv. Ctr. 210B
Tue 8:00 am to 10:10 am

EUV Source

Session Chairs: **Moshe E. Preil,** GLOBALFOUNDRIES Inc. (USA); **Michael J. Lercel,** SEMATECH Inc. (USA)

8:00 am: **Accelerator-based EUV lithography source: FEL-oscillator, SASE-FEL, or a very different beast?** *(Invited Paper)*, Atoosa Meseck, Andreas Jankowiak, Jens Knobloch, Johannes Bahrdt, Andreas Gaupp, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany); Diana Spengler, Erik M. Sohmen, Carl Zeiss SMT GmbH (Germany); Udo Dinger, Carl Zeiss AG (Germany); Michael Patra, Carl Zeiss SMT GmbH (Germany) . . . . . [9048-10]

8:30 am: **LPP EUV source readiness for NXE 3300**, David C. Brandt, Igor V. Fomenkov, Nigel R. Farrar, Bruno La Fontaine, David W. Myers, Daniel J. Brown, Alex I. Ershov, Norbert R. Bowering, Cymer, Inc. (USA); Rudy Peeters, Hans Meiling, Noreen Harned, Daniel A. Smith, ASML Netherlands B.V. (Netherlands) . . . . . [9048-11]

8:50 am: **Sub-hundred Watt operation demonstration of HVM LPP-EUV source**, Hakaru Mizoguchi, Takashi Saitou, Taku Yamazaki, Shinji Okazaki, Hiroaki Nakarai, Tamotsu Abe, Takeshi Kodama, Tatsuya Yanagida, Tsukasa Hori, Takeshi Ohta, Krzysztof M. Nowak, Yasufumi Kawasuji, Hiroshi Tanaka, Yutaka Shiraishi, Yukio Watanabe, Tsuyoshi Yamada, Georg Soumagne, Gigaphoton Inc. (Japan). . . . . [9048-12]

9:10 am: **Highly-efficient high-power pulsed CO_2 laser characterized by transverse-flow laser amplifiers**, Yoichi Tanino, Jun-ichi Nishimae, Tatsuya Yamamoto, Taichiro Tamida, Koji Funaoka, Shuichi Fujikawa, Mitsubishi Electric Corp. (Japan). . . . . [9048-13]

9:30 am: **In situ plasma cleaning method for collector optics**, Daniel Elg, David N. Ruzic, Univ. of Illinois at Urbana-Champaign (USA). . . . . [9048-14]

9:50 am: **Spectral purity enhancement for the EUV source by suppressing UV reflection from multilayer mirrors**, Qiushi Huang, Toine van den Boogaard, Robbert W. van de Kruijs, Erwin Zoethout, FOM Institute DIFFER (Netherlands); Eric Louis, Fred Bijkerk, FOM Institute DIFFER (Netherlands) and Univ. Twente (Netherlands) . . . . . [9048-15]

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

Conference 9049

Alternative Lithographic Technologies VI

Session 2
Location: Conv. Ctr. 220A
Tue 8:10 am to 10:10 am

DSA Process and Integration

Session Chairs: **Joy Y. Cheng,** IBM Almaden Research Ctr. (USA); **Elizabeth A. Dobisz,** HGST (USA)

8:10 am: **Defect reduction and defect stability in IMEC's 14nm half-pitch chemo-epitaxy DSA flow** *(Invited Paper)*, Roel Gronheid, Yu-Tsung Lee, IMEC (Belgium); Yi Cao, YoungJun Her, AZ Electronic Materials USA Corp. (USA); Lucia D'Urzo, Entegris, Inc. (Germany); Dieter Van den Heuvel, IMEC (Belgium); Paulina A. Rincon Delgadillo, The Univ. of Chicago (USA); Ainhoa Romo-Negreira, Tokyo Electron Europe Ltd. (USA); Mark H. Somervell, Tokyo Electron America, Inc. (USA); Ryoto Harukawa, Venkat R. Nagaswami, KLA-Tencor Corp. (USA) . . . . . .[9049-4]

8:40 am: **Pattern replication and pattern transfer using sequential infiltration synthesis in block copolymer patterns for sub-15nm lithography**, Yves-Andre Chapuis, HGST (USA); Shisheng Xiong, The Univ. of Chicago (USA); Lei Wan, Jeffery Lille, Kanaiyalal C. Patel, HGST (USA); Paul F. Nealey, The Univ. of Chicago (USA); Thomas R. Albrecht, Ricardo Ruiz, HGST (USA) . . . . . .[9049-5]

9:00 am: **Pattern transfer challenges in >2 Tbpsi bit patterned media template fabrication using PS-b-PDMS**, Shuaigang Xiao, Xiaomin Yang, Kim Y. Lee, Zhaoning Yu, David S. Kuo, Seagate Technology LLC (USA). . . .[9049-6]

9:20 am: **Computational simulations and parametric studies for DSA process development**, Azat M. Latypov, Grant Garner, Moshe E. Preil, Gerard M. Schmid, Ji Xu, Yi Zou, GLOBALFOUNDRIES Inc. (USA). . . . . .[9049-7]

9:40 am: **Toward electrical testable SOI devices using DSA for fin formation** *(Invited Paper)*, Chi-Chun Liu, Cristina Estrada-Raygoza, Hong He, IBM Corp. (USA); Michael J. Cicoria, David Hetzer, Vinayak Rastogi, Nihar Mohanty, Akiteru Ko, TEL Technology Ctr., America, LLC (USA); Hsinyu Tsai, TEL Technology Ctr., America, LLC (USA) and IBM Corp. (USA); Anthony R. Schepis, Jassem A. Abdallah, IBM Corp. (USA); Jason R. Cantone, Sylvie Mignot, Ryoung-Han Kim, GLOBALFOUNDRIES Inc. (USA); Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA); Melia Tjio, Joy Y. Cheng, IBM Almaden Research Ctr. (USA); Mark H. Somervell, Tokyo Electron America, Inc. (USA); Matthew E. Colburn, IBM Research (USA). .[9049-8]

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

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 4
Location: Conv. Ctr. 220 B
Tue 8:00 am to 10:00 am

SEM Simulation and Emulation I: Joint Session with Conferences 9050 and 9051

Session Chairs: **Shunsuke Koshihara,** Hitachi High-Technologies Corp. (Japan); **Thomas I. Wallow,** GLOBALFOUNDRIES Inc. (USA)

8:00 am: **Influence of metrology error in measurement of line-edge roughness power spectral density**, Benjamin D. Bunday, SEMATECH Inc. (USA); Chris A. Mack, Lithoguru.com (USA) . . . . . [9050-15]

8:20 am: **Monte Carlo simulator of resist shrinkage in SEM metrology**, Sergey Babin, abeam Technologies, Inc. (USA) . . . . . [9050-16]

8:40 am: **A new integrated Monte-Carlo code for the simulation of high-resolution scanning electron microscopy images for metrology in microlithography**, Mauro Ciappa, Emre Ilgüsatiroglu, Alexey Y. Illarionov, ETH Zürich (Switzerland); Lars H. Bomholt Jr., Synopsys Switzerland, LLC (Switzerland) . . . . . [9050-17]

9:00 am: **Correction of EB-induced shrinkage in contour measurements**, Takeyoshi Ohashi, Shoji Hotta, Atsuko Yamaguchi, Junichi Tanaka, Hitachi, Ltd. (Japan); Hiroki Kawada, Hitachi High-Technologies Corp. (Japan) . . . . . [9050-18]

9:20 am: **Investigation of interactions between metrology and lithography with a CD SEM simulator**, Mark D. Smith, Chao Fang, John J. Biafore, Alessandro Vaglio Pret, Stewart A. Robertson, KLA-Tencor Texas (USA) . . . . . [9051-8]

9:40 am: **Dependence of secondary-electron yield on aspect ratio of several trench patterns**, Daisuke Bizen, Yasunari Sohda, Hitachi, Ltd. (Japan); Hideyuki Kazumi, Hitachi High-Technologies Corp. (Japan) . . . . . [9050-19]

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

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 4
Location: Conv. Ctr. 220 B
Tue 8:00 am to 10:00 am

SEM Simulation and Emulation I: Joint Session with Conferences 9050 and 9051

Session Chairs: **Shunsuke Koshihara,** Hitachi High-Technologies Corp. (Japan); **Thomas I. Wallow,** GLOBALFOUNDRIES Inc. (USA)

8:00 am: **Influence of metrology error in measurement of line-edge roughness power spectral density**, Benjamin D. Bunday, SEMATECH Inc. (USA); Chris A. Mack, Lithoguru.com (USA) . . . . . [9050-15]

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9:40 am: **Dependence of secondary-electron yield on aspect ratio of several trench patterns**, Daisuke Bizen, Yasunari Sohda, Hitachi, Ltd. (Japan); Hideyuki Kazumi, Hitachi High-Technologies Corp. (Japan). . . . . [9050-19]

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

Conference 9052

Optical Microlithography XXVII

Location: Conv. Ctr. 210C
8:20 am to 8:40 am

Opening Remarks

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

Session 1
Location: Conv. Ctr. 210C
Tue 8:40 am to 10:00 am

Keynote Session

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

8:40 am: **3D optical laser lithography: No limits?** *(Keynote Presentation)*, Martin Wegener, Karlsruher Institut für Technologie (Germany) . . . . . [9052-1]

9:20 am: **Going wide in the cloud: Why stability matters in a simulation-driven world,** *(Keynote Presentation)*, David Pellerin, Amazon Web Services (USA) . . . . . [9052-2]

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

Conference 9054

Advanced Etch Technology for Nanopatterning III

Session 3
Location: San Jose Marriott Salon III
Tue 8:30 am to 10:10 am

Plasma and Resist Interactions, Including Patterning Quality Control (LER, CD Uniformity, etc.)

Session Chairs: **Sebastian U. Engelmann,** IBM Thomas J. Watson Research Ctr. (USA)

8:30 am: **Advanced patterning: plasma etch challenges and solutions** *(Invited Paper)*, Thorsten B. Lill, Gowri Kamarthy, Aaron Eppler, Tae Won Kim, Harmeet Singh, Lam Research Corp. (USA) . . . . . [9054-9]

9:00 am: **30nm pitch compatible, stepwise hydrogen anneal for LER reduction of silicon nanowires** *(Invited Paper)*, Sarunya Bangsaruntip, Guy M. Cohen, Markus Brink, Hsinyu Tsai, Sebastian U. Engelmann, Joseph S. Newbury, Lynne M. Gignac, Christopher M. Breslin, David P. Klaus, Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA) . . . . . [9054-10]

9:30 am: **The influence of the initial LWR, CD, and EUV-resist composition on LWR evolution by H2 plasma treatment**, Peter De Schepper, Efrain Altamirano-Sánchez, Terje Hansen, Stefan De Gendt, IMEC (Belgium) . . . . . [9054-11]

9:50 am: **Line-width roughness formation during plasma etching: mechanism and reduction**, Meng Lingkuan, Xiaobin He, Chunlong Li, Junfeng Li, Jiang Yan, Chao Zhao, Institute of Microelectronics (China) . . . . . [9054-12]

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

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 5
Location: Conv. Ctr. 210B
Tue 10:40 am to 12:00 pm

EUV Mask I

Session Chairs: **Frank Goodwin,** SEMATECH Inc. (USA); **Naoya Hayashi,** Dai Nippon Printing Co., Ltd. (Japan)

10:40 am: **Production of EUV mask blanks with low killer defects**, Alin O. Antohe, Patrick A. Kearney, Milton C. Godwin, SEMATECH Inc. (USA); Long He, SEMATECH Inc. (USA) and Intel Corp. (USA); Arun John Kadaksham, Frank Goodwin, SEMATECH Inc. (USA); Alfred Weaver, Steve Trigg, Alan Hayes, Veeco Instruments Inc. (USA) [9048-16]

11:00 am: **Mitigation of EUV mask blank substrate pit and scratch defects by accelerated neutral atom beam (ANAB) processing**, Richard Svrluga, Michael Walsh, Kiet Chau, Bernhard P. Piwczyk, Exogenesis Corp. (USA); Frank Goodwin, SEMATECH Inc. (USA); Sean Kirkpatrick, Exogenesis Corp. (USA); Dave K. Balachandran, SEMATECH Inc. (USA) . . . . . [9048-17]

11:20 am: **Durability of Ru-based EUV masks and the improvement**, Suyoung Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . [9048-18]

11:40 am: **B4C as an alternate capping layer for EUV masks**, Arun J. Kadaksham, Mason Jang, Alin O. Antohe, Patrick A. Kearney, Frank Goodwin, SEMATECH Inc. (USA); Carl Ventrice Jr., Tyler Mowll, Univ. at Albany (USA). . . . . [9048-19]

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

Conference 9049

Alternative Lithographic Technologies VI

Session 3
Location: Conv. Ctr. 220A
Tue 10:40 am to 12:10 pm

Novel Nanolithography

Session Chairs: **Ivo W. Rangelow,** Technische Univ. Ilmenau (Germany); **Helmut Schift,** Paul Scherrer Institut (Switzerland)

10:40 am: **Closed-loop high-speed 3D thermal probe nanolithography** *(Invited Paper)*, Armin W. Knoll, Michal Zientek, IBM Zürich Research Lab. (Switzerland); Lin Lee Cheong, Massachusetts Institute of Technology (United States); Colin Rawlings, IBM Zürich Research Lab. (Switzerland); Philip C. Paul, Felix Holzner, SwissLitho AG (Switzerland); Daniel J. Coady, James L. Hedrick, Robert Allen, IBM Almaden Research Ctr. (United States); Urs Duerig, IBM Zürich Research Lab. (Switzerland) . . . . . [9049-9]

11:10 am: **Sub-wavelength printing with displacement Talbot lithography in the deep-UV region**, Li Wang, Eulitha AG (Switzerland); Francis Clube, Eulitha AG (Switzerland) and Paul Scherrer Institut (Switzerland); Christian Dais, Harun H. Solak, Eulitha AG (Switzerland); Jens Gobrecht, Paul Scherrer Institut (Switzerland) . . . . . [9049-10]

11:30 am: **Positive and negative-tone mode closed-loop scanning probe lithography on calixarene molecular glass resist**, Marcus Kaestner, Konrad Nieradka, Steve Lenk, Ahmad Ahmad, Tihomir Angelov, Alexander Reum, Yana Krivoshapkina, Manuel Hofer, Ivo W. Rangelow, Technische Univ. Ilmenau (Germany) . . . . [9049-11]

11:50 am: **A frequency multiplication technique based on EUV near-field imaging**, Yijian Chen, Peking Univ. (China); Yashesh A. Shroff, Intel Corp. (USA) . . . . . [9049-12]

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

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 5
Location: Conv. Ctr. 220 B
Tue 10:30 am to 11:50 am

SEM Simulation and Emulation II: Joint Session with Conferences 9050 and 9051

Session Chairs: **Benjamin D. Bunday,** SEMATECH Inc. (USA); **Clifford L. Henderson,** Georgia Institute of Technology (USA)

10:30 am: **The effect of adaptive filtering and edge rotation on line-edge roughness**, Thomas Verduin, Cornelis W. Hagen, Pieter Kruit, Technische Univ. Delft (Netherlands) . . . . [9050-20]

10:50 am: **Assessing CD-SEM contour-based OPC models quality using rigorous simulation**, Francois Weisbuch, Aravind Narayana Samy, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany) . . . . . [9051-9]

11:10 am: **Cross-sectional profile prediction from top-view SEM images based on root-cause decomposition of line-edge roughness**, Hiroshi Fukuda, Hitachi High-Technologies Corp. (Japan). . . . . [9050-21]

11:30 am: **Simulation-aided exclusion of underlayer visible pattern for sub-10nm SEM metrology and inspection**, Ofer Adan, Applied Materials, Inc. (Israel); Kfir Dotan, Applied Materials, Inc. (USA); Shimon Levi, Ishai Schwartsband, Maayan Bar-Zvi, Applied Materials, Inc. (Israel) . . . . . [9051-10]

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

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 5
Location: Conv. Ctr. 220 B
Tue 10:30 am to 11:50 am

SEM Simulation and Emulation II: Joint Session with Conferences 9050 and 9051

Session Chairs: **Benjamin D. Bunday,** SEMATECH Inc. (USA); **Clifford L. Henderson,** Georgia Institute of Technology (USA)

10:30 am: **The effect of adaptive filtering and edge rotation on line-edge roughness**, Thomas Verduin, Cornelis W. Hagen, Pieter Kruit, Technische Univ. Delft (Netherlands) . . . . [9050-20]

10:50 am: **Assessing CD-SEM contour-based OPC models quality using rigorous simulation**, Francois Weisbuch, Aravind Narayana Samy, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany) . . . . . [9051-9]

11:10 am: **Cross-sectional profile prediction from top-view SEM images based on root-cause decomposition of line-edge roughness**, Hiroshi Fukuda, Hitachi High-Technologies Corp. (Japan). . . . . [9050-21]

11:30 am: **Simulation-aided exclusion of underlayer visible pattern for sub-10nm SEM metrology and inspection**, Ofer Adan, Applied Materials, Inc. (Israel); Kfir Dotan, Applied Materials, Inc. (USA); Shimon Levi, Ishai Schwartsband, Maayan Bar-Zvi, Applied Materials, Inc. (Israel) . . . . . [9051-10]

Lunch/Exhibition Break . . Tue 11:50 am to 1:40 pm

Conference 9052

Optical Microlithography XXVII

Session 2
Location: Conv. Ctr. 210C
Tue 10:30 am to 12:00 pm

Optics and Beyond

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

10:30 am: **The saga of sigma: influences of illumination throughout lithography generations** *(Invited Paper)*, Bruce W. Smith, Rochester Institute of Technology (USA) . . . . . [9052-3]

11:00 am: **The impact of mask absorber profiles (M3D) and resist profiles (R3D) in immersion and EUV lithography**, Jo Finders, ASML Netherlands B.V. (Netherlands) . . . . . [9052-4]

11:20 am: **Topographic and other effects on DUV/EUV pattern fidelity**, Chandrasekhar Sarma, SEMATECH Inc. (USA); Trey Graves, KLA-Tencor Texas (USA); Mark Neisser, SEMATECH Inc. (USA); Stewart A. Robertson, KLA-Tencor Texas (USA) . . . . . [9052-5]

11:40 am: **Next-generation multi-wavelength lithography: survey and roadmap**, John S. Petersen, Periodic Structures, Inc. (USA); John T. Fourkas, Univ. of Maryland, College Park (USA); Steven R. J. Brueck, The Univ. of New Mexico (USA); Dave Markle, Rudi Hendel, Periodic Structures, Inc. (USA) . . . [9052-6]

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

Conference 9054

Advanced Etch Technology for Nanopatterning III

Session 4
Location: San Jose Marriott Salon III
Tue 10:40 am to 12:00 pm

Patterning Integration Schemes (multilayer patterning, self-aligned patterning, etc.)

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

10:40 am: **Plasma etching and integration challenges using alternative patterning techniques for 11nm node and beyond** *(Invited Paper)*, Sebastien Barnola, Patricia Pimenta Barros, CEA-LETI (France); Christian Arvet, STMicroelectronics (France); Christian Vizioz, Nicolas Posseme, CEA-LETI (France); Ahmed Gharbi, CEA-LETI-Minatec (France); Maxime Argoud, CEA-LETI (France); Raluca Tiron, Jonathan Pradelles, Latifa Desvoivres, CEA-LETI-Minatec (France); Sylvain Barraud, CEA-LETI (France); Gilles Cunge, LTM CNRS (France) . . . . . [9054-13]

11:10 am: **Double patterning strategies for advanced CMOS processing** *(Invited Paper)*, Eddy Kunnen, Janko Versluijs, Frederic Lazzarino, Vincent Truffert, Efrain Altamirano, Stefan Decoster, Steven Demuynck, Chris Wilson, Hubert Hody, Ming Mao, IMEC (Belgium) . . . . . [9054-14]

11:40 am: **Etch challenges for DSA implementation in CMOS via patterning**, Patricia Pimenta Barros, Sebastien Barnola, CEA-LETI (France); Ahmed Gharbi, CEA-LETI-Minatec (France); Maxime Argoud, Isabelle Servin, CEA-LETI (France); Xavier Chevalier, ARKEMA SA (France); Christophe Navarro, Arkema S.A. (France); Eugenie Martinez, Commissariat à l'Énergie Atomique (France); Raluca Tiron, CEA-LETI-Minatec (France) . . . . . [9054-15]

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

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 6
Location: Conv. Ctr. 210B
Tue 1:30 pm to 3:10 pm

EUV Mask II

Session Chairs: **Emily E. Gallagher,** IBM Corp. (USA); **Guojing Zhang,** Intel Corp. (USA)

1:30 pm: **Study of alternative capping and absorber layers for EUV masks for sub-16nm HP nodes**, Abbas Rastegar, Matthew House, Ruahi Tian, SEMATECH Inc. (USA); Thomas Laursen, Univ. at Albany (USA); Alin O. Antohe, Patrick A. Kearney, SEMATECH Inc. (USA) . . . . . [9048-20]

1:50 pm: **Evaluation of mask repair strategies via focused electron, helium, and neon beam-induced processing for EUV applications**, Carlos M. Gonzalez, The Univ. of Tennessee (USA); Winand Slingenbergh, Univ. of Groningen (Netherlands); Rajendra Timilsina, Joo Hyon Noh, Philp D. Rack, The Univ. of Tennessee (USA); Ted Liang, Intel Corp. (USA) . . . . . [9048-21]

2:10 pm: **Effect of cleaning chemistries on surface energy and adhesion on EUV masks, substrates, and multilayers**, Dave K. Balachandran, Arun J. Kadaksham, SEMATECH Inc. (USA) . . . . . [9048-22]

2:30 pm: **Direct measurement of carbon contamination topography on patterned EUV masks**, Yu-Jen Fan, SEMATECH Inc. (USA); Thomas Murray, Univ. at Albany (USA); Frank Goodwin, Dominic Ashworth, SEMATECH Inc. (USA); Gregory Denbeaux, Univ. at Albany (USA) . . . . . [9048-23]

2:50 pm: **Particle control challenges in process chemicals and ultrapure water for sub-10nm technology nodes**, Abbas Rastegar, Martin Samayoa, Matthew House, Hüseyin Kurtuldu, Sang-Kee Eah, SEMATECH Inc. (USA); Lauren Morse, Univ. of Worcester (USA); Jenah Harris-Jones, SEMATECH Inc. (USA) . . . . . [9048-24]

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

Conference 9049

Alternative Lithographic Technologies VI

Sessions 4 and 5 run concurrently.

Session 4
Location: Conv. Ctr. 220A
Tue 1:30 pm to 3:10 pm

Roll to Roll UV Nanoimprint Lithography

Session Chairs: **John G. Maltabes,** Hewlett-Packard Labs. (USA); **Laurent Pain,** CEA-LETI (France)

1:30 pm: **Large-area, continuous roll-to-roll (R2R) nanoimprinting with PFPE hybrid molds: A route to high-throughput manufacturing of sensors**, Jacob John, Martin Muthee, Sigfrid K. Yngvesson, Kenneth R. Carter, Univ. of Massachusetts Amherst (USA) . . . . . [9049-13]

1:50 pm: **High-resolution patterning for flexible electronics via roll-to-roll imprint lithography**, Sami Sabik, Joris De Riet, Edsger C. P. Smits, Iryna Yakimets, TNO (Netherlands) . . . . [9049-14]

2:10 pm: **Scalable roll-based nanopatterning using jet and flash imprint lithography**, Se Hyun Ahn, Maha Ganapathisubramanian, Shuqiang Yang, Vik Singh, Marlon Menezes, Frank Y. Xu, Michael L. Miller, Byung Jin Choi, Douglas J. Resnick, S. V. Sreenivasan, Molecular Imprints, Inc. (USA) . . . . . [9049-15]

2:30 pm: **Photocurable resists for large area and high-throughput processing by roll-to-roll nanoimprint**, Manuel W. Thesen, Marko Vogler, micro resist technology GmbH (Germany); Stephan Ruttloff, Dieter Nees, JOANNEUM RESEARCH Forschungsgesellschaft mbH (Austria); Gabi Grützner, micro resist technology GmbH (Germany) . . . . . [9049-16]

2:50 pm: **Challenges for pattern formation with sub-100nm residual-layer thickness by roll-to-roll nanoimprint lithography**, Ryoichi Inanami, Kazuto Matsuki, Tomoko Ojima, Takuya Kono, Tetsuro Nakasugi, Toshiba Corp. (Japan) . . . . . [9049-17]

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

Session 5
Location: Conv. Ctr. 220B
Tue 1:20 pm to 3:10 pm

Metrology and Inspection for Directed Self-Assembly: Joint Session with Conferences 9049 and 9050

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

1:20 pm: **Directed self-assembly: Where does the line roughness come from?** *(Invited Paper)*, Ricardo Ruiz, Lei Wan, He Gao, Yves-Andre Chapuis, Kanaiyalal C. Patel, Jeffrey Lille, Thomas R. Albrecht, HGST (USA) . . . . . [9049-18]

1:50 pm: **Kinetics of defect annihilation in directed self-assembly of block copolymers using chemically nanopatterned surfaces**, Paulina A. Rincon Delgadillo, The Univ. of Chicago (USA) and IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Ryota Harukawa, KLA-Tencor Corp. (USA); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Yu-Tsung Lee, Boon Teik Chan, IMEC (Belgium); Guanyang Lin, Yi Cao, AZ Electronic Materials USA Corp. (USA); Venkat R. Nagaswami, KLA-Tencor Corp. (USA); Mark H. Somervell, Kathleen Nafus, Tokyo Electron America, Inc. (USA); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9049-19]

2:10 pm: **Metrology for directed self-assembly block lithography using optical scatterometry**, Dhairya J. Dixit, SUNY College of Nanoscale Science & Engineering (USA); Vimal K. Kamineni, Richard A. Farrell, Erik Hosler, Moshe E. Preil, GLOBALFOUNDRIES Inc. (USA); Joseph Race, Brennan L. Peterson, Nanometrics Inc. (USA); Alain C. Diebold, SUNY College of Nanoscale Science & Engineering (USA) . . . . . [9050-22]

2:30 pm: **Novel metrology methods for fast 3D characterization of DSA patterns for high-volume manufacturing**, Chandrasekhar Sarma, Benjamin D. Bunday, Aron J. Cepler, SEMATECH Inc. (USA); Thaddeus Dziura, KLA-Tencor Corp. (USA); JiHoon Kim, Guanyang Lin, Jian Yin, AZ Electronic Materials USA Corp. (USA) . . . . . [9050-23]

2:50 pm: **Measurement of the buried structure of sub-30nm block copolymer lithography patterns using resonant x-ray scattering**, Daniel F. Sunday, Wen-li Wu, R. Joseph Kline, National Institute of Standards and Technology (USA) . . . . . [9049-20]

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

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 6
Location: Conv. Ctr. 220B
Tue 1:20 pm to 3:10 pm

Metrology and Inspection for Directed Self-Assembly: Joint Session with Conferences 9049 and 9050

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

1:20 pm: **Directed self-assembly: Where does the line roughness come from?** *(Invited Paper)*, Ricardo Ruiz, Lei Wan, He Gao, Yves-Andre Chapuis, Kanaiyalal C. Patel, Jeffrey Lille, Thomas R. Albrecht, HGST (USA) . . . . . [9049-18]

1:50 pm: **Kinetics of defect annihilation in directed self-assembly of block copolymers using chemically nanopatterned surfaces**, Paulina A. Rincon Delgadillo, The Univ. of Chicago (USA) and IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Ryota Harukawa, KLA-Tencor Corp. (USA); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Yu-Tsung Lee, Boon Teik Chan, IMEC (Belgium); Guanyang Lin, Yi Cao, AZ Electronic Materials USA Corp. (USA); Venkat R. Nagaswami, KLA-Tencor Corp. (USA); Mark H. Somervell, Kathleen Nafus, Tokyo Electron America, Inc. (USA); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9049-19]

2:10 pm: **Metrology for directed self-assembly block lithography using optical scatterometry**, Dhairya J. Dixit, SUNY College of Nanoscale Science & Engineering (USA); Vimal K. Kamineni, Richard A. Farrell, Erik Hosler, Moshe E. Preil, GLOBALFOUNDRIES Inc. (USA); Joseph Race, Brennan L. Peterson, Nanometrics Inc. (USA); Alain C. Diebold, SUNY College of Nanoscale Science & Engineering (USA) . . . . . [9050-22]

2:30 pm: **Novel metrology methods for fast 3D characterization of DSA patterns for high-volume manufacturing**, Chandrasekhar Sarma, Benjamin D. Bunday, Aron J. Cepler, SEMATECH Inc. (USA); Thaddeus Dziura, KLA-Tencor Corp. (USA); JiHoon Kim, Guanyang Lin, Jian Yin, AZ Electronic Materials USA Corp. (USA) . . . . . [9050-23]

2:50 pm: **Measurement of the buried structure of sub-30nm block copolymer lithography patterns using resonant x-ray scattering**, Daniel F. Sunday, Wen-li Wu, R. Joseph Kline, National Institute of Standards and Technology (USA) . . . . . [9049-20]

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

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 6
Location: Conv. Ctr. 220C
Tue 1:40 pm to 3:40 pm

New Materials and Processes

Session Chairs: **Robert Allen,** IBM Almaden Research Ctr. (USA); **Ramakrishnan Ayothi,** JSR Micro, Inc. (USA)

1:40 pm: **Further investigations of bottom-up/top-down lithography using vertically assembled block brush polymers**, Peter Trefonas III, James W. Thackeray, Dow Electronic Materials (USA); Guorong Sun, Sangho Cho, Corrie Clark, Fan Yang, Stanislav V. Verkhoturov, Emile A. Schweikert, Karen L. Wooley, Texas A&M Univ. (USA) [9051-11]

2:00 pm: **Chiral nanomaterial fabrication by means of on-edge lithography**, Kay Dietrich, Dennis Lehr, Oliver Puffky, Ernst-Bernhard Kley, Andreas Tünnermann, Friedrich-Schiller-Univ. Jena (Germany) . . . . . [9051-12]

2:20 pm: **Positive tone cross-linked resists based on photoacid inhibition of cross linking**, Richard A. Lawson, Laren M. Tolbert, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . [9051-13]

2:40 pm: **In-situ FTIR spectroscopy to study surface chemistry of SIS lithography**, Mahua Biswas, Joseph A. Libera, Argonne National Lab. (USA); Seth B. Darling, Argonne National Lab. (USA) and The Univ. of Chicago (USA); Jeffrey W. Elam, Argonne National Lab. (USA). . . . . [9051-14]

3:00 pm: **Nanopatterning with tailored molecules**, Hans-Werner Schmidt, Florian Wieberger, Tristan Kolb, Andreas Ringk, Christian Neuber, Univ. Bayreuth (Germany); Christopher K. Ober, Cornell Univ. (USA) . . . . . [9051-15]

3:20 pm: **Rational design of photoresist and photoacid generator for sub-millisecond laser post-exposure bake**, Jing Jiang, Michael O. Thompson, Christopher K. Ober, Cornell Univ. (USA) . . . . . [9051-16]

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

Conference 9052

Optical Microlithography XXVII

Session 3
Location: Conv. Ctr. 210C
Tue 1:30 pm to 3:30 pm

Image and Process Control

Session Chairs: **Tsai-Sheng Gau,** Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Carlos Fonseca,** Tokyo Electron America, Inc. (USA)

1:30 pm: **Advanced 3D-modeling to improve best-focus shift detection and process control**, Anna Szucs, Jonathan Planchot, Vincent Farys, Emek Yesilada, STMicroelectronics (France); Laurent Depre, Brion Technologies, Inc. (USA); Cécile Gourgon, CEA-LETI (France); Maxime Besacier, CEA-LETI-Minatec (France); Sanjay Kapasi, Brion Technologies, Inc. (USA); Frank A. Driessen, Orion Mouraille, ASML Netherlands B.V. (Netherlands) . . . . . [9052-7]

1:50 pm: **Study of lens heating behavior and thick mask effects with a computational method**, Ningning Jia, Seung-Hune Yang, Sangwook Kim, Young-Chang Kim, Jungdal Choi, Ho-Kyu Kang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9052-8]

2:10 pm: **Scanner performance predictor and optimizer in further low-k1 lithography**, Hajime Aoyama, Toshiharu Nakashima, Taro Ogata, Shintaro Kudo, Naonori Kita, Junji Ikeda, Ayako Sukegawa, Katsushi Makino, Masayuki Murayama, Kazuo Masaki, Tomoyuki Matsuyama, Nikon Corp. (Japan). . . . . [9052-9]

2:30 pm: **Imaging control functions of optical scanners**, Hisashi Nishinaga, Toru Hirayama, Hajime Yamamoto, Hiroshi Irihama, Taro Ogata, Tomoyuki Matsuyama, Nikon Corp. (Japan) . . . . . [9052-10]

2:50 pm: **Experimental validation of rigorous, 3D profile models for negative-tone develop resists**, Weimin Gao, Synopsys, Inc. (Belgium); Ulrich Klostermann, Thomas Schmoeller, Synopsys GmbH (Germany); Kevin Lucas, Synopsys, Inc. (USA); Wolfgang Demmerle, Synopsys GmbH (Germany); Peter De Bisschop, Julien Mailfert, IMEC (Belgium). . . . . [9052-11]

3:10 pm: **Wafer sub-layer impact in OPC/ORC models for advanced node implant layers**, Jean-Christophe Le Denmat, Jean-Christophe Michel, Elodie Sungauer, Emek Yesilada, Frederic Robert, STMicroelectronics (France); Song Lan, Mu Feng, Laurent Depre, Xiaobo Xie, Sanjay Kapasi, Brion Technologies, Inc. (USA). . . . . [9052-12]

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

Conference 9054

Advanced Etch Technology for Nanopatterning III

Session 5
Location: San Jose Marriott Salon III
Tue 1:30 pm to 3:10 pm

New Plasma Sources and New Etching Technologies

Session Chairs: **Seiji Samukawa,** Tohoku Univ. (Japan); **Julie Bannister,** Tokyo Electron America, Inc. (USA)

1:30 pm: **Large-radius neutral beam-enhanced chemical vapor deposition process for non-porous ultra-low-k SiOCH** *(Invited Paper)*, Yoshiyuki Kikuchi, Yasuaki Sakakibara, Tokyo Electron Ltd. (Japan); Seiji Samukawa, Tohoku Univ. (Japan). . . . . [9054-16]

2:00 pm: **Gas cluster ion-beam etching for precision uniformity correction** *(Invited Paper)*, Noel M. Russell, Vincent Gizzo, Joshua D. LaRose, Brian D. Pfeiffer, TEL Technology Ctr., America, LLC (USA); R. Dasaka, Laertis Economikos, Rich Wise, IBM Corp. (USA) . . . . . [9054-17]

2:30 pm: **Highly selective etching for next-generation device using time-modulation plasma**, Michikazu Morimoto, Hitachi High-Technologies Corp. (Japan); Naoki Yasui, Hitachi High Technologies America, Inc. (USA); Miyako Matsui, Hitachi, Ltd. (Japan) . . . . . [9054-18]

2:50 pm: **Advanced plasma source for the 450mm etch process**, Hong-Young Chang, KAIST (Korea, Republic of). . . . . [9054-19]

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

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 7
Location: Conv. Ctr. 210B
Tue 3:40 pm to 6:00 pm

EUV Integration

Session Chairs: **Patrick P. Naulleau,** Lawrence Berkeley National Lab. (USA); **Anthony Yen,** TSMC Taiwan (Taiwan)

3:40 pm: **EUV source-mask optimization for 7nm-node and beyond**, Xiaofeng Liu, Rafael C. Howell, Stephen D. Hsu, Kaiyu Yang, Keith D. Gronlund, Brion Technologies, Inc. (USA); Frank A. Driessen, ASML Netherlands B.V. (Netherlands); Hua-Yu Liu, Brion Technologies, Inc. (USA); Steven Hansen, ASML US, Inc. (USA); Koen van Ingen Schenau, Thijs Hollink, Paul van Adrichem, Kars Troost, ASML Netherlands B.V. (Netherlands); Jörg Zimmermann, Oliver Schumann, Carl Zeiss SMT GmbH (Germany); Christoph Hennerkes, Carl Zeiss AG (Germany); Paul Gräupner, Carl Zeiss SMT GmbH (Germany) . . [9048-25]

4:00 pm: **EUV overlay strategy for improving MMO**, Byoung-Hoon Lee, Inhwan Lee, Yoonsuk Hyun, Seo Min Kim, Chang-Moon Lim, Myoung Soo Kim, Sung-Ki Park, SK Hynix, Inc. (Korea, Republic of) . . . . . [9048-26]

4:20 pm: **Prospects of DUV OoB suppression techniques in EUV lithography**, Chang-Min Park, Insung Kim, Sang-Hyun Kim, Dongwan Kim, Sun-Nam Kim, Cheolhong Park, Hyun-Woo Kim, Jeongho Yeo, Seong-Sue Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9048-27]

4:40 pm: **Feasibility of compensating for EUV field edge effects through OPC**, Chris Maloney, Rochester Institute of Technology (USA) and Mentor Graphics Corp. (USA) and IMEC (Belgium); James C. Word, Germain L. Fenger, Mentor Graphics Corp. (USA); Ardavan Niroomand, Micron Technology, Inc. (USA); Gian F. Lorusso, Rik Jonckheere, IMEC (Belgium); Bruce W. Smith, Rochester Institute of Technology (USA); Eric Hendrickx, IMEC (Belgium). . . . . [9048-28]

5:00 pm: **Comprehensive defect avoidance solution for mitigating EUV mask defects**, Abde Ali H. Kagalwalla, Puneet Gupta, Univ. of California, Los Angeles (USA) . . . . . [9048-29]

5:20 pm: **Pattern fidelity verification for logic design in EUV lithography**, Minoru Sugawara, Sony Corp. (Japan); Eric Hendrickx, Vicky Philipsen, IMEC (Belgium); Chris Maloney, Mentor Graphics Corp. (USA). . . . . [9048-30]

5:40 pm: **EUV OPC modeling and correction requirements**, Tamer H. Coskun, Thomas I. Wallow, GLOBALFOUNDRIES Inc. (USA); Gek Soon Chua, GLOBALFOUNDRIES Singapore (Singapore); Keith P. Standiford, Craig D. Higgins, Yi Zou, GLOBALFOUNDRIES Inc. (USA) . . . . . [9048-31]

Conference 9049

Alternative Lithographic Technologies VI

Session 6
Location: Conv. Ctr. 220A
Tue 3:40 pm to 5:00 pm

Beam Lithography

Session Chairs: **William M. Tong,** KLA-Tencor Corp. (USA); **Ines A. Stolberg,** Vistec Electron Beam GmbH (Germany)

3:40 pm: **Size and shape control of sub-20nm patterns fabricated using focused electron-beam induced processing**, Cornelis W. Hagen, Jules C. van Oven, Sangeetha Hari, Frans Berwald, Technische Univ. Delft (Netherlands); Karl K. Berggren, Massachusetts Institute of Technology (USA); Pieter Kruit, Technische Univ. Delft (Netherlands) . . . . . .[9049-21]

4:00 pm: **The next-generation proton beam writing**, Yong Yao, Jeroen A. Jeroen, National Univ. of Singapore (Singapore) . . . .[9049-22]

4:20 pm: **Increased throughput, determined by a suite of benchmark patterns, in a Gaussian electron-beam lithography tool with a 100 MHz writing rate**, James H. Smith II, Nigel C. E. Crosland, Samuel K. Doran, Robert C. Dowling Jr., Vistec Lithography, Inc. (USA); John G. Hartley, Univ. at Albany (USA); Philip C. Hoyle, David M. P. King, Vistec Lithography, Inc. (United Kingdom); Lawrence Kutcher Jr., Vistec Lithography, Inc. (USA); Andrew McClelland, Cambeam Systems Design Services, Ltd. (United Kingdom); Martin Turnidge, Vistec Lithography, Inc. (USA) . . . . . .[9049-23]

4:40 pm: **Impact of model inaccuracy on patterning in electron-beam lithography**, Cheng-Hung Chen, Tsung-Chih Chien, Pei-Yi Liu, Wen-Chuan Wang, Jaw-Jung Shin, Shy-Jay Lin, Burn J. Lin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . .[9049-24]

Panel Discussion on Alternative Forms of Scaling
Location: Conv. Ctr. 220A
Tue 5:15 pm to 7:00 pm

Moderators: **Christopher Bencher,** Applied Materials, Inc.; **H.-S. Philip Wong,** Stanford Univ.

Panelists: **Johann Alsmeier,** SanDisk Corp.; **Liam Madden,** Xilinx Inc.; **Kunal Parekh,** Micron Technology, Inc.; **Michael Van Buskirk,** Adesto Technologies, Inc.

The options for next generation lithography and alternative patterning techniques have been thoroughly debated within our lithography conferences and communities. Orthogonal to these 2D scaling efforts, several new device architectures have been developed which offer the potential to supplement planar scaling using 3D methods.

3D NAND is coming to market as an alternative to planar NAND and potentially displace quad-patterning requirements in one market segment. Re-RAM is another developing 3D-compatible memory device with potential to affect patterning requirements further upstream in the memory hierarchy. DRAM has seen the emergence of 3D die-stacking as a means to supplement planar scaling in high performance DRAM applications. FPGA makers have come-to-market with heterogeneous 2.5D and 3D solutions for high performance programmable logic applications.

This panel is assembled to discuss the technical and economic merits of these new device architectures, and their potential influence to the needs and requirements for alternative lithography.

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 7
Location: Conv. Ctr. 220B
Tue 3:40 pm to 5:00 pm

Metrology for Process Control

Session Chairs: **Costas J. Spanos,** Univ. of California, Berkeley (USA); **Alexander Starikov,** I&I Consulting (USA)

3:40 pm: **Estimating pattern sensitivity to the printing process for varying dose/focus conditions for RET development in the sub-22nm era**, Benoit Seguin, Maria Gabrani, IBM Zürich Research Lab. (Switzerland); Virginia Estellers, Ecole Polytechnique Fédérale de Lausanne (Switzerland) . . . . . [9050-24]

4:00 pm: **Lithography run-to-run control in high-mix manufacturing environment with a dynamic state estimation approach**, Mark E. Yelverton, Gaurav K. Agrawal, GLOBALFOUNDRIES Inc. (USA) . . . . . [9050-25]

4:20 pm: **Improvement of interfield CDU by using on-product focus control**, Kyeong Dong Park, Tony Park, Jong Hyun Hwang, Jinphil Choi, Young Seog Kang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of). . . . . [9050-26]

4:40 pm: **Improving on-product performance via litho-cluster control using integrated, process-robust, diffraction-based metrology fueled by computationally designed device-like targets fit for advanced technologies (including FinFet)**, Kaustuve Bhattacharyya, ASML Netherlands B.V. (Netherlands); Chih-Ming Ke, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9050-27]

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 7
Location: Conv. Ctr. 220C
Tue 4:10 pm to 5:50 pm

DSA Materials I

Session Chairs: **Ralph R. Dammel,** AZ Electronic Materials USA Corp. (USA); **Yoshio Kawai,** Shin-Etsu Chemical Co., Ltd. (Japan)

4:10 pm: **Process optimization of templated DSA flows**, Roel Gronheid, Nadia Vandenbroeck, IMEC (Belgium); Safak Sayan, Intel Corp. (Belgium); Ainhoa Romo-Negreira, Mark H. Somervell, Tokyo Electron America, Inc. (USA) . . . . . [9051-17]

4:30 pm: **An in situ hard mask block copolymer approach for the fabrication of ordered, large scale, horizontally aligned, Si nanowire arrays on Si substrate**, Tandra Ghoshal, Ramsankar Senthamaraikannan, Univ. College Cork (Ireland); Matthew T. Shaw, Intel Ireland Ltd. (Ireland); Justin D. Holmes, Michael A. Morris, Univ. College Cork (Ireland) . . . . . [9051-18]

4:50 pm: **Investigation of cross-linking poly(methyl methacrylate) as a guiding material in block copolymer directed self-assembly**, Robert Seidel, The Univ. of Chicago (USA); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9051-19]

5:10 pm: **Novel surface treatment materials for aligning block-copolymer in directed self-assembly processes**, Yasunobu Someya, Hiroyuki Wakayama, Takafumi Endo, Rikimaru Sakamoto, Nissan Chemical Industries, Ltd. (Japan) . [9051-20]

5:30 pm: **Directed self-assembly process integration: Fin patterning approaches and challenges**, Safak Sayan, IMEC (Belgium) and Intel Corp. (USA); Roel Gronheid, Min-Soo Kim, B. T. Chen, IMEC (Belgium); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Lance Williamson, The Univ. of Chicago (USA) and IMEC (Belgium) . . . . . [9051-21]

Conference 9052

Optical Microlithography XXVII

Session 4
Location: Conv. Ctr. 210C
Tue 4:00 pm to 6:00 pm

Non-IC Applications

Session Chairs: **Andreas Erdmann,** Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); **Kazuhiro Takahashi,** Canon Inc. (Japan)

4:00 pm: **Optical lithography: Enabling grey scale and binary microoptics for applications in advanced manufacturing, life sciences, defense, and communication** *(Invited Paper)*, Marc D. Himel, JENOPTIK Optical Systems GmbH (Germany); Jeremiah D. Brown, JENOPTIK Optical Systems, Inc. (USA) . . . . . [9052-13]

4:30 pm: **193nm immersion lithography for high-performance silicon photonic circuits** *(Invited Paper)*, Shankar Kumar Selvaraja, Gustaf Winroth, Sabrina Locorotondo, Gayle Murdoch, Alexey P. Milenin, Christie Delvaux, Patrick Ong, Shibnath Pathak, IMEC (Belgium); WeiQiang Xie, Univ. Gent (Belgium); Gunther Sterckx, Guy Lepage, IMEC (Belgium); Dries Van Thourhout, Wim Bogaerts, Univ. Gent (Belgium); Joris Van Campenhout, Philippe Absil, IMEC (Belgium) . . . . . [9052-14]

5:00 pm: **Lithographic process window optimization for mask aligner proximity lithography**, Reinhard Voelkel, Uwe Vogler, Arianna Bramati, SUSS MicroOptics SA (Switzerland); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Nezih Ünal, Ulrich Hofmann, GenISys GmbH (Germany); Marc Hennemeyer, Ralph Zoberbier, SUSS MicroTec Lithography GmbH (Germany); David Nguyen, Juergen Brugger, Ecole Polytechnique Fédérale de Lausanne (Switzerland) . . . . . [9052-15]

5:20 pm: **The solution to enhance i-line stepper application by improving mix and match process overlay accuracy**, Yuhei Sumiyoshi, Ryo Sasaki, Yasuo Hasegawa, Kentaro Ushiku, Hirotaka Sano, Atsushi Shigenobu, Bunsuke Takeshita, Seiya Miura, Canon Inc. (Japan) . . . . . [9052-16]

5:40 pm: **Study on built-in lens mask lithography**, Yoshihiko Hirai, Akio Misaka, Naoki Ueda, Hiroaki Kawata, Hisao Kikuta, Masaru Sasago, Osaka Prefecture Univ. (Japan) . . . . . [9052-17]

Joint Panel Discussion on The Battle for the 7nm Node: What are the Non-EUV Solutions?
Location: Conv. Ctr. 220A
Tue 7:45 pm to 9:00 pm

Session Chairs: **Will Conley,** Cymer, Inc. (USA); **Kafai Lai,** IBM Corp. (USA)

Moderators: **Will Conley,** Cymer, Inc., and **Kafai Lai,** IBM Corp.

Joint with Conferences 9050, 9051, 9052 9503, 9054

Conference 9054

Advanced Etch Technology for Nanopatterning III

Session 6
Location: San Jose Marriott Salon III
Tue 3:40 pm to 5:30 pm

Emerging Patterning Technologies (DSA and others)

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

3:40 pm: **Self-aligned double-patterning plasma etch challenges** *(Invited Paper)*, Rich Wise, John Arnold, Sivananda Kanakasabapathy, Massud Aminpur, IBM Corp. (USA) . . . . . [9054-20]

4:10 pm: **A comparison of the pattern transfer of line-space patterns from graphoepitaxial and chemoepitaxial block co-polymer directed self-assembly** *(Invited Paper)*, Dan B. Millward, Gurpreet Lugani, Ranjan Khuran, Scott L. Light, Micron Technology, Inc. (USA); Ardavan Niroomand, Micron Technology, Inc. (Belgium); Philip D. Hustad, Peter Trefonas, Shih-Wei Chang, Dow Electronic Materials (USA); Christopher N. Lee, The Dow Chemical Co. (USA); Dung Quach, Dow Electronic Materials (USA) . . . . . [9054-21]

4:40 pm: **Fabrication of large arrays of sub-10nm features for bit-patterned media** *(Invited Paper)*, He Gao, Lei Wan, Jeffrey Lille, Kanayalal C. Patel, Yves-Andre Chapuis, Tsai-Wei Wu, Alexei L. Bogdanov, Ricardo Ruiz, Thomas R. Albrecht, HGST (USA) . . . . . [9054-22]

5:10 pm: **Directed self-assembly of PS-b-PDMS into 193nm photoresist patterns and transfer etching**, Marc Zelsmann, CEA-LETI (France); Sophie Archambault, Mathieu Salaun, Cécile Girardot, CEA Grenoble (France); Michael Delalande, Lab. des Technologies de la Microélectronique (France); Gilles Cunge, LTM CNRS (France); Erwine Pargon, CEA-LETI (France); Olivier Joubert, LTM CNRS (France) . . . . . [9054-23]

Conference End.

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

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

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

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

EUV source modeling, Subodh Kulkarni, Igor E. Golovkin, Joseph J. MacFarlane, Prism Computational Sciences, Inc. (USA) . . . . . [9048-63]

A study of the effect of pellicle-support structures on aerial-image quality in EUV lithography by rigorous electromagnetic simulation, Michael S. Yeung, Fastlitho Inc. (USA); Eytan Barouch, Boston Univ. (USA); Hye-Keun Oh, Hanyang Univ. (Korea, Republic of) . . . . . [9048-64]

Emission properties of tin droplets laser-produced-plasma light sources, Hong Chen, Xinbing Wang, Haihong Zhu, Wuhan National Lab. for Optoelectronics (China) . . . . . [9048-66]

Design and synthesis of novel resist materials for EUVL, V. S. V. Satyanarayana, Vikram Singh, Subrata Ghosh, Satinder K. Sharma, Indian Institute of Technology Mandi (India); Kenneth E. Gonsalves, The Univ. of North Carolina at Charlotte (USA) and Indian Institute of Technology Mandi (India) . . . . . [9048-67]

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Alternative Lithographic Technologies VI

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Using chemoepitaxial directed self-assembly for repair and frequency multiplication of EUVL contact-hole patterns, Arjun Singh, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Boon Teik Chan, Roel Gronheid, IMEC (Belgium) . . . . . [9049-88]

Effects of surface characteristics of geometrically confined prepatterns on contact-hole patterning using directed self-assembly lithography, Sungwook Hwang, Soon Mok Ha, Joon-Soo Park, Suk-woo Nam, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . [9049-89]

Creation of chemical guiding patterns for directed self-assembly of block co-polymers by AFM lithography, Francesc X. Pérez-Murano, Marta Fernandez-Regúlez, Laura Evangelio, Ctr. Nacional de Microelectrónica (Spain); Jordi Fraxedas, Institut Català de Nanotecnologia (Spain) . . . . . [9049-90]

Scanner effects on directed self-assembly patterning, Stephen P. Renwick, Nikon Research Corp. of America (USA) . . . . . [9049-91]

Via layer DSA hot spot removal through local rerouting, Yuelin Du, Zigang Xiao, Martin D. F. Wong, Univ. of Illinois at Urbana-Champaign (USA); He Yi, H. S. Philip Wong, Stanford Univ. (USA) . . . . . [9049-92]

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

Pattern density multiplication using block copolymer directed self-assembly via chemoepitaxy without traditional pinning stripes, Benjamin Nation, Andrew J. Peters, Richard A. Lawson, Peter J. Ludovice, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . [9049-93]

Multiscale DSA simulations for efficient hotspot analysis, Yoshihiro Hori, Kenji Yoshimoto, Kyoto Univ. (Japan) . . . . . [9049-94]

Achieving sub-10nm half-pitch structures by directed assembly of PS-b-PLA diblock copolymer thin films, Xiao Li, Changchun Institute of Applied Chemistry (China) and The Univ. of Chicago (USA); Yadong Liu, Xiaosa Zhang, Changchun Institute of Applied Chemistry (China); Lei Wan, HGST (USA); Paul F. Nealey, The Univ. of Chicago (USA); Shengxiang Ji, Changchun Institute of Applied Chemistry (China). . . . . [9049-95]

The formation of novel conformal self-assembly (DSA) for via pattern forming, Kuan Hsin Lo, Ching-Yu Chang, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9049-96]

Development of fast DSA simulation method using OCTA system, Hiroshi Morita, National Institute of Advanced Industrial Science and Technology (Japan) . . . . . [9049-97]

Design rules for directed-assembly of block copolymer films using topcoats, Hyo Seon Suh, The Univ. of Chicago (USA); Abelardo Ramírez-Hernández, The Univ. of Chicago (USA) and Argonne National Lab. (USA); Jeong In Lee, The Univ. of Chicago (USA); Kouhei Aida, Yasuhiko Tada, Hiroshi Yoshida, Hitachi Research Lab. (Japan); Lei Wan, Ricardo Ruiz, HGST (USA); Yoshihito Ishida, Kanagawa Univ. (Japan); Wei Chen, Argonne National Lab. (USA); Juan J. de Pablo, Paul F. Nealey, The Univ. of Chicago (USA) and Argonne National Lab. (USA) . . . . . [9049-98]

Investigation of the resist outgassing and hydrocarbonaceous contamination induced for multi-electron-beam lithography tools, Armel-Petit Mebiene-Engohang, Marie-Line Pourteau, Jean-Christophe Marusic, Philippe Michallon, Sylviane Cêtre, Laurent Pain, CEA-LETI-Minatec (France); Miyake Akira, Takahiro Nakayama, Canon Inc. (Japan); Marc Smits, MAPPER Lithography (Netherlands); Jumana Boussey-Said, CEA-LETI-Minatec (France) . . . . . [9049-100]

Conference 9052

Optical Microlithography XXVII

Image Control

Estimation of 1D proximity budget impacts due to light source for 40nm half-pitch node and next advanced node, Simon Hsieh, Cymer Southeast Asia, Ltd. (Taiwan); Jui-Chun Peng, Tung-Li Wu, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); Ivan Lalovic, Omar Zurita, Cymer, Inc. (USA) . . . . . [9052-54]

In-situ aberration measurement method using a phase-shift ring mask, Sikun Li, Xiangzhao Wang, Jishuo Yang, Feng Tang, Guanyong Yan, Shanghai Institute of Optics and Fine Mechanics (China); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) . . . . . [9052-55]

Design for feature size reduction and depth of focus improvement of optical lithography, Qiang Song, Jing Zhu, Huijie Huang, Baoxi Yang, Shanghai Institute of Optics and Fine Mechanics (China) . . . . . [9052-56]

A defocus measurement method for an in-situ aberration measurement method using a phase-shift ring mask, Sikun Li, Jishuo Yang, Xiangzhao Wang, Feng Tang, Guanyong Yan, Shanghai Institute of Optics and Fine Mechanics (China); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) . . . . . [9052-57]

Alternative lithographic methods for variable aspect ratio vias, Anthony R. Schepis, Bruce W. Smith, Rochester Institute of Technology (USA) . . . . . [9052-58]

Process window enhancement using advanced RET techniques for 20nm contact layer, Yang Y. Ping, Sarah McGowan, GLOBALFOUNDRIES Inc. (USA); Ying Gong, Yee Mei Foong, GLOBALFOUNDRIES Singapore (Singapore); Jianhong Qiu, Vincent Shu, Bo Yan, Jun Ye, Taksh Pandey, Chris Aquino, Stanislas Baron, Sanjay Kapasi, Brion Technologies, Inc. (USA). . . [9052-59]

The mitigation of mask roughness via pupil plane filtering for interference-like lithography, Burak Baylav, Chris Maloney, Zach Levinson, Rochester Institute of Technology (USA); Joost P. Bekaert, Alessandro V. Pret, IMEC (Belgium); Bruce W. Smith, Rochester Institute of Technology (USA) . [9052-60]

Multiple Patterning

Understanding the critical challenges of self-aligned octuple patterning, Ji Yu, Jun You, Yijian Chen, Peking Univ. (China) . . . . . [9052-61]

An edge-placement yield model for self-aligned multiple patterning, Pan Zhang, Yijian Chen, Peking Univ. (China) . . . . . [9052-62]

Dual-photoresist complimentary lithography applied to sapphire substrate for submicro patterning, Donyau Chiang, Chun-Ming Chang, Shih-Feng Tseng, Chao-Te Lee, Instrument Technology Research Ctr. (Taiwan); Jer-Liang A. Yeh, Instrument Technology Research Ctr. (Taiwan) and National Tsing Hua Univ. (Taiwan) . . . [9052-63]

Non-IC Applications

TCO less dye sensitized solar cell lithographic methods for injecting the electrolyte, Hyun Chul Ki, Hyang Yoon Jung, Seon Hoon Kim, Doo-Gun Kim, Tae Un Kim, Korea Photonics Technology Institute (Korea, Republic of). . . . . [9052-65]

Portable UV-LED exposure system for low-cost photolithography, Ilyas Farhat, Murat Kaya Yapici, Khalifa Univ. of Science, Technology and Research (United Arab Emirates) . . . . . [9052-66]

Micro-optics: Enabling technology for illumination shaping in optical lithography, Reinhard Voelkel, SUSS MicroOptics SA (Switzerland) . . . . . [9052-67]

OPC Algorithms

Feasibility study of production by full-chip application of model-based mask data preparation, Katsuya Hayano, Takashi Adachi, Ayako Tani, Hideyoshi Takamizawa, Dai Nippon Printing Co., Ltd. (Japan); Shohei Matsushita, Daisuke Hara, Masahiro Tateishi, D2S K.K. (Japan); Aki Fujimura, D2S, Inc. (USA) . . . . . [9052-68]

Model-based pattern dummy generation for logic devices, Jongwon Jang, SK Hynix, Inc. (Korea, Republic of). . . . . [9052-70]

Adaptive OPC approach based on pattern grouping algorithm, Cheming Hu, Chung-Te Hsuan, show Hsieh, Fred Lo, Elvis Yang, D.H Yang, K.C Chen, C.Y Lu, Macronix International Co., Ltd. (Taiwan) . . . . . [9052-71]

Study of the pattern aware OPC, Shin-Shing Yeh, Powerchip Technology Corp. (Taiwan); James R. Chen, Cadence Design Systems, Inc. (Taiwan) . . . . . [9052-72]

OPC Verification

The advanced verification methodology for OPC model via distance calculation in 3D image parameter space (DC-3D-IPS), Jungkee Choi, Yong-Jin Chun, Sukjoo Lee, Byung-Il Choi, Jahum Ku, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9052-73]

Full-chip model-based OPC verification by using rigorous model, Dong-ho Kong, SK Hynix, Inc. (Korea, Republic of). . . . . [9052-74]

OPC Modeling

Effect of mask 3D and scanner focus difference on OPC modeling and verification, GuoXiang Ning, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Yong Wah Cheng, GLOBALFOUNDRIES Singapore (Singapore); Sergey Kropinov, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Lloyd C. Litt, Paul W. Ackmann, GLOBALFOUNDRIES Inc. (USA); Yee Mei Foong, GLOBALFOUNDRIES Singapore (Singapore). . . . . [9052-75]

Combining lithography and etch models in OPC modeling, Lena V. Zavyalova, Synopsys, Inc. (USA); Lan Luan, Synposys, Inc. (USA); Hua Song, Synopsys, Inc. (USA); Thomas Schmoeller, Synopsys GmbH (Germany); James P. Shiely, Synopsys, Inc. (USA). . . . . [9052-76]

Fast rigorous modeling applied to wafer topography effects for optical proximity correction, Jean-Christophe Michel, STMicroelectronics (France) and Lab. Hubert Curien (France); Jean-Christophe Le Denmat, STMicroelectronics (France); Alexandre V. Tishchenko, Yves Jourlin, Lab. Hubert Curien (France) . . . . . [9052-77]

Bringing SEM-contour based OPC to production, Francois Weisbuch, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Kar Kit Koh, GLOBALFOUNDRIES Singapore (Singapore); Kenneth Jantzen, Mentor Graphics Corp. (USA) . . . . . [9052-78]

A stochastic approach to SRAF printing prediction, Andrey Lutich, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany) . . . . . [9052-79]

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The benefit of mask written by model-based mask database preparation (MB-MDP) on advanced node, Chain Ting Huang, United Microelectronics Corp. (Taiwan) . . . . . [9052-80]

Resist toploss modeling for OPC applications, Christian D. Zuniga, Yunfei Deng, Mentor Graphics Corp. (USA) . . . . . [9052-81]

Process Control

Improving on-wafer CD correlation analysis using advanced diagnostics and across-wafer light-source monitoring, Paolo Alagna, Cymer, Inc. (Belgium); Omar Zurita, Gregory Rechtsteiner, Ivan Lalovic, Cymer, Inc. (USA); Joost P. Bekaert, IMEC (Belgium) . . . . . [9052-82]

Study on abnormal intra-field CD uniformity induced by Efese-tilt application upon complex leveling scheme, Guogui Deng, Jingan Hao, Boxiu S. Cai, Bin Xing, Xin Yao, Qiang Zhang, Tianhui Li, Yi-Shih Lin, Qiang Wu, Xuelong Shi, Semiconductor Manufacturing International Corp. (China) [9052-83]

Pattern environment impact on wafer of metal layers with high-NA process on advanced node, Chain Ting Huang, United Microelectronics Corp. (Taiwan) . . . . . [9052-84]

Simulation

Closing the loop in lithography simulation by adding capabilities for accurate modeling of SEM, Sergey Babin, Sergey S. Borisov, abeam Technologies, Inc. (USA) . . . . . [9052-85]

SMO

Effective simulation for robust inverse lithography using convolution-variation separation method, Wen Lv, Shiyuan Liu, Xinjiang Zhou, Haiqing Wei, Huazhong Univ. of Science and Technology (China) . . . . . [9052-86]

Proteus inverse lithography technology: ILT where it is needed, Mindy Lee, Guangming Xiao, Kevin Lucas, Synopsys, Inc. (USA); Woo J. Sim, Ho Sun Cha, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9052-87]

Toolings

Technology for monitoring shot-level light source performance data to achieve high-optimization of lithography processes, Masato Moriya, Hideyuki Ochiai, Yoshinobu Watabe, Keisuke Ishida, Hiroyuki Masuda, Youichi Sasaki, Takahito Kumazaki, Akihiko Kurosu, Takeshi Ohta, Kouji Kakizaki, Takashi Matsunaga, Hakaru Mizoguchi, Gigaphoton Inc. (Japan) . . . . . [9052-88]

A temperature control algorithm of immersion liquid for immersion lithography, Junwei He, Xiaoping Li, Min Lei, Bing Chen, Jinchun Wang, Huazhong Univ. of Science and Technology (China) . . . . . [9052-89]

Novel wafer stepper with violet LED light source, Shyi-Long Shy, National Nano Device Labs. (Taiwan) . . . . . [9052-90]

Illumination system without scanning slit for lithographic tools, Yunbo Zhang, Aijun Zeng, Ying Wang, Mingxing Chen, Shanhua Zhang, Qiao Yuan, Huijie Huang, Shanghai Institute of Optics and Fine Mechanics (China) . . . . . [9052-91]

Glass ceramic ZERODUR(R) enabling nanometer precision, Thomas Westerhoff, Ralf Jedamzik, Johannes Nieder, Clemens Kunisch, SCHOTT AG (Germany) . . . . . [9052-92]

Improvements in energy timing control (ETC) for XLR 660xi systems, Will Conley, Josh Thrones, Kevin O'Brien, Alicia Russin, Hoang Dao, John Wyman, David Dunlap, Cymer, Inc. (USA) [9052-93]

New technologies enable green manufacturing, Hitomi Fukuda, Tatsuo Enami, Yuji Minegishi, Young Sun Yoo, Naoto Hisanaga, Gigaphoton Inc. (Japan) . . . . . [9052-94]

Conference 9054

Advanced Etch Technology for Nanopatterning III

Litho-resist rework influences on Cu metal layer patterning with TiN-hardmask, Marcus Dankelmann, Markus Czekalla, Heiko Estel, Jens Hahn, Bee-Kim Hong, Mario Lamm, Eric Neubert, Michael Renner, Rainer Scheibel, Maik Stegemann, Jens Schneider, Infineon Technologies Dresden (Germany) . . . . . [9054-24]

Spin on carbon using fullerene derivatives, Andreas Frommhold, The Univ. of Birmingham (United Kingdom); Alan G. Brown, Irresistible Materials Ltd. (United Kingdom); Tom Lada, Nano-C, Inc. (USA); Richard E. Palmer, Alex P. G. Robinson, The Univ. of Birmingham (United Kingdom) . . . . . [9054-25]

Dual-frequency mid-gap capacitively coupled plasma (CCP) for conventional and DSA patterning at 10nm node and beyond, Nihar R. Mohanty, Akiteru Ko, Christopher Cole, Vinayak Rastogi, Kaushik Kumar, TEL Technology Ctr., America, LLC (USA); Gerard Schmid, Richard A. Farrell, Ji Xu, Moshe Preil, GLOBALFOUNDRIES Inc. (USA). . . . . [9054-27]

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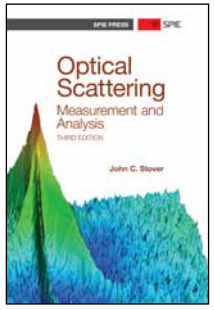

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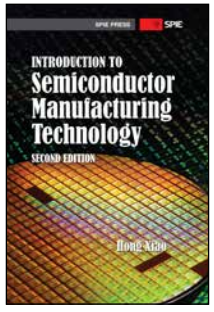

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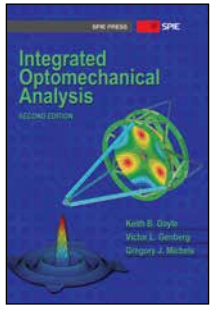

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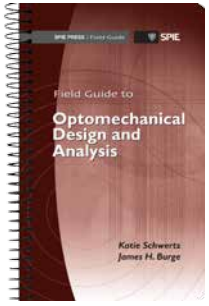

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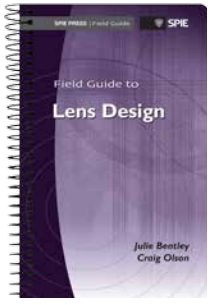

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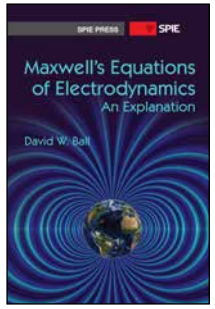

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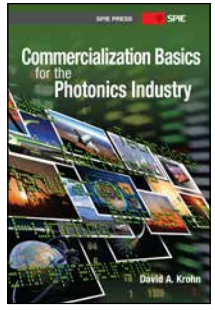

Commercialization Basics for the Photonics Industry

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Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 8
Location: Conv. Ctr. 210B
Wed 8:00 am to 10:10 am

EUV Mask Metrology

Session Chairs: **Ted Liang,** Intel Corp. (USA); **Jan Hendrik Peters,** Carl Zeiss SMS GmbH (Germany)

8:00 am: **Actinic review of EUV masks: First results from the AIMS™ EUV system integration** *(Invited Paper)*, Dirk Hellweg, Markus R. Weiss, Carl Zeiss SMT GmbH (Germany); Jan Hendrik Peters, Sascha Perlitz, Anthony D. Garetto, Carl Zeiss SMS GmbH (Germany); Michael Goldstein, SEMATECH Inc. (USA). . . . . [9048-32]

8:30 am: **Actinic mask imaging: Recent results and future directions from the SHARP EUV Microscope**, Kenneth A. Goldberg, Markus P. Benk, Iacopo Mochi, Lawrence Berkeley National Lab. (USA) . . . . . [9048-33]

8:50 am: **EUV patterned mask inspection with an advanced projection electron microscope (PEM) system**, Ryoichi Hirano, Susumu Iida, Tsuyoshi Amano, Tsuneo Terasawa, Hidehiro Watanabe, EUVL Infrastructure Development Ctr., Inc. (Japan); Masahiro Hatakeyama, Takeshi Murakami, Kenji Terao, EBARA Corp. (Japan). . . . . [9048-34]

9:10 am: **Novel zone plate design for EUV mask inspection**, Yow-Gwo Wang, Univ. of California, Berkeley (USA) and Lawrence Berkeley National Lab. (USA); Ryan H. Miyakawa, Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Univ. of California, Berkeley (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA) . . [9048-35]

9:30 am: **A novel concept for actinic mask inspection method using ptychography at the Swiss Light Source**, Sangsul Lee, Manuel Guizar-Sicairos, Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . . [9048-36]

9:50 am: **E-beam inspection of EUV mask defects: To etch or not to etch?**, Ravi K. Bonam, Scott D. Halle, IBM Corp. (USA); Fei Wang, Hermes-Microvision Inc., USA (USA) . . . . . [9048-37]

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

Conference 9049

Alternative Lithographic Technologies VI

Session 7
Location: Conv. Ctr. 220A
Wed 8:00 am to 10:10 am

DSA Materials and Processes I: Joint Session with Conferences 9049 and 9051

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

8:00 am: **High-volume manufacturing equipment and processing for directed self-assembly applications** *(Invited Paper)*, Mark H. Somervell, Benjamen M. Rathsack, Tokyo Electron America, Inc. (USA); Takashi Yamauchi, Shinchiro Kawakami, Soichiro Okada, Tadatoshi Tomita, Tokyo Electron Kyushu Ltd. (Japan); Takanori Nishi, Tokyo Electron America, Inc. (USA); Makoto Muramatsu, Tokyo Electron Kyushu Ltd. (Japan); Etsuo Iijima, Tokyo Electron Miyagi Ltd. (Japan); Takeo Nakano, Takumi Ishiguro, Seiji Nagahara, Hiroyuki Iwaki, Tokyo Electron Ltd. (Japan); Makiko Dojun, Tokyo Electron Kyushu Ltd. (Japan); Mariko Ozawa, Tokyo Electron Ltd. (Japan); Ainhoa Romo-Negreira, Tokyo Electron Ltd. (Belgium); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Kathleen Nafus, Tokyo Electron Ltd. (Belgium); Jean-Luc Peyre, Tokyo Electron Europe Ltd. (France); Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan). . . . . [9051-22]

8:30 am: **Improvements of self-assembly properties thanks to homopolymer addition or block-copolymer blends**, Xavier Chevalier, Célia Nicolet, Arkema S.A. (France); Raluca Tiron, Ahmed Gharbi, CEA-LETI-Minatec (France); Maxime Argoud, CEA-LETI (France); Christophe Couderc, CEA-LETI-Minatec (France); Guillaume Fleury, Georges Hadziioannou, Univ. Bordeaux 1 (France); Ilias Iliopoulos, Christophe Navarro, Arkema S.A. (France) . . . . . [9049-25]

8:50 am: **300mm wafer performance characterization of the SMART™ directed self-assembly**, Jihoon Kim, Jingxiu Wan, AZ Electronic Materials USA Corp. (USA); Shinji Miyazaki, AZ Electronic Materials (Japan) K.K. (Japan); Yi Cao, AZ Electronic Materials USA Corp. (USA); YoungJun Her, AZ Electronic Materials Ltd. (Korea, Republic of); Hengpeng Wu, Jianhui Shan, Guanyang Lin, AZ Electronic Materials USA Corp. (USA) . . . . . [9049-26]

9:10 am: **Extending the scope of polystyrene-block-polymethyl methacrylate in directed self-assembly**, Thomas Bennett, Kevin S. Jack, The Univ. of Queensland (Australia); Kristofer J. Thurecht, The Australian Institute for Bioengineering and Nanotechnology (Australia); Idriss Blakey, The Univ. of Queensland (Australia)[9049-27]

9:30 am: **Simulation study of the effect of differences in block energy and density on the self-assembly of block copolymers**, Richard A. Lawson, Andrew J. Peters, Benjamin Nation, Peter J. Ludovice, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9049-28]

9:50 am: **Directed self-assembly of block copolymers under graphoepitaxial confinement**, Mingqi Li, Dung Quach, Dow Electronic Materials (USA); Jong-Keun Park, Dow Advanced Materials (USA); Jeffrey D. Weinhold, Valeriy V. Ginzburg, The Dow Chemical Co. (USA); Peter Trefonas III, Phillip D. Hustad, Dow Electronic Materials (USA); Dan B. Millward, Ranjan Khurana, Gurpreet Lugani, Scott L. Light, Micron Technology, Inc. (USA). . . . . [9049-29]

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

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 8
Location: Conv. Ctr. 220B
Wed 8:00 am to 10:00 am

SEM, AFM, and SPM

Session Chairs: **Masafumi Asano,** Toshiba Corp. (Japan); **Shunsuke Koshihara,** Hitachi High-Technologies Corp. (Japan)

8:00 am: **CD-SEM metrology for sub-10nm width features**, Benjamin D. Bunday, Aron J. Cepler, Abraham Arceo, Aaron Cordes, SEMATECH Inc. (USA) . . . . . [9050-28]

8:20 am: **Improving SEM image quality using pixel superresolution technique**, Myungjun Lee, Jason R. Cantone, Ji Xu, Lei Sun, Ryoung-Han Kim, GLOBALFOUNDRIES Inc. (USA) . . . . . [9050-29]

8:40 am: **Contour-based metrology for complex 2D shaped patterns printed by multiple-patterning process**, Daisuke Fuchimoto, Toru Ishimoto, Hiroyuki Shindo, Hitoshi Sugahara, Hitachi High-Technologies Corp. (Japan); Yasutaka Toyoda, Hitachi, Ltd. (Japan); Julien Mailfert, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Peter De Bisschop, IMEC (Belgium) . . . [9050-30]

9:00 am: **Parallel SPM cantilever arrays for large-area surface metrology and lithography**, Teodor P. Gotszalk, Wroclaw Univ. of Technology (Poland); Ivo W. Rangelow, Tzvetan Ivanow, Technische Univ. Ilmenau (Germany) . . . . . [9050-31]

9:20 am: **In-situ defect classification by AFM-based nanomechanical measurement**, Aaron Cordes, Jenah Harris-Jones, SEMATECH Inc. (USA); Sean Hand, Bruker Nano Inc. (USA) . . . . . [9050-32]

9:40 am: **The pattern wiggling metrology using CD-SEM**, Changhwan Lee, SK Hynix, Inc. (Korea, Republic of) . . . . [9050-121]

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

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 8
Location: Conv. Ctr. 220A
Wed 8:00 am to 10:10 am

DSA Materials and Processes I: Joint Session with Conferences 9049 and 9051

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

8:00 am: **High-volume manufacturing equipment and processing for directed self-assembly applications** *(Invited Paper)*, Mark H. Somervell, Benjamen M. Rathsack, Tokyo Electron America, Inc. (USA); Takashi Yamauchi, Shinchiro Kawakami, Soichiro Okada, Tadatoshi Tomita, Tokyo Electron Kyushu Ltd. (Japan); Takanori Nishi, Tokyo Electron America, Inc. (USA); Makoto Muramatsu, Tokyo Electron Kyushu Ltd. (Japan); Etsuo Iijima, Tokyo Electron Miyagi Ltd. (Japan); Takeo Nakano, Takumi Ishiguro, Seiji Nagahara, Hiroyuki Iwaki, Tokyo Electron Ltd. (Japan); Makiko Dojun, Tokyo Electron Kyushu Ltd. (Japan); Mariko Ozawa, Tokyo Electron Ltd. (Japan); Ainhoa Romo-Negreira, Tokyo Electron Ltd. (Belgium); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Kathleen Nafus, Tokyo Electron Ltd. (Belgium); Jean-Luc Peyre, Tokyo Electron Europe Ltd. (France); Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan). . . . . [9051-22]

8:30 am: **Improvements of self-assembly properties thanks to homopolymer addition or block-copolymer blends**, Xavier Chevalier, Célia Nicolet, Arkema S.A. (France); Raluca Tiron, Ahmed Gharbi, CEA-LETI-Minatec (France); Maxime Argoud, CEA-LETI (France); Christophe Couderc, CEA-LETI-Minatec (France); Guillaume Fleury, Georges Hadziioannou, Univ. Bordeaux 1 (France); Ilias Iliopoulos, Christophe Navarro, Arkema S.A. (France) . . . . . [9049-25]

8:50 am: **300mm wafer performance characterization of the SMART™ directed self-assembly**, Jihoon Kim, Jingxiu Wan, AZ Electronic Materials USA Corp. (USA); Shinji Miyazaki, AZ Electronic Materials (Japan) K.K. (Japan); Yi Cao, AZ Electronic Materials USA Corp. (USA); YoungJun Her, AZ Electronic Materials Ltd. (Korea, Republic of); Hengpeng Wu, Jianhui Shan, Guanyang Lin, AZ Electronic Materials USA Corp. (USA) . . . . . [9049-26]

9:10 am: **Extending the scope of polystyrene-block-polymethyl methacrylate in directed self-assembly**, Thomas Bennett, Kevin S. Jack, The Univ. of Queensland (Australia); Kristofer J. Thurecht, The Australian Institute for Bioengineering and Nanotechnology (Australia); Idriss Blakey, The Univ. of Queensland (Australia)[9049-27]

9:30 am: **Simulation study of the effect of differences in block energy and density on the self-assembly of block copolymers**, Richard A. Lawson, Andrew J. Peters, Benjamin Nation, Peter J. Ludovice, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9049-28]

9:50 am: **Directed self-assembly of block copolymers under graphoepitaxial confinement**, Mingqi Li, Dung Quach, Dow Electronic Materials (USA); Jong-Keun Park, Dow Advanced Materials (USA); Jeffrey D. Weinhold, Valeriy V. Ginzburg, The Dow Chemical Co. (USA); Peter Trefonas III, Phillip D. Hustad, Dow Electronic Materials (USA); Dan B. Millward, Ranjan Khurana, Gurpreet Lugani, Scott L. Light, Micron Technology, Inc. (USA) . . . . . [9049-29]

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

Conference 9052

Optical Microlithography XXVII

Session 5
Location: Conv. Ctr. 210C
Wed 8:20 am to 10:00 am

OPC Algorithms

Session Chairs: **Sachiko Kobayashi,** Toshiba Corp. (Japan); **Xuelong Shi,** Semiconductor Manufacturing International Corp. (China)

8:20 am: **Automated sample plan selection for OPC modeling**, Nathalie Casati, Maria Gabrani, IBM Zürich Research Lab. (Switzerland); Ramya Viswanathan, IBM India Private Ltd. (India); Zikri Bayraktar, IBM Corp. (USA); David L. DeMaris, IBM Austin Research Lab. (USA); Amr Y. Abdo, James Oberschmidt, IBM Corp. (USA); Rainer Andreas Krause, ETH Zürich (Switzerland) . . . . . .[9052-18]

8:40 am: **Manufacturable conversion for freeform mask patterns using eigen-direction transformation**, Jue-Chin Yu, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . .[9052-19]

9:00 am: **Decreased shot count from shot overlapping and model-based fracturing for edge-based OPC layouts**, Shangliang Jiang, Avideh Zakhor, Univ. of California, Berkeley (USA).[9052-20]

9:20 am: **11nm logic optical lithography with OPC-lite**, Michael C. Smayling, Tela Innovations, Inc. (USA); Koichiro Tsujita, Canon Inc. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan); Valery Axelrad, Sequoia Design Systems, Inc. (USA); Ryo Nakayama, Canon Inc. (Japan); Kenichi Oyama, Arisa Hara, Tokyo Electron AT Ltd. (Japan) . . . . .[9052-21]

9:40 am: **Model-based OPC using the MEEF matrix II**, Le Hong, J. J. Lei, George Lippincott, James Word, Mentor Graphics Corp. (USA) . . . . . .[9052-22]

Coffee Break . . . . . Wed 10:00 am to 10:20 am

Conference 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

Session 1
Location: San Jose Marriott Salon III
Wed 8:00 am to 10:10 am

Patterns in DTCO

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

8:00 am: **Lithography-induced limits to scaling of design quality** *(Invited Paper)*, Andrew B. Kahng, Univ. of California, San Diego (USA) . . . . . [9053-1]

8:30 am: **A pattern-driven design regularization methodology**, Jason P. Cain, Norma P. Rodriguez, Advanced Micro Devices, Inc. (USA); Jason Sweis, Frank E. Gennari, Ya-Chieh Lai, Cadence Design Systems, Inc. (USA). . . . . [9053-2]

8:50 am: **Systematic physical verification with topological patterns**, Vito Dai, GLOBALFOUNDRIES Inc. (USA); Ya-Chieh Lai, Frank E. Gennari, Cadence Design Systems, Inc. (USA); Edward Teoh, Luigi Capodieci, GLOBALFOUNDRIES Inc. (USA) . . [9053-3]

9:10 am: **Synthesis of lithographic test patterns through topology-oriented pattern extraction and classification**, Seong-Bo Shim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) and KAIST (Korea, Republic of); Young-soo Shin, KAIST (Korea, Republic of) . . . . . [9053-4]

9:30 am: **Systematic data mining using a pattern database to accelerate yield ramp**, Edward Teoh, Vito Dai, Luigi Capodieci, GLOBALFOUNDRIES Inc. (USA); Ya-Chieh Lai, Frank E. Gennari, Cadence Design Systems, Inc. (USA) . . . . . [9053-5]

9:50 am: **Layout pattern-driven design rule evaluation**, Yasmine A. Badr, Univ. of California, Los Angeles (USA); Ko-wei Ma, NVIDIA Corp. (USA); Puneet Gupta, Univ. of California, Los Angeles (USA) . . . . . [9053-6]

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

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 9
Location: Conv. Ctr. 210B
Wed 10:40 am to 12:00 pm

Metrology Sources and Modeling

Session Chairs: **Michael Goldstein,** SEMATECH Inc. (USA); **Anna Tchikoulaeva,** Lasertec U.S.A., Inc. Zweigniederlassung Deutschland (Germany)

10:40 am: **High-radiance LDP source for mask-inspection application**, Yusuke Teramoto, Bárbara Santos, Ushio Inc. (Germany); Felix Küpper, Fraunhofer-Institut für Lasertechnik (Germany); Takuma Yokoyama, Gota Niimi, Hironobu Yabuta, Akihisa Nagano, Masaki Yoshioka, Takahiro Shirai, Noritaka Ashizawa, Hiroto Sato, Kiyotada Nakamura, Kunihiko Kasama, Ushio Inc. (Japan) . . . . . [9048-38]

11:00 am: **Table-top EUV/soft x-ray source and wavefront measurements at short wavelengths**, Klaus Mann, Jens-Oliver Dette, Tobias Mey, Matthias Müller, Bernd Schäfer, Laser-Lab. Göttingen e.V. (Germany) . . . . . [9048-39]

11:20 am: **Three-dimensional plasma shape effects on the EUV emission distribution in laser-droplet interactions**, Andrea Z. Giovannini, Reza S. Abhari, ETH Zürich (Switzerland) . . . [9048-40]

11:40 am: **Enhancing the performance of LPP sources for EUV and BEUV lithography**, Ahmed Hassanein, Tatyana Sizyuk, Purdue Univ. (USA) . . . . . [9048-41]

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

Conference 9049

Alternative Lithographic Technologies VI

Session 8
Location: Conv. Ctr. 220A
Wed 10:40 am to 12:00 pm

DSA Materials and Processes II: Joint Session with 9049 and 9051

Session Chairs: **James A. Liddle,** National Institute of Standards and Technology (USA); **Sean D. Burns,** IBM Corp. (USA)

10:40 am: **Directed self-assembly of ABA triblock copolymer on chemical contrast pattern for sub-10nm nanofabrication by solvent annealing**, Shisheng Xiong, The Univ. of Chicago (USA); Lei Wan, Yves-Andre Chapuis, Thomas R. Albrecht, Ricardo Ruiz, HGST (USA); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9049-30]

11:00 am: **Sub-10nm patterning process using directed self-assembly with high-χ block copolymers**, Naoko Kihara, Yuriko Seino, Hironobu Sato, Yusuke Kasahara, Katsutoshi Kobayashi, Ken Miyagi, Shinya Minegishi, Koichi Yatsuda, Tomoharu Fujiwara, Noriyuki Hirayanagi, Hideki Kanai, Yoshiaki Kawamonzen, Katsuyoshi Kodera, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan); Teruaki Hayakawa, Tokyo Institute of Technology (Japan) . . . . . [9049-31]

11:20 am: **Guided self-assembly of Si-containing block copolymer with a topcoat surface treatment**, Takehiro Seshimo, Yoshiyuki Utsumi, Takahiro Dazai, Takaya Maehashi, Katsumi Ohmori, Tokyo Ohka Kogyo Co., Ltd. (Japan) . . . . . [9049-32]

11:40 am: **Self-assembly of high-resolutions PS-b-PMMA block-copolymers: processes capabilities and integration on 300mm track**, Xavier Chevalier, Célia Nicolet, Arkema S.A. (France); Raluca Tiron, Jonathan Pradelles, Ahmed Gharbi, CEA-LETI-Minatec (France); Maxime Argoud, Patricia Pimenta-Barros, CEA-LETI (France); Gilles Cunges, LTM CNRS (France); Jean-Luc Peyre, Rick Van Spaandonk, Tokyo Electron Europe Ltd. (France); Guillaume Fleury, Georges Hadziioannou, Univ. Bordeaux 1 (France); Christophe Navarro, Arkema S.A. (France) . . . . . [9049-33]

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

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 9
Location: Conv. Ctr. 220B
Wed 10:30 am to 11:50 am

X-Ray Scattering Methods

Session Chairs: **John A. Allgair,** GLOBALFOUNDRIES Inc. (USA); **Richard M. Silver,** National Institute of Standards and Technology (USA)

10:30 am: **CD-SAXS comparison study of lab sources versus synchrotrons**, Daniel F. Sunday, Donald Windover, Wen-li Wu, National Institute of Standards and Technology (USA); Benjamin D. Bunday, SEMATECH Inc. (USA); R. Joseph Kline, National Institute of Standards and Technology (USA). . . . . .[9050-33]

10:50 am: **Characterization of directed self-assembly process using grazing incidence small-angle x-ray scattering**, Hyo Seon Suh, Xuanxuan Chen, The Univ. of Chicago (USA); Paulina A. Rincon Delgadillo, The Univ. of Chicago (USA) and IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Lingshu Wan, The Univ. of Chicago (USA); Jiang Zhang, Joseph Strzalka, Jin Wang, Wei Chen, Argonne National Lab. (USA); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . .[9050-34]

11:10 am: **Correlation of CD-SAXS and CD-AFM measurements for FinFET fabrication process monitoring**, Charles M. Settens, SUNY College of Nanoscale Science & Engineering (USA) and SEMATECH Inc. (USA); Aaron Cordes, SEMATECH Inc. (USA); R. Joseph Kline, National Institute of Standards and Technology (USA); Benjamin D. Bunday, SEMATECH Inc. (USA); Abner F. Bello, Vimal K. Kamineni, Abhijeet Paul, Jody Fronheiser, GLOBALFOUNDRIES Inc. (USA); Richard J. Matyi, SUNY College of Nanoscale Science & Engineering (USA) . . . . . .[9050-35]

11:30 am: **Nanometrology on gratings with GISAXS: Traceablility and FEM reconstruction**, Victor Soltwisch, Jan Wernecke, Anton Haase, Michael Krumrey, Frank Scholze, Physikalisch-Technische Bundesanstalt (Germany) . . . . . .[9050-36]

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

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 9
Location: Conv. Ctr. 220A
Wed 10:40 am to 12:00 pm

DSA Materials and Processes II: Joint Session with 9049 and 9051

Session Chairs: **James A. Liddle,** National Institute of Standards and Technology (USA); **Sean D. Burns,** IBM Corp. (USA)

10:40 am: **Directed self-assembly of ABA triblock copolymer on chemical contrast pattern for sub-10nm nanofabrication by solvent annealing**, Shisheng Xiong, The Univ. of Chicago (USA); Lei Wan, Yves-Andre Chapuis, Thomas R. Albrecht, Ricardo Ruiz, HGST (USA); Paul F. Nealey, The Univ. of Chicago (USA) [9049-30]

11:00 am: **Sub-10nm patterning process using directed self-assembly with high-χ block copolymers**, Naoko Kihara, Yuriko Seino, Hironobu Sato, Yusuke Kasahara, Katsutoshi Kobayashi, Ken Miyagi, Shinya Minegishi, Koichi Yatsuda, Tomoharu Fujiwara, Noriyuki Hirayanagi, Hideki Kanai, Yoshiaki Kawamonzen, Katsuyoshi Kodera, Tsukasa Azuma, EUVL Infrastructure Development Ctr., Inc. (Japan); Teruaki Hayakawa, Tokyo Institute of Technology (Japan) . . . . . [9049-31]

11:20 am: **Guided self-assembly of Si-containing block copolymer with a topcoat surface treatment**, Takehiro Seshimo, Yoshiyuki Utsumi, Takahiro Dazai, Takaya Maehashi, Katsumi Ohmori, Tokyo Ohka Kogyo Co., Ltd. (Japan) . . . . . [9049-32]

11:40 am: **Self-assembly of high-resolutions PS-b-PMMA block-copolymers: processes capabilities and integration on 300mm track**, Xavier Chevalier, Célia Nicolet, Arkema S.A. (France); Raluca Tiron, Jonathan Pradelles, Ahmed Gharbi, CEA-LETI-Minatec (France); Maxime Argoud, Patricia Pimenta-Barros, CEA-LETI (France); Gilles Cunges, LTM CNRS (France); Jean-Luc Peyre, Rick Van Spaandonk, Tokyo Electron Europe Ltd. (France); Guillaume Fleury, Georges Hadziioannou, Univ. Bordeaux 1 (France); Christophe Navarro, Arkema S.A. (France) . . . . . [9049-33]

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

Conference 9052

Optical Microlithography XXVII

Session 6
Location: Conv. Ctr. 210C
Wed 10:20 am to 12:20 pm

Multiple Patterning and SMO

Session Chairs: **Geert Vandenberghe,** IMEC (Belgium); **Young Seog Kang,** SAMSUNG Electronics Co., Ltd. (Korea, Republic of)

10:20 am: **Immersion lithography extension to sub-10nm nodes with multiple patterning**, Soichi Owa, Shiniji Wakamoto, Nikon Corp. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan); Kenichi Oyama, Tokyo Electron AT Ltd. (Japan). . . . . [9052-23]

10:40 am: **Hybrid lithography for triple-patterning decomposition and e-beam lithography**, Haitong Tian, Martin D. F. Wong, Univ. of Illinois at Urbana-Champaign (USA) . . . . . [9052-24]

11:00 am: **Metal1 patterning study for random-logic applications with 193i, using calibrated OPC for litho and etch**, Julien Mailfert, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Jeroen Van de Kerkhove, Werner Gillijns, Peter De Bisschop, IMEC (Belgium); Kristin De Meyer, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium) . . . . . [9052-25]

11:20 am: **Pattern fidelity in multiple-patterning process**, Masatoshi Yamato, Kenichi Oyama, Arisa Hara, Sakurako Natori, Shohei Yamauchi, Hidetami Yaegashi, Tokyo Electron Ltd. (Japan). . . . . [9052-26]

11:40 am: **Joint optimization of source, mask, and pupil in optical lithography**, Li Jia, Edmund Y. Lam, The Univ. of Hong Kong (Hong Kong, China) . . . . . [9052-27]

12:00 pm: **Efficient source polarization optimization for robust optical lithography**, Xu Ma, Jie Gao, Chunying Han, Yanqiu Li, Lisong Dong, Lihui Liu, Beijing Institute of Technology (China) . . . . . [9052-28]

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

Conference 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

Session 2
Location: San Jose Marriott Salon III
Wed 10:30 am to 12:20 pm

Multipatterning

Session Chairs: **Robert Aitken,** ARM Inc. (USA); **Vivek K. Singh,** Intel Corp. (USA)

10:30 am: **Bridging the gap from mask to physical design for multiple patterning lithography** *(Invited Paper)*, David Z. Pan, The Univ. of Texas at Austin (USA) . . . . . [9053-7]

11:00 am: **Demonstrating production quality SIT-aware routing for the 10nm node**, Lars W. Liebmann, IBM Corp. (USA); Vassilios Gerousis, Paul Gutwin, Mike Zhang, Cadence Design Systems, Inc. (USA); Brian Cline, ARM Inc. (USA); Gustavo Tellez, IBM Corp. (USA) . . . . . [9053-8]

11:20 am: **A fast triple-patterning solution with fix guidance**, Weiping Fang, Synopsys, Inc. (USA); Peter De Bisschop, IMEC (Belgium); Marco A. Hug, Srini Arikati, Erdem Cilingir, Synopsys, Inc. (USA); Julien Mailfert, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); Kevin Lukas, Synopsys, Inc. (USA); Weimin Gao, Synopsys, Inc. (Belgium) and IMEC (Belgium) . . . . . [9053-9]

11:40 am: **Benchmarking process integration and layout decomposition of directed self-assembly and self-aligned multiple patterning techniques**, Yijian Chen, Jun You, Wei Xiao, Peking Univ. (China) . . . . . [9053-10]

12:00 pm: **Self-aligned quadruple patterning-friendly routing**, Fumiharu Nakajima, Chikaaki Kodama, Toshiba Corp. (Japan); Hirotaka Ichikawa, Toshiba Microelectronics Corp. (Japan); Koichi Nakayama, Shigeki Nojima, Toshiya Kotani, Toshiba Corp. (Japan). . . . . [9053-11]

Lunch/Exhibition Break . . . . . Wed 12:20 pm to 1:30 pm

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 10
Location: Conv. Ctr. 210B
Wed 1:30 pm to 3:10 pm

EUV Resist Outgas Testing

Session Chairs: **Soichi Inoue,** EUVL Infrastructure Development Ctr., Inc. (Japan); **Kurt G. Ronse,** IMEC (Belgium)

1:30 pm: **Prediction of EUV resist outgassing**, Shu-Hao Chang, Ming-Chin Chien, Shang-Chieh Chien, TSMC Taiwan (Taiwan); Shu-Fang Chen, Brian C. Lee, Jui-Ching Wu, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); Jack J.-H. J. Chen, Anthony Yen, TSMC Taiwan (Taiwan) . . . . . [9048-42]

1:50 pm: **The influence of witness sample intensity on resist outgas testing**, Shannon B. Hill, Nadir S. Faradzhev, Robert F. Berg, Charles Tarrio, Thomas B. Lucatorto, National Institute of Standards and Technology (USA) . . . . . [9048-43]

2:10 pm: **Contribution of EUV resist components to the non-cleanable contaminations**, Eishi Shiobara, Toshiya Takahashi, Norihiko Sugie, Yukiko Kikuchi, Isamu Takagi, Kazuhiro Katayama, Hiroyuki Tanaka, Soichi Inoue, EUVL Infrastructure Development Ctr., Inc. (Japan); Tetsuro Harada, Takeo Watanabe, Hiroo Kinoshita, EUVL Infrastructure Development Ctr., Inc. (Japan) and Univ. of Hyogo (Japan) . . . . . [9048-44]

2:30 pm: **Resist outgassing contamination on EUV multilayer mirror analogues**, Gregory Denbeaux, Diego Alvarado, Yudhishthir P. Kandel, Univ. at Albany (USA); Jaewoong Sohn, Tonmoy Chakraborty, Dominic Ashworth, SEMATECH Inc. (USA). [9048-45]

2:50 pm: **Relationship between resist outgassing and witness sample contamination in NXE outgas qualification using electrons and EUV photons**, Ivan Pollentier, Ananth Tirumala Venkata, Roel Gronheid, IMEC (Belgium) . . . . . [9048-46]

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

Conference 9049

Alternative Lithographic Technologies VI

Session 9
Location: Conv. Ctr. 220A
Wed 1:30 pm to 3:20 pm

Step and Repeat UV Nanoimprint Lithography

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

1:30 pm: **Hard disk drive thin-film head manufactured using nanoimprint lithography** *(Invited Paper)*, Daniel Sullivan, Thomas R. Boonstra, Mark T. Kief, Lily H. Youtt, Sethuraman Jayashankar, Carolyn Van Dorn, Harold N. Gentile, Sriram Viswanathan, Dexin Wang, Dion Song, Dongsung Hong, Sung-Hoon Gee, Seagate Technology LLC (USA) . . . . . .[9049-34]

2:00 pm: **High-throughput jet and flash imprint lithography for advanced semiconductor memory**, Niyaz Khusnatdinov, Zhengmao Ye, Kang Luo, Timothy B. Stachowiak, Xiaoming Lu, J. W. Irving, Matt Shafran, Whitney Longsine, Van Truskett, Brian Fletcher, Weijun Liu, Frank Y. Xu, Dwayne L. LaBrake, S. V. Sreenivasan, Molecular Imprints, Inc. (USA) . . . . . .[9049-35]

2:20 pm: **The prospects of design for nanoimprint lithography: Layout refinement utilizing process simulation**, Sachiko Kobayashi, Mitsuko Shimizu, Toshiba Corp. (Japan); Satoshi Tanaka, Yohko Furutono, Toshiba Materials Co., Ltd. (Japan); Masayuki Hatano, Toshiba Corp. (Japan); Shoji Mimotogi, Toshiba Materials Co., Ltd. (Japan) . . . . . .[9049-36]

2:40 pm: **Development status of nanoimprint template quality**, Koji Ichimura, Masaaki Kurihara, Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan) . . . . . .[9049-37]

3:00 pm: **Step-and-repeat nanoimprinting on pre-spin coated film: from sub-15nm metal patterning to the fabrication of a spectrometer-on-chip**, Giuseppe Calafiore, abeam Technologies, Inc. (USA); Scott Dhuey, The Molecular Foundry (USA); Alexander Koshelev, Nano-Optic Devices (USA); Marko Volger, micro resist technology GmbH (Germany); Deirdre L. Olynick, The Molecular Foundry (USA); Alexander Goltsov, Nano-Optic Devices (USA); Stefano Cabrini, The Molecular Foundry (USA); Christophe Peroz, abeam Technologies, Inc. (USA) . . . . . .[9049-38]

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

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 10
Location: Conv. Ctr. 220B
Wed 1:20 pm to 3:00 pm

Overlay Measurement and Control: Joint Session with Conferences 9050 and 9052

Session Chairs: **Alexander Starikov,** I&I Consulting (USA); **Pary Baluswamy,** Micron Technology, Inc. (USA)

1:20 pm: **Characterization and mitigation of overlay error on silicon wafers with nonuniform stress**, Timothy A. Brunner, Vinayan C. Menon, Cheuk W. Wong, Nelson Felix, Michael B. Pike, Oleg Gluschenkov, Michael Belyansky, IBM Corp. (USA); Pradeep Vukkadala, Sathish Veeraraghavan, Jaydeep K. Sinha, KLA-Tencor Corp. (USA) . . . . . .[9052-29]

1:40 pm: **Monitoring process-induced overlay errors through high-resolution wafer geometry measurements**, Kevin T. Turner, Univ. of Pennsylvania (USA); Pradeep Vukkadala, Sathish Veeraraghavan, Jaydeep K. Sinha, KLA-Tencor Corp. (USA) . . . . . .[9050-37]

2:00 pm: **Analysis of overlay errors induced by exposure energy in negative-tone development process for photolithography**, Young Ha Kim, Jang-Sun Kim, Young-Hoon Kim, Byeong-Ok Cho, Jinphil Choi, Young Seog Kang, Hunhwan Ha, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . .[9052-30]

2:20 pm: **Investigation on reticle heating effect induced overlay error**, Mi Jung Lim, Geunhak Kim, Seo-Min Kim, Byoung-Hoon Lee, Seokkyun Kim, Chang-Moon Lim, Myoung Soo Kim, Sung-Ki Park, SK Hynix, Inc. (Korea, Republic of) . . . . . .[9050-38]

2:40 pm: **Compensating process nonuniformity to improve wafer overlay by RegC**, Philippe J. Leray, Shaunee Y. Cheng, IMEC (Belgium); Avi Cohen, Erez Graitzer, Vladimir Dmitriev, Nadav Wertsman, Carl Zeiss SMS Ltd. (Israel). . . . . .[9050-39]

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

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 10
Location: Conv. Ctr. 220C
Wed 1:30 pm to 3:30 pm

Materials and Process Fundamentals

Session Chairs: **James W. Thackeray,** Dow Electronic Materials (USA); **Qinghuang Lin,** IBM Thomas J. Watson Research Ctr. (USA)

1:30 pm: **An in-situ analysis of resist dissolution in alkali-based and organic solvent-based developers using high-speed atomic force microscopy**, Julius Joseph S. Santillan, Motoharu Shichiri, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan). . . . . [9051-23]

1:50 pm: **In-situ analysis of defect formation in coat develop track process**, Masahiko Harumoto, Osamu Tamada, Tadashi Miyagi, Koji Kaneyama, Dainippon Screen Manufacturing Co., Ltd. (Japan); Charles Pieczulewski, SOKUDO Co., Ltd. (Japan); Masaya Asai, Dainippon Screen Manufacturing Co., Ltd. (Japan) . [9051-24]

2:10 pm: **Methods of controlling cross-linking in negative-tone resists**, Richard A. Lawson, Laren M. Tolbert, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9051-25]

2:30 pm: **How to design a good photoresist solvent package using solubility parameters and high-throughput research**, Michael P. Tate, Charlotte A. Cutler, Mike Sakillaris, Michael Kaufman, Tom Estelle, Carol Mohler, Chris Tucker, James W. Thackeray, The Dow Chemical Co. (USA). . . . . [9051-26]

2:50 pm: **Ionic contrast enhancement for organic solvent negative-tone develop**, Gregory M. Wallraff, Linda K. Sundberg, Luisa D. Bozano, Hoa Truong, Martha I. Sanchez, IBM Almaden Research Ctr. (USA); Dario L. Goldfarb, IBM Thomas J. Watson Research Ctr. (USA); Karen E. Petrillo, Albany NanoTech (USA); William D. Hinsberg, Columbia Technical Consulting, Inc. (USA) . . . . . [9051-27]

3:10 pm: **Introduction of an innovative solvent-free photoresist stripping process using intelligent fluids**, Matthias Rudolph, Yaver Thrun, Fraunhofer Ctr. Nanoelectronic Technologies IPMS (Germany); Christoph K. Hohle, Fraunhofer Institute for Photonic Microsystems IPMS (Germany); Dirk Schumann, Anita Hoehne, Silvio Esche, bubbles and beyond GmbH (Germany). . . . . [9051-28]

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

Conference 9052

Optical Microlithography XXVII

Session 7
Location: Conv. Ctr. 220B
Wed 1:20 pm to 3:00 pm

Overlay Measurement and Control: Joint Session with Conferences 9050 and 9052

Session Chairs: **Alexander Starikov,** I&I Consulting (USA); **Pary Baluswamy,** Micron Technology, Inc. (USA)

1:20 pm: **Characterization and mitigation of overlay error on silicon wafers with nonuniform stress**, Timothy A. Brunner, Vinayan C. Menon, Cheuk W. Wong, Nelson Felix, Michael B. Pike, Oleg Gluschenkov, Michael Belyansky, IBM Corp. (USA); Pradeep Vukkadala, Sathish Veeraraghavan, Jaydeep K. Sinha, KLA-Tencor Corp. (USA) . . . . . .[9052-29]

1:40 pm: **Monitoring process-induced overlay errors through high-resolution wafer geometry measurements**, Kevin T. Turner, Univ. of Pennsylvania (USA); Pradeep Vukkadala, Sathish Veeraraghavan, Jaydeep K. Sinha, KLA-Tencor Corp. (USA) . . . . . .[9050-37]

2:00 pm: **Analysis of overlay errors induced by exposure energy in negative-tone development process for photolithography**, Young Ha Kim, Jang-Sun Kim, Young-Hoon Kim, Byeong-Ok Cho, Jinphil Choi, Young Seog Kang, Hunhwan Ha, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . .[9052-30]

2:20 pm: **Investigation on reticle heating effect induced overlay error**, Mi Jung Lim, Geunhak Kim, Seo-Min Kim, Byoung-Hoon Lee, Seokkyun Kim, Chang-Moon Lim, Myoung Soo Kim, Sung-Ki Park, SK Hynix, Inc. (Korea, Republic of) . . . . . .[9050-38]

2:40 pm: **Compensating process nonuniformity to improve wafer overlay by RegC**, Philippe J. Leray, Shaunee Y. Cheng, IMEC (Belgium); Avi Cohen, Erez Graitzer, Vladimir Dmitriev, Nadav Wertsman, Carl Zeiss SMS Ltd. (Israel). . . . . .[9050-39]

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

Conference 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

Session 3
Location: San Jose Marriott Salon III
Wed 1:30 pm to 3:20 pm

Hotspots

Session Chairs: **Lars W. Liebmann,** IBM Corp. (USA); **Jason P. Cain,** Advanced Micro Devices, Inc. (USA)

1:30 pm: **Challenges in OPC and design at 20nm and below** *(Invited Paper)*, Sarah McGowan, GLOBALFOUNDRIES Inc. (USA) . . . . . .[9053-12]

2:00 pm: **Accurate lithography hotspot detection based on PCA-SVM classifier with hierarchical data clustering**, Jhih-Rong Gao, Bei Yu, David Z. Pan, The Univ. of Texas at Austin (USA) .[9053-13]

2:20 pm: **Model-based multilayers fix for litho-hotspots beyond 20nm node**, Asmaa Rabie, Kareem Madkour, Mentor Graphics Egypt (Egypt); Kirolos George, Mentor Graphics Corp. (Egypt); Wael El-Manhawy, Jean-Marie Brunet, Joe Kwan, Mentor Graphics Corp. (USA) . . . . . .[9053-14]

2:40 pm: **Configurable hotspot fixing system**, Masanari Kajiwara, Sachiko Kobayashi, Hiromitsu Mashita, Ryota Aburada, Toshiba Corp. (Japan); Nozomu Furuta, Toshiba Materials Co., Ltd. (Japan); Toshiya Kotani, Toshiba Corp. (Japan) . . . . . .[9053-15]

3:00 pm: **Smart source, mask, and target co-optimization to improve design related lithographically weak spots**, Bong-Ryoul Choi, ASML Korea Co., Ltd. (Korea, Republic of); No-Young Chung, Pil-Soo Kang, Na-Rae Bang, Sukjoo Lee, Byung-Il Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Sung-Woon Park, Ki-Ho Baik, ASML Korea Co., Ltd. (Korea, Republic of); Stephen D. Hsu, Xiaofeng Liu, Rafael C. Howell, Keith D. Gronlund, Brion Technologies, Inc. (USA) . . . . . .[9053-16]

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

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 11
Location: Conv. Ctr. 210B
Wed 3:40 pm to 6:00 pm

EUV Resist I

Session Chairs: **Thomas I. Wallow,** GLOBALFOUNDRIES Inc. (USA); **Christopher S. Ngai,** Applied Materials, Inc. (USA)

3:40 pm: **Oxide nanoparticle photoresists: EUV patterning and mechanistic evidence**, Souvik Chakrabarty, Li Li, Cornell Univ. (USA); Chandrasekhar Sarma, SEMATECH Inc. (USA); Emmanuel P. Giannelis, Christopher K. Ober, Cornell Univ. (USA). . . . . [9048-47]

4:00 pm: **Novel EUV resist materials for 16nm half pitch and EUV resist defects**, Motohiro Shiratani, JSR Engineering Co., Ltd. (Japan); Ken Maruyama, Ramakrishnan Ayothi, Yoshi Hishiro, JSR Micro, Inc. (USA); Andreia Santos, Xaver Buch, JSR Micro N.V. (Belgium); Tooru Kimura, JSR Engineering Co., Ltd. (Japan)[9048-48]

4:20 pm: **Novel EUV resist materials design for 14nm half-pitch and below**, Hideaki Tsubaki, Shinji Tarutani, Toru Fujimori, Hiroo Takizawa, Takahiro Goto, FUJIFILM Corp. (Japan) . . . . . [9048-49]

4:40 pm: **Electron and hole transfer in anion-bound chemically amplified resists used in extreme-ultraviolet lithography**, Yoshitaka Komuro, Tokyo Ohka Kogyo Co., Ltd. (Japan) and Osaka Univ. (Japan); Hiroki Yamamoto, The Institute of Scientific and Industrial Research (Japan); Yoshiyuki Utsumi, Katsumi Ohmori, Tokyo Ohka Kogyo Co., Ltd. (Japan); Takahiro Kozawa, The Institute of Scientific and Industrial Research (Japan) . . . . . [9048-50]

5:00 pm: **Secondary electrons in EUV: Experimental studies**, Justin Torok, Sanjana Das, Ryan Del Re, Henry Herbol, Univ. at Albany (USA); Leonidas E. Ocola, Argonne National Lab. (USA); Carl Ventrice Jr., Robert L. Brainard, Gregory Denbeaux, Univ. at Albany (USA) . . . . . [9048-51]

5:20 pm: **Comparative analysis of shot noise characteristics of EUV and e-beam lithography**, Suchit Bhattarai, Univ. of California, Berkeley (USA); Weilun Chao, Lawrence Berkeley National Lab. (USA); Andrew R. Neureuther, Univ. of California, Berkeley (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA)[9048-52]

5:40 pm: **Improved measurement capabilities at the NIST EUV Reflectometry Facility**, Charles Tarrio, Steven E. Grantham, Thomas B. Lucatorto, National Institute of Standards and Technology (USA); Michael D. Kriese, Yuriy Y. Platonov, Licai Jiang, Jim R. Rodriguez, Rigaku Innovative Technologies, Inc. (USA) . . . . . [9048-53]

Conference 9049

Alternative Lithographic Technologies VI

Session 10
Location: Conv. Ctr. 220A
Wed 3:50 pm to 5:50 pm

Multiple Electron Beam Direct Write Lithography

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

3:50 pm: **MAPPER pre-production platform: Outlook on the 1st lithographic performances** *(Invited Paper)*, Laurent Pain, CEA-LETI (France); Béatrice Icard, CEA-LETI-Minatec (France); Ludovic Lattard, Jérôme Belledent, CEA-LETI (France); Jonathan Pradelles, CEA-LETI-Minatec (France); Arame Ndeye Thiam, Isabelle Servin, Karine Jullian, Sébastien Bérard-Bergery, CEA-LETI (France); Christophe Constancias, Bernard Dal'zotto, CEA-LETI-Minatec (France); Claire Sourd, CEA-LETI (France); Marie-Line Pourteau, CEA-LETI-Minatec (France); Jean-Christophe Marusic, Soitec S.A. (France); Guido de Boer, Marco J. Wieland, Bert Jan Kampherbeek, Pieter Brandt, Pablo Wiedmann, Abdi Farah, Marc Smits, MAPPER Lithography (Netherlands); Serge Tedesco, CEA-LETI (France); Armel-Petit Mebiene, STMicroelectronics (France); Erwin Slot, MAPPER Lithography (Netherlands) . . . . . [9049-39]

4:20 pm: **Demonstration of EDA flow for massively parallel e-beam lithography**, Pieter Brandt, MAPPER Lithography (Netherlands); Jérôme Belledent, CEA-LETI (France); Céline Tranquillin, Thiago R. Figueiro, Aselta Nanographics (France); Stéfanie Meunier, CEA-LETI (France); Sébastien Bayle, Aselta Nanographics (France); Aurélien Fay, CEA-LETI (France); Matthieu Milléquant, Aselta Nanographics (France); Béatrice Icard, CEA-LETI-Minatec (France); Marco J. Wieland, MAPPER Lithography (Netherlands) . . . . . [9049-40]

4:40 pm: **Reflective electron-beam lithography: alignment and stitching of patterns printed via CMOS DPG chip** *(Invited Paper)*, Thomas Gubiotti, Anthony Cheung, Shinichi Kojima, Fuge Sun, Jason Yang, Francoise Kidwingira, John J. Hench, Zhiyang Wei, Mark A. McCord, Paul Petric, Allen Carroll, Alan D. Brodie, William M. Tong, Christopher F. Bevis, KLA-Tencor Corp. (USA) . . . . . [9049-41]

5:10 pm: **The REBL digital pattern generator: recent innovations and remaining challenges**, Allen Carroll, Luca Grella, Kirk Murray, Mark A. McCord, Paul Petric, William M. Tong, Christopher F. Bevis, KLA-Tencor Corp. (USA); Shy-Jay Lin, Tsung-Hsin Yu, Tze-Chiang Huang, T. P. Wang, Wen-Chuan Wang, J. J. Shin, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9049-42]

5:30 pm: **Massively parallel EB direct writing (MPEBDW) system based on microelectromechanical system (MEMS)/nc-Si emitter array**, Akira Kojima, Crestec Corp. (Japan); Naokatsu Ikegami, Tokyo Univ. of Agriculture and Technology (Japan); Takashi Yoshida, Hiroshi Miyaguchi, Hitoshi Nishino, Tohoku Univ. (Japan); Masanori Sugata, Crestec Corp. (Japan); Sinya Yoshida, Masanori Muroyama, Tohoku Univ. (Japan); Hideyuki Ohyi, Crestec Corp. (Japan); Nobuyoshi Koshida, Tokyo Univ. of Agriculture and Technology (Japan); Masayoshi Esashi, Tohoku Univ. (Japan). . . . . [9049-43]

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 11
Location: Conv. Ctr. 220B
Wed 3:30 pm to 6:10 pm

Inspection

Session Chairs: **Timothy F. Crimmins,** Intel Corp. (USA); **Chih-Ming Ke,** Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

3:30 pm: **Optical three-dimensional volumetric detection of sub-20nm dense patterned defects with noise**, Bryan M. Barnes, Martin Sohn, Hui Zhou, András E. Vladár, Francois Goasmat, Richard M. Silver, National Institute of Standards and Technology (USA); Abraham Arceo, SEMATECH Inc. (USA) . . . . . .[9050-40]

3:50 pm: **9nm-node wafer defect inspection using visible light**, Renjie Zhou, Lynford L. Goddard, Gabriel Popescu, Univ. of Illinois at Urbana-Champaign (USA). . . . . .[9050-41]

4:10 pm: **Highly-effective and accurate weak point monitoring method for advanced design rule (1xnm) devices**, Jeongho Ahn, Shijin Seong, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Gangadharan Sivaraman, Chang Ho Lee, KLA-Tencor Corp. (USA) . . . . . .[9050-42]

4:30 pm: **Real-time inspection system utilizing scatterometry pupil data**, Jae Yeon Baek, Univ. of California, Berkeley (USA); Anne-Laure Charley, Philippe J. Leray, IMEC (Belgium); Robert J. Socha, ASML US, Inc. (USA); Costas J. Spanos, Univ. of California, Berkeley (USA). . . . . .[9050-43]

4:50 pm: **New inspection technology for observing nanometer size defects using expansion soft template**, Seiji Morita, Ryoji Yoshikawa, Takashi Hirano, Tatsuhiko Higashiki, Toshiba Corp. (Japan). . . . . .[9050-44]

5:10 pm: **Parallel, miniaturized scanning probe microscope for defect inspection and review**, Hamed Sadeghian, TNO (Netherlands) and Technische Univ. Delft (Netherlands); Teun C. van den Dool, Rodolf Herfst, Jasper Winters, Will E. Crowcombe, Norbert B. Koster, Geerten Kramer, TNO (Netherlands) . . . . . .[9050-45]

5:30 pm: **Quantitative tabletop coherent diffraction imaging EUV microscope for EUV lithography mask inspection**, Daniel Adams, Bosheng Zhang, Matthew D. Seaberg, Dennis F. Gardner, JILA (USA); Henry C. Kapteyn, JILA (USA) and Kapteyn-Murnane Labs., Inc. (USA); Margaret M. Murnane, JILA (USA) . . . . . .[9050-46]

5:50 pm: **Computational techniques for determining printability of real defects in EUV mask pilot line**, Paul Morgan, Daniel L. Rost, Daniel Price, MP Mask Technology Ctr., LLC (USA); Ying Li, Danping Peng, Dong-Hwan Son, Noel Corcoran, Luminescent Technologies (USA); Dean Yonenaga, MP Mask Technology Ctr., LLC (USA); Vikram L. Tolani, Luminescent Technologies (USA) . . . . . .[9050-47]

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 11
Location: Conv. Ctr. 220C
Wed 4:00 pm to 5:40 pm

Advanced Patterning Processes

Session Chairs: **Plamen Tzviatkov,** FUJIFILM Electronic Materials U.S.A., Inc. (USA); **Douglas Guerrero,** Brewer Science, Inc. (USA)

4:00 pm: **Reduction of image placement error on photomask-making for multiple patterning**, Takahiro Hiromatsu, Tooru Fukui, Kenta Tsukagoshi, Kazunori Ono, Masahiro Hashimoto, HOYA Corp. (Japan). . . . . [9051-29]

4:20 pm: **Robust complementary technique with multiple-patterning for sub-10nm node device**, Kenichi Oyama, Shohei Yamauchi, Sakurako Natori, Arisa Hara, Masatoshi Yamato, Tokyo Electron AT Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan). . . . . [9051-30]

4:40 pm: **Advanced develop processes for reducing defects related with e-beam resists**, Byunghoon Lee, Sung-Jae Han, Se-Gun Moon, Hee Bom Kim, Inkyun Shin, Chanuk Jeon, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9051-31]

5:00 pm: **Recent progress on multiple-patterning process**, Hidetami Yaegashi, Kenichi Oyama, Shohei Yamauchi, Arisa Hara, Sakurako Natori, Masatoshi Yamato, Tokyo Electron Ltd. (Japan). . . . . [9051-33]

5:20 pm: **Novel and cost-effective multiple patterning technology by means of invisible SiO_xNy hardmask**, Linus Jang, Young Joon Moon, Ryoung-Han Kim, GLOBALFOUNDRIES Inc. (USA); Christopher Bencher, Peng Xie, Huixiong Dai, Daniel Diehl, Yong Cao, Applied Materials, Inc. (USA). . . . . [9051-34]

Conference 9052

Optical Microlithography XXVII

Session 8
Location: Conv. Ctr. 210C
Wed 3:30 pm to 5:10 pm

OPC Modeling

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

3:30 pm: **Hybrid OPC modeling with SEM contour technique for 10nm node process**, Keiichiro Hitomi, Hitachi America, Ltd. (USA); Scott D. Halle, IBM Corp. (USA); Shoji Hotta, Hitachi, Ltd. (Japan); Marshal A. Miller, Ioana C. Graur, Nicole Saulnier, Derren N. Dunn, IBM Corp. (USA); Nobuhiro Okai, Hitachi America, Ltd. (USA); Atsuko Yamaguchi, Hitachi, Ltd. (USA); Hitoshi Komuro, Toru Ishimoto, Shunsuke Koshihara, Yutaka Hojo, Hitachi High-Technologies Corp. (Japan) . . . . . [9052-31]

3:50 pm: **Improving 3D resist profile compact modeling by exploiting 3D resist physical mechanisms**, Yongfa Fan, Synopsys, Inc. (USA); Cheng-En R. Wu, Synopsys Taiwan Ltd. (Taiwan); Hua Song, Synopsys, Inc. (USA); Thomas Schmoeller, Synopsys GmbH (Germany) . . . . . [9052-32]

4:10 pm: **Resist profile simulation with fast lithography model**, Yan-Ying He, Chih-Shiang Chou, Yu-Po Tang, Wen-Chun Huang, Ru-Gun Liu, Tsai-Sheng Gau, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9052-33]

4:30 pm: **Modeling the lithography of ion implantation resists on topography**, Gustaf Winroth, IMEC (Belgium); Alessandro Vaglio Pret, KLA-Tencor/ ICOS Belgium (Belgium); Stewart A. Robertson, John J. Biafore, KLA-Tencor Texas (USA) . . . . . [9052-34]

4:50 pm: **Analytical etch modeling and correction for highly polymerizing processes in sub-2x CMOS nodes**, Alexandre Villaret, STMicroelectronics (France). . . . . [9052-35]

Conference 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

Session 4
Location: San Jose Marriott Salon III
Wed 3:50 pm to 4:50 pm

Design Optimization I

Session Chairs: **Michael L. Rieger,** Synopsys, Inc. (USA); **Mark E. Mason,** Texas Instruments Inc. (USA)

3:50 pm: **Layout induced variability and manufacturability checks in FinFETs process and its impact on performance and power**, Yongchan Ban, Hanah Jung, Seongkyeong Park, Hyunha Seo, Moeun Jung, LG Electronics Inc. (Korea, Republic of); Philippe Hurat, Cadence Design Systems, Inc. (USA); Yongseok Kang, Kuktae Hong, Woo Hyun Paik, LG Electronics Inc. (Korea, Republic of) . . . . . [9053-17]

4:10 pm: **Rigorous layout optimization for array edges of periodic contact patterns using negative-tone development**, Jin-Hyuck Jeon, Shinyoung Kim, Chan-Ha Park, Hyun Jo Yim, Dong Gyu Yim, SK Hynix, Inc. (Korea, Republic of) . . . . . [9053-19]

4:30 pm: **An in-design DFM flow with pattern compaction for 16nm FinFET SoC design**, Hosoon Shin, Yongchan Ban, Yongjin Kwon, Yongseok Kang, Woo Hyun Paik, LG Electronics Inc. (Korea, Republic of) . . . . . [9053-20]

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

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

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Evaluation of lens heating effect in high transmission NTD processes at the 20nm technology node, Bumhwan Jeon, Chien-Hsien Lee, Lokesh Subramany, Chen Li, Shyam Pal, Sheldon Meyers, Sohan S. Mehta, Yayi Wei, David R. Cho, GLOBALFOUNDRIES Inc. (USA) . [9050-61]

Automatically high accurate and efficient photomask defects management solution for advanced lithography manufacture, Chingyun Hsiang, Anchor Semiconductor, Inc. (USA); Jun Zhu, Lijun Chen, Lantao Ma, Dejian Li, Lihong Pan, Hongmin Jia, Shanghai Huali Microelectronics Corp. (China); Guojie Chen, Anchor Semiconductor, Inc. (China); Shijie Chen, Shanghai Huali Microelectronics Corp. (China); Li Ling, Wenkui Liao, Shanghai Huali Microelectronics Corp. (China) and Anchor Semiconductor, Inc. (China) . [9050-62]

Design of the phase-shifting algorithm for the flatness measurement of a mask blank glass, Yangjin Kim, The Univ. of Tokyo (Japan); Kenichi Hibino, National Institute of Advanced Industrial Science and Technology (Japan); Naohiko Sugita, Mamoru Mitsuishi, The Univ. of Tokyo (Japan). . . . . [9050-63]

Precise CD-SEM metrology of resist patterns at around 20nm for 0.33NA EUV lithography, Nobuhiro Okai, Hitachi America, Ltd. (USA); Erin Lavigne, IBM Corp. (USA); Keiichiro Hitomi, Hitachi America, Ltd. (USA); Scott D. Halle, IBM Corp. (USA); Shoji Hotta, Hitachi America, Ltd. (Japan); Atsuko Yamaguchi, Junichi Tanaka, Hitachi, Ltd. (Japan); Todd C. Bailey, IBM Corp. (USA) [9050-64]

Lithography focus/exposure control and corrections to improve CDU at post etch step, Young Ki Kim, GLOBALFOUNDRIES Inc. (USA); Jie Gao, KLA-Tencor Corp. (USA) . . . . . [9050-65]

The metal ions from track filter and its impact to product yield in IC manufacturing, Tung-Chang Kuo, United Microelectronics Corp. (Taiwan) . . . . . [9050-66]

Advanced broadband optical inspection on complex logic structures using NanoPoint at sub-20nm design nodes, Abhishek Vikram, GLOBALFOUNDRIES Inc. (USA); Ravikumar Sanapala, KLA-Tencor Corp. (USA); Peter Lin, Aleister Mraz, Victor S. K. Lim, GLOBALFOUNDRIES Inc. (USA); Rahul Lakhawat, KLA-Tencor Corp. (USA); Sumanth Kini, GLOBALFOUNDRIES Inc. (USA) and KLA-Tencor Corp. (USA); Satya Kurada, Ankit Jain, KLA-Tencor Corp. (USA) . . . . . [9050-67]

In cleanroom, sub-PPB real-time monitoring of volatile organic compounds using proton-transfer reaction/time of flight/mass spectrometry, Nathalie Hayeck, Aix-Marseille Univ. (France) and TERA Environnement (France); Philippe Maillot, Thomas Vitrani, Nicolas Pic, STMicroelectronics (France); Henri Wortham, Sasho Gligorvski, Brice Temime-Roussel, Aurélie Mizzi, Aix-Marseille Univ. (France); Irène Poulet, TERA Environnement (France). . . . . [9050-68]

AFM image placement accuracy and automation for the next mask manufacturing generation, Sean Hand, Eric Milligan, Andrew S. Lopez, Jason Osborne, Vladimir Fonoberov, Adam Feinstein, Jim M. Young, Bruker Nano Inc. (USA); Elba Gomar-Nadal, Adam Seeger, Kyung M. Lee, Malahat A. Tavassoli, Intel Corp. (USA). . . . . [9050-70]

Optical technologies for TSV and 3D-IC packaging inspection, Arun A. Aiyer, Frontier Semiconductor, Inc. (USA) . . . . . [9050-71]

A new method for wafer quality monitoring using process big data, Younghoon Sohn, Hyun Lee, Mingoo Seo, Baejin Lee, Yusin Yang, Chungsam Jun, Sangkil Lee, Kyupil Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9050-72]

Investigation of a methodology for in-film defects detection on film coated blank wafers, Akiko Kiyotomi, Arnaud Dauendorffer, Shinobu Miyazaki, Satoru Shimura, Tokyo Electron Kyushu Ltd. (Japan); Takemasa Miyagi, Shigeru Ota, Koji Haneda, Oksen Baris, KLA-Tencor Corp. (USA) . . . . . [9050-73]

Improving the accuracy of overlay measurements with calibration of wafer-induced shifts, Wooseok Ko, Yusin Yang, Sangkil Lee, ChungSam Jun, SAMSUNG Electronics Co., Ltd. (Korea, Republic of). . . . . [9050-74]

Across wafer CD uniformity optimization by wafer film scheme at double-patterning lithography process, Hsiao-Chiang Lin, Yang-Liang Li, Shiuan-Chuan Wang, Chien-Hung Liu, Zih-Song Wang, Jhung-Yuin Hsuh, Powerchip Technology Corp. (Taiwan) . . . . . [9050-75]

Defect analysis methodology for contact hole graphoepitaxy DSA, Ryota Harukawa, Masami Aoki, KLA-Tencor Japan (Japan); Andrew J. Cross, KLA-Tencor England (United Kingdom); Venkat R. Nagaswami, KLA-Tencor Corp. (USA); Shinichiro Kawakami, Takashi Yamauchi, Tokyo Electron Kyushu Ltd. (Japan); Tadatoshi Tomita, Tokyo Electron Europe Ltd. (Japan); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Makoto Muramatsu, Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan). . . . . [9050-76]

Dimensional and defectivity nanometrology of directed self-assembly patterns, C. Simão, W. Khunsin, Institut Català de Nanotecnologia (Spain); A. Amann, Univ. College Cork (Ireland); N. Kehagias, Institut Català de Nanotecnologia (Spain); M. A. Morris, Tyndall National Institute (Ireland) and Trinity College Dublin (Ireland) and Univ. College Cork (Ireland); C. M. Sotomayor Torres, Institut Català de Nanotecnologia (Spain) . . . . . [9050-77]

New robust edge detection methodology for qualifying DSA characteristics by using CD SEM, Satoru Yamaguchi, Kazuhiro Ueda, Hitachi High-Technologies Corp. (Japan); Takeshi Kato, Hitachi High-Tech Trading Corp. (Japan); Norio Hasegawa, Hitachi High-Technologies Corp. (Japan); Takashi Yamauchi, Shinichiro Kawakami, Makoto Muramatsu, Tokyo Electron Kyushu Ltd. (Japan); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan). . . . . [9050-79]

Laser-based vacuum-ultraviolet light source, John Szilagyi, Homaira Parchamy, Majid Masnavi, Martin C. Richardson, Univ. of Central Florida (USA) . . . . . [9050-80]

A novel analytical method for the measurement of trace level acidic and basic AMC using liquid-free sample traps, Tyler M. Moulton, Emily C. Zaloga, Katherine M. Chase, Jürgen M. Lobert Jr., Entegris, Inc. (USA) . . . . . [9050-81]

Analytical method for the measurement of moisture and trace level gas contamination in carbon dioxide, Jürgen M. Lobert Jr., Tyler M. Moulton, Charles M. Miller, Jeffrey L. Hermann, Christopher J. Ruple, Entegris, Inc. (USA) [9050-82]

A method for the combined measurement of volatile and condensable organic AMC in semiconductor applications, Charles M. Miller, Emily C. Zaloga, Jürgen M. Lobert Jr., Entegris, Inc. (USA) . . . . . [9050-83]

Handling, clamping, and alignment evaluation for multibeam technology on Matrix1.1 platform, Ludovic Lattard, Jonathan Pradelles, CEA-LETI (France); Niels Vergeer, Erwin Slot, MAPPER Lithography (Netherlands); Laurent Pain, CEA-LETI (France); Erik de Jong, MAPPER Lithography (Netherlands); Gianpaolo Torriani, Dainippon Screen Deutschland GmbH (Germany); Charles N. Pieczulewski, SOKUDO Co., Ltd. (Japan) . . . . . [9050-85]

Focus control budget analysis for critical layers of flash devices, Jong Hoon Jang, Kyeong Dong Park, Tony Park, SAMSUNG Electronics Co., Ltd. (Korea, Republic of). . . . . [9050-86]

Macroscopic exploration and visual quality inspection of thin film deposit, Simon-Frédéric Désage, Gilles Pitard, Hugues Favrelière, Maurice Pillet, Univ. de Savoie (France); Olivier Dellea, Pascal Fugier, Philippe Coronel, Emmanuel Ollier, CEA LITEN (France) . . . . . [9050-87]

Wafer surface pre-treatment study for micro-bubble free of lithography process, Xiaosong Yang, Semiconductor Manufacturing International Corp. (China). . . . . [9050-88]

Characterization of e-beam patterned grating structures with Mueller matrix polarimetry, Xiuguo Chen, Shiyuan Liu, Chuanwei Zhang, Huazhong Univ. of Science and Technology (China); Hao Jiang, The Univ. of Texas at Arlington (USA) . . . . . [9050-89]

Run-time scanner data analysis for HVM lithography process monitoring and stability control, Woong Jae Chung, Young Ki Kim, GLOBALFOUNDRIES Inc. (USA). . . . . [9050-90]

Isolation grooves scatterometry simulation with GPU and groove shapes optimization, Hirokimi Shirasaki, Tamagawa Univ. (Japan). . . . . [9050-91]

Deep-level data fusion for CD metrology: Heterogeneous hybridization of scatterometry, CDSEM, and AFM data, Nicolas Chesneau, Johann Foucher, Guillaume Evin, Axel Largent, Thomas Janvier, Alexandre Derville, Romain Thérèse, Jérome Hazart, CEA-LETI (France) . . . . . [9050-92]

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

Accurate contour extraction system of mask SEM image, Izumi Santo, Akira Higuchi, Anazawa Mirai, Hideaki Bandoh, Holon Co., Ltd. (Japan). . . . . [9050-93]

Accuracy improvement of overlay measurement, Kentaro Kasa, Kazuya Fukuhara, Toshiba Corp. (Japan). . . . . [9050-94]

Mean offset optimization for multipattering overlay using Monte-Carlo simulation method, Wenhui Wang, Liping Cui, Lei Sun, Ryoung-Han Kim, GLOBALFOUNDRIES Inc. (USA). . . . [9050-95]

Lithography develop process electrostatic discharge effect mechanism study and process optimization, Xiaosong Yang, Semiconductor Manufacturing International Corp. (China) [9050-96]

20nm middle-of-line overlay case study, Lokesh Subramany, Michael Hsieh, Chen Li, Hui Peng Koh, David R. Cho, GLOBALFOUNDRIES Inc. (USA); Anna Golotsvan, KLA-Tencor Israel (USA); Vidya Ramanathan, Ramkumar Karur-Shanmugam, KLA-Tencor Corp. (USA) . . . . . [9050-97]

Metrology of advanced N14 process pattern split at lithography, WeiYuan Chu, KLA-Tencor Corp. (USA) . . . . . [9050-98]

Development of UV inspection system on the defect of electrode for 5µm level multilayer pattern, Jaisoon Kim, Kee Namgung, Jihun Woo, Sanghee Lim, Seungil Lee, Jisoo Lee, Seung Il Lim, Myongji Univ. (Korea, Republic of); Jaewon Lim, Byongkyeom Kim, Auros Technology, Inc. (Korea, Republic of) . . . . . [9050-99]

Scatterometry performance improvement by parameter and spectrum feed-forward, Jie Li, Nanometrics Inc. (USA); Shahin Zangooie, HGST (USA); Karthik Boinapally, Jiangtao Hu, Zhuan Liu, Sanjay K. Yedur, Nanometrics Inc. (USA); Peter J. Wilkens, Avraham Ver, Robert Cohen, Babak Khamsepour, HGST (USA) . . . . . [9050-100]

Spectroscopic critical dimension technology (SCD) for directed self-assembly, Venkat R. Nagaswami, Senichi Nishibe, Thaddeus Dziura, KLA-Tencor Corp. (USA); Roel Gronheid, IMEC (Belgium) . . . . . [9050-101]

SEM-contour shape analysis method based on pattern structure for advanced systematic defect inspection, Yasutaka Toyoda, Hitachi, Ltd. (Japan); Hiroyuki Shindo, Yutaka Hojo, Daisuke Fuchimoto, Hitachi High-Technologies Corp. (Japan) [9050-102]

Innovative fast technique for checking overlay accuracy with ASC (Archer self-calibration), Nuriel Amir, KLA-Tencor Israel (Israel); Simon C. C. Hsu, United Microelectronics Corp. (Taiwan) . . . . . [9050-103]

Overlay improvements using a real-time machine learning algorithm, Emil Schmitt-Weaver, Daan Slotboom, Michael Kubis, Wolfgang Henke, Tom Hoogenboom, Jan Mulkens, Peter ten Berge, Martyn J. Coogans, Frank van de Mast, ASML Netherlands B.V. (Netherlands) . . . . . [9050-105]

Method and system for real-time overlay measurement using fluorescent markers, Diederik J. Maas, Erwin J. van Zwet, TNO (Netherlands) . . . . . [9050-106]

High-precision tool to tool CD matching with focus target assist pattern by computational ways, Ki-Yeop Park, Chang-Hoon Ryu, ASML Korea Co., Ltd. (Korea, Republic of); Qi-Tong Fan, Brion Technologies Co., Ltd. (China); Ki-Ho Baik, ASML Korea Co., Ltd. (Korea, Republic of); Sung-Man Kim, Yong-Ho Kim, Byung-Roh Kim, Sung-Il Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9050-108]

In-line focus monitoring and fast determination of best focus using scatterometry measurements, Steven T. Ha, SAMSUNG Austin Semiconductor LLC (USA); Christian Sparka, KLA-Tencor Germany (Germany); Benjamin G. Eynon Jr., SAMSUNG Austin Semiconductor LLC (USA); Antonio Mani, KLA-Tencor Italy SRL (Italy); SeungHoon Yoon, KLA-Tencor Korea (USA); David C. Tien, John C. Robinson, KLA-Tencor Corp. (USA); Saroja Ramamurthi, KLA-Tencor Texas (USA) . . . . . [9050-109]

Comparative defect classifications and analysis of Lasertec's M1350 and M7360, Milton C. Godwin, Dave K. Balachandran, SEMATECH Inc. (USA); Tomoya Tamura, Lasertec Corp. (Japan); Anwei Jia, Lasertec USA Inc. (USA) . . . . [9050-110]

Tracking defectivity of EUVand SADP processing using bright-field inspection, Nadine Alexis, Kfir Dotan, Huixiong Dai, Peng Xie, Yongmei Chen, Jun Xue, Dale Huang, Alison Nalven, Bharath Vijayaraghavan, Applied Materials, Inc. (USA); Gaetano Santoro, Applied Materials, Inc. (Belgium); Christopher S. Ngai, Christopher Bencher, Applied Materials, Inc. (USA) . . . . . [9050-111]

Improving reticle requalification efficiency and reducing wafer print-checks via automated defect classification and simulation, Shazad Paracha, Benjamin G. Eynon Jr., SAMSUNG Austin Semiconductor LLC (USA); Hwa-Sung Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Anthony D. Vacca, Peter J. Fiekowsky, Daniel I. Fiekowsky, AVI-Photomask (USA); Young Mog Ham, Douglas Uzzele, Michael J. Green, Daniel Chalom, Photronics, Inc. (USA) . . . . . [9050-112]

Direct-scatterometry-enabled PEC model calibration with two-dimensional layouts, Chih-Yu Chen, National Taiwan Univ. (Taiwan), ASML Taiwan Ltd. (Taiwan); Chun-Hung Liu, Kuen-Yu Tsai, Jia-Han Li, National Taiwan Univ. (Taiwan); Jason J. Shieh, Alek C. Chen, ASML Taiwan Ltd. (Taiwan) [9050-113]

Implementation of background scattering variance reduction on the rapid nanoparticle scanner, Peter van der Walle, Sandro Hannemann, Daan van Eijk, Wouter Mulckhuyse, Jacques C. J. van der Donck, TNO (Netherlands) . . . . . [9050-114]

The measurement uncertainty of CD measurement in the optical measurement technology using pupil, Kuniharu Nagashima, Toshiba Materials Co., Ltd. (Japan); Hideaki Abe, Yuichiro Yamazaki, Toshiba Corp. (Japan)[9050-115]

Process control using set-membership vector-form affine projection adaptive filtering scheme, Chia-Chang Hu, Kui-He Chen, National Chung Cheng Univ. (Taiwan) . . . . . [9050-116]

Phase-shift focus monitor (PSFM) for OAI and high-NA immersion scanners, H. M. Kuo, R. C. Peng, H. H. Liu, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9050-117]

CD uniformity optimization at volume ramp-up stage for new product introduction, Jin-Soo Kim, Won Kwang Ma, Young-Sik Kim, Chang-Moon Lim, Myoung-Soo Kim, Sung-Ki Park, SK Hynix, Inc. (Korea, Republic of); Peter Nikolsky, Marian Otter, Maryana Escalante Marun, Roy Anunciado, ASML Netherlands B.V. (Netherlands); Kyu-Tae Sun, ASML Netherlands B.V. (Korea, Republic of); Ewould van West, Greet Storms, ASML Netherlands B.V. (Netherlands) . . . . . [9050-118]

Plasma-etched surface scanning inspection recipe creation based on bidirectional reflectance distribution function and polystyrene latex spheres, Tiffany Saldana, Hitachi High Technologies America (USA); Steve McGarvey, Hitachi High Technologies America, Inc. (USA); Steve Ayers, Hitachi High Technologies America (USA)[9050-120]

Conference 9051

Advances in Patterning Materials and Processes XXXI

Advanced Patterning Processes

Thermal reflow and etching processes of DUV KrF resist for isolated 10nm contact hole, Wei-Su Chen, Frederick T. Chen, Tzu-Kun Ku, Industrial Technology Research Institute (Taiwan) . . [9051-51]

Innovative solutions on 193 immersion-based self-aligned multiple patterning, Sakurako Natori, Shohei Yamauchi, Arisa Hara, Masatoshi Yamato, Kenichi Oyama, Tokyo Electron AT Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan). . . . . [9051-52]

Wet particle source identification and reduction using a new filter cleaning process, Toru Umeda, Nihon Pall Ltd. (Japan); Akihiko Morita, Hideki Shimizu, Dainippon Screen Manufacturing Co., Ltd. (Japan); Shuichi Tsuzuki, Nihon Pall Ltd. (Japan). . . . . [9051-53]

Adsorption characteristics of lithography filters in various solvents using application-specific ratings, Toru Umeda, Shuichi Tsuzuki, Nihon Pall Ltd. (Japan) . . . . . [9051-54]

Removal of highly crosslinked resists and hybrid polymers for single-microparts fabrication and nanoimprint stamp rework, Anja Voigt, Rainer Engelke, Gisela Ahrens, Arne Schleunitz, Jan Jasper Klein, Gabi Grützner, micro resist technology GmbH (Germany) . . . . . [9051-56]

The research on pattern design that affect the well resistance, Jihyun Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9051-57]

Characterization of chemically-amplified resists for electron-beam lithography, Tomoharu Yamazaki, Hiroki Yamamoto, Takahiro Kozawa, Osaka Univ. (Japan); Wen-Chuan Wang, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9051-58]

Improved adhesion of novolak and epoxy-based resists by cationic organic materials on critical substrates for high-volume patterning applications, Anja Voigt, Gisela Ahrens, micro resist technology GmbH (Germany); Andrew Thompson, DisChem, Inc. (USA); Gabi Grützner, micro resist technology GmbH (Germany) . . . . . [9051-59]

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

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

Materials and Process Fundamentals

Modeling acid transport in chemically-amplified resist films, Gila Stein, Abhijit Patil, Manolis Doxastakis, Univ. of Houston (USA) . . . . . [9051-60]

The investigation of hybrid nanoparticle EUV photoresists: Influence of electrolyte solution on the particle size change, Li Li, Souvik Chakrabarty, Christine Y. Ouyang, Panagiotis Dallas, Cornell Univ. (USA); Mark Neisser, Chandrasekhar Sarma, SEMATECH Inc. (USA); Christopher K. Ober, Emmanuel P. Giannelis, Cornell Univ. (USA) . . . . . [9051-61]

Deprotonation mechanism of ionized poly(4-hydroxystyrene), Toshihiko Susa, Kazumasa Okamoto, Takuya Ishida, Hokkaido Univ. (Japan); Takahiro Kozawa, Hiroki Yamamoto, Osaka Univ. (Japan); Ryoko Huziyoshi, Hokkaido Univ. (Japan); Kikuo Umegaki, Hokkaido Univ. Hospital (Japan). . . . . [9051-62]

Numerical analysis for resist profile after thermal process in display manufacturing, Vitaliy Domnenko, Synopsys SPb, LLC (Russian Federation); Sangmin Shin, Jonghyoek Ryu, Sung Won Choi, Hyunwoo Cho, Samsung Display Co., Ltd. (Korea, Republic of); Eun-Soo Jeong, Synopsys Korea Inc. (Korea, Republic of); Hans-Jürgen Stock, Synopsys GmbH (Germany); Jung-Hoe Choi, Synopsys Korea Inc. (Korea, Republic of). [9051-63]

Photoresist analysis to investigate LWR generation mechanism, Kenji Mochida, Shinichi Nakamura, Tooru Kimura, JSR Corp. (Japan); Yoshihiko Taguchi, Hirofumi Seki, Naoki Man, Toray Research Ctr., Inc. (Japan) . . . . . [9051-64]

Decreasing curing temperature of spin-on dielectric by using additives, Jinhee Bae, Kwen Woo Han, Cheil Industries Inc. (Korea, Republic of) . . . . . [9051-65]

Study of acid diffusion behaves form PAG by using topcoat method, Atsushi Sekiguchi, Litho Tech Japan Co., Ltd. (Japan) . . . . . [9051-67]

Fluidity dependence of deprotonation kinetics of chemically amplified resist, Kazumasa Okamoto, Takuya Ishida, Hokkaido Univ. (Japan); Hiroki Yamamoto, Takahiro Kozawa, Osaka Univ. (Japan); Ryoko Fujiyoshi, Kikuo Umegaki, Hokkaido Univ. (Japan). . . . . [9051-68]

New Materials and Processes

Inorganic resist materials based on zirconium phosphonate for atomic force microscope lithography, Mankyu Kang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) and Hanyang Univ. (Korea, Republic of); Seonae Kim, Jin-Hyuck Jung, Hanyang Univ. (Korea, Republic of); Hee Bom Kim, Inkyun Shin, Chanuk Jeon, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Haiwon Lee, Hanyang Univ. (Korea, Republic of) . . . . . [9051-69]

Tailor-made inorganic-organic hybrid polymer materials for advanced micro- and nanolithography processes and production, Arne Schleunitz, Jan Jasper Klein, Marko Vogler, Gabi Grützner, micro resist technology GmbH (Germany) . . . . . [9051-70]

Organic-inorganic hybrid resists for EUVL, Vikram Singh, Vishwanath Kalyani, V. S. V. Satynarayana, Pradeep Parameswaran, Satinder K. Sharma, Subrata Ghosh, Indian Institute of Technology Mandi (India); Kenneth E. Gonsalves, Indian Institute of Technology Mandi (India) and The Univ. of North Carolina at Charlotte (USA) [9051-71]

Development of high-carbon spin-on hard masks for high-resolution lithography, Takanori Kudo, M. Dalil Rahman, Douglas S. McKenzie, Clement T. Anyadiegwu, Munirathna Padmanaban, AZ Electronic Materials USA Corp. (USA). . . . [9051-72]

Effective resist profile control for 20nm node and beyond, Chen-Yu Liu, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9051-73]

Study on resist performance of chemically-amplified molecular resist based on noria derivative and calixarene derivative, Hiroki Yamamoto, Osaka Univ. (Japan); Hiroto Kudo, Kansai Univ. (Japan); Takahiro Kozawa, Osaka Univ. (Japan). . . . . [9051-74]

SRAF window improvement with under-coating layer, Takahiro Hiromatsu, Tooru Fukui, Kenta Tsukagoshi, Kazunori Ono, Masahiro Hashimoto, HOYA Corp. (Japan) . . . . . [9051-76]

Development of new xanthendiol derivatives applied to the negative-tone molecular resists for EB/EUVL, Takashi Sato, Masako Yamakawa, Yumi Ochiai, Yu Okada, Takashi Makinoshima, Masaaki Takasuka, Masatoshi Echigo, Mitsubishi Gas Chemical Co., Inc. (Japan). . . . . [9051-77]

Organic coating material tuning for CMP, Su Yu Chung, TSMC Taiwan (Taiwan) . . . . . [9051-78]

Chemical shrink process for NTD (Negative Tone Development) resist, Tatsuro Nagahara, Yoshihiro Miyamoto, Georg Pawlowski, AZ Electronic Materials (Japan) K.K. (Japan); John Sagan, AZ Electronic Materials USA Corp. (USA). . . . [9051-79]

Novel polymeric sulfonium photoacid generator and its application for chemically-amplified photoresists, Liyuan Wang, Juan Liu, Beijing Normal Univ. (China) . . . . . [9051-80]

Evaluation of novel hydrophilic derivatives for chemically amplified EUV resists, Hiroyuki Tanagi, Hiroyasu Tanaka, Shoichi Hayakawa, Kikuo Furukawa, Mitsubishi Gas Chemical Co., Inc. (Japan); Hiroki Yamamoto, Takahiro Kozawa, Osaka Univ. (Japan) . . . . . [9051-81]

ArF photoresist polymers with nitrogen or sulfone moieties for negative-tone development process, Dong-Gyun Kim, Su-Jee Kwon, Seoul National Univ. (Korea, Republic of); Suk-Koo Hong, Joon Je Lee, Hyung Rae Lee, Hyo-jin Yun, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Ji-Hoon Baik, Seoul National Univ. (Korea, Republic of); Dohyuk Lim, Eujean Jang, Jae-Woo Lee, Jae-Hyun Kim, Dongjin Semichem Co., Ltd. (Korea, Republic of); Jong-Chan Lee, Seoul National Univ. (Korea, Republic of) . . . . . [9051-82]

Development of novel protecting derivatives for chemically amplified extreme ultraviolet resist, Hiroyasu Tanaka, Hiroyuki Tanagi, Shoichi Hayakawa, Kikuo Furukawa, Mitsubishi Gas Chemical Co., Inc. (Japan); Hiroki Yamamoto, Takahiro Kozawa, Osaka Univ. (Japan). . . [9051-83]

Development of antistatic film for electron-beam lithography, Hiroya Fukuda, Masashi Uzawa, Mitsubishi Rayon Co., Ltd. (Japan) . . . . . [9051-84]

High-chi organic block copolymers for directed self-assembly, Ankit Vora, Anindarupa Chunder, Melia Tjio, Srinivasan Balakrishnan, Elizabeth M. Lofano, Joy Y. Cheng, Daniel P. Sanders, IBM Almaden Research Ctr. (USA); Eri Hirahara, Yasushi Akiyama, AZ Electronic Materials (Japan) K.K. (Japan); Orest Polishchuk, Margareta Paunescu, SungEun Hong, Durairaj Baskaran, Guanyang Lin, AZ Electronic Materials USA Corp. (USA). [9051-85]

EUV resists prepared from compounds containing bismuth, tellurium, and tin, James Passarelli, Brian Cardineau, Westley Tear, Ryan Del Re, Miriam Sortland, SUNY College of Nanoscale Science & Engineering (USA); Chandrasekhar Sarma, Mark Neisser, SEMATECH Inc. (USA); Daniel A. Freedman, State Univ. of New York at New Paltz (USA); Robert L. Brainard, SUNY College of Nanoscale Science & Engineering (USA) . [9051-86]

Underlayers and Spin-On Materials Processing

Novel spin-on metal hardmask materials for filling applications, Alberto D. Dioses, Venkata Chada, Elizabeth Wolfer, Edward Ng, Salem Mullen, Huirong Yao, JoonYeon Cho, Munirathna Padmanaban, AZ Electronic Materials USA Corp. (USA) . . . . . [9051-87]

Novel silicon hard mask design for collapse margin improvemnt, Chen-Yu Liu, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9051-88]

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

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Conference 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

Decomposition-aware layout optimization for 20/14nm standard cells, Lynn T. Wang, Sriram Madhavan, Shobhit Malik, Eric K. Chiu, Luigi Capodieci, GLOBALFOUNDRIES Inc. (USA) . . . . . [9053-32]

Resist profile aware source mask optimization, Ao Chen, Yee Mei Foong, GLOBALFOUNDRIES Singapore (Singapore); Michael Hsieh, Andrew Khoh, GLOBALFOUNDRIES Inc. (USA); Stephen D. Hsu, Mu Feng, Jianhong Qiu, Chris Aquino, Brion Technologies, Inc. (USA) . . . . . [9053-33]

Fast lithographic hotspot identification and monitoring, Aviram Tam, Applied Materials, Inc. (Israel); Clare Wu, Applied Materials, Inc. (Taiwan); Sivan Lifschitz, Applied Materials, Inc. (Israel) . . . . . [9053-34]

Robust and automated solution for correcting hotspots locally using cost-function based OPC solver, Dongok Yang, GLOBALFOUNDRIES Singapore (Singapore); Carl P. Babcockb, Sarah McGowan, GLOBALFOUNDRIES Inc. (USA); Bo Yan, Jun Ye, Jianhong Qiu, Stanislas Baron, Taksh Pandey, Sanjay H. Kapasi, Chris Aquino, Brion Technologies, Inc. (USA) . . . . . [9053-35]

An improved coloring algorithm for layout decomposition in self-aligned multiple patterning, Jun You, Ji Yu, Yijian Chen, Peking Univ. (China) . . . . . [9053-37]

Work smarter not harder: How to get more results with less modeling, Kareem Madkour, Mentor Graphics Egypt (Egypt); Fedor G. Pikus, Mentor Graphics Corp. (USA); Mohab Anis, The American Univ. in Cairo (Egypt). . . . . [9053-38]

Scanner correction capabilities-aware CMP lithography hotspot analysis, Ushasree Katakamsetty, Colin C. W. Hui, Sky Yeo, Perez Valerio, Yang Qing, Quek Shyue Fong, GLOBALFOUNDRIES Singapore (Singapore); Narayana Samy Aravind, Ruhm Matthias, Roberto Schiwon, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany). . . . . [9053-39]

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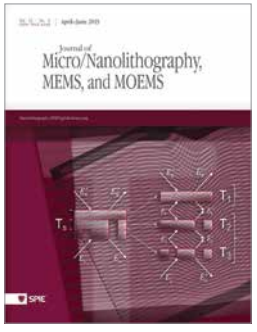

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 12
Location: Conv. Ctr. 210B · Thu 8:00 am to 10:10 am

Exposure Tools and Extendibility

Session Chairs: **Markus Bender,** Advanced Mask Technology Ctr. GmbH Co. KG (Germany); **Chang-Moon Lim,** SK Hynix, Inc. (Korea, Republic of)

8:00 am: **EUV lithography: NXE platform performance overview** *(Invited Paper)*, Rudy Peeters, Sjoerd Lok, Martijn van Noordenburg, Noreen Harned, ASML Netherlands B.V. (Netherlands); Peter Kuerz, Martin Lowisch, Carl Zeiss SMT GmbH (Germany); Guido Schiffelers, Alberto Pirati, Judon Stoeldraijer, ASML Netherlands B.V. (Netherlands); David C. Brandt, Nigel R. Farrar, Igor V. Fomenkov, ASML Netherlands B.V. (USA); Herman Boom, Hans Meiling, Ron Kool, ASML Netherlands B.V. (Netherlands) . . . . . [9048-54]

8:30 am: **Projection optics for EUVL microfield exposure tools with 0.5 NA**, Holger K. Glatzel, Zygo Corporation (USA); Dominic Ashworth, SEMATECH Inc. (USA); Daniel J. Bajuk, Matt Bjork, Mark Bremer, Rodney Chin, Mark A. Cordier, Zygo Corporation (USA); Kevin D. Cummings, SEMATECH Inc. (USA); Luc Girard, Zygo Corporation (USA); Michael Goldstein, SEMATECH Inc. (USA); Eric M. Gullikson, Lawrence Berkeley National Lab. (USA); Russell Hudyma, Hyperion Development LLC (United States); Jame Kennon, Robert Kestner, Louis A. Marchetti, Keyvan Nouri, Zygo Corporation (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA); Regina Soufli, Lawrence Livermore National Lab. (USA); Eberhard Adolf Spiller, Spiller X-ray Optics (USA); Daniel J. Pierce, Zygo Corporation (USA) . . . . . [9048-55]

8:50 am: **Across scanner platform optimization to enable EUV lithography at the 10nm logic node**, Jan Mulkens, Jaap Karssenberg, Michael Kubis, Leon Verstappen, ASML Netherlands B.V. (Netherlands) . . . . . [9048-56]

9:10 am: **Update on the SEMATECH 0.5 NA extreme-ultraviolet lithography (EUVL) microfield exposure tool (MET)**, Kevin D. Cummings, Dominic Ashworth, SEMATECH Inc. (USA); Mark Bremer, Rodney Chin, Zygo Corporation (USA); Yu-Jen Fan, SEMATECH Inc. (USA); Luc Girard, Holger K. Glatzel, Zygo Corporation (USA); Michael Goldstein, SEMATECH Inc. (USA); Eric M. Gullikson, Lawrence Berkeley National Lab. (USA); Jame Kennon, Robert Kestner, Louis A. Marchetti, Zygo Corporation (USA); Patrick P. Naulleau, Lawrence Berkeley National Lab. (USA); Regina Soufli, Lawrence Livermore National Lab. (USA); Johannes M. Bauer, Markus Mengel, Joachim Welker, Michael Grupp, Erik M. Sohmen, Carl Zeiss SMT GmbH (Germany); Stefan Wurm, SEMATECH Inc. (USA) . . . . . [9048-57]

9:30 am: **Progress on EUV-pellicle development**, Carmen Zoldesi, Kursat Bal, ASML Netherlands B.V. (Netherlands); Brian D. Blum, ASML (USA); Guus Bock, Derk Brouns, ASML Netherlands B.V. (Netherlands); Florian Dhalluin, ASML Netherlands B.V (Netherlands); Nina V. Dziomkina, ASML Netherlands B.V. (Netherlands); Juan Diego Espinoza, ASML Netherlands B.V (Netherlands); Joost de Hoogh, Silvester Houweling, Maarten J. Jansen, Mohammad Kamali, Alain Kempa, Robert C. de Kruif, Jorge Lima, Yang Liu, Henk Meijer, Hans Meiling, Ijen van Mil, Marco Reijnen, Luigi Scaccabarozzi, Daniel A. Smith, Beatrijs Verbrugge, Laurens de Winters, ASML Netherlands B.V. (Netherlands); Xugang Xiong, John D. Zimmerman, ASML (USA) . . . . . [9048-58]

9:50 am: **Driving the industry to a consensus on high-NA EUV**, Patrick A. Kearney, SEMATECH Inc. (USA); Eric Hendrickx, IMEC (Belgium); Obert R. Wood II, GLOBALFOUNDRIES Inc. (USA); Gregory R. McIntyre, IBM Corp. (USA); Soichi Inoue, EUVL Infrastructure Development Ctr., Inc. (Japan); Stefan Wurm, SEMATECH Inc. (USA) . . . . . [9048-59]

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

Conference 9049

Alternative Lithographic Technologies VI

Session 11
Location: Conv. Ctr. 220A
Thu 8:20 am to 10:00 am

DSA Line Patterning

Session Chairs: **Frank M. Schellenberg; Juan J. de Pablo,** The Univ. of Chicago (USA)

8:20 am: **Block copolymer lithography in the fabrication of templates with high-bit aspect ratio rectangular bits**, Lei Wan, He Gao, Ricardo Ruiz, Jeffrey Lille, Yves-Andre Chapuis, Kanaiyalal C. Patel, Alexei L. Bogdanov, Thomas R. Albrecht, HGST (USA) . . . . . [9049-44]

8:40 am: **Customization of directed self-assembly patterns from chemoepitaxial etch trim using a self-aligned hardmask (CHEETAH)**, Gregory S. Doerk, Joy Y. Cheng, Charles T. Rettner, Gurpreet Singh, Srinivasan Balakrishnan, Noel Arellano, Melia Tjio, Hoa Truong, IBM Almaden Research Ctr. (USA); Markus Brink, Hsinyu Tsai, IBM Thomas J. Watson Research Ctr. (USA); Elizabeth M. Lofano, Jed W. Pitera, IBM Almaden Research Ctr. (USA); Michael A. Guillorn, IBM Thomas J. Watson Research Ctr. (USA); Daniel P. Sanders, IBM Almaden Research Ctr. (USA) . . . . . [9049-45]

9:00 am: **Tuning the strength of chemical patterns for directed self-assembly of block copolymers**, Lance D. Williamson, IMEC (Belgium) and The Univ. of Chicago (USA); Roel Gronheid, IMEC (Belgium); Paul F. Nealey, The Univ. of Chicago (USA) . . . . . [9049-46]

9:20 am: **Predicting process windows for pattern density multiplication using block copolymer directed self-assembly in conjunction with chemoepitaxial guiding layers**, Benjamin Nation, Andrew Peters, Richard A. Lawson, Peter J. Ludovice, Clifford L. Henderson, Georgia Institute of Technology (USA) . . . . . [9049-47]

9:40 am: **Directed self-assembly of diblock copolymers in laterally confining channels: Effect of rough surfaces on line-edge roughness (LER) and defectivity**, Bongkeun Kim, Navil Laachi, Kris T. Delaney, Glenn H. Fredrickson, Univ. of California, Santa Barbara (USA) . . . . . [9049-48]

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

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 12
Location: Conv. Ctr. 220B
Thu 8:00 am to 10:00 am

Scatterometry and Optical Methods

Session Chairs: **Matthew J. Sendelbach,** Nova Measuring Instruments Inc. (USA); **Eric Solecky,** IBM Corp. (USA)

8:00 am: **Novel in-line metrology methods for Fin pitch walking monitoring in 14nm node and beyond**, Robin Hsin-Kuo Chao, IBM Corp. (USA) . . . . . [9050-119]

8:20 am: **Weak measurements applied to process monitoring using focused beam scatterometry**, Thomas G. Brown, Miguel A. Alonso, Anthony Vella, Michael J. Theisen, Stephen Head, Univ. of Rochester (USA) [9050-49]

8:40 am: **Enhanced optical CD metrology by hybridization and azimuthal scatterometry**, Shahin Zangooie, HGST (USA); Jie Li, Karthik Boinapally, Nanometrics Inc. (USA); Peter J. Wilkens, Avraham Ver, Babak Khamsepour, Holger Schroder, John B. Piggot, HGST (USA); Sanjay K. Yedur, Zhuan Liu, Jiangtao Hu, Nanometrics Inc. (USA) . [9050-50]

9:00 am: **High-speed optical metrology solution for after etch process monitoring and control**, Anne-Laure Charley, Philippe J. Leray, Wouter Pypen, Shaunee Y. Cheng, IMEC (Belgium); Alok Verma, Mohamed El Kodadi, Baukje Wisse, Hugo Cramer, Henk Niesing, Stefan Kruijswijk, ASML Netherlands B.V. (Netherlands) . . . . . [9050-51]

9:20 am: **Visualization of Si surface and interface quality by non-contact optical characterization techniques**, Woo Sik Yoo, Kitaek Kang, Toshikazu Ishigaki, Takeshi Ueda, WaferMasters, Inc. (USA) . . . . . [9050-52]

9:40 am: **Integrated ADI optical metrology solution for lithography process control of CD and OV**, Marlene G. Strobl, Wilhelm Tsai, Andy Lan, Tom Chen, Wilson Hsu, Henry Chen, Inotera Memories Inc. (Taiwan); Frida Liang, Alan Wang, Platt Hung, David Huang, Ethan Chiu, Paul Yu, ASML Taiwan Ltd. (Taiwan); Yi Song, Sylvia Yuan, Mohamed El Kodadi, Remco Dirks, Noelle Wright, Mariya Ponomarenko, Hugo Cramer, Baukje Wisse, Stefan Kruijswijk, Henk Niesing, ASML Netherlands B.V. (Netherlands) . . . . . [9050-107]

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

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 12
Location: Conv. Ctr. 220C
Thu 8:20 am to 10:00 am

DSA Materials II

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

8:20 am: **Manufacturability considerations for graphoepitaxy DSA**, Gerard M. Schmid, Richard A. Farrell, Ji Xu, Moshe E. Preil, GLOBALFOUNDRIES Inc. (USA); Michael Cicoria, Tokyo Electron America, Inc. (USA); David Hetzer, Nihar Mohanty, Anton deVilliers, TEL Technology Ctr., America, LLC (USA) . . . . . [9051-35]

8:40 am: **Formation of sub-7nm feature size PS-b-P4VP block copolymer structures by solvent vapor process**, Atul B. Chaudhari, Tandra Ghoshal, Univ. College Cork (Ireland) and Trinity College Dublin (Ireland); Matthew T. Shaw, Trinity College Dublin (Ireland) and Univ. College Cork (Ireland) and Intel Ireland Ltd. (Ireland); Cian Cummins, Dipu Borah, Justin D. Holmes, Michael A. Morris, Univ. College Cork (Ireland) and Trinity College Dublin (Ireland) . . . . . [9051-36]

9:00 am: **New materials for directed self-assembly for advanced patterning**, Jieqian Zhang, The Dow Chemical Co. (USA); Jong Park, Janet Wu, Dow Advanced Materials (USA); Mingqi Li, Dow Electronic Materials (USA); Matthew D. Christianson, Paul Clark, Jeffrey D. Weinhold, Valeriy V. Ginzburg, The Dow Chemical Co. (USA); Phillip D. Hustad, Peter Trefonas III, Dow Electronic Materials (USA) . . . . . [9051-37]

9:20 am: **Orientation control of high-χ block copolymers using polymeric topcoat surface treatments**, William J. Durand, Christopher M. Bates, Gregory Blachut, Michael J. Maher, Matthew Carlson, Jeffrey L. Self, Christopher J. Ellison, C. Grant Willson, The Univ. of Texas at Austin (USA) . . . . . [9051-38]

9:40 am: **Enhanced characterization of BCP-based DSA processes using innovative CD SEM analysis**, Todd R. Younkin, Robert Bristol, Michael J. Leeson, Eungnak Han, Florian Gstrein, David Shykind, Intel Corp. (USA); Takeshi Kato, Hitachi High-Tech Trading Corp. (Japan); Kazuhiro Ueda, Akiyuki Sugiyama, Hitachi High-Technologies Corp. (Japan); Hiroshi Yoshida, Hitachi, Ltd. (Japan); Alex Danilevsky, Andy Self, Hitachi High Technologies America, Inc. (USA) . . . . . [9051-39]

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

Conference 9052

Optical Microlithography XXVII

Session 9
Location: San Jose Marriott Salon III
Thu 8:20 am to 10:00 am

Pattern-Aware Techniques: Joint Session with Conferences 9052 and 9053

Session Chairs: **Luigi Capodieci,** GLOBALFOUNDRIES Inc. (USA); **Jongwook Kye,** GLOBALFOUNDRIES Inc. (USA)

8:20 am: **Fast detection of novel problematic patterns based on dictionary learning and boundary detection of failure regions**, Frank de Morsier, Nathalie Casati, IBM Zürich Research Lab. (Switzerland); David L. DeMaris, IBM Austin Research Lab. (USA); Maria Gabrani, IBM Zürich Research Lab. (Switzerland); Alkis Gotovos, Rainer Andreas Krause, ETH Zurich (Switzerland)[9052-37]

8:40 am: **Pattern-based full-chip process verification**, Changsheng Ying, Yongjun Kwon, Paul Fornari, Gökhan Perçin, Anwei Liu, Cadence Design Systems, Inc. (USA) . . . . . .[9052-38]

9:00 am: **Characterization of 1D layout technology at advanced nodes and low k1**, Valery Axelrad, Sequoia Design Systems, Inc. (USA); Koji Mikami, Canon Inc. (Japan); Michael C. Smayling, Tela Innovations, Inc. (USA); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan); Koichiro Tsujita, Canon Inc. (Japan) . . . . . .[9052-39]

9:20 am: **Pattern-based lithographic-target optimization using a predictive yield model**, Rani S. Ghaida, Piyush Pathak, GLOBALFOUNDRIES Inc. (USA). . . . . .[9053-21]

9:40 am: **Lithography yield estimation model to predict layout pattern distortions with a reduced set of lithography simulations**, Sergio Gomez Fernandez, Francesc Moll Echeto, Juan Mauricio, Univ. Politècnica de Catalunya (Spain) . . . . . .[9053-36]

Coffee Break . . . . . Thu 10:00 am to 10:20 am

Conference 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

Session 5
Location: San Jose Marriott Salon III
Thu 8:20 am to 10:00 am

Pattern-Aware Techniques: Joint Session with Conferences 9052 and 9053

Session Chairs: **Luigi Capodieci,** GLOBALFOUNDRIES Inc. (USA); **Jongwook Kye,** GLOBALFOUNDRIES Inc. (USA)

8:20 am: **Fast detection of novel problematic patterns based on dictionary learning and boundary detection of failure regions**, Frank de Morsier, Nathalie Casati, IBM Zürich Research Lab. (Switzerland); David L. DeMaris, IBM Austin Research Lab. (USA); Maria Gabrani, IBM Zürich Research Lab. (Switzerland); Alkis Gotovos, Rainer Andreas Krause, ETH Zurich (Switzerland)[9052-37]

8:40 am: **Pattern-based full-chip process verification**, Changsheng Ying, Yongjun Kwon, Paul Fornari, Gökhan Perçin, Anwei Liu, Cadence Design Systems, Inc. (USA) . . . . . [9052-38]

9:00 am: **Characterization of 1D layout technology at advanced nodes and low k1**, Valery Axelrad, Sequoia Design Systems, Inc. (USA); Koji Mikami, Canon Inc. (Japan); Michael C. Smayling, Tela Innovations, Inc. (USA); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan); Koichiro Tsujita, Canon Inc. (Japan) . . . . . [9052-39]

9:20 am: **Pattern-based lithographic-target optimization using a predictive yield model**, Rani S. Ghaida, Piyush Pathak, GLOBALFOUNDRIES Inc. (USA). . . . . [9053-21]

9:40 am: **Lithography yield estimation model to predict layout pattern distortions with a reduced set of lithography simulations**, Sergio Gomez Fernandez, Francesc Moll Echeto, Juan Mauricio, Univ. Politècnica de Catalunya (Spain) . . . . . [9053-36]

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

Conference 9048

Extreme Ultraviolet (EUV) Lithography V

Session 13
Location: Conv. Ctr. 210B
Thu 10:40 am to 12:20 pm

EUV Manufacturing

Session Chairs: **Daniel Corliss,** IBM Corp. (USA); **Seong-Sue Kim,** SAMSUNG Electronics Co., Ltd. (Korea, Republic of)

10:40 am: **Whatever will be the EUVL extension technology which realizes a next-generation semiconductor device?** *(Invited Paper)*, Tatsuhiko Higashiki, Toshiba Corp. (Japan) . . . . . .[9048-60]

11:10 am: **Integration of a EUV metal layer: 20/14nm test-chip demonstration** *(Invited Paper)*, Craig D. Higgins, GLOBALFOUNDRIES Inc. (USA); Erik A. Verduijn, GLOBALFOUNDRIES Inc. (Belgium); Xiang Hu, Jean Raymond Fakhoury, Mark Zaleski, Yi Zhou, Pawitter J. Mangat, GLOBALFOUNDRIES Inc. (USA). . . . . .[9048-61]

11:40 am: **The economic impact of EUV lithography on critical process modules**, Arindam Mallik, Naoto Horiguchi, Jürgen Bömmels, Aaron Thean, Kathy Barla, Geert Vandenberghe, Kurt G. Ronse, Julien Ryckaert, Abdelkarim Mercha, Laith Altimime, Diederik Verkest, An Steegen, IMEC (Belgium). . . . . .[9048-62]

12:00 pm: **High-resist sensitization by pattern and flood combination lithography**, Seiichi Tagawa, Akihiro Oshima, Satoshi Enomoto, Osaka Univ. (Japan) . . . . . .[9048-106]

Conference End.

Conference 9049

Alternative Lithographic Technologies VI

Session 12
Location: Conv. Ctr. 220A
Thu 10:30 am to 12:20 pm

Nanodevice Fabrication

Session Chairs: **Kenneth R. Carter,** Univ. of Massachusetts Amherst (USA); **Kevin T. Turner,** Univ. of Pennsylvania (USA)

10:30 am: **Nanoimprint lithography process chains for the fabrication of micro- and nanodevices** *(Invited Paper)*, Helmut Schift, Paul Scherrer Institut (Switzerland) . . . . . [9049-49]

11:00 am: **Detection of the early stage of recombinational DNA repair by nanowire transistors fabricated by oxidation scanning probe lithography**, Marco Chiesa, Instituto de Ciencia de Materiales de Madrid (Spain) and Instituto de Microelectrónica de Madrid (Spain); Paula P. Cardenas, Ctr. Nacional de Biotecnologia (Spain); Francisco Otón, Institut de Ciència de Materials de Barcelona (Spain); Javier Martinez, Instituto de Microelectrónica de Madrid (Spain); Marta Mas-Torrent, Institut de Ciència de Materials de Barcelona (Spain); Fernando Garcia, Instituto de Microelectrónica de Madrid (Spain); Juan C. Alonso, Ctr. Nacional de Biotecnologia (Spain); Concepció Rovira, Institut de Ciència de Materials de Barcelona (Spain); Ricardo Garcia, Instituto de Ciencia de Materiales de Madrid (Spain) and Instituto de Microelectrónica de Madrid (Spain) . . . . . [9049-50]

11:20 am: **Lithography challenges and opportunities in fabrication of bit patterned media with areal density beyond 1.5 Tdpsi**, XiaoMin Yang, Shuaigang Xiao, Yautzong E. Hsu, Hongying Wang, Zhaoning Yu, Nobuo Kurataka, Michael R. Feldbaum, Philip Steiner, Gene G. Gauzner, Koichi Wago, Kim Y. Lee, David S. Kuo, Seagate Technology LLC (USA) . . . . . [9049-51]

11:40 am: **UV nanoimprint lithography for the fabrication of MEMS tunable Fabry-Perot infrared filters**, Jan Besser, Marco Meinig, Steffen Kurth, Fraunhofer-Institut für Elektronische Nanosysteme (Germany); Mario Seifert, Karla Hiller, Technische Univ. Chemnitz (Germany); Maik Wiemer, Fraunhofer-Institut für Elektronische Nanosysteme (Germany); Thomas Gessner, Fraunhofer-Institut für Elektronische Nanosysteme (Germany) and Technische Univ. Chemnitz (Germany) . . . . . [9049-52]

12:00 pm: **New lithography technology for sub-10nm patterning with shrinking organic material**, Seiji Morita, Toshiba Corp. (Japan). . . . . [9049-53]

Lunch Break . . . . . Thu 12:20 pm to 1:35 pm

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Presentation of The Karel Urbanek Best Student Paper Award
Location: Conv. Ctr. 220B
10:30 am to 10:40 am

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Session 13
Location: Conv. Ctr. 220B
Thu 10:40 am to 11:40 am

Reference Metrology, Accuracy, Standards

Session Chairs: **Benjamin D. Bunday,** SEMATECH Inc. (USA); **Vladimir A. Ukraintsev,** Nanometrology International, Inc. (USA)

10:40 am: **Sidewall roughness and line profile measurement of photoresist and finFET features by cross-section STEM image for reference metrology**, Kiyoshi Takamasu, Haruki Okitou, Satoru Takahashi, The Univ. of Tokyo (Japan); Mitsuru Konno, Osamu Inoue, Hiroki Kawada, Hitachi High-Technologies Corp. (Japan) . .[9050-53]

11:00 am: **Verification metrology system by using inline reference metrology**, Hideaki Abe, Yasuhiko Ishibashi, Chihiro Ida, Toshiba Corp. (Japan); Takahiro Ikeda, Toshiba Materials Co., Ltd. (Japan); Yuichiro Yamazaki, Toshiba Corp. (Japan) . . . . . .[9050-54]

11:20 am: **Impact of shrinking measurement error budgets on qualification metrology sampling and cost**, Matthew J. Sendelbach, Nova Measuring Instruments Inc. (USA); Niv Sarig, Nova Measuring Instruments Ltd. (Israel); Masafumi Asano, Kazuto Matsuki, Toshiba Corp. (Japan); Carmen Osorio, Alok Vaid, GLOBALFOUNDRIES Inc. (USA) . . . . . .[9050-55]

Lunch Break . . . . . Thu 11:40 am to 1:00 pm

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 13
Location: Conv. Ctr. 220C
Thu 10:30 am to 12:40 pm

Underlayers and Spin-on Materials Processing

Session Chairs: **Luisa D. Bozano,** IBM Almaden Research Ctr. (USA); **Christoph K. Hohle,** Fraunhofer Institute for Photonic Microsystems IPMS (Germany)

10:30 am: **Extending lithography with advanced materials** *(Invited Paper)*, Douglas Guerrero, Brewer Science, Inc. (USA) . . . .[9051-40]

11:00 am: **Spin-on organic hardmask materials for topo-patterned substrate**, Kazuhiko Komura, Yoshi Hishiro, JSR Micro, Inc. (USA); Goji Wakamatsu, Yoshio Takimoto, Tomoki Nagai, Tooru Kimura, Yoshikazu Yamaguchi, Tsutomu Shimokawa, JSR Corp. (Japan); Gregory Breyta, Noel Arellano, Srinivasan Balakrishnan, Luisa D. Bozano, Ananthakrishnan Sankaranarayanan, Daniel P. Sanders, Carl E. Larson, IBM Almaden Research Ctr. (USA); Martin Grodde, Anuja de Silva, IBM Thomas J. Watson Research Ctr. (USA); Krishna Mohan Bajjuri, IBM Almaden Research Ctr. (USA) . . . . . .[9051-41]

11:20 am: **EUV lithography and etching performance enhancement by EUV sensitive Si hard mask (EUV Si-HM) for 1Xnm hp generation**, Wataru Shibayama, Syuhei Shigaki, Hiroaki Yaguchi, Ryuji Onishi, Noriaki Fujitani, Rikimaru Sakamoto, Nissan Chemical Industries, Ltd. (Japan) . . . . . .[9051-42]

11:40 am: **Spin on lithographic resist trim process optimization and process window evaluation**, Christos F. Karanikas, GLOBALFOUNDRIES Inc. (USA); James C. Taylor, Dow Advanced Materials (USA); Naveen Vaduri, Tafsirul Islam, GLOBALFOUNDRIES Inc. (USA). . . . . .[9051-43]

12:00 pm: **A chemical underlayer approach to mitigate shot noise in EUV contact-hole patterning**, Jin Li, Yasuaki Ide, Shigemasa Nakasugi, Motoki Misumi, Hiroshi Yanagita, Fumihiro Suzuki, Georg Pawlowski, Kazuma Yamamoto, AZ Electronic Materials (Japan) K.K. (Japan); JoonYeon Cho, Huirong Yao, Takanori Kudo, Munirathna Padmanaban, YoungJun Her, Yi Cao, AZ Electronic Materials USA Corp. (USA) . . . . . .[9051-44]

12:20 pm: **Anti-spacer double patterning**, Michael D. Hyatt, Micron Technology, Inc. (USA); Karen Huang, JSR Micro, Inc. (USA); Anton deVilliers, TEL Technology Ctr., America, LLC (USA); Zhi Liu, Mark Slezak, JSR Micro, Inc. (USA) . . . . . .[9051-45]

Lunch Break . . . . . Thu 12:40 pm to 1:40 pm

Conference 9052

Optical Microlithography XXVII

2014 Best Student Paper Award
Location: Conv. Ctr. 210C
10:20 am to 10:25 am

Session Chairs: **Kafai Lai,** IBM Corp. (USA); **Will Conley,** Cymer, Inc. (USA)

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Session 10
Location: Conv. Ctr. 210C
Thu 10:25 am to 12:25 pm

Mask Topography Modeling

Session Chairs: **Wilhelm Maurer,** Infineon Technologies AG (Germany); **John S. Petersen,** Periodic Structures, Inc. (USA)

10:25 am: **Rigorous and fast simulation method for electromagnetic light-scattering computations with complex illuminations**, Lin Zschiedrich, Jan Pomplun, JCMwave GmbH (Germany); Sven Burger, Frank Schmidt, JCMwave GmbH (Germany) and Konrad-Zuse-Zentrum für Informationstechnik Berlin (Germany) . . . . . .[9052-40]

10:45 am: **Availability study of extended and CFD-based mask 3D model for next-generation lithography technologies**, Masanori Takahashi, Toshiba Corp. (Japan); Yuichi Kawabata, Toshiba Information Systems (Japan) Corp. (Japan); Satoshi Tanaka, Shimon Maeda, Shoji Mimotogi, Toshiba Materials Co., Ltd. (Japan) .[9052-41]

11:05 am: **Rapid, accurate improvement in 3D mask representation via input geometry optimization and crosstalk**, David Fryer, Michael Lam, Kostas Adam, John Sturtevant, Mentor Graphics Corp. (USA); ChangAn Wang, GLOBALFOUNDRIES Inc. (USA); Scott Mansfield, IBM Thomas J. Watson Research Ctr. (USA) . . . . . .[9052-42]

11:25 am: **Fixing the focus shift caused by mask 3D diffractions**, Bayram Yenikaya, Kostyantyn Chuyeshov, Cadence Design Systems, Inc. (USA) . . . . . .[9052-43]

11:45 am: **Impact of topographic mask models on scanner matching solutions**, Jacek K. Tyminski, Nikon Research Corp. of America (USA); Jan Pomplun, JCMwave GmbH (Germany); Stephen P. Renwick, Nikon Research Corp. of America (USA) . . . . . .[9052-44]

12:05 pm: **Joint optimization of mask, optical, and photoresist models for computational lithography**, Edita Tejnil, John Sturtevant, Mentor Graphics Corp. (USA). . . . . .[9052-45]

Lunch Break . . . . . .Thu 12:25 pm to 1:35 pm

Conference 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

Session 6
Location: San Jose Marriott Salon III
Thu 10:30 am to 12:00 pm

Design Optimization II

Session Chairs: **Chi-Min Yuan,** Freescale Semiconductor, Inc. (USA); **David Z. Pan,** The Univ. of Texas at Austin (USA)

10:30 am: **Technology-design-manufacturing co-optimization for advanced mobile SoCs** *(Invited Paper)*, Geoffrey Yeap, Qualcomm Inc. (USA). . . . . [9053-23]

11:00 am: **Optimizing standard cell design for quality**, Chi-Min Yuan, Dave Tipple, Jeff Warner, Freescale Semiconductor, Inc. (USA) . . . . . [9053-24]

11:20 am: **Analysis of process-induced electromigration and design-friendly compact model in 16nm FinFET SoC design**, Yongchan Ban, Chang-Seok Choi, Yongseok Kang, Woo Hyun Paik, LG Electronics Inc. (Korea, Republic of) . . . . . [9053-25]

11:40 am: **Design technology co-optimization for a robust 10nm solution for logic design and sram**, Boris Vandewalle, Bharani Chava, Sushil Sakhare, IMEC (Belgium); Mircea V. Dusa, ASML (Belgium) . . . . . [9053-26]

Lunch Break . . . . . .Thu 12:00 pm to 1:35 pm

Conference 9049

Alternative Lithographic Technologies VI

Session 13
Location: Conv. Ctr. 220A
Thu 1:35 pm to 3:35 pm

DSA Design for Manufacturability: Joint Session with Conferences 9049, 9052, and 9053

Session Chairs: **Michael A. Guillorn,** IBM Thomas J. Watson Research Ctr. (USA); **Bruce W. Smith,** Rochester Institute of Technology (USA)

1:35 pm: **Computational lithography platform for 193i-guided directed self-assembly**, Kafai Lai, Melih Ozlem, Anthony R. Schepis, Chi-Chun Liu, IBM Corp. (USA); Jed W. Pitera, IBM Almaden Research Ctr. (USA); Daniel J. Dechene, Neal V. Lafferty, Daniel A. Brue, Azalia Krasnoperova, IBM Corp. (USA); Michael A. Guillorn, Hsinyu Tsai, Markus Brink, IBM Thomas J. Watson Research Ctr. (USA); Jassem A. Abdallah, IBM Corp. (USA); Gregory S. Doerk, Joy Y. Cheng, Melia Tjio, IBM Almaden Research Ctr. (USA) . . . . . .[9052-46]

1:55 pm: **Applying ILT mask synthesis for co-optimizing design rules and DSA model parameters**, Thuc Dam, Synopsys, Inc. (USA)[9052-47]

2:15 pm: **Rigorous simulation and optimization of the lithography/ directed self-assembly co-process**, Tim Fühner, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Ulrich Welling, Marcus Müller, Georg-August-Univ. Göttingen (Germany); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) . . . . . .[9052-48]

2:35 pm: **Physical verification and manufacturing of contact/via layers using graphoepitaxy DSA processes**, Juan Andres Torres, Kyohei Sakajiri, Yuri Granik, Yuansheng Ma, Mentor Graphics Corp. (USA); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Benjamen M. Rathsack, Tokyo Electron America, Inc. (USA); Shinichiro Kawakami, Tokyo Electron Kyushu Ltd. (Japan); Tadatoshi Tomita, Tokyo Electron Europe Ltd. (Germany); Takashi Yamauchi, Tokyo Electron Ltd. (Japan); Makoto Muramatsu, Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan); Gurdaman S. Khaira, The Univ. of Chicago (USA) . . . .[9053-27]

2:55 pm: **A full-chip DSA correction framework**, Wei-Long Wang, Azat M. Latypov, Yi Zou, Tamer H. Coskun, GLOBALFOUNDRIES Inc. (USA) . . . . . .[9049-54]

3:15 pm: **DFM for defect-free DSA hole shrink process**, Ken Fukawatase, Kenji Yoshimoto, Kyoto Univ. (Japan); Yoshihiro Naka, Toshiba Corp. (Japan); Shimon Maeda, Satoshi Tanaka, Toshiba Materials Co., Ltd. (Japan); Seiji Morita, Hisako Aoyama, Toshiba Corp. (Japan); Shoji Mimotogi, Toshiba Materials Co., Ltd. (Japan) . .[9049-55]

Coffee Break . . . . . Thu 3:35 pm to 4:05 pm

Conference 9050

Metrology, Inspection, and Process Control for Microlithography XXVIII

Session 14
Location: Conv. Ctr. 220B
Thu 1:00 pm to 2:20 pm

Overlay

Session Chairs: **Chih-Ming Ke,** Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **John C. Robinson,** KLA-Tencor Corp. (USA)

1:00 pm: **The effect of individually-induced processes on image-based overlay and diffraction-based overlay**, SeungHwa Oh, Jeongjin Lee, Chan Hwang, Seung Yoon Lee, Gilheyun Choi, Ho-Kyu Kang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . [9050-57]

1:20 pm: **Real-cell overlay measurement through design-based metrology**, Gyun Yoo, Jungchan Kim, Chan-Ha Park, Taehyeong Lee, Hyun-Jo Yang, Dong Gyu Yim, SK Hynix, Inc. (Korea, Republic of) . . . . . [9050-58]

1:40 pm: **Integrated production overlay field-by-field control for leading edge technology nodes**, Woong Jae Chung, GLOBALFOUNDRIES Inc. (USA); Kevin C. Huang, KLA-Tencor Corp. (USA); John Tristan, Karsten Gutjahr, Lokesh Subramany, Mark E. Yelverton, Jeong Soo Kim, Win Kong Ching, GLOBALFOUNDRIES Inc. (USA); William Pierson, Ramkumar Karur-Shanmugam, Brent Riggs, Sven Jug, John C. Robinson, KLA-Tencor Corp. (USA) . . [9050-59]

2:00 pm: **Mask contribution to intra-field wafer overlay**, Frank Laske, KLA-Tencor MIE GmbH (Germany); William Chou, United Microelectronics Corp. (Taiwan); Hsien-Min Chang, Luminescent Technologies (USA); Klaus-Dieter Roeth, KLA-Tencor MIE GmbH (Germany); Slawomir Czerkas, Vistec Semiconductor Systems GmbH (Germany); Michael Ferber, KLA-Tencor MIE GmbH (Germany); Mehdi Daneshpanah, KLA-Tencor Corp. (USA) . . . . [9050-60]

Session 15
Location: Conv. Ctr. 220B
Thu 2:20 pm to 3:00 pm

Late Breaking News

Session Chairs: **Jason P. Cain,** Advanced Micro Devices, Inc. (USA); **Ofer Adan,** Applied Materials, Inc. (Israel)

2:20 pm: **Innovative techniques for improving overlay accuracy by using DCM (device correlated metrology) targets as reference**, Nuriel Amir, KLA-Tencor Israel (Israel); Wei-Jhe Tzai, United Microelectronics Corp. (Taiwan) . . . . . [9050-104]

2:40 pm: **The pattern wiggling metrology using CD-SEM,** Chang Hwan Lee, Young Soon Yoo, Jury Song, Hae Jung Lee, Hynix Semiconductors Inc. (Korea, Republic of); Dong Su Kwak, Jae Cheol Jo, Hitachi High-Technologies Korea (Korea, Republic of); Hiroki Kawada, Takahiro Kawasaki, Hitachi High-Technologies (Japan); Hyung Won Yoo, Hynix Semiconductors Inc. (Korea, Republic of) . . . . . [9050-122]

Conference End.

Conference 9051

Advances in Patterning Materials and Processes XXXI

Session 14
Location: Conv. Ctr. 220C
Thu 1:40 pm to 3:20 pm

EUV Materials

Session Chairs: **Scott W. Jessen,** Texas Instruments Inc. (USA); **Sean D. Burns,** IBM Corp. (USA)

1:40 pm: **Optimisation of fullerene-based negative tone chemically amplified resist for extreme ultraviolet lithography**, Andreas Frommhold, Dong Xu Yang, The Univ. of Birmingham (United Kingdom); Xiang Xue, Nano-C, Inc. (USA); Yasin Ekinci, Paul Scherrer Institut (Switzerland); Richard E. Palmer, Alex P. G. Robinson, The Univ. of Birmingham (United Kingdom). . [9051-46]

2:00 pm: **Patterning chemistry of HafSOx resist**, Douglas A. Keszler, Rose Ruther, Richard Oleksak, Gregory Herman, Shawn P. Decker, Jenn Amador, Oregon State Univ. (USA). . . . [9051-47]

2:20 pm: **Photolithographic properties of tin-oxo clusters using EUV light (13.5nm)**, Brian Cardineau, Ryan Del Re, SUNY College of Nanoscale Science & Engineering (USA); Miles Marnell, Hashim Al-Mashat, State Univ. of New York at New Paltz (USA); Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland); Chandrasekhar Sarma, Mark Neisser, SEMATECH Inc. (USA); Daniel A. Freedman, State Univ. of New York at New Paltz (USA); Robert L. Brainard, SUNY College of Nanoscale Science & Engineering (USA) . . . . . [9051-48]

2:40 pm: **Inhomogeneity of PAGs in resist film studied by molecular-dynamics simulations for EUV lithography**, Minoru Toriumi, Toshiro Itani, EUVL Infrastructure Development Ctr., Inc. (Japan). . . . . [9051-49]

3:00 pm: **A platinum-fullerene complex for patterning metal containing nanostructures**, Dong Xu Yang, Andreas Frommhold, Dongsheng He, Ziyou Li, Richard E. Palmer, The Univ. of Birmingham (United Kingdom); Maria A. Lebedeva, Thomas W. Chamberlain, Andrei N. Khlobystov, The Univ. of Nottingham (United Kingdom); Alex P. G. Robinson, The Univ. of Birmingham (United Kingdom). . . . . [9051-50]

Conference End.

Conference 9052

Optical Microlithography XXVII

Session 11
Location: Conv. Ctr. 220A
Thu 1:35 pm to 3:35 pm

DSA Design for Manufacturability: Joint Session with Conferences 9049, 9052, and 9053

Session Chairs: **Michael A. Guillorn,** IBM Thomas J. Watson Research Ctr. (USA); **Bruce W. Smith,** Rochester Institute of Technology (USA)

1:35 pm: **Computational lithography platform for 193i-guided directed self-assembly**, Kafai Lai, Melih Ozlem, Anthony R. Schepis, Chi-Chun Liu, IBM Corp. (USA); Jed W. Pitera, IBM Almaden Research Ctr. (USA); Daniel J. Dechene, Neal V. Lafferty, Daniel A. Brue, Azalia Krasnoperova, IBM Corp. (USA); Michael A. Guillorn, Hsinyu Tsai, Markus Brink, IBM Thomas J. Watson Research Ctr. (USA); Jassem A. Abdallah, IBM Corp. (USA); Gregory S. Doerk, Joy Y. Cheng, Melia Tjio, IBM Almaden Research Ctr. (USA) . . . . . [9052-46]

1:55 pm: **Applying ILT mask synthesis for co-optimizing design rules and DSA model parameters**, Thuc Dam, Synopsys, Inc. (USA) . . . . . [9052-47]

2:15 pm: **Rigorous simulation and optimization of the lithography/ directed self-assembly co-process**, Tim Fühner, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Ulrich Welling, Marcus Müller, Georg-August-Univ. Göttingen (Germany); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) . . . . . [9052-48]

2:35 pm: **Physical verification and manufacturing of contact/via layers using graphoepitaxy DSA processes**, Juan Andres Torres, Kyohei Sakajiri, Yuri Granik, Yuansheng Ma, Mentor Graphics Corp. (USA); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Benjamen M. Rathsack, Tokyo Electron America, Inc. (USA); Shinichiro Kawakami, Tokyo Electron Kyushu Ltd. (Japan); Tadatoshi Tomita, Tokyo Electron Europe Ltd. (Germany); Takashi Yamauchi, Tokyo Electron Ltd. (Japan); Makoto Muramatsu, Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan); Gurdaman S. Khaira, The Univ. of Chicago (USA) . . . . . [9053-27]

2:55 pm: **A full-chip DSA correction framework**, Wei-Long Wang, Azat M. Latypov, Yi Zou, Tamer H. Coskun, GLOBALFOUNDRIES Inc. (USA) . . . . . [9049-54]

3:15 pm: **DFM for defect-free DSA hole shrink process**, Ken Fukawatase, Kenji Yoshimoto, Kyoto Univ. (Japan); Yoshihiro Naka, Toshiba Corp. (Japan); Shimon Maeda, Satoshi Tanaka, Toshiba Materials Co., Ltd. (Japan); Seiji Morita, Hisako Aoyama, Toshiba Corp. (Japan); Shoji Mimotogi, Toshiba Materials Co., Ltd. (Japan) . [9049-55]

Coffee Break . . . . . Thu 3:35 pm to 4:05 pm

Conference 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

Session 7
Location: Conv. Ctr. 220A
Thu 1:35 pm to 3:35 pm

DSA Design for Manufacturability: Joint Session with Conferences 9049, 9052, and 9053

Session Chairs: **Michael A. Guillorn,** IBM Thomas J. Watson Research Ctr. (USA); **Bruce W. Smith,** Rochester Institute of Technology (USA)

1:35 pm: **Computational lithography platform for 193i-guided directed self-assembly**, Kafai Lai, Melih Ozlem, Anthony R. Schepis, Chi-Chun Liu, IBM Corp. (USA); Jed W. Pitera, IBM Almaden Research Ctr. (USA); Daniel J. Dechene, Neal V. Lafferty, Daniel A. Brue, Azalia Krasnoperova, IBM Corp. (USA); Michael A. Guillorn, Hsinyu Tsai, Markus Brink, IBM Thomas J. Watson Research Ctr. (USA); Jassem A. Abdallah, IBM Corp. (USA); Gregory S. Doerk, Joy Y. Cheng, Melia Tjio, IBM Almaden Research Ctr. (USA) . . . . . [9052-46]

1:55 pm: **Applying ILT mask synthesis for co-optimizing design rules and DSA model parameters**, Thuc Dam, Synopsys, Inc. (USA) . . . . . [9052-47]

2:15 pm: **Rigorous simulation and optimization of the lithography/ directed self-assembly co-process**, Tim Fühner, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Ulrich Welling, Marcus Müller, Georg-August-Univ. Göttingen (Germany); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) . . . . . [9052-48]

2:35 pm: **Physical verification and manufacturing of contact/via layers using graphoepitaxy DSA processes**, Juan Andres Torres, Kyohei Sakajiri, Yuri Granik, Yuansheng Ma, Mentor Graphics Corp. (USA); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Benjamen M. Rathsack, Tokyo Electron America, Inc. (USA); Shinichiro Kawakami, Tokyo Electron Kyushu Ltd. (Japan); Tadatoshi Tomita, Tokyo Electron Europe Ltd. (Germany); Takashi Yamauchi, Tokyo Electron Ltd. (Japan); Makoto Muramatsu, Takahiro Kitano, Tokyo Electron Kyushu Ltd. (Japan); Gurdaman S. Khaira, The Univ. of Chicago (USA) . . [9053-27]

2:55 pm: **A full-chip DSA correction framework**, Wei-Long Wang, Azat M. Latypov, Yi Zou, Tamer H. Coskun, GLOBALFOUNDRIES Inc. (USA) . . . . . [9049-54]

3:15 pm: **DFM for defect-free DSA hole shrink process**, Ken Fukawatase, Kenji Yoshimoto, Kyoto Univ. (Japan); Yoshihiro Naka, Toshiba Corp. (Japan); Shimon Maeda, Satoshi Tanaka, Toshiba Materials Co., Ltd. (Japan); Seiji Morita, Hisako Aoyama, Toshiba Corp. (Japan); Shoji Mimotogi, Toshiba Materials Co., Ltd. (Japan) [9049-55]

Coffee Break . . . . . .Thu 3:35 pm to 4:05 pm

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Conference 9049

Alternative Lithographic Technologies VI

Session 14
Location: Conv. Ctr. 220A
Thu 4:05 pm to 5:45 pm

DSA Via Patterning

Session Chairs: **Ricardo Ruiz,** HGST (USA); **Shy-Jay Lin,** Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

4:05 pm: **Evaluation of integration schemes for contact-hole graphoepitaxy DSA: A study of substrate and template affinity control**, Ainhoa Romo-Negreira, Tokyo Electron Europe Ltd. (Netherlands); Todd R. Younkin, Intel Corp. (USA); Roel Gronheid, Steven Demuynck, Nadia Vandenbroeck, IMEC (Belgium); Takehito Seo, Tokyo Ohka Kogyo Co., Ltd. (Japan); Douglas Guerrero, Brewer Science, Inc. (USA); Doni Parnell, Tokyo Electron Europe Ltd. (Netherlands); Makoto Muramatsu, Shinichiro Kawakami, Takashi Yamauchi, Tokyo Electron Kyushu Ltd. (Japan); Kathleen Nafus, Mark H. Somervell, Tokyo Electron America, Inc. (USA) . . . . . .[9049-56]

4:25 pm: **Field-theoretic simulations of directed self-assembly in cylindrical confinement: Placement and rectification aspects**, Nabil Laachi, Univ. of California, Santa Barbara (USA); Tatsuhiro Iwama, Asahi Kasei E-materials Corp. (USA) and The Materials Research Lab. (USA); Kris T. Delaney, Bongkeun Kim, Univ. of California, Santa Barbara (USA); Robert Bristol, David Shykind, Corey J. Weinheimer, Intel Corp. (USA); Glenn H. Fredrickson, Univ. of California, Santa Barbara (USA) . . . . . .[9049-57]

4:45 pm: **Contact holes patterning by directed self-assembly of block copolymers: What would be the Bossung plot?**, Ahmed Gharbi, Raluca Tiron, CEA-LETI-Minatec (France); Maxime Argoud, CEA-LETI (France); Xavier Chevalier, Arkema S.A. (France); Jérôme Belledent, CEA-LETI (France); Jonathan Pradelles, CEA-LETI-Minatec (France); Patricia Pimenta Barros, CEA-LETI (France); Christophe Navarro, Célia Nicolet, Arkema S.A. (France); Georges Hadziioannou, Guillaume Fleury, Univ. Bordeaux 1 (France); Gilles Cunge, LTM CNRS (France); Sébastien Barnola, CEA-LETI (France) . . . . . .[9049-58]

5:05 pm: **Influence of litho-patterning on DSA placement errors**, Sander Wuister, Tamara Druzhinina, Davide Ambesi, ASML Netherlands B.V. (Netherlands); Bart Laenens, Brion Technologies, Inc. (USA); Linda He Yi, Stanford Univ. (USA); Jo Finders, ASML Netherlands B.V. (Netherlands) . . . . . .[9049-59]

5:25 pm: **Directed self-assembly patterning for sub-20nm half-pitch using conventional lithography system**, Jaewoo Nam, Eun Sung Kim, Kyoungseon Kim, Shiyong Yi, Chul-Ho Shin, Gilheyun Choi, Ho-Kyu Kang, E. S. Jung, SAMSUNG Electronics Co., Ltd. (Korea, Republic of). . . . . .[9049-60]

Conference End.

Conference 9052

Optical Microlithography XXVII

Session 12
Location: Conv. Ctr. 210C
Thu 4:05 pm to 5:45 pm

Toolings

Session Chairs: **Soichi Owa,** Nikon Corp. (Japan); **Reinhard Voelkel,** SUSS MicroOptics SA (Switzerland)

4:05 pm: **Critical assessment of the transport of intensity equation as a phase recovery technique in optical lithography**, Aamod Shanker, Univ. of California, Berkeley (USA); Martin Sczyrba, Advanced Mask Technology Ctr. GmbH Co. KG (Germany); Brid Connolly, Franklin Kalk, Toppan Photomasks, Inc. (Germany); Andrew R. Neureuther, Laura Waller, Univ. of California, Berkeley (USA) . . . . . [9052-49]

4:25 pm: **Extremely-long life and low-cost 193nm excimer laser chamber technology for 450mm wafer multipatterning lithography**, Hiroaki Tsushima, Hisakazu Katsuumi, Hiroyuki Ikeda, Takeshi Asayama, Takahito Kumazaki, Akihiko Kurosu, Takeshi Ohta, Kouji Kakizaki, Takashi Matsunaga, Hakaru Mizoguchi, Gigaphoton Inc. (Japan) . . . . . [9052-50]

4:45 pm: **Flexible power 90 w to 120 w ArF immersion light source for high-volume semiconductor lithography**, Russell Burdt, Cymer, Inc. (USA) . . . . . [9052-51]

5:05 pm: **Immersion scanners enabling 10nm half-pitch production and beyond**, Hiroyuki Egashira, Yusaku Uehara, Yosuke Shirata, Yuichi Shibazaki, Jun Ishikawa, Takayuki Funatsu, Masanori Ohba, Nikon Corp. (Japan) . . . . . [9052-52]

5:25 pm: **Extending ArFi immersion scanner capability in support of 1xnm production nodes**, Remi C. Pieternella, Joost Smits, Igor Bouchoms, Janneke van Heteren, Martijn Leenders, Marjin Hoofman, Roelof F. de Graaf, Haico Kok, Matthew G. McLaren, Wim P. de Boeij, ASML Netherlands B.V. (Netherlands) . . . . . [9052-53]

Location: Conv. Ctr. 210C
5:45 pm to 5:50 pm

Closing Remarks

Conference End.

Conference 9053

Design-Process-Technology Co-optimization for Manufacturability VIII

Session 8
Location: San Jose Marriott Salon III
Thu 4:05 pm to 5:25 pm

Design Optimization III

Session Chairs: **Andrew R. Neureuther,** Univ. of California, Berkeley (USA); **Fang-Cheng Chang,** Cadence Design Systems, Inc. (USA)

4:05 pm: **Automated fill modification to support late-stage design changes**, Jeff S. Wilson, Mentor Graphics Corp. (USA); Greg Davis, Mentor Graphics Corp. (USA) and Design to Silicon (USA); Anderson Chiu, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); Ricky Yang, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) and Design to Silcon (USA); Yao-Jen Chuang, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan) . . . . . [9053-28]

4:25 pm: **Yield-aware decomposition for LELE double patterning**, Yukihide Kohira, Univ. of Aizu (Japan); Yoko Yokoyama, Chikaaki Kodama, Toshiba Corp. (Japan); Atsushi Takahashi, Tokyo Institute of Technology (Japan); Shigeki Nojima, Satoshi Tanaka, Toshiba Corp. (Japan). . . . . [9053-29]

4:45 pm: **A generalized model to predict Fin-width roughness induced FinFET device variations using the boundary perturbation method**, Qi Cheng, Jun You, Yijian Chen, Peking Univ. (China) . . . . . [9053-30]

5:05 pm: **Hotspot fixing with localized layout modification technique for litho-etch-litho-etch double patterning**, Yoko Yokoyama, Keishi Sakanushi, Toshiba Corp. (Japan); Yukihide Kohira, Univ. of Aizu (Japan); Atsushi Takahashi, Tokyo Institute of Technology (Japan); Chikaaki Kodama, Toshiba Corp. (Japan); Satoshi Tanaka, Shigeki Nojima, Toshiba Materials Co., Ltd. (Japan). . . . . [9053-31]

Conference End.

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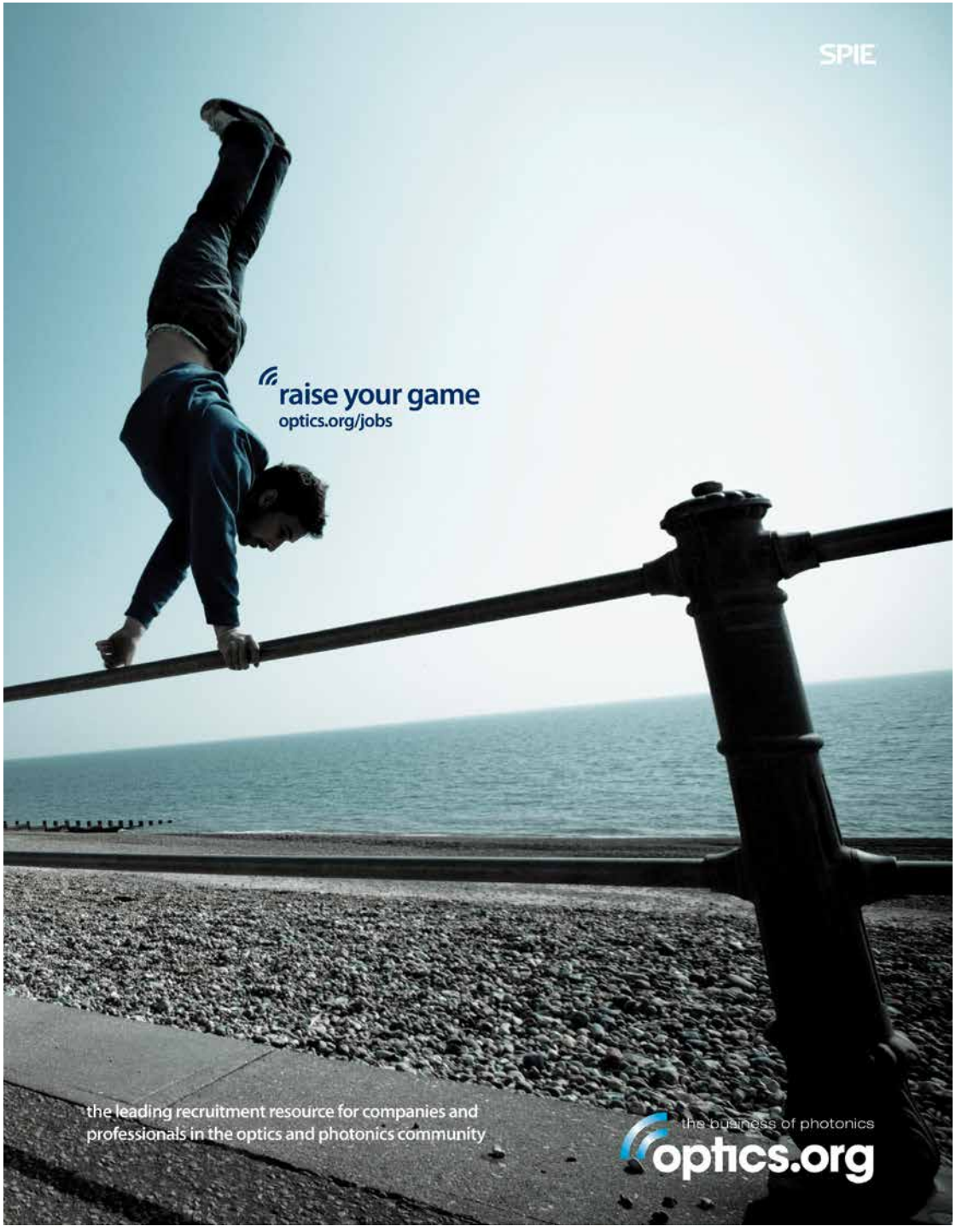

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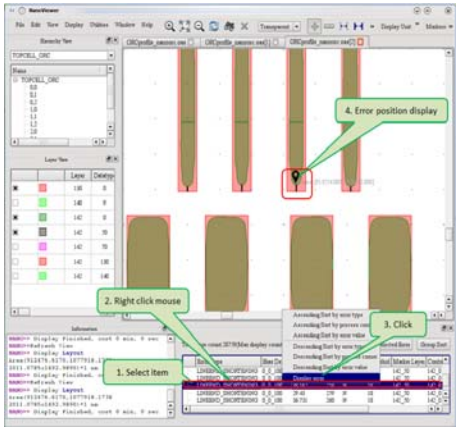
Super-fast Lithography Verification Through Process Window

*NanoORC is a production-proven super-fast lithography verification tool capable of full-chip verification through process window. Its GPU-based system achieves **10X speed up** over traditional CPU based system. Its model accuracy had been verified by its customer between 130nm and 28nm nodes. It checks bridging, broken, pinching, line-end shortening, CD, EPE, sidelobe, image-missing, nils and meef etc.*



Assured Accuracy

- Theoretical results match PROLITH
- Calibrated model verified by customers
- Verification done between 130nm and 28 nm nodes

Super-fast Speed

- Explores massive parallelism in GPU
- Achieves ***10x in speed*** **vs CPU tools**
- CPU cluster upgradable to GPU cluster

Process-window Awareness

- Verification at each of multiple process corners
- Verification on Process-Variation-Band (PVB)
- Computes common process window for many cutlines on product layout
- Results grouped by process corner, by error type, filtered and sorted by error value
- High performance viewer for probing hot-spots for layout and for process corners

Low Cost of Ownership

- CPU version cost competitive on absolute term
- GPU version cost competitive relative to performance
- GPU hardware adds only 25% to total hardware cost

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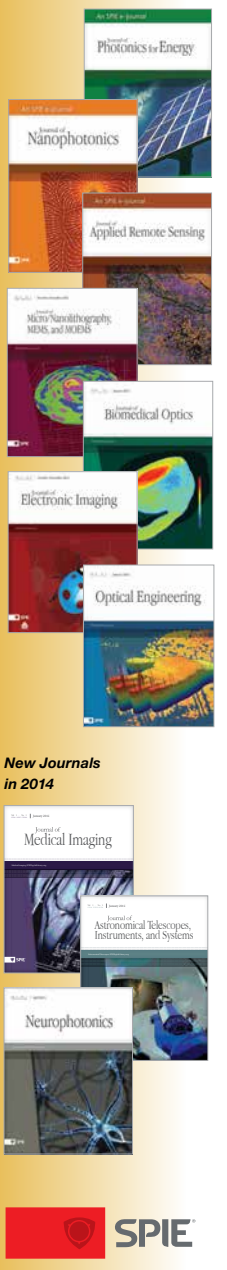

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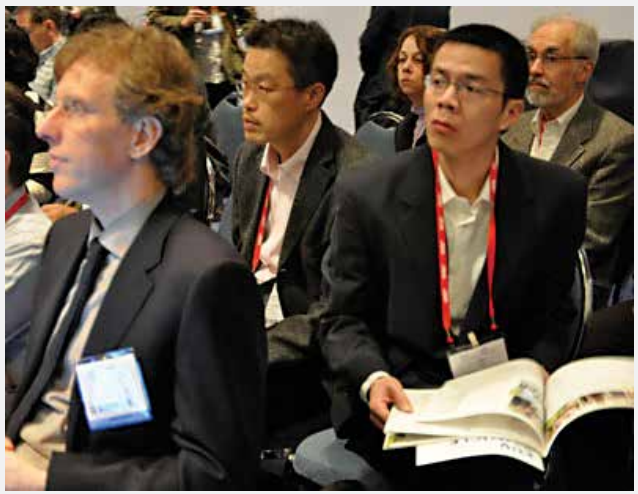

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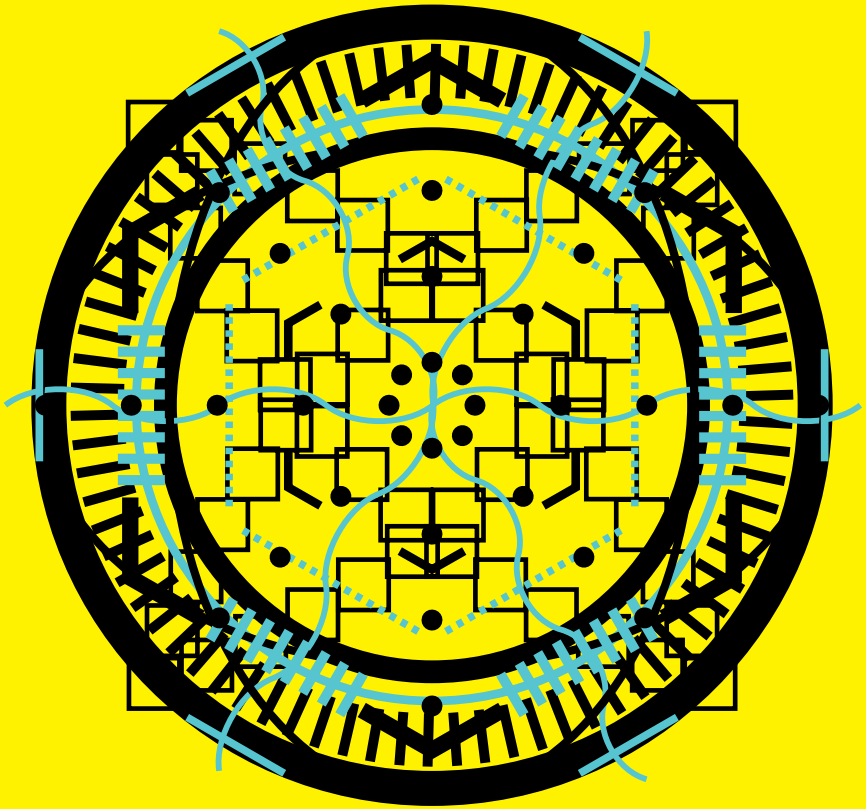

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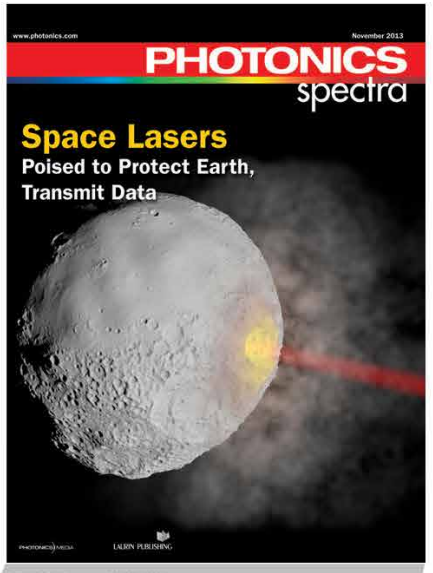

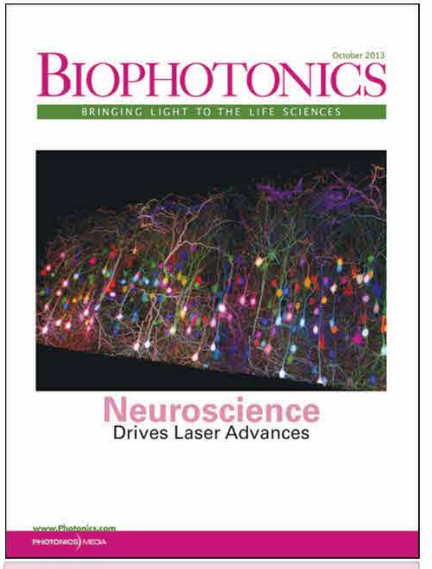

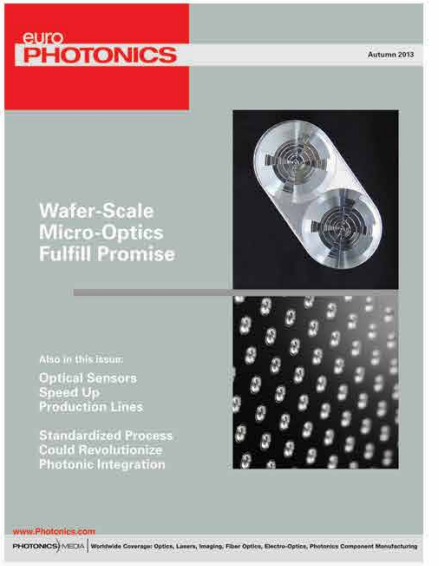

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