ADVANCED LITHOGRAPHY

TECHNICAL PROGRAM

SAN JOSE, CALIFORNIA, USA

Conferences and Courses:
23–27 February 2020

Exhibition:
25–26 February 2020

#SPIELitho spie.org/al

SPIE.

ADVANCED LITHOGRAPHY

CONNECTING MINDS.
ADVANCING LIGHT.

ADVANCED LITHOGRAPHY 2020

TECHNOLOGIES FOR LITHOGRAPHY R&D, DEVICES, TOOLS, FABRICATION, AND SERVICES

Conferences and Courses: 23–27 February 2020

Exhibition: 25–26 February 2020

San Jose, California, USA

Welcome to San Jose

CUTTING-EDGE RESEARCH

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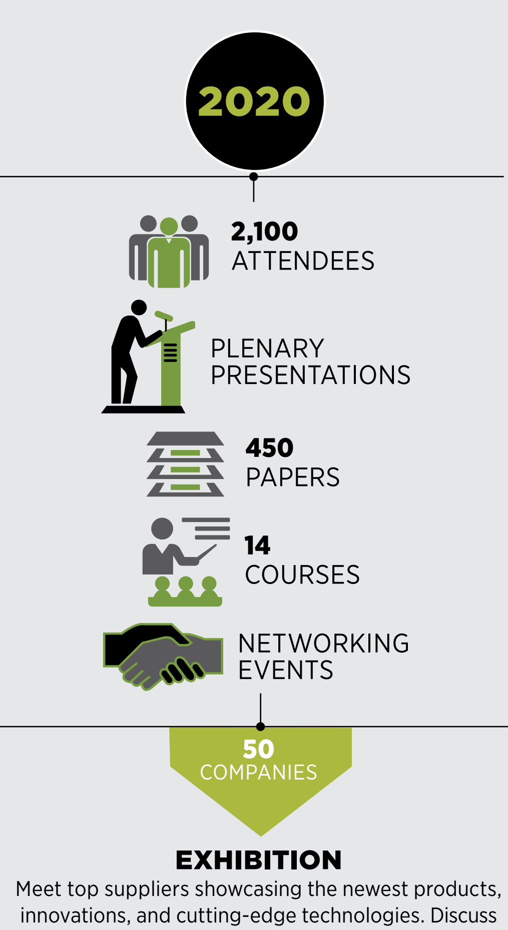
FOCUSED TECHNICAL TOPICS

spie.org/AL

New data laws mean you must opt in: Please sign up to receive email updates about this event — **www.spie.org/signup**



SPIE is the international society for optics and photonics, an educational not-for-profit organization founded in 1955 to advance light-based science, engineering, and technology. The Society serves nearly 264,000 constituents from 166 countries, offering conferences and their published proceedings, continuing education, books, journals, and the SPIE Digital Library in support of interdisciplinary information exchange, professional networking, and patent precedent. SPIE provided more than $5 million in support of education and outreach programs in 2019.

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

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

Welcome

For over 40 years, SPIE Advanced Lithography has played a key role in bringing together the micro- and nanolithography community. Lithography continues to be challenged to extend into ever-shrinking generations, yet remain manufacturable and cost effective. State-of-the-art processes continue with immersion lithography and multiple patterning, while EUV lithography moves closer toward production readiness. At the same time, the lithography community aggressively pursues alternative patterning approaches and complementary solutions. Success calls for unique interdisciplinary interactions and coordinated efforts between lithographers, layout designers, materials scientists, and metrology/process control engineers to enable cost-efficient patterning solutions.

A full spectrum of lithography and patterning topics are encompassed by this year's symposium across seven complementary conferences. Participants come from a broad array of backgrounds to share and learn about state-of-the-art lithographic tools, resists, metrology, materials, etch, design, process integration, and novel new approaches. Through provocative panel discussions and seminars, the symposium also probes current issues being faced as we extend current methods, move toward alternative approaches, and identify new ways to complement one technology with another.

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

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

We welcome you to San Jose for SPIE Advanced Lithography's 45th year!

2020 SYMPOSIUM CHAIRS

Will Conley
Cymer—An ASML company (USA)

Kafai Lai
IBM T.J. Watson Research Ctr. (USA)

Plenary Presentations
pages 6–7

Don't miss these world-class speakers discussing the latest directions and most promising breakthroughs.

Special Events
page 8

Join your peers and colleagues at these special events including the Welcome Reception, and a Panel Discussion: EUV Lithography Perspective: From the Beginning to HVM, and symposium-wide Panel Discussion.

Award Announcements
page 9

Don't miss any of the award announcemnts and presenations at 2020 Advanced Lithography.

Exhibition
page 13

Exhibit at SPIE Advanced Lithography. Join global suppliers for lithography research and development, devices, tools, fabrication, and services.

EXECUTIVE COMMITTEE

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Will Conley, Cymer – An ASML company (USA)
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Chris A. Mack, Fractilia, LLC (USA)
Christopher J. Progler, Photronics, Inc. (USA)
Bruce W. Smith, Rochester Institute of Technology (USA)
Anthony Yen, ASML US, LP (USA)

Download the SPIE Conference App

Join industry leaders to solve the latest challenges in lithography and patterning in the semiconductor industry.

Conferences: Hear the latest advancements in optical lithography, metrology, and EUV.

7 CONFERENCES

Extreme Ultraviolet (EUV) Lithography XI *(Felix)* 16–45

Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020 *(Sanchez)* 16–45

Metrology, Inspection, and Process Control for Microlithography XXXIV *(Adan)* 16–45

Advances in Patterning Materials and Processes XXXVII *(Gronheid)* 16–34

Optical Microlithography XXXIII *(Owa)* 17–35

Design-Process-Technology Co-optimization for Manufacturability XIV *(Yuan)* 17–45

Advanced Etch Technology for Nanopatterning IX *(Wise)* 17–33

APPLICATION TRACKS

Look for these icons to help you easily locate presentations you want to attend on these hot topics. The presentations are scheduled to prevent timing conflicts.

Stochastics

Overlay

Machine Learning

Courses: Stay competitive. Optimal training for career enhancement, taught by recognized experts in industry and academia. See page 11 for schedule.

14 COURSES

- SC101 **Introduction to Microlithography: Theory, Materials, and Processing** (Bowden, Dammel)
- SC1030 **Interaction of Physical Design and Lithography** (Yuan)
- SC1099 **Chemistry and Lithography** (Okoroanyanwu)
- SC1100 **Scatterometry in Profile, Overlay and Focus Process Control** (Cramer, Turovets)
- SC111 **Lithography Process Control** (Levinson)
- SC1132 **Computational Basis for Advanced Lithography Techniques** (Lai)
- SC1133 **Advanced concepts in Metrology Toolset Stability and Matching** (Adan)
- SC1158 Overlay **Metrology of Image Placement** (Starikov)
- SC1263 Stochastics **Stochastic Lithography** (Mack, Petersen)
- SC1264 Machine Learning **Machine Learning for Lithography** (Shiely)
- SC616 **Practical Photoresist Processing** (Dammel)
- SC885 **Principles and Practical Implementation of Multiple Patterning** (Dusa, Hsu) CANCELLED
- SC888 **EUV Lithography** (Bakshi, Ahn, Naulleau)
- SC992 **Lithography Integration for Semiconductor FEOL & BEOL Fabrication** (Lin, Zhang)

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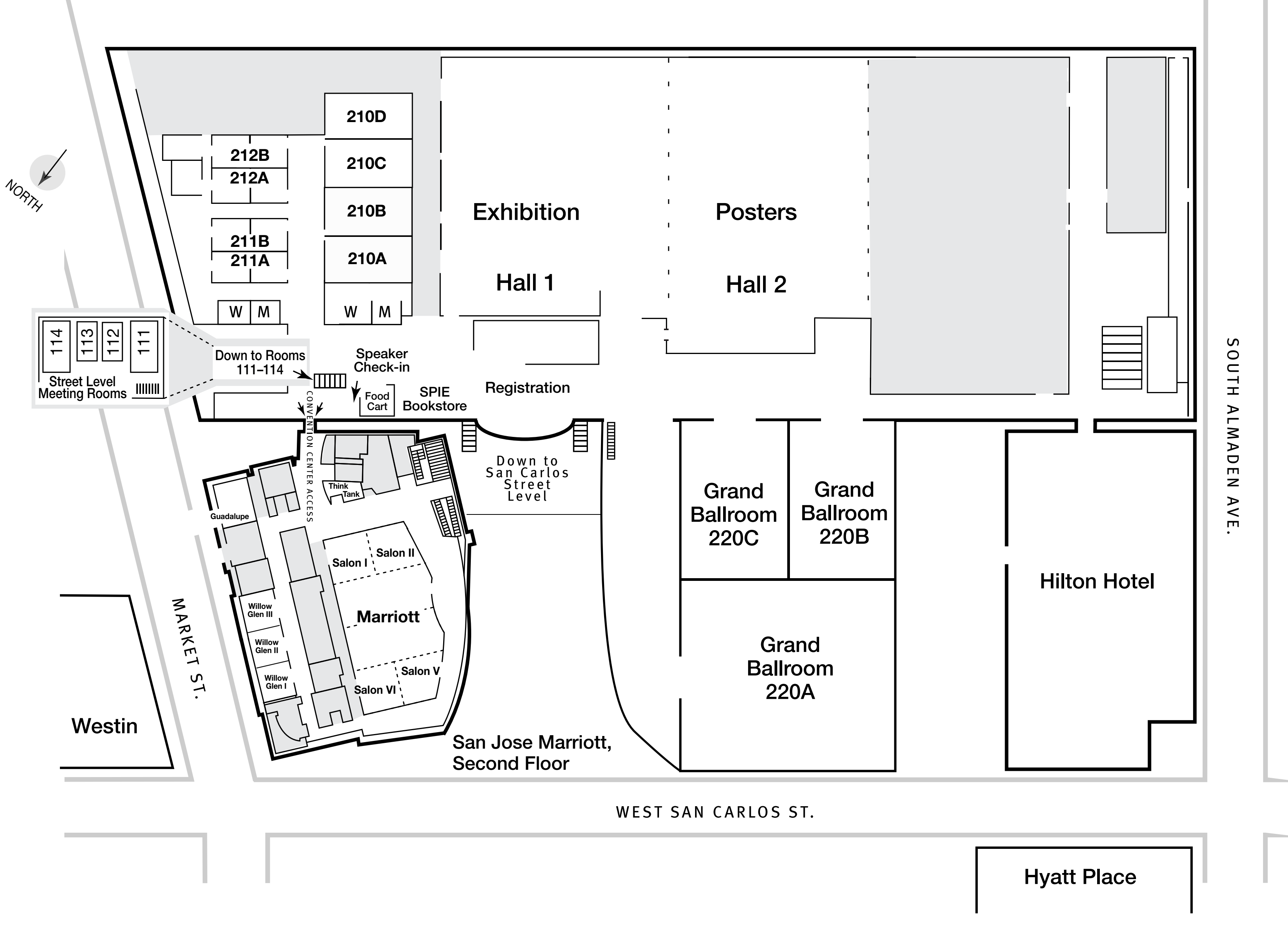
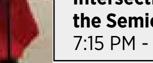
SAN JOSE CONVENTION CENTER AND MARRIOTT HOTEL 2ND LEVEL



DAILY SCHEDULE

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY

Special Events



MONDAY

Welcome and Announcements; Introduction of New SPIE Fellows; Presentation of the Zernike Awards; Presentation of the Nick Cobb Memorial Scholarship, 8:00 - 8:30 AM, p. 6

Plenary Presentation: **High performance mapping for deep learning applications** (Rush), 8:30 - 9:10 AM, p, 6

Plenary Presentation: **In-memory computing for AI applications** *(Eleftheriou),* 8:30 AM - 9:10 AM, p. 7

Plenary Presentation: **Process technologies leading a future of semiconductor memory (KIOKU) devices** *(Hashimoto),* 9:50 AM - 10:30 AM, p. 7

SPIE Fellow Member and Student Luncheon, 12:30 PM - 1:30 PM, p. 8

Welcome and Networking Event, 6:00 PM - 7:00 PM, p. 8

Intersecting the Quantum Future and the Semiconductor Industry *(Barnes),* 7:15 PM - 8:45 PM, p. 8

TUESDAY

EXHIBITION, 10:00 AM - 5:00 PM

Women in Optics Networking Lunch, 12:00 PM - 1:00 PM, p. 8

Panel Discussion: **EUV Lithography Perspective: From the Beginning to HVM,** 3:50 PM - 5:50 PM, p. 8

LGBTQ Lithographers Social, 5:00 PM - 8:00 PM, p. 8

Symposium-wide Panel Discussion, 6:00 PM - 8:00 PM, p. 8

WEDNESDAY

EXHIBITION, 10:00 AM - 4:00 PM

Poster Session, 5:30 PM - 7:30 PM, p. 8

Conferences

Conference	Days
Extreme Ultraviolet (EUV) Lithography XI *(Felix),* p. 16–45	Monday – Thursday
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020 *(Sanchez),* p. 16-45	Monday – Thursday
Metrology, Inspection, and Process Control for Microlithography XXXIV *(Adan),* p. 16–45	Monday – Thursday
Advances in Patterning Materials and Processes XXXVII *(Gronheid),* p. 16–35	Monday – Thursday
Optical Microlithography XXXIII *(Owa),* p. 17–35	Tuesday – Wednesday
Design-Process-Technology Co-optimization for Manufacturability XIV *(Yuan),* p. 17–45	Wednesday – Thursday
Advanced Etch Technology for Nanopatterning IX *(Wise),* p. 17–33	Tuesday – Wednesday

COURSES: Sunday, Monday, and Thursday
See Course schedule page 11.
See course descriptions and register onsite.

Monday 24 February 2020 · 8:00 AM - 10:30 AM
Location: Convention Center, Grand Ballroom 220A

8:00 AM - 8:30 AM

Welcome and Announcements

Symposium Chairs: **Will Conley,** Cymer-An ASML Company (USA) and **Kafai Lai,** IBM T. J. Watson Research Ctr. (USA)

- Introduction of New SPIE Fellows

- 2020 Zernike Award Presentation to

Winfried Kaiser,
Semiconductor Manufacturing Technology Business Group; Carl Zeiss SMT GmbH

- Presentation of the Nick Cobb Memorial Scholarship

8:30 AM - 10:30 AM

Plenary Presentations

Plenary presentations sponsored by

Canon

8:30 AM - 9:10 AM

High performance mapping for deep learning applications

Allen Rush
Senior Fellow, Advanced Micro Devices, Inc. (USA)

Deep Learning has emerged as a powerful tool for many types of applications, including detection, classification, semantic interpretation and many other challenging, data driven applications. This talk addresses the challenges of the mapping of the key algorithms for deep learning onto the various engines and accelerators that are used in HW and SW platforms.

Allen Rush is currently a Senior Fellow at AMD. His main responsibility is chief scientist for machine learning, including strategies, technology development and product planning. Previously he held a similar role for imaging and computer vision. Prior to joining AMD, he spent many years focusing on imaging technologies, including CTO positions at several startup companies.

9:10 AM - 9:50 AM

In-memory computing for AI applications

Evangelos Eleftheriou
IBM Fellow, Cloud & Computing Infrastructure Zurich Research Laboratory, IBM Research - Zürich (Switzerland)

Performing computations on conventional von Neumann computing systems results in a significant amount of data being moved back and forth between the physically separated memory and processing units. This costs time and energy, and constitutes an inherent performance bottleneck. It is becoming increasingly clear that for application areas such as AI (Artificial Intelligence), we need to transition to computing architectures in which memory and logic coexist in some form. In-memory computing is a novel non-von Neumann approach where certain computational tasks are performed in the memory itself. This is enabled by the physical attributes and state dynamics of memory devices, in particular resistance-based non-volatile memory technology. Several computational tasks such as logical operations, arithmetic operations and even certain machine learning tasks can be implemented in such a computational memory unit. I will present how computational memories accelerate AI applications and will show small- and large-scale experimental demonstrations that perform high-level computational primitives, such as ultra-low-power inference engines, optimization solvers including compressed sensing and sparse coding, linear solvers and temporal correlation detection. Moreover, I will discuss the efficacy of this approach to efficiently address not only inferencing but also training of deep neural networks. The results show that

this co-existence of computation and storage at the nanometer scale could be the enabler for new, ultra-dense, low-power, and massively parallel computing systems. Thus, by augmenting conventional computing systems, in-memory computing could help achieve orders of magnitude improvement in performance and efficiency.

Evangelos Eleftheriou, received his Ph.D. degree in Electrical Engineering from Carleton University, Ottawa, Canada, in 1985. In 1986, he joined the IBM Research – Zurich laboratory in Rüschlikon, Switzerland, as a Research Staff Member. Since 1998, he has held various management positions and is currently responsible for the neuromorphic computing activities of IBM Research – Zurich. His research interests include signal processing, coding, non-volatile memory technologies and emerging computing paradigms such as neuromorphic and in-memory computing for AI applications. He has authored or coauthored over 200 publications, and holds over 160 patents (granted and pending applications). In 2002, he became a Fellow of the IEEE. He was co-recipient of the 2003 IEEE Communications Society Leonard G. Abraham Prize Paper Award. He was also co-recipient of the 2005 Technology Award of the Eduard Rhein Foundation. In 2005, he was appointed an IBM Fellow. The same year he was also inducted into the IBM Academy of Technology. In 2009, he was co-recipient of the IEEE CSS Control Systems Technology Award and of the IEEE Transactions on Control Systems Technology Outstanding Paper Award. In 2016, he received an honoris causa professorship from the University of Patras, Greece. In 2018, he was inducted into the US National Academy of Engineering as Foreign Member.

9:50 AM - 10:30 AM

Process technologies leading a future of semiconductor memory (KIOKU) devices

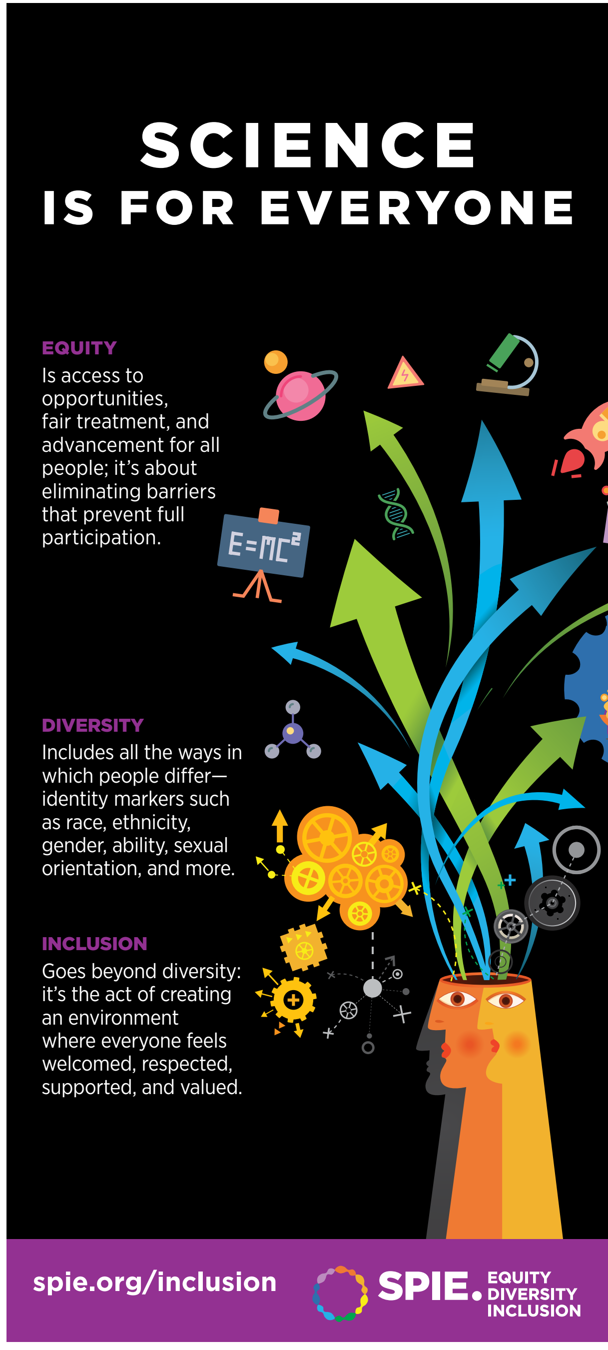
Koji Hashimoto

General Manager, Process Technology Research & Development Center, KIOXIA Corp. (Japan)

"KIOKU" in Japanese means "memory," but the word entails much more than merely recording data. KIOKU encompasses powerful, emotional and nostalgic memories – the type of memories that define humanity and life. To uplift the world with memory (KIOKU), we have developed new memory technologies to meet the demands of a rapidly changing market. As we enter the IoT era, the amount of data produced and consumed by data centers, in industry, by surveillance, in automobiles, and so on, continues to grow. Therefore, the demand for and importance of non-volatile memory also continues to grow, alongside demands for lower prices, higher performance and improved reliability. To meet these demands, we developed revolutionary technologies including multi-bit-per cell technology and three-dimensional Flash memory technology. Recently, in addition, new storage class memory (SCM) technology is being developed to bridge the gap between flash memory and DRAM, enabling a new generation of electronic devices. Manufacturing process technology must adapt quickly and efficiently to keep up with rapidly changing design techniques. During this talk, Mr. Hashimoto will provide an overview of the key steps in the memory manufacturing process. In addition, Mr. Hashimoto will provide guidance regarding how process and lithography engineers might approach the current paradigm shift in manufacturing process technology.

Koji Hashimoto received an MS degree in electric engineering from Kyusyu University, Fukuoka, in 1988. After joining Toshiba ULSI Research Center, Toshiba Corporation, Kawasaki, in 1988, he worked on the development of megabit DRAM device technology with Fujio Masuoka who is inventor of Flash memory. With the first announcement of RIM type (Self aligned) Phase shift mask technology in IEDM 1989, he worked on Phase shift mask development for sub-half micron lithography. From 1993 to 1996, he joined the quarter micron DRAM development project with IBM and Siemens at IBM East Fishkill, NY, and worked on lithography process development. From 1996 to 2009, he worked the development of high-end lithography technology and its application to the Flash memory, DRAM, high-end CMOS, SRAM, CMOS Sensors at the Process and Manufacturing Engineering Center, Toshiba Corporation, Yokohama. From 2009 to 2013, for Group Manager of Advanced Lithography Process Group, at the Advanced Memory Development Center, Toshiba Corporation, Yokkaichi, he led lithography development for 32nm to 15nm NAND Flash memory. From 2013 to 2016, for Director of Advanced Fine-patterning Development Department and Advanced Process Development Department, at the Advanced Memory Development Center, Toshiba Corporation, Yokkaichi, he managed the development of lithography, dry etching and other unit processes for the 3D memories. After joining to the Institute of Memory Technology Research and Development in 2017, for General Manager of Process Technology Research and Development Center, Toshiba Memory Corporation, Yokkaichi, he has been top managed Research and Development of all unit processes related to new memories. From Oct. 1th 2019, Toshiba Memory Corporation was changed company name to Kioxia Corporation. In SPIE related work, his 7 papers in SPIE Micro-lithography (1998, 2002, 2003, 2004, 2006, 2008, 2009) and 2 papers in SPIE Asia (2008) were published for the first author.

Break 10:30 AM to 11:00 AM
Coffee service available until 4:00 PM



SPECIAL EVENTS

Technical Events

Intersecting the Quantum Future and the Semiconductor Industry

Monday 24 February 2020 · 7:15 PM - 8:45 PM
Location: Convention Center, Grand Ballroom 220C

Moderators: **Bryan M. Barnes,** NIST; **Erik Hosler,** PsiQuantum; R. **Joseph Kline,** NIST

Quantum computing has been a long-anticipated emerging computational paradigm to complement and compete with conventional CMOS technologies. The last decade has featured reports of the initial development of using CMOS processing techniques for qubits and the atomistic fabrication of single atom transistors. Will the semiconductor industry embrace this new architype, and if so, how? When quantum devices begin to scale as predicted, will our industry be ready to integrate radically different architectures and device structures? Are there known obstacles not yet addressed that would enable the industry to more readily adopt and benefit from today's achievements in the laboratory? What are the emerging designs and the potential fundamental challenges that are to be overcome? We have assembled a panel of experts that will share their insights on the state-of-the-art in quantum computing as well as intellectual leaders that will share their vision of the eventual merger of these new technologies with our computing capabilities today, even as lithography is approaching the near-atomic domain. Join us as we discuss the impending critical impact of quantum computing on the semiconductor industry.

Panel Discussion: *EUV Lithography Perspective: From the Beginning to HVM*

Tuesday 25 February 2020 · 3:50 PM - 5:50 PM
Location: Convention Center, Grand Ballroom 220A

Moderatos: **Nelson Felix,** IBM Thomas J. Watson Research Ctr. and **David T. Attwood,** Univ. of California, Berkeley.

SPIE will celebrate the entry of Extreme Ultraviolet Lithography (EUVL) into high volume manufacturing (HVM) with a special retrospective session. Highlights will include perspectives by true pioneers of EUVL, the formation of early teams, the gathering of resources and organization of the industry based EUV LLC and its partnering with the three national laboratory 'Virtual National Laboratory', the hand-off to SEMATECH and industry partners, the emergence of key suppliers, and IC manufacturers' efforts in partnership with ASML and other suppliers.

Presenters: Hiroo Kinoshita, Bill Silfvast, Andy Hawryluk, John Carruthers, Chuck Gwyn, Peter Silverman, Rick Stulen, Don Sweeney, Stefan Wurm, Yan Borodovsky, Anthony Yen, Winfried Kaiser, Jos Benschop, Robert Brainard, Frank Abboud, Song-Sue Kim, and Martin van den Brink.

Sponsored by

Symposium-wide Panel Discussion

Tuesday 25 February 2020
6:00 PM - 8:00 PM
Location: Convention Center,
Grand Ballroom 220A

Symposium Chairs: **Will Conley,** Cymer–An ASML company and **Kafai Lai,** IBM T. J. Watson Research Ctr.

Moderators: **Chris Mack,** Fractilia, LLC and **Harry J. Levinson,** HJL Lithography.

The topic of this year's symposium-wide panel is "A toast to Lithography's past: what we learned from technologies not used in HVM." Over the years, a number of lithographic concepts were pursued for use in manufacturing when optical lithography finally reached its long-anticipated limits. While there appeared to be good reasons initially to invest substantially, in terms of people and money, in these concepts, most were not ultimately adopted for use in high-volume manufacturing (HVM). In this year's symposium-wide panel, people who were involved in developing these concepts will share their perspectives on what lessons can be learned from their experiences.

Poster Session

Wednesday 26 February 2020
5:30 PM - 7:30 PM
Location: Convention Center, Hall 2

All symposium attendees – You are invited to attend the evening Poster Session to view the high-quality posters and engage the authors in discussion. Enjoy light refreshments while networking with colleagues in your field. Authors may set up their posters between 10:00 am and 5:00 pm the day of their poster session. Attendees are required to wear their conference registration badges to access the poster session.

Posters that are not set up by the 5:00 pm cut-off time will be considered no-shows, and their manuscripts may not be published. Poster authors should accompany their posters from 5:30 to 7:30 pm to answer questions from attendees. All posters and other materials must be removed no later than 7:45 pm. Any posters or materials left behind at the close of the poster session will be considered unwanted and will be discarded. SPIE assumes no responsibility for posters left up after the end of each poster session.

Sponsored by EMD Performance Materials

Social Networking Events

SPIE Fellow Member and Student Luncheon

Monday 24 February 2020 · 12:30 PM - 1:30 PM
Location: Marriott, Salon V

Student conference attendees and SPIE Fellow Members are invited to this engaging networking lunch. This event gives students an opportunity to network with SPIE Fellows who will share their insights into career paths in lithography. Lunch is complimentary. Fellow Members will receive a personal invitation, student seating is available on a first-come, first-served basis.

Women in Optics Networking Lunch

Tuesday 25 February 2020 · 12:30 PM - 1:30 PM
Location: Convention Center, Room 114

Join other women in the field for informal discussions and networking during the scheduled lunch on Tuesday. Open to women with a paid registration badge. No advance registration is required. However, seating is limited and will be granted on a first-come, first-served basis..

LGBTQ+ Lithographers Social

Tuesday 25 February 2020 · 7:00 PM - 8:00 PM
Location: Paper Plane (72 S. First Street)

Relax and make new friends at this informal gathering of LGBTQ+ lithographers and scientists! The event will be held a short walk from the Convention Center at the Paper Plane cocktail bar. Allies always welcome. Contact Maryann (tungmc@stanford.edu) with any questions.

Welcome and Networking Event

Monday 24 February 2020 · 6:00 PM - 7:00 PM
Location: Convention Center, Grand Ballroom Concourse

Join your colleagues at the Welcome Reception. Relax, socialize, and enjoy beverages and hors-d'oeuvres on the first night of the conference. All attendees welcome.

Please remember to wear your registration badge. Dress is casual.

Meet the Editor Reception

Wednesday 26 February 2020 · 5:30 PM - 6:30 PM
Location: Convention Center, Hall 2, (during the Poster Session)

Meet Harry Levinson, Co-Editor-in-Chief of the SPIE Journal of Micro/Nanolithography, MEMS, and MOEMS (JM3). Please remember to wear your conference registration badge to access the poster session.

Metrology, Inspection, and Process Control for Microlithography (11325)

Monday 24 February 2020 · 10:50 to 11:10 AM

Presentation of the 2019 Diana Nyyssonen Memorial Award for Best Paper in Metrology

Award Sponsored by

Thursday 27 February 2020 · 9:40 to 10:00 AM

Presentation of the 2020 Karel Urbánek Best Student Paper Award

Award Sponsored by

Advances in Patterning Materials and Processes (11326)

Monday 24 February 2020 · 2:00 to 2:10 PM

Presentation of the 2019 C. Grant Willson Award for Best Paper

and

Presentation of the 2019 Hiroshi Ito Memorial Award for the Best Student Paper

These Awards Sponsored by

Presentation of the 2019 Jeffrey Byers Memorial Best Poster Award

Award Sponsored by

Extreme Ultraviolet (EUV) Lithography (11323)

Thursday 27 February 2020 · 3:10 to 3:30 PM

Presentation of the 2020 Cymer Leadership for Best Student Paper Award

Award Sponsored by

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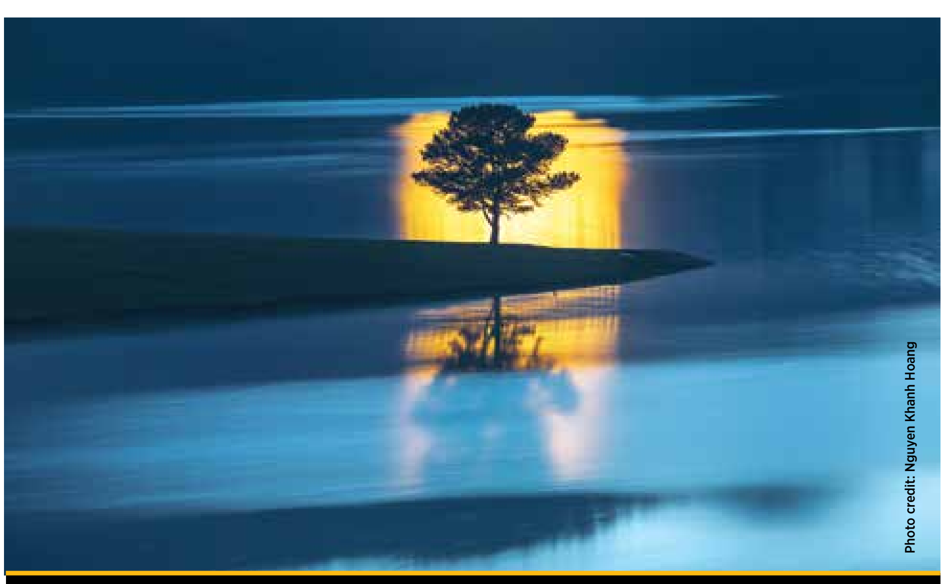
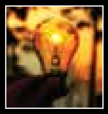
COURTESY OF SPIE.



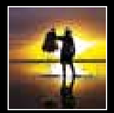
The International Day of Light is a global initiative highlighting to the citizens of the world the importance of light and light-based technologies in their lives, for their futures, and for the development of society.

SPIE supports the International Day of Light and its annual celebration on 16 May.



SPIE IDL GRANTS

SPIE will provide seed funding up to US$3,000 to organizations creating Day of Light activities.



IDL RESOURCES

SPIE encourages communities to plan their own annual celebration on 16 May and provides various resources to help create an event.

SPIE PHOTO CONTEST

Amateur and professional photographers alike should submit photos demonstrating the vital role that light plays in our lives for a chance to win US$2,500.

SPIE.

Learn more: **spie.org/idl**

COMMUNITY SUPPORT

Helping You Create The Future

In 2019, SPIE provided over $5 million in community support including scholarships and awards, outreach and advocacy programs, travel grants, public policy, and educational resources.

We are an educational, not-for-profit organization that contributes a significant percentage of revenue, every month, every year, without a separate fundraising campaign or administrative foundation.

It's what we do.

But we couldn't do it without you and the time of volunteers around the world.

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Learn more and join us.

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COURSES

SPIE Courses are focused, efficient training from the most experienced and accomplished minds in industry and research.

Gain knowledge from the experts and apply it directly to your daily work.

- Learn from the best. This is your opportunity for direct instruction from legends in the semi/litho industry, many of whom are pioneers in their fields
- Course topics are aligned with current industry needs and trends
- Earn CEUs for professional continuing education requirements

spie.org/education

Information for Course attendees:
spie.org/education/course-attendees

SUNDAY 23 FEBRUARY 2020

SC101 **Introduction to Microlithography: Theory, Materials, and Processing** (Bowden, Dammel) 8:30 AM - 5:30 PM, $685 / $397 / $805

SC111 **Lithography Process Control** (Levinson) 8:30 AM - 5:30 PM, $730 / $415 / $850

SC885 **Principles and Practical Implementation of Multiple Patterning** (Dusa, Hsu) 8:30 AM - 5:30 PM, $685 / $397 / $805 CANCELLED

SC888 **EUV Lithography** (Bakshi, Ahn, Naulleau) 8:30 AM - 5:30 PM, $920 / $491 / $1,040

SC992 **Lithography Integration for Semiconductor FEOL & BEOL Fabrication** (Lin, Zhang) 8:30 AM - 5:30 PM, $685 / $397 / $805

SC1099 **Chemistry and Lithography** (Okoroanyanwu) 8:30 AM - 5:30 PM, $785 / $437 / $905

SC1100 **Scatterometry in Profile, Overlay and Focus Process Control** (Cramer, Turovets) 1:30 PM to 5:30 PM, $420 / $269 / $485

SC1132 **Computational Basis for Advanced Lithography Techniques** (Lai) 8:30 AM - 12:30 PM, $420 / $269 / $485

SC1133 **Advanced concepts in Metrology Toolset Stability and Matching** (Adan) 1:30 PM - 5:30 PM, $420 / $269 / $485

SC1158 **Metrology of Image Placement** (Starikov) 1:30 PM to 5:30 PM, $425 / $271 / $490

SC1263 **Stochastic Lithography** (Mack, Petersen) 8:30 AM - 5:30 PM, $685 / $397 / $805

SC1264 **Machine Learning for Lithography** (Shiely) 8:30 AM - 5:30 PM, $730 / $415 / $850

MONDAY 24 FEBRUARY 2020

SC1030 **Interaction of Physical Design and Lithography** (Yuan) 1:30 PM to 5:30 PM, $420 / $269 / $485

THURSDAY 27 FEBRUARY 2020

SC616 **Practical Photoresist Processing** (Dammel) 8:30 AM - 12:30 PM, $420 / $269 / $485

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- **Stochastics**
- **Overlay**

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Tuesday 25 February 2020
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Wednesday 26 February 2020
10:00 AM - 4:00 PM

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SESSION SCHEDULE

	CONFERENCE 11323 **Extreme Ultraviolet (EUV) Lithography XI**	CONFERENCE 11324 **Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020**	CONFERENCE 11325 **Metrology, Inspection, and Process Control for Microlithography XXXIV**
Monday 24 February	**Session 1** · Mon 11:00 AM to 12:20 PM **Keynote Session** **Session 2** · Mon 1:20 PM to 3:20 PM **The Future is High NA** **Session 3** · Mon 3:50 PM to 5:50 PM **Inorganic Resists: Joint Session with conferences 11323 and 11326**	**Opening Remarks** · 3:30 PM to 3:50 PM **Session 1** · Mon 3:50 PM to 5:10 PM **Keynote Session**	**Opening Remarks and Award Announcements** · 10:50 AM to 11:10 AM **Session 1** · Mon 11:10 AM to 12:30 PM **Keynote Session** **Session 2** · Mon 1:30 PM to 3:30 PM **Pattern Placement and Overlay Metrology I** **Session 3** · Mon 3:50 PM to 5:30 PM **Challenges and New Methods**
Tuesday 25 February	**Session 4** · Tue 8:00 AM to 10:00 am **Stochastics: Joint Sessions with Conferences 11323 and 11326** **Session 5** · Tue 10:30 AM to 12:30 PM **Stochastics of EUV Patterning** **Session 6** · Tue 2:00 PM to 3:00 PM **EUV Scanner Monitoring** **EUV Poster Preview Speed Talks I** · 3:00 to 3:20 PM **Panel discussion** · 3:50 PM to 5:50 PM **EUV Lithography Retrospective: from the beginning to HVM**	**Session 2** · Tue 8:00 AM to 10:00 AM **Imprint Lithography** **Session 3** · Tue 10:30 AM to 12:10 PM **Scanning Probe Lithography** **Session 4** · Tue 1:40 PM to 3:00 PM **Nanoimprint Lithography for Semiconductors** **Session 5** · Tue 3:30 PM to 6:30 PM **Quantum Computing**	**Session 4** · Tue 8:00 AM to 10:00 am **Inspection and Mass Metrology** **Session 5** · Tue 10:30 AM to 12:10 PM **High Aspect Ratio Metrology** **Session 6** · Tue 1:40 PM to 3:00 PM **Roughness Metrology** **Session 7** · Tue 3:30 PM to 5:10 PM **New Methods: Student Session**
Wednesday 26 February	**Session 7** · Wed 8:00 AM to 10:00 am **EUV Patterning and Etch: Joint session with conferences 11323 and 11329** **Session 8** · Wed 10:30 AM to 11:50 am **Progress in EUV Sources** **Session 9** · Wed 1:20 PM to 3:40 PM **Progress in EUV Masks** **Session 10** · Wed 4:10 PM to 4:50 PM **EUV OPC and Modeling** **EUV Poster Preview Speed Talks II** · 4:50 to 5:30 PM	**Session 6** · Wed 8:00 AM to 10:00 AM **Multi-Beam Mask Writing** **Session 7** · Wed 10:30 AM to 12:10 PM **Multi-Beam Direct Write Lithography** **Session 8** · Wed 1:40 PM to 3:00 PM **3-D Printing** **Session 9** · Wed 3:30 PM to 5:30 PM **Neuromorphic Computing**	**Session 8** · Wed 8:00 AM to 10:00 am **3D Profile and Shape Analysis** **Session 9** · Wed 10:30 AM to 12:10 PM **Scatterometry** **Session 10** · Wed 1:40 PM to 3:00 PM **Machine Learning** **Session 11** · Wed 3:30 PM to 5:30 PM **Pattern Placement and Overlay Metrology II**
Thursday 27 February	**Session 11** · Thu 8:00 AM to 10:20 am **EUV Resist Fundamentals** **Session 12** · Thu 10:50 AM to 12:30 PM **EUV Mask Inspection and Pellicle** **Session 13** · Thu 1:30 PM to 3:10 PM **New Concepts in EUV** **ASML Best Student Paper Award and Closing Remarks** · 3:10 PM to 3:30 PM	**Session 10** · Thu 8:00 AM to 10:00 AM **Atomically Precise Lithography: TopDown Approach** **Session 11** · Thu 10:30 AM to 11:50 AM **Atomically Precise Lithography: BottomUp Approach** **Session 12** · Thu 1:40 PM to 3:20 PM **MEMS/NEMS** **Session 13** · Thu 3:50 PM to 4:50 PM **Novel Patterning and Applications**	**Session 12** · Thu 8:00 AM to 9:40 AM **Metrology for the EUV Era** **2020 Karel Urbánek Best Student Paper Award Presentation** · 9:40 AM to 10:00 AM **Session 13** · Thu 10:30 AM to 12:10 PM **Pattern Placement and Overlay Metrology III** **Session 14** · Thu 1:40 PM to 3:00 PM **Late Breaking News**

CONFERENCE 11326 **Advances in Patterning Materials and Processes XXXVII**	CONFERENCE 11327 **Optical Microlithography XXXIII**	CONFERENCE 11328 **Design-Process-Technology Co-optimization for Manufacturability XIV**	CONFERENCE 11329 **Advanced Etch Technology for Nanopatterning IX**
Opening Remarks and Awards Announcements · 2:00 PM to 2:10 PM **Session 1** · Mon 2:10 PM to 3:10 PM **Keynote Session** **Session 2** · Mon 3:50 PM to 5:50 PM **Inorganic Resists: Joint Session with conferences 11323 and 11326**			
Session 3 · Tue 8:00 AM to 10:00 AM **Stochastics: Joint Sessions with Conferences 11323 and 11326** **Session 4** · Tue 10:30 AM to 12:10 PM **Novel Resists** **Session 5** · Tue 1:40 PM to 3:20 PM **Fundamentals and Modeling** **Session 6** · Tue 3:50 PM to 5:30 PM **Integration**	**Session 1** · Tue 10:30 AM to 12:10 PM **Keynote Session and Latest Topic** **Session 2** · Tue 1:40 PM to 3:20 PM **Machine Learning and Computational Lithography I** **Session 3** · Tue 3:50 PM to 5:30 PM **Machine Learning and Computational Lithography II**		**Session 1** · Tue 8:00 AM to 10:00 AM **Keynote Session** **Session 2** · Tue 10:30 AM to 12:10 PM **Materials and Etch Integration** **Session 3** · **Tue 1:40 PM to 3:20 PM** **Computational Patterning and Patterning Process Control** **Session 4** · Tue 3:50 PM to 5:40 PM **Atomic Layer Etching and Novel Plasma Techniques**
Session 7 · Wed 8:10 AM to 10:00 AM **Deposition-based Patterning** **Session 8** · Wed 10:30 AM to 12:10 PM **Novel Patterning** **Session 9** · Wed 1:40 PM to 3:00 PM **Supplier** **Session 10** · Wed 3:30 PM to 5:10 PM **Underlayers** **Poster Preview Speed Talks** · 5:10 PM to 5:30 pm	**Session 4** · Wed 8:00 AM to 10:00 am **Process Control, Resist Modeling** **Session 5** · Wed 10:30 AM to 12:10 PM **Lithography Equipment, Focus Control** **Session 6** · Wed 1:40 PM to 3:00 PM **DUV and EUV Matching** **Session 7** · Wed 3:30 PM to 5:10 PM **Overlay and CD control**	**Session 1** · Wed 8:00 AM to 10:00 AM **AI and Machine Learning** **Session 2** · Wed 10:30 AM to 12:10 PM **Advanced Designs** **Session 3** · Wed 1:40 PM to 3:10 PM **Pattern Matching** **Session 4** · Wed 3:40 PM to 4:40 PM **DFM by Chip Makers**	**Session 5** · Wed 8:00 AM to 10:00 AM **EUV Patterning and Etch: Joint session with conferences 11323 and 11329** **Session 6** · Wed 10:30 AM to 12:10 PM **Patterning Solutions for Emerging Applications** **Session 7** · Wed 1:40 PM to 4:00 PM **Advanced Patterning Integration**
		Session 5 · Thu 8:00 AM to 10:00 AM **Design for Manufacturing** **Session 6** · Thu 10:30 AM to 12:00 PM **Device and Integration** **Session 7** · Thu 1:30 PM to 3:00 PM **DPTCO from Equipment Vendors** **Session 8** · Thu 3:30 PM to 5:00 PM **DPTCO from EDA Vendors**	**APPLICATION TRACKS** Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences. • **Machine Learning** • **Stochastics** • **Overlay**

CONFERENCE 11323

Monday - Thursday 24–27 February 2020 • Proceedings of SPIE Vol. 11323

Extreme Ultraviolet (EUV) Lithography XI

Conference Chair: **Nelson M. Felix,** IBM Corp. (USA)

Conference Co-Chair: **Anna Lio,** Intel Corp. (USA)

Program Committee: **Jos P. Benschop,** ASML Netherlands B.V. (Netherlands); **Robert L. Brainard,** SUNY CNSE/SUNYIT (USA); **Martin Burkhardt,** IBM Thomas J. Watson Research Ctr. (USA); **Sonia Castellanos Ortega,** Advanced Research Ctr. for Nanolithography (Netherlands); **Yasin Ekinci,** Paul Scherrer Institut (Switzerland); **Andreas Erdmann,** Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); **Allen H. Gabor,** IBM Corp. (USA); **Emily E. Gallagher,** IMEC (Belgium); **Kenneth A. Goldberg,** Lawrence Berkeley National Lab. (USA); **Naoya Hayashi,** Dai Nippon Printing Co., Ltd. (Japan); **Eric Hendrickx,** IMEC (Belgium); **Soichi Inoue,** Toshiba Memory Corp. (Japan); **Srividya Jayaram,** Mentor, a Siemens Business (USA); **Bryan S. Kasprowicz,** Photronics, Inc. (USA); **Insung Kim,** SAMSUNG Electronics Co., Ltd. (Korea, Republic of); **Seong-Sue Kim,** SAMSUNG Electronics Co., Ltd. (Korea, Republic of); **Toshio Konishi,** Toppan Printing Co., Ltd. (Japan); **Marie E. Krysak,** Intel Corp. (USA); **Ted Liang,** Intel Corp. (USA); **Chang-Moon Lim,** SK Hynix, Inc. (Korea, Republic of); **Luciana Meli,** IBM Corp. (USA); **Lawrence S. Melvin III,** Synopsys, Inc. (USA); **Hiroaki Morimoto,** Toppan Printing Co., Ltd. (Japan); **Patrick P. Naulleau,** Lawrence Berkeley National Lab. (USA); **Christopher S. Ngai,** Applied Materials, Inc. (USA); **Shinji Okazaki,** ALITECS Co., Ltd. (Japan); **Eric M. Panning,** Intel Corp. (USA); **Moshe E. Preil,** KLA Corp. (USA); **Kurt G. Ronse,** IMEC (Belgium); **Akiyoshi Suzuki,** Gigaphoton Inc. (Japan); **Anna Tchikoulaeva,** Lasertec U.S.A., Inc. Zweigniederlassung Deutschland (Germany); **Edita Tejnil,** Mentor Graphics Corp. (USA); **Thomas I. Wallow,** ASML Brion (USA); **Obert R. Wood II,** GLOBALFOUNDRIES Inc. (USA)

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CONFERENCE 11324

Monday - Thursday 24–27 February 2020 • Proceedings of SPIE Vol. 11324

Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

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

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

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Conference 11324 begins on page 20.

CONFERENCE 11325

Monday - Thursday 24–27 February 2020 • Proceedings of SPIE Vol. 11325

Metrology, Inspection, and Process Control for Microlithography XXXIV

Conference Chair: **Ofer Adan,** Applied Materials (Israel)

Conference Co-Chair: **John C. Robinson,** KLA Corp. (USA)

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CONFERENCE 11326

Monday - Wednesday 24–26 February 2020 • Proceedings of SPIE Vol. 11326

Advances in Patterning Materials and Processes XXXVII

Conference Chair: **Roel Gronheid,** KLA-Tencor/ICOS Belgium (Belgium)

Conference Co-Chair: **Daniel P. Sanders,** IBM Research - Almaden (USA)

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CONFERENCE 11327

Tuesday - Wednesday 25–26 February 2020 • Proceedings of SPIE Vol. 11327

Optical Microlithography XXXIII

Conference Chair: **Soichi Owa,** Nikon Corp. (Japan)

Conference Co-Chair: **Mark C. Phillips,** Intel Corp. (USA)

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CONFERENCE 11328

Wednesday - Thursday 26–27 February 2020 • Proceedings of SPIE Vol. 11328

Design-Process-Technology Co-optimization for Manufacturability XIV

Conference Chair: **Chi-Min Yuan,** NXP Semiconductors (USA)

Conference Co-Chair: **Ryoung-Han Kim,** IMEC (Belgium)

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CONFERENCE 11329

Tuesday - Wednesday 25–26 February 2020 • Proceedings of SPIE Vol. 11329

Advanced Etch Technology for Nanopatterning IX

Conference Chair: **Richard S. Wise,** Lam Research Corp. (USA)

Conference Co-Chair: **Catherine B. Labelle,** Intel Corp. (USA)

Program Committee: **Efrain Altamirano-Sánchez,** IMEC (Belgium); **John Arnold,** IBM Thomas J. Watson Research Ctr. (USA); **Keun Hee Bai,** SAMSUNG Electronics Co., Ltd. (Korea, Republic of); **Julie Bannister,** Tokyo Electron America, Inc. (USA); **Maxime Darnon,** LN2 CNRS (Canada); **Sebastian U. Engelmann,** IBM Thomas J. Watson Research Ctr. (USA); **Eric A. Hudson,** Lam Research Corp. (USA); **Kaushik A. Kumar,** Tokyo Electron Ltd. (Japan); **Qinghuang Lin,** IBM Thomas J. Watson Research Ctr. (USA); **Ru-Gun Liu,** Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Nihar Mohanty,** Oculus VR, LLC (USA); **Jake O'Gorman,** Hitachi High Technologies America, Inc. (USA); **Erwine Pargon,** CNRS/LTM (France); **Nicolas Posseme,** CEA-LETI (France); **Ricardo Ruiz,** Lawrence Berkeley National Lab. (USA); **Yuyang Sun,** Mentor Graphics Corp. (USA); **Ying Zhang,** NAURA (USA); **Anthony Yen,** ASML US, LP (USA)

Conference 11329 begins on page 21.

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Monday 24 February

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

PLENARY SESSION · ROOM: CONVENTION CENTER, GRAND BALLROOM 220A · 8:00 AM TO 10:00 AM

8:00 AM to 8:30 AM · **Welcome and Announcements**

Symposium Chairs: **Will Conley,** Cymer, An ASML Company (USA), and **Kafai Lai,** IBM T. J. Watson Research Ctr. (USA)

- **Introduction of New SPIE Fellows**
- **Presentation of the Zernike Award**
- **Presentation of the Nick Cobb Memorial Scholarship**

Plenary presentations sponsored by

8:30 AM:

High performance mapping for deep learning applications

Allen Rush, Advanced Micro Devices, Inc. (USA)

9:10 AM:

In-memory computing for AI applications

Evangelos Eleftheriou, IBM Research - Zürich (Switzerland)

9:50 AM:

Process technologies leading a future of semiconductor memory (KIOKU) devices

Koji Hashimoto, kioxia Corporation (Japan)

Coffee Break · Mon 10:30 AM to 11:00 AM

SESSION 1
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A MON 11:00 AM TO 12:20 PM

Keynote Session

Session Chairs: **Nelson M. Felix,** IBM Thomas J. Watson Research Ctr. (USA); **Anna Lio,** Intel Corp. (USA)

11:00 am: **Next generation patterning using EUV lithography** *(Keynote Presentation)*, Sam Sivakumar, Intel Corp. (USA). . . . . [11323-1]

11:40 am: **Pushing EUV patterning to the atomic scale** *(Keynote Presentation)*, Patrick P. Naulleau, The Ctr. for X-Ray Optics (USA) . . . . [11323-2]

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

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B, 10:50 AM TO 11:10 AM

Opening Remarks and Award Announcements

Session Chairs: **Ofer Adan,** Applied Materials Israel, Ltd. (Israel); **John C. Robinson,** KLA Corp. (USA)

Presentation of the **2019 Diana Nyyssonen Best Paper Award in Metrology**

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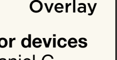


SESSION 1
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B , MON 11:10 AM TO 12:30 PM

Keynote Session

Session Chairs: **Ofer Adan,** Applied Materials Israel, Ltd. (Israel); **John C. Robinson,** KLA Corp. (USA)

11:10 am: **Metrology for advanced transistor and memristor devices and materials** *(Keynote Presentation)*, Alain C. Diebold, Nathaniel C. Cady, SUNY Polytechnic Institute (USA). . . . . [11325-1]

11:50 am: **Metrology requirements driven by memory scaling** *(Keynote Presentation)*, Cornel Bozdog, Micron Technology, Inc. (USA). [11325-100]

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

APPLICATION TRACKS

Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences.

• Overlay

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 2
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A MON 1:20 PM TO 3:20 PM

Stochastics

Overlay

The Future is High NA

Session Chairs: **Kenneth A. Goldberg,** Lawrence Berkeley National Lab. (USA); **Ted Liang,** Intel Corp. (USA)

1:20 pm: **High-NA EUV lithography exposure tool: program progress** *(Invited Paper)*, Jan Van Schoot, Eelco van Setten, Kars Troost, Sjoerd Lok, Judon Stoeldraijer, Rudy Peeters, Jos Benschop, ASML Netherlands B.V. (Netherlands); Paul Graeupner, Lars Wischmeier, Peter Kuerz, Winfried Kaiser, Carl Zeiss SMT GmbH (Germany) . . . . [11323-3]

1:40 pm: **High-NA EUV lithography optics becomes reality** *(Invited Paper)*, Lars Wischmeier, Paul Gräupner, Peter Kürz, Winfried Kaiser, Carl Zeiss SMT GmbH (Germany); Jan Van Schoot, Jörg Mallmann, Joost de Pee, Judon Stoeldraijer, ASML Netherlands B.V. (Netherlands) . . . . [11323-4]

2:00 pm: **Perspectives and tradeoffs of novel absorber materials for high NA EUV lithography**, Andreas Erdmann, Hazem M. S. Mesilhy, Peter Evanschitzky, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Vicky Philipsen, imec (Belgium); Frank Timmermans, ASML Netherlands B.V. (Netherlands); Markus Bauer, Carl Zeiss SMT GmbH (Germany) . . . . [11323-5]

2:20 pm: **Lithographic pattern formation in the presence of aberrations in anamorphic optical systems**, Zac A. Levinson, Synopsys, Inc. (USA); Bruce W. Smith, Rochester Institute of Technology (USA) . . . . [11323-6]

2:40 pm: **How we made the Berkeley MET5 stable and productive**, Christopher Neil Anderson, Lawrence Berkeley National Lab. (USA) . . . [11323-7]

3:00 pm: **Reviewing the EUV resists status towards high-NA EUV lithography**, Xiaolong Wang, Li-Ting Tseng, Iacopo Mochi, Chia-Kai Yeh, Michaela Vockenhuber, Paul Scherrer Institut (Switzerland); Lidia Protasova, Rolf Custers, Gijsbert Rispens, Rik Hoefnagels, ASML Netherlands B.V. (Netherlands); Yasin Ekinci, Paul Scherrer Institut (Switzerland) . . . . [11323-8]

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

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 2
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B, MON 1:30 PM TO 3:30 PM

Pattern Placement and Overlay Metrology I

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

1:30 pm: **Computational phase imaging technique for the wafer inspection**, Seung Beom Park, Jaehyeon Son, Kyungwon Yun, Taewan Kim, Myungjin Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . . . [11325-101]

1:50 pm: **Contour based metrology: "make measurable what is not so"**, Bertrand Le-Gratiet, Regis Bouyssou, Julien Ducote, Christophe Dezauzier, Alain Ostrovsky, Charlotte Beylier, Christian Gardin, STMicroelectronics S.A. (France); Nivea G. Schuch, Paolo Petroni, Loïc Schneider, Matthieu Millequant, Patrick Schiavone, ASELTA Nanographics (France) [11325-3]

2:10 pm: **Understanding advanced DRAM edge placement error budget and opportunities for control**, Jaeseung Jeong, Jinho Lee, Jinsun Kim, Sunyoung Yea, Chan Hwang, Seung Yoon Lee, Jeongjin Lee, Joon-Soo Park, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Peter Nikolsky, ASML Netherlands B.V. (Netherlands); Daniel Park, ASML Netherlands B.V. (Korea, Republic of); Antonio Corradi, Hyun-Woo Yu, Sun Wook Jung, Denis Ovchinnikov, Vadim Timoshkov, Isabel de la Fuente Valentin, Yuxiang Yin, Kaustubh Padhye, Wim Tel, Harm Dillen, Koen Thuijs, Daan Slotboom, ASML Netherlands B.V. (Netherlands); Miao Wang, Rhys Su, Marc Kea, ASML Netherlands B.V. (USA); Jin-Woo Lee, Yun-A Sung, Sang-Uk Kim, Young-Hoon Song, Oh-Sung Kwon, ASML Netherlands B.V. (Korea, Republic of); James Lee, ASML Korea Co., Ltd. (Korea, Republic of). . . . . [11325-4]

2:30 pm: **Real-time full-wafer design-based interlayer virtual metrology**, John L. Sturtevant, Lianghong Yin, Shumay Shang, Kostas Adam, Mentor, a Siemens Business (USA); Young-Chang Kim, Mentor Graphics Korea Co. Inc. (USA); Marko Chew, Abhinandan Nath, Mentor, a Siemens Business (USA); Alberto López Gómez, Boris Habets, Qoniac GmbH (Germany) . . . . [11325-5]

2:50 pm: **Optical scribe target vs. on device overlay bias accuracy validation**, Yaniv Abramovitz, Applied Materials Israel, Ltd. (Israel) . . . . [11325-106]

3:10 pm: **Application of high throughput contour based edge placement error metrology in leading edge DRAM process development**, Sudharshanan Raghunathan, Teng Wang, Lingling Pu, Stefan Hunsche, ASML US, Inc. (USA); Daniel Park, Jaden Song, ASML Korea Co., Ltd. (Korea, Republic of); Jung-chan Kim, Sun-keun Ji, Sang-woo Kim, Gyun Yoo, Cheol-Kyun Kim, Chan-ha Park, SK Hynix, Inc. (Korea, Republic of) . . . . [11325-107]

Coffee Break . . . . Mon 3:30 pm to 3:50 pm

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C , 2:00 PM TO 2:10 PM

Opening Remarks and Awards Announcements

Session Chairs: **Roel Gronheid,** ICOS VISION SYSTEMS NV (Belgium); **Daniel P. Sanders,** IBM Research - Almaden (USA)

Presentation of the C. Grant Willson Best Paper Award

Presentation of the Hiroshi Ito Memorial Best Student Paper Award

Awards Sponsored by

Presentation of the Jeffrey Byers Memorial Award

Awards Sponsored by

SESSION 1
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C MON 2:10 PM TO 3:10 PM

Keynote Session

Session Chairs: **Daniel P. Sanders,** IBM Research - Almaden (USA); **Roel Gronheid,** ICOS VISION SYSTEMS NV (Belgium)

2:10 pm: **Selective deposition approaches based on atomic layer deposition and etching** *(Keynote Presentation)*, Erwin W. M. M. Kessels, Technische Univ. Eindhoven (Netherlands) . . . . [11326-1]

2:40 pm: **Metrology for next generation patterning** *(Keynote Presentation)*, R. Joseph Kline, National Institute of Standards and Technology (USA) . . . . [11326-2]

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

Monday 24 February

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 3
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
MON 3:50 PM TO 5:50 PM

Stochastics

Inorganic Resists

Joint Session with conferences 11323 and 11326

Session Chairs: **Anuja De Silva,** IBM Research - Almaden (USA); **Robert L. Brainard,** SUNY CNSE/SUNYIT (USA)

3:50 pm: **Zr-based metal oxo clusters with enhanced EUV absorptivity**, Lianjia Wu, Ivan Bespalov, Sonia Castellanos Ortega, Advanced Research Ctr. for Nanolithography (Netherlands) . . . . [11323-9]

4:10 pm: **Unlocking pitch scaling with EUV lithography: the quest for high-contrast, low-noise EUV resists**, Marie E. Krysak, James M. Blackwell, Robert Bristol, Lauren Doyle, Iulian Hetel, Grant Kloster, Florian Gstrein, Intel Corp. (USA). [11323-10]

4:30 pm: **Unveiling and exploiting the reactivity of organic components in hybrid EUV resists**, Sonia Castellanos Ortega, Lianjia Wu, Neha Thakur, Olivier Lugier, Advanced Research Ctr. for Nanolithography (Netherlands) . . . . [11323-11]

4:50 pm: **All new nickel based metal core organic cluster (MCOC) resist for N7+ node patterning**, Satinder Sharma, Indian Institute of Technology Mandi (India) . . . . [11326-3]

5:10 pm: **Enhancing the reactivity of polymerizable antimony carboxylate EUV photoresists**, Michael Murphy, SUNY Polytechnic Institute (USA); James Passarelli, Northwestern Univ. (USA); Maximilian Weires, SUNY Polytechnic Institute (USA); Jodi Grzeskowiak, TEL Technology Ctr., America, LLC (USA); Robert L. Brainard, SUNY Polytechnic Institute (USA) . . . . [11326-4]

5:30 pm: **EUV lithography stochastic simulations of a MOx-specific parameterized resist model: calibration and comparisons with experimental data**, Craig D. Needham, Amrit K. Narasimhan, Inpria Corp. (USA); Lawrence S. Melvin III, Synopsys, Inc. (USA); Ulrich Welling, Synopsys GmbH (Germany); Stephen Meyers, Inpria Corp. (USA) . . . . . [11323-12]

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

LOCATION: CONVENTION CENTER, ROOM 210C
3:30 PM TO 3:50 PM

Opening Remarks

Session Chairs: **Martha I. Sanchez,** IBM Research - Almaden (USA); **Eric M. Panning,** Intel Corp. (USA)

SESSION 1
LOCATION: CONVENTION CENTER, ROOM 210C
MON 3:50 PM TO 5:50 PM

Keynote Session

Session Chairs: **Eric M. Panning,** Intel Corp. (USA); **Martha I. Sanchez,** IBM Research - Almaden (USA)

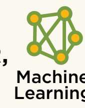
3:50 pm: **Photonic quantum computing** *(Keynote Presentation)*, Mark G. Thompson, PsiQuantum Corp. (USA) . . . .[11324-1]

4:30 pm: **3D mesostructures from 2D lithographically defined precursors** *(Keynote Presentation)*, John A. Rogers, Northwestern Univ (USA) . . . .[11324-2]

5:10 pm: **Advanced semiconductor manufacturing economics: how the industry can prosper amid escalating manufacturing costs** *(Keynote Presentation)*, Risto Puhakka, VLSI Research Inc. (USA). . . . .[11324-59]

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 3
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
MON 3:50 PM TO 5:30 PM


Machine Learning

Challenges and New Methods

Session Chairs: **Shunsuke Koshihara,** Hitachi High-Technologies Corp. (Japan); **Christopher J. Raymond,** Nanometrics Inc. (USA)

3:50 pm: **Atom probe tomography using Extreme-Ultraviolet Light**, Luis Miaja Avila, Ann Chiaramonti, Benjamin Caplins, National Institute of Standards and Technology (USA); David Diercks, Brian Gorman, Colorado School of Mines (USA); Norman Sanford, National Institute of Standards and Technology (USA) . . . . [11325-6]

4:10 pm: **White light interference solution for Xtacking 3D NAND VIA dishing metrology**, Xiao-Ye Ding, Si-Cong Wang, Yi Zhou, Yangtze Memory Technologies Co., Ltd. (China); Chi Chen, Le Yang, Yan-Zhong Ma, Skyverse Ltd. (China) . . . . [11325-7]

4:30 pm: **High resolution acoustic metrology by combining high GHZ frequency ultrasound and scanning probe microscopy**, Maarten H. van Es, Paul L.M.J. van Neer, Benoit A. I. Quesson, Daniele Piras, Laurent Fillinger, Abbas Mohtashami, Rob Willekers, TNO (Netherlands) . . . . [11325-8]

4:50 pm: **Inline Part Average Testing (I-PAT) for automotive die reliability**, John C. Robinson, David W. Price, KLA Corp. (USA) . . . . [11325-9]

5:10 pm: **E-TEST validation of EPE budget and metrology**, Etienne De Poortere, ASML Belgium (Belgium); Guillaume Schelcher, imec (Belgium); Nicola Kissoon, ASML Belgium (Belgium); Sara Paolillo, imec (Belgium); Cyrus Tabery, ASML US, Inc. (USA); Sandip Halder, Philippe Leray, imec (Belgium); Jan Mulkens, Moyra McManus, ASML Netherlands B.V. (Netherlands) . . . . [11325-10]

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII

SESSION 2
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
MON 3:50 PM TO 5:50 PM

Inorganic Resists

Joint Session with conferences 11323 and 11326

Session Chairs: **Anuja De Silva,** IBM Research - Almaden (USA); **Robert L. Brainard,** SUNY CNSE/SUNYIT (USA)

3:50 pm: **Zr-based metal oxo clusters with enhanced EUV absorptivity**, Lianjia Wu, Ivan Bespalov, Sonia Castellanos Ortega, Advanced Research Ctr. for Nanolithography (Netherlands) . . . . [11323-9]

4:10 pm: **Unlocking pitch scaling with EUV lithography: the quest for high-contrast, low-noise EUV resists**, Marie E. Krysak, James M. Blackwell, Robert Bristol, Lauren Doyle, Iulian Hetel, Grant Kloster, Florian Gstrein, Intel Corp. (USA). [11323-10]

4:30 pm: **Unveiling and exploiting the reactivity of organic components in hybrid EUV resists**, Sonia Castellanos Ortega, Lianjia Wu, Neha Thakur, Olivier Lugier, Advanced Research Ctr. for Nanolithography (Netherlands) . . . . [11323-11]

4:50 pm: **All new nickel based metal core organic cluster (MCOC) resist for N7+ node patterning**, Satinder Sharma, Indian Institute of Technology Mandi (India) . . . . [11326-3]

5:10 pm: **Enhancing the reactivity of polymerizable antimony carboxylate EUV photoresists**, Michael Murphy, SUNY Polytechnic Institute (USA); James Passarelli, Northwestern Univ. (USA); Maximilian Weires, SUNY Polytechnic Institute (USA); Jodi Grzeskowiak, TEL Technology Ctr., America, LLC (USA); Robert L. Brainard, SUNY Polytechnic Institute (USA) . . . . [11326-4]

5:30 pm: **EUV lithography stochastic simulations of a MOx-specific parameterized resist model: calibration and comparisons with experimental data**, Craig D. Needham, Amrit K. Narasimhan, Inpria Corp. (USA); Lawrence S. Melvin III, Synopsys, Inc. (USA); Ulrich Welling, Synopsys GmbH (Germany); Stephen Meyers, Inpria Corp. (USA) . . . . . [11323-12]

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 4
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
TUE 8:00 TO 10:00 AM

Stochastics

Stochastics

Joint Sessions with Conferences 11323 and 11326

Session Chairs: **Gilles R. Amblard,** SAMSUNG Austin Semiconductor LLC (USA); **Marie E. Krysak,** Intel Corp. (USA)

8:00 am: **The contribution of EUV resist materials to stochastic printing failures**, Martha I. Sanchez, Gregory Wallraff, IBM Research - Almaden (USA); William Hinsberg, Columbia Hill Technical Consulting (USA). . . . . [11326-5]

8:20 am: **Algebraic model for extremely unlikely resist dissolution events**, Andrew R. Neureuther, Luke Long, Univ. of California, Berkeley (USA); Patrick Naulleau, The Ctr. for X-Ray Optics, Lawrence Berkeley National Lab. (USA) . . . [11326-6]

8:40 am: **Understanding EUV stochastic defects: material and process contributions to the defect floor**, Paulina A. Rincon-Delgadillo, Romuald Blanc, Philippe Foubert, Christophe Beral, Sandip Halder, imec (Belgium) . . . . [11326-7]

9:00 am: **EUV chemically amplified resist component distribution and efficiency for stochastic defect control**, Dario L. Goldfarb, Rui Wang, Conor Thomas, Heather Polgrean, Margaret Lawson, Alexander Hess, Anuja De Silva, IBM Corp. (USA) . . . . [11326-8]

9:20 am: **Cluster of correlated reactions as a cause for various types of stochastic defects in extreme ultraviolet lithography**, Hiroshi Fukuda, Hitachi High-Technologies Corp. (Japan). . . . . [11323-13]

9:40 am: **Modeling photon, electron, and chemical interactions in a hafnium oxide nanocluster resist**, Patrick Theofanis, James M. Blackwell, Marie E. Krysak, Eric Mattson, Florian Gstrein, Intel Corp. (USA) . . . . [11323-14]

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

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 2
LOCATION: CONVENTION CENTER, ROOM 210C
TUE 8:00 AM TO 10:00 AM

Imprint Lithography

Session Chairs: **John G. Maltabes,** Applied Materials GmbH & Co. KG (Germany); **Douglas J. Resnick,** Canon Nanotechnologies, Inc. (USA)

8:00 am: **Lithography today: challenges and solutions across a diverse market** *(Invited Paper)*, Kazunori Iwamoto, Canon Inc. (Japan) . . . . [11324-3]

8:40 am: **Leveraging advanced imprint lithography to disrupt the smart window market** *(Invited Paper)*, James Abbott, Crown Electrokinetics (USA) . . . . [11324-4]

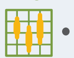
9:20 am: **Fabrication of device structures using hybrid materials sets and Roll-to-Roll nanoimprint lithography** *(Invited Paper)*, Yiliang Zhou, James J. Watkins, Kenneth R. Carter, Univ. of Massachusetts Amherst (USA). . . . . [11324-5]

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

APPLICATION TRACKS

Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences.

• Machine Learning


• Stochastics

• Overlay

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 4
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
TUE 8:40 AM TO 10:00 AM

Inspection and Mass Metrology

Session Chairs: **Timothy Crimmins,** Intel Corp. (USA); **Byoung-Ho Lee,** SK Hynix, Inc. (Korea, Republic of)

8:40 am: **Multi-beam Inspection (MBI) development progress and applications**, Eric Long Ma, Weiming Ren, Xinan Luo, Xuerang Hu, Xuedong Liu, Chiyan Kuan, Kevin Chou, Martijn Maassen, Weihua Yin, Aiden Chen, Niladri Sen, Martin Ebert, Lei Liu, Fei Wang, Oliver D. Patterson, Hermes-Microvision Inc., USA (USA) . . [11325-11]

9:00 am: **Quantitative Inspection**, Younghoon Sohn, Hojeong Kwak, Min-Chul Yoon, Yusin Yang, Chihoon Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . [11325-12]

9:20 am: **Novel post-lithography macro inspection strategies for advanced legacy fabs challenges**, Annalisa Bordogna, STMicroelectronics SRL (Italy); Simona Seminato, STMicroelectronics (Italy); Andrea Corno, Alberto Beccalli, Lavinia Motta, STMicroelectronics SRL (Italy); Giovanna Pistone, STMicroelectronics (Italy); Francesco Ferrario, Paolo Piacentini, STMicroelectronics SRL (Italy); Bernardo Micali, STMicroelectronics (Italy); Parikshit Sharma, Loemba Bouckou, Paolo Parisi, Thomas Groos, KLA Corp. (USA)[11325-13]

9:40 am: **Massive metrology of 2D logic patterns on BEOL EUVL**, Sayantan Das, imec (Belgium); Seul-Ki Kang, NGR Inc. (Japan); Sandip Halder, imec (Belgium); Kotaro Maruyama, NGR Inc. (Japan); Philippe Leray, imec (Belgium); Yuichiro Yamazaki, NGR Inc. (Japan) . . [11325-14]

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

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII

SESSION 3
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
TUE 8:00 AM TO 10:00 AM

Stochastics

Stochastics

Joint Sessions with Conferences 11323 and 11326

Session Chairs: **Gilles R. Amblard,** SAMSUNG Austin Semiconductor LLC (USA); **Marie E. Krysak,** Intel Corp. (USA)

8:00 am: **The contribution of EUV resist materials to stochastic printing failures**, Martha I. Sanchez, Gregory Wallraff, IBM Research - Almaden (USA); William Hinsberg, Columbia Hill Technical Consulting (USA). . . . . [11326-5]

8:20 am: **Algebraic model for extremely unlikely resist dissolution events**, Andrew R. Neureuther, Luke Long, Univ. of California, Berkeley (USA); Patrick Naulleau, The Ctr. for X-Ray Optics, Lawrence Berkeley National Lab. (USA) . . . . [11326-6]

8:40 am: **Understanding EUV stochastic defects: material and process contributions to the defect floor**, Paulina A. Rincon-Delgadillo, Romuald Blanc, Philippe Foubert, Christophe Beral, Sandip Halder, imec (Belgium) . . . . [11326-7]

9:00 am: **EUV chemically amplified resist component distribution and efficiency for stochastic defect control**, Dario L. Goldfarb, Rui Wang, Conor Thomas, Heather Polgrean, Margaret Lawson, Alexander Hess, Anuja De Silva, IBM Corp. (USA) . . . . [11326-8]

9:20 am: **Cluster of correlated reactions as a cause for various types of stochastic defects in extreme ultraviolet lithography**, Hiroshi Fukuda, Hitachi High-Technologies Corp. (Japan) . . . [11323-13]

9:40 am: **Modeling photon, electron, and chemical interactions in a hafnium oxide nanocluster resist**, Patrick Theofanis, James M. Blackwell, Marie E. Krysak, Eric Mattson, Florian Gstrein, Intel Corp. (USA) . . . . [11323-14]

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

CONFERENCE 11329
Advanced Etch Technology for Nanopatterning IX

SESSION 1
LOCATION: CONVENTION CENTER, ROOM 211B
TUE 8:00 AM TO 10:00 AM

Keynote Session

Session Chairs: **Catherine B. Labelle,** Intel Corp. (USA); **Julie Bannister,** Tokyo Electron America, Inc. (USA)

8:00 am: **Etch and film co-optimization for high fidelity patterning** *(Keynote Presentation)*, Akiteru Ko, Tokyo Electron Ltd. (Japan) . . . . [11329-1]

8:40 am: **Precise etching profile control in high-aspect-ratio hole etching for 3D memory fabrication** *(Keynote Presentation)*, Mitsuhiro Omura, Toshiba Materials Co., Ltd. (Japan). . . . . [11329-2]

9:20 am: **CMOS scaling roadmap, Nanosheet FET, AI chips** *(Keynote Presentation)*, Huiming Bu, IBM Thomas J. Watson Research Ctr. (USA)[11329-4]

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

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 5
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
TUE 10:30 AM TO 12:30 PM

Stochastics

Stochastics of EUV Patterning

Session Chairs: **Christopher S. Ngai,** Applied Materials, Inc. (USA); **Eric M. Panning,** Intel Corp. (USA)

10:30 am: **On the dependencies of the stochastic patterning-failure cliffs in EUVL**, Peter De Bisschop, Eric Hendrickx, imec (Belgium) . . . . [11323-15]

10:50 am: **Prediction of EUV stochastic microbridge probabilities by lithography simulations**, Erik A. Verduijn, Synopsys GmbH (Belgium); Ulrich Welling, Jiuzhou Tang, Hans-Jürgen Stock, Ulrich klostermann, Wolfgang Demmerle, Synopsys GmbH (Germany); Peter De Bisschop, imec (Belgium). . . . . . [11323-16]

11:10 am: **Probability prediction of EUV process failure due to resist-exposure stochastic and dose-focus variations**, Azat Latypov, Gurdaman Khaira, Germain L. Fenger, John L. Sturtevant, Mentor Graphics Corp. (USA); Chih-I Wei, Mentor Graphics Corp. (Belgium); Peter De Bisschop, imec (Belgium) . . . . [11323-17]

11:30 am: **High-Z metal-based underlayer patterning for improving EUV stochastics**, Anuja De Silva, Jennifer Church, Dominik Metzler, Luciana Meli, Nelson M. Felix, IBM Thomas J. Watson Research Ctr. (USA); Phil Friddle, Bhaskar Nagabhirava, Mike Goss, Siva Kanakasabapathy, Rich Wise, Lam Research Corp. (USA) . . . . [11323-18]

11:50 am: **EUV contact hole patterning development for defect reduction**, Tae-Hwan Oh, Teahoi Park, Nakhee Sung, Keun Hee Bai, Sora Han, Sangjin Kim, Joonsoo Park, Kyoungsub Shin, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) . . . . [11323-19]

12:10 pm: **Fundamental characterization of stochastic variation for improved yield in sub-32nm pitch single-expose EUV patterning**, Jennifer Church, Luciana Meli, Jing Guo, Karen Petrillo, Anuja DeSilva, Mary Breton, Ravi Bonam, Romain Lallement, Eric Miller, Brad Austin, Nelson M. Felix, IBM Thomas J. Watson Research Ctr. (USA); Chris Mack, Fractilia, LLC (USA) . . . . [11323-20]

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

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 3
LOCATION: CONVENTION CENTER, ROOM 210C
TUE 10:30 AM TO 12:10 PM

Scanning Probe Lithography

Session Chairs: **Ivo W. Rangelow,** Technische Univ. Ilmenau (Germany); **Laurent Pain,** CEA-LETI (France)

10:30 am: **Transport and assembly of nano particles inside a t-SPL patterned nanofluidic slit** *(Invited Paper)*, Francesca Ruggeri, Christian Schwemmer, IBM Research - Zürich (Switzerland); Kirsten Kochems, Univ. des Saarlandes (Germany); Mirko Stauffer, Patrick Bosshart, Dimitrios Fotiadis, Univ. Bern (Switzerland); Heiko Wolf, Armin Knoll, IBM Research - Zürich (Switzerland) . . . . [11324-6]

11:10 am: **Recent advancements of III-N materials in probe scanning lithography and metrology** *(Invited Paper)*, Tito L. Busani, Univ of New Mexico (USA); Ivo Rangelow, Institute for nano and electronic (Germany) . . . . [11324-7]

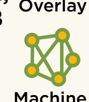
11:50 am: **Tip- and laser- based nanofabrication up to 100 mm with sub-nanometre precision**, Ingo Ortlepp, Michael Kühnel, Martin Hofmann, Laura Weidenfeller, Johannes Kirchner, Shraddha Supreeti, Rostyslav Mastylo, Roland Füßl, Ivo Rangelow, Thomas Fröhlich, Eberhard Manske, Technische Univ. Ilmenau (Germany) . . . . [11324-8]

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

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 5
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
TUE 10:30 AM TO 12:10 PM

Overlay



High Aspect Ratio Metrology

Session Chairs: **Richard M. Silver,** National Institute of Standards and Technology (USA); **Hugo Cramer,** ASML Netherlands B.V. (Netherlands)

10:30 am: **Determination of deep hole structure for advanced semiconductor devices analyzed by transmission X-ray scattering**, Kazuhiko Omote, Yoshiyasu Ito, Goto Takumi, Rigaku Corp. (Japan). . . . . [11325-15]

10:50 am: **3D-NAND wafer process monitoring using high voltage SEM with auto e-Beam tilt technology**, Leeming Tu, Jian Mi, Henry Fan, Haydn Zhou, Felix Xiong, Louis Tu, Yangtze Memory Technologies Co., Ltd. (China); Gangyi Chen, Hitachi High-Technologies (Shanghai) Co., Ltd. (China); Chuanyu Shao, Long Zhang, Shinji Kubo, Hitachi High-Technologies Corp. (Japan) . . . . [11325-16]

11:10 am: **3D analysis of high-aspect ratio features in 3D-NAND**, Jens-Timo Neumann, Dmitry Klochkov, Thomas Korb, Carl Zeiss SMT GmbH (Germany); Sheetal B. Gupta, Carl Zeiss India (Bangalore) Pvt. Ltd. (India); Amir Avishai, Ramani Pichumani, Keum Sil Lee, Alex Buxbaum, Carl Zeiss X-Ray Microscopy, Inc. (USA); Eugen Foca, Carl Zeiss SMT GmbH (Germany) . . . . [11325-17]

11:30 am: **Accuracy improvement of 3D-profiling for HAR features using deep learning**, Wei Sun, Pushe Zhao, Hitachi, Ltd. (Japan); Yasunori Goto, Takuma Yamamoto, Taku Ninomiya, Hitachi High-Technologies Corp. (Japan) . . . . [11325-18]

11:50 am: **Machine learning and hybrid metrology using HV-SEM and optical methods to monitor channel hole tilting in-line for 3D NAND wafer production**, Michael Meng, Leeming Tu, Jian Mi, Haydn Zhou, Yangtze Memory Technologies Co., Ltd. (China); Xi Zou, Nanometrics Inc. (USA) . . [11325-19]

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

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII

SESSION 4
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C
TUE 10:30 AM TO 12:10 PM

Novel Resists

Session Chairs: **Danilo De Simone,** imec (Belgium); **Jason K. Stowers,** Inpria Corp. (USA)

10:30 am: **EUV resist chemical gradient enhancement by UV flood exposure for improvement in EUV resist resolution, process control, roughness and sensitivity**, Seiji Nagahara, Tokyo Electron Ltd. (Japan); Cong Que Dinh, Tokyo Electron Kyushu Ltd. (Japan); Keisuke Yoshida, Tokyo Electron Kyushu Ltd. (Belgium); Gosuke Shiraishi, Yoshihiro Kondo, Kosuke Yoshihara, Tokyo Electron Kyushu Ltd. (Japan); Kathleen Nafus, Tokyo Electron America, Inc. (Belgium); John S. Petersen, Danilo De Simone, Philippe Foubert, Geert Vandenberghe, imec (Belgium); Hans-Jürgen Stock, Balint Meliorisz, Synopsys GmbH (Germany) . . . . [11326-9]

10:50 am: **Molecular resists equipped with fluorinated aromatic units for electron-beam and extreme UV lithography**, Jin-Kyun Lee, Hyun-Taek Oh, Inha Univ. (Korea, Republic of); Kanghyun Kim, Sangsul Lee, Byeong-Gyu Park, Pohang Accelerator Lab., Pohang Univ. of Science and Technology (Korea, Republic of) . . . . [11326-10]

11:10 am: **High sensitivity non-CAR resists for EUV and EB lithography**, Kazuyo Morita, Kimiko Yamamoto, Oji Holdings Corp. (Japan); Masahiko Harumoto, Yuji Tanaka, Chisayo Mori, You Arisawa, Tomohiro Motono, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Harold Stokes, SCREEN SPE Germany GmbH (Germany); Masaya Asai, SCREEN Semiconductor Solutions Co., Ltd. (Japan) [11326-11]

11:30 am: **Sensitivity enhancement of chemically amplified EUV resist by adding diphenyl sulfone derivatives**, Kazumasa Okamoto, Osaka Univ. (Japan); Shunpei Kawai, Hokkaido Univ. (Japan); Takahiro Kozawa, Osaka Univ. (Japan). . . [11326-12]

11:50 am: **Explorations of missing hole defect in EUV patterning**, Hidetami Yaegashi, Tokyo Electron Ltd. (Japan) . . . . [11326-13]

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

CONFERENCE 11327
Optical Microlithography XXXIII

SESSION 1
LOCATION: CONVENTION CENTER, ROOM 210A
TUE 10:30 AM TO 12:10 PM

Keynote Session and Latest Topic

Session Chairs: **Soichi Owa,** Nikon Corp. (Japan); **Mark C. Phillips,** Intel Corp. (USA)

10:30 am: **Optical lithography: its extendibility and challenges** *(Keynote Presentation)*, Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan) . . . . [11327-1]

11:10 am: **Maskless lithography applications and technology for advanced packaging** *(Keynote Presentation)* Thomas Uhrmann, EV Group (Austria) . . . . [11327-2]

11:50 am: **Pixelated mask optimization on quantum computers**, Yosuke Okudaira, Satoshi Yashiki, Nikon Corp. (Japan) . . . . [11327-3]

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

CONFERENCE 11329
Advanced Etch Technology for Nanopatterning IX

SESSION 2
LOCATION: CONVENTION CENTER, ROOM 211B
TUE 10:30 AM TO 12:10 PM

Materials and Etch Integration

Session Chairs: **Eric A. Hudson,** Lam Research Corp. (USA); **Efrain Altamirano-Sánchez,** imec (Belgium)

10:30 am: **Novel etch technologies utilizing atomic layer process for advanced patterning** *(Invited Paper)*, M. Honda, T. Katsunuma, Tokyo Electron Miyagi Ltd. (Japan); S. Kumakura, Tokyo Electron Ltd. (Japan); T. Hisamatsu, Y. Kihara, Tokyo Electron Miyagi Ltd. (Japan) . . . . [11329-5]

11:00 am: **Isotropic etch challenges for nanosheet device fabrication** *(Invited Paper)*, Yusuke Oniki, Efrain Altamirano-Sánchez, imec (Belgium) [11329-6]

11:30 am: **Materials engineering solutions to extend DRAM scaling**, Regina Freed, Applied Materials, Inc. (USA) . . . . [11329-7]

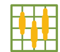
11:50 am: **Plasma process of Silicon Germanium alloy: molecular dynamics simulation study**, Hojin Kim, Yun Han, Mingmei Wang, Andrew Metz, Peter Biolsi, TEL Technology Ctr., America, LLC (USA) . . . . [11329-8]

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

APPLICATION TRACKS

Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences.

• Machine Learning

 • Stochastics

• Overlay

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 6
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
TUE 2:00 PM TO 3:00 PM

Stochastics

EUV Scanner Monitoring

Session Chairs: **Moshe E. Preil,** KLA Corp. (USA); **Thomas I. Wallow,** ASML San Jose (USA)

2:00 pm: **Leveraging sub-E0 dose assessment methodology to improve EUV lithography cluster dose performance**, Chris F. Robinson, Cody J. Murray, Luciana Meli, Anuja De Silva, Dario Goldfarb, Conor Thomas, Madhana Sunder, Mary Ann Zaitz, Guoda Lian, Yiping Yao, Leo Tai, Jay Bunt, Jim Rosa, Malik Ali, Steven Boettcher, Mark Stalter, IBM Corp. (USA) . . . . [11323-21]

2:20 pm: **Accurate mapping of dose variations on EUV scanners using dose-to-clear exposures and optical ellipsometry**, Vineet Vijayakrishnan Nair, Lieve Van Look, Remko Aubert, Eric Hendrickx, imec (Belgium) . . . . [11323-22]

2:40 pm: **Novel monitoring of EUV litho cluster for manufacturing insertion**, Vincent Truffert, Kit Ausschnitt, Vineet Vijayakrishnan Nair, Koen D'havé, imec (Belgium). . . . . [11323-23]

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
3:00 PM TO 3:20 PM

EUV Poster Preview Speed Talks I

Session Chairs: **Nelson M. Felix,** IBM Thomas J. Watson Research Ctr. (USA); **Anna Lio,** Intel Corp. (USA)

Previews from Posters:

11323-57

11323-58

11323-59

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

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 4
LOCATION: CONVENTION CENTER, ROOM 210C
TUE 1:40 PM TO 3:00 PM

Overlay

Nanoimprint Lithography for Semiconductors

Session Chairs: **Naoya Hayashi,** Dai Nippon Printing Co., Ltd. (Japan); **Chandrasekhar Sarma,** Intel Corp. (USA)

1:40 pm: **Nanoimprint defectivity, throughput, alignment and overlay improvements for high volume semiconductor manufacturing**, Atsushi Kimura, Takehiko Iwanaga, Yukio Takabayashi, Mitsuru Hiura, Keita Sakai, Hiroshi Morohoshi, Hiroyuki Sekiguchi, Toshiya Asano, Takamitsu Komaki, Canon Inc. (Japan) . . . . [11324-9]

2:00 pm: **Addressing mix and match overlay errors using drop pattern compensation for nanoimprint lithography**, Anshuman Cherala, Canon Nanotechnologies, Inc. (USA) . . . . [11324-10]

2:20 pm: **Advanced materials to enhance the productivity of nanoimprint lithography**, Kasumi Okabe, Takeshi Higuchi, Motofumi Komori, Takuya Kono, Toshiba Memory Corp. (Japan) . . . [11324-11]

2:40 pm: **Development of nanoimprint templates for metal layer lithography**, Takaharu Nagai, Katsutoshi Suzuki, Ryugo Hikichi, Koji Ichimura, Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan) . . . . [11324-12]

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

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 6
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
TUE 1:20 PM TO 3:00 PM

Stochastics

Roughness Metrology

Session Chairs: **Xiaomeng Chen,** Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Masafumi Asano,** Tokyo Electron Ltd. (Japan)

1:20 pm: **Comparing algorithms for edge detection and their impact on unbiased roughness measurement precision and accuracy**, Chris A. Mack, Fractilia, LLC (USA) . . . . [11325-20]

1:40 pm: **Comparison of SEM and AFM performances for LER reference metrology**, Ryosuke Kizu, Ichiko Misumi, Akiko Hirai, Satoshi Gonda, National Institute of Advanced Industrial Science and Technology (Japan) . . . . [11325-21]

2:00 pm: **Reference metrology using 3D-PSD of post-etch LWR**, Kiyoshi Takamasu, Satoru Takahashi, The Univ. of Tokyo (Japan); Hiroki Kawada, Masami Ikota, Hitachi High-Technologies Corp. (Japan). . . . . [11325-22]

2:20 pm: **Line top loss and top roughness characterizations of EUV resists**, Daniel Schmidt, Karen Petrillo, Mary A. Breton, Jennifer Fullam, IBM Thomas J. Watson Research Ctr. (USA); Sean Hand, Jason Osborne, Weijie Wang, David Fey, Bruker Nano Inc. (USA). . . . . [11325-23]

2:40 pm: **Characterization of defects in line/space patterns**, Vassilios Constantoudis, NCSR Demokritos (Greece) and Nanometrisis P.C. (Greece); Bradley Williams, MOXTEK, Inc. (USA); Nikolaos Kehagias, Institut Català de Nanociència i Nanotecnologia (Spain); George Papavieros, NCSR Demokritos (Greece) and Nanometrisis P.C. (Greece); Clivia M. Sotomoyor Torres, Institut Català de Nanociència i Nanotecnologia (Spain) and 6ICREA, Institució Catalana de Recerca i Estudis Avançats (Spain); Evangelos Gogolides, NCSR Demokritos (Greece) and Nanometrisis P.C. (Greece). . . . . [11325-105]

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

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII

SESSION 5
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C
TUE 1:40 PM TO 3:20 PM

Stochastics

Machine Learning

Fundamentals and Modeling

Session Chairs: **Craig D. Higgins,** GLOBALFOUNDRIES Inc. (USA); **Ramakrishnan Ayothi,** JSR Micro, Inc. (USA)

1:40 pm: **Multiscale simulation of photoresist patterning in EUV lithography : From PEB to Development process**, Maenghyo Cho, Seoul National Univ. (Korea, Republic of) . . . . . . [11326-14]

2:00 pm: **Mechanism of resist heating effect in chemically amplified resist**, Yuta Ikari, Kazumasa Okamoto, Naoki Maeda, Akihiro Konda, Takahiro Kozawa, Osaka Univ. (Japan); Takao Tamura, NuFlare Technology, Inc. (Japan) . . . . [11326-15]

2:20 pm: **Line width roughness reduction strategies utilizing power spectral density analysis**, Charlotte A. Cutler, Dan Millward, Choong-Bong Lee, James W. Thackeray, John Nelson, Jason DeSisto, Rochelle Rena, DuPont Electronics & Imaging (USA); Chris Mack, Fractilia, LLC (USA) . . . . [11326-16]

2:40 pm: **A physics-driven complex-valued neural network (CVNN) model for lithographic analysis**, Heehwan Lee, Minjong Hong, Min Kang, Samsung Display Co., Ltd. (Korea, Republic of) . . . . [11326-17]

3:00 pm: **Infiltration synthesis of hybrid nanocomposite resists for advanced nanolithography**, Nikhil Tiwale, Brookhaven National Lab. (USA); Ashwanth Subramanian, Stony Brook Univ. (USA); Kim Kisslinger, Ming Lu, Brookhaven National Lab. (USA); Jiyoung Kim, The Univ. of Texas at Dallas (USA); Aaron Stein, Brookhaven National Lab. (USA); Chang-Yong Nam, Brookhaven National Lab. (USA) and Stony Brook Univ. (USA) . [11326-18]

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

CONFERENCE 11327
Optical Microlithography XXXIII

SESSION 2
LOCATION: CONVENTION CENTER, ROOM 210A
TUE 1:40 PM TO 3:20 PM

Machine Learning and Computational Lithography I

Session Chairs: **Kunal N. Taravade,** Synopsys, Inc. (USA); **Edita Tejnil,** Mentor Graphics Corp. (USA)

1:40 pm: **Establishing fast, practical, full-chip ILT flows using Machine Learning** *(Invited Paper)*, Tom Cecil, Ahmed S. Omran, Jason Shu, Amyn Poonawala, Clark Vandam, Jiechang Hou, Kyle Braam, Synopsys, Inc. (USA) . . . . [11327-4]

2:10 pm: **Mask synthesis using machine learning software and hardware platforms** *(Invited Paper)*, Peng Liu, Synopsys, Inc. (USA). . . . . [11327-5]

2:40 pm: **Achieving stitchless full chip curvilinear ILT in a day**, P. Jeffrey Ungar, Ali Bouaricha, Ryan Pearman, Linyong Pang, Aki Fujimura, D2S, Inc. (USA) [11327-6]

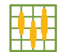
3:00 pm: **Physics based feature vector design: a critical step towards machine learning based inverse lithography**, Xuelong Shi, YuHang Zhao, Shoumian Chen, Chen Li, Wei Yuan, Shanghai Integrated Circuit Research & Development Ctr. Co., Ltd. (China); Leon Yao, Wenhao Zhao, Yanjun Xiao, Xiaohui Kang, Stephen Hsu, ASML (China) [11327-7]

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

APPLICATION TRACKS

Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences.

• **Machine Learning**

 • **Stochastics**

• **Overlay**

CONFERENCE 11329
Advanced Etch Technology for Nanopatterning IX

SESSION 3
LOCATION: CONVENTION CENTER, ROOM 211B
TUE 1:40 PM TO 3:20 PM

Computational Patterning and Patterning Process Control

Session Chairs: **Yuyang Sun,** Mentor, a Siemens Business (USA); **Qinghuang Lin,** ASML US, Inc. (USA)

1:40 pm: **Reduction of Systematic Defects Through Machine Learning from Design to Fab** *(Invited Paper)*, James Word, Yuansheng Ma, Vlad Liubich, Le Hong, Liang Cao, Fan Jiang, Joerg Mellmann, Young-Chang Kim, Germain Fenger, Srividya Jayaram, Mentor, a Siemens Business (USA). . . . . . . [11329-9]

2:10 pm: **Implementing effective process control strategies and reaping the benefits of data utilization** *(Invited Paper)*, Carlos Fonseca, Tokyo Electron America, Inc. (USA) . . . . [11329-10]

2:40 pm: **Bayesian neural network modeling of SAQP**, Scott Halle, IBM Thomas J. Watson Research Ctr. (USA); Max O. Bloomfield, Rensselaer Polytechnic Institute (USA); Derren Dunn, IBM Thomas J. Watson Research Ctr. (USA) . . . . [11329-11]

3:00 pm: **Optimal etch recipe prediction for 3D NAND structures**, Leandro Medina, Kara Kearney, Bryan Sundahl, Meghali Chopra, Roger T. Bonnecaze, SandBox Semiconductor (USA) . . . . [11329-12]

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

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

PANEL DISCUSSION
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
3:50 PM TO 5:50 PM

EUV Lithography Retrospective: from the beginning to HVM

Moderators: **Nelson M. Felix,** IBM Thomas J. Watson Research Ctr. (USA); **David T. Attwood Jr.,** Univ. of California, Berkeley (USA)

SPIE will celebrate the entry of Extreme Ultraviolet Lithography (EUVL) into high volume manufacturing (HVM) with a special retrospective session. Highlights will include perspectives by true pioneers of EUVL, the formation of early teams, the gathering of resources and organization of the industry based EUV LLC and its partnering with the three national laboratory 'Virtual National Laboratory', the hand-off to SEMATECH and industry partners, the emergence of key suppliers, and IC manufacturers' efforts in partnership with ASML and other suppliers.

Presenters: Hiroo Kinoshita, Bill Silfvast, Andy Hawryluk, John Carruthers, Chuck Gwyn, Peter Silverman, Rick Stulen, Don Sweeney, Stefan Wurm, Yan Borodovsky, Anthony Yen, Winfried Kaiser, Jos Benschop, Robert Brainard, Frank Abboud, Song-Sue Kim, and Martin van den Brink.

Sponsored by ASML

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 5
LOCATION: CONVENTION CENTER, ROOM 210C
TUE 3:30 PM TO 6:30 PM

Quantum Computing

Session Chairs: **Erik R. Hosler,** PsiQuantum (USA); **Daniel J. C. Herr,** The Univ. of North Carolina at Greensboro (USA)

3:30 pm: **Future needs of characterization and metrology for silicon qubits in quantum computing** *(Invited Paper)*, Neil Zimmerman, Richard M. Silver, National Institute of Standards and Technology (USA) . . . . [11324-13]

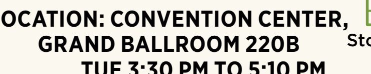
4:10 pm: **Improving wafer-scale Josephson junction resistance variation in superconducting quantum coherent circuits** *(Invited Paper)*, Irfan Siddiqi, John Mark Kreikebaum, Univ. of California, Berkeley (USA); Kevin P. O'Brien, Massachusetts Institute of Technology (USA) . . . . [11324-14]

4:50 pm: **Hardware scaling of superconducting quantum processors** *(Invited Paper)*, Markus Brink, IBM Thomas J. Watson Research Ctr. (USA) . . . . [11324-15]

5:30 pm: **Building quantum matter with scanning probe lithography** *(Invited Paper)*, Sven Rogge, The Univ. of New South Wales (Australia) . . . . [11324-16]

6:10 pm: **Quantum inspire: QuTech's platform for co-development and collaboration in quantum computing**, Thorsten Last, Netherlands Organisation for Applied Scientific Research (Netherlands) . . . . [11324-17]

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV



SESSION 7
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
TUE 3:30 PM TO 5:10 PM

Stochastics

New Methods: Student Session

Session Chairs: **Alexander Starikov,** I&I Consulting (USA); **Benjamin D. Bunday,** Abeam Technologies, Inc. (USA)

3:30 pm: **White-light Mueller-matrix Fourier scatterometry for the characterization of nanostructures with large parameter spaces**, Maria Laura Gödecke, Karsten Frenner, Wolfgang Osten, Univ. Stuttgart (Germany) . . . . [11325-24]

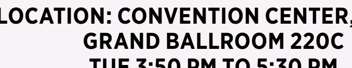
3:50 pm: **Metrology of Nanowire/ Nanosheet FETs for advanced technology nodes**, Madhulika S. Korde, SUNY Polytechnic Institute (USA); Joseph Kline, Daniel F. Sunday, National Institute of Standards and Technology (USA); Nick Keller, Nanometrics Inc. (USA); Subhadeep Kal, Cheryl Alix, Aelan Mosden, TEL Technology Ctr., America, LLC (USA); Alain C. Diebold, SUNY Polytechnic Institute (USA) [11325-25]

4:10 pm: **Nanoscale grating characterization through EUV spectroscopy aided by machine learning techniques**, Lukas Bahrenberg, Sven Glabisch, Serhiy Danylyuk, Moein Ghafoori, Sascha Brose, RWTH Aachen Univ. (Germany); Jochen Stollenwerk, Peter Loosen, Fraunhofer-Institut für Lasertechnik ILT (Germany). . . . . [11325-26]

4:30 pm: **Plasma halogenated amorphous carbon as growth inhibiting layer for area-selective deposition of titanium oxide**, Mikhail Krishtab, KU Leuven (Belgium) and imec (Belgium); Rob Ameloot, KU Leuven (Belgium); Silvia Armini, imec (Belgium); Joey Hung, Nova Measuring Instruments Inc. (USA); Roy Koret, Igor Turovets, Nova Measuring Instruments Ltd. (Israel); Kavita Shah, Srinivasan Rangarajan, Laxmi Warad, Vanessa Zhang, Nova Measuring Instruments Inc. (USA). . . . . [11325-27]

4:50 pm: **Understanding the influence of 3D sidewall roughness on observed line-edge roughness in scanning electron microscopy images**, Luc Van Kessel, Technische Univ. Delft (Netherlands); Thomas Huisman, ASML (Netherlands); Cornelis Hagen, Technische Univ. Delft (Netherlands) . . . . [11325-28]

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII



SESSION 6
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C
TUE 3:50 PM TO 5:30 PM

Overlay

Integration

Session Chairs: **Ryan Callahan,** FUJIFILM Electronic Materials U.S.A., Inc. (USA); **Ryusuke Uchida,** Tokyo Ohka Kogyo America, Inc. (USA)

3:50 pm: **Fin bending in dimensional scaling**, Liping Zhang, imec (Belgium); David Hellin, Lam Research Corp. (Belgium); Alfonso Sepúlveda Márquez, Efrain Altamirano-Sánchez, Frederic Lazzarino, Pierre Morin, Shouhua Wang, Toby Hopf, Karine Kenis, Christophe Lorant, Farid Sebaai, Dmitry Batuk, Basoene Briggs, Hans Mertens, Steven Demuynck, imec (Belgium) . . . . [11326-19]

4:10 pm: **How to improve overlay of largely deformed 3D NAND wafers?**, Michael Kubis, Jing Jin, Steven E. Steen, ASML Netherlands B.V. (Netherlands); Fayaz Shaikh, Bart van Schravendijk, Lam Research Corp. (USA) . . . . [11326-20]

4:30 pm: **Transparent KrF photoresist for 3D NAND application**, Yang Song, DuPont Electronics & Imaging (USA) . . . . [11326-21]

4:50 pm: **A DOE study of plasma etched microlens shape for CMOS image sensors**, Delia Ristoiu, Francois Leverd, Etienne Mortini, Jean-Luc Huguenin, STMicroelectronics S.A. (France) . . . . [11326-22]

5:10 pm: **Unique freeze cleaning technology**, Daisuke Matsushima, Kensuke Demura, Sadayuki Jimbo, Kei Hattori, Shibaura Mechatronics Corp. (Japan). . . . . [11326-23]

APPLICATION TRACKS

Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences.

• Machine Learning

• Stochastics

• Overlay

CONFERENCE 11327
Optical Microlithography XXXIII

SESSION 3
LOCATION: CONVENTION CENTER, ROOM 210A
TUE 3:50 PM TO 5:30 PM

Machine Learning

Machine Learning and Computational Lithography II

Session Chairs: **Harsha Grunes,** Intel Corp. (USA); **Stephen D. Hsu,** ASML San Jose (USA)

3:50 pm: **Accurate etch modeling with high-volume metrology and deep-learning technology**, Wei Yuan, Yifei Lu, Shanghai Integrated Circuit Research & Development Ctr. Co., Ltd. (China); Xichen Sheng, Jinze Wang, Leon Yao, Yanjun Xiao, ASML (China) . . . . [11327-8]

4:10 pm: **SRAF printing prediction using artificial neural network**, Yonghwi Kwon, Jinho Yang, KAIST (Korea, Republic of); Sungho Kim, Cheolkyun Kim, SK Hynix, Inc. (Korea, Republic of); Youngsoo Shin, KAIST (Korea, Republic of). . . . . [11327-9]

4:30 pm: **Improving wafer hotspot detection by combining aerial images metrology and rigorous simulation**, François Weisbuch, GLOBALFOUNDRIES Dresden Module Two, GmbH & Co. KG (Germany); Thomas Thaler, Ute Buttgereit, Christian Stötzel, Thomas Zeuner, Carl Zeiss SMT GmbH (Germany) . . . . [11327-10]

4:50 pm: **Dual tone sub-resolution assist features to improve corner rounding**, Cheng Chi, Hao Tang, Jing Guo, Geng Han, Oseo Park, Jeffrey C. Shearer, Sean D. Burns, IBM Thomas J. Watson Research Ctr. (USA) . . . . [11327-11]

5:10 pm: **Fast all-angle Mask 3D for ILT patterning**, Ryan Pearman, Mike Meyer, Jeff Ungar, Henry Yu, Leo Pang, Aki Fujimura, D2S, Inc. (USA) . . . . . [11327-12]

CONFERENCE 11329
Advanced Etch Technology for Nanopatterning IX

SESSION 4
LOCATION: CONVENTION CENTER, ROOM 211B
TUE 3:50 PM TO 5:40 PM

Atomic Layer Etching and Novel Plasma Techniques

Session Chairs: **Keun Hee Bai,** SAMSUNG Electronics Co., Ltd. (Korea, Republic of); **Jake O'Gorman,** Hitachi High Technologies America, Inc. (USA)

3:50 pm: **High precision and low damage spacer etch** *(Invited Paper)*, Nicolas Posséme, CEA-LETI (France) . . . . [11329-13]

4:20 pm: **Highly selective SiO2 etching over Si3N4 using a cyclic process with BCl3 and CF4 gas chemistries for multiple patterning** *(Invited Paper)*, Miyako Matsui, Hitachi, Ltd. (Japan); Kenichi Kuwahara, Hitachi High-Technologies Corp. (Japan). . . . . [11329-14]

4:50 pm: **Thermal prefunctionalization of SiO2 and SiNx surfaces to influence the etch per cycle in atomic layer etching** *(Invited Paper)*, Sumit Agarwal, Colorado School of Mines (USA). . . . . [11329-15]

5:20 pm: **Cycling of implantation step and remote plasma process step for nitride spacer etching applications.**, Nicolas Loubet, STMicroelectronics S.A. (France); Camille Petit-Etienne, Vincent Renaud, Lab. des Technologies de La Microélectronique (France); Cécile Jenny, STMicroelectronics S.A. (France); Erwine Pargon, Lab. des Technologies de La Microélectronique (France) . . . . [11329-16]

Symposium-wide Panel Discussion

Tuesday 25 February 2020 · 6:00 PM - 8:00 PM · Location: Convention Center, Grand Ballroom 220A

Symposium Chairs: **Will Conley,** Cymer–An ASML company and **Kafai Lai,** IBM T. J. Watson Research Ctr.

Moderators: **Chris Mack,** Fractilia, LLC and **Harry J. Levinson,** HJL Lithography.

The topic of this year's symposium-wide panel is "A toast to Lithography's past: what we learned from technologies not used in HVM." Over the years, a number of lithographic concepts were pursued for use in manufacturing when optical lithography finally reached its long-anticipated limits. While there appeared to be good reasons initially to invest substantially, in terms of people and money, in these concepts, most were not ultimately adopted for use in high-volume manufacturing (HVM). In this year's symposium-wide panel, people who were involved in developing these concepts will share their perspectives on what lessons can be learned from their experiences.

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CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 7
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
WED 8:00 AM TO 9:40 AM

Stochastics

EUV Patterning and Etch

Joint Session with conferences 11323 and 11329

Session Chairs: **Yuyang Sun,** Mentor, a Siemens Business (USA); **John Arnold,** IBM Thomas J. Watson Research Ctr. (USA); **Allen H. Gabor,** IBM Thomas J. Watson Research Ctr. (USA)

8:00 am: **0.33 NA EUV systems for high-volume manufacturing**, Ron f Schuurhuis, ASML (Netherlands); Marcel Mastenbroek, ASML Netherlands B.V. (Netherlands); Frank Bornebroek, Roel Moors, ASML Netherlands B.V. (Netherlands); Geert Fisser, Payam Tayebati, Roderik Van Es, ASML Netherlands B.V. (Netherlands). . . . . [11323-91]

8:20 am: **Extending EUV lithography for DRAM applications**, Gijsbert Rispens, Claire Van Lare, Dorothe Oorschot, Rik Hoefnagels, Shih-Hsiang Liu, Willem Van Mierlo, Ziyang Wang, Mark John Maslow, Jo Finders, ASML Netherlands B.V. (Netherlands); Roberto Fallica, Andreas Frommhold, Eric Hendrickx, imec (Belgium); Ardavan Niroomand, Scott Light, Micron Technology, Inc. (USA) . . . . [11323-25]

8:40 am: **Strategies for aggressive scaling of EUV multipatterning to sub-20 nm features**, Ashim Dutta, Jennifer Church, Joe Lee, Brendan O'Brien, Luciana Meli, Chi-Chun Liu, Saumya Sharma, Karen Petrillo, Cody J. Murray, IBM Corp. (USA); Eric Liu, Katie Lutker-Lee, Chia-Yun Hsieh, Qiaowei Lou, Jake Kaminsky, Stephanie Oyola-Reynoso, Subhadeep Kal, David O'Meara, Akiteru Ko, Aelan Mosden, Angélique Raley, Lior Huli, Dave Hetzer, Naoki Shibat, Robert Brandt, TEL Technology Ctr., America, LLC (USA) . . . . [11323-26]

9:00 am: **Simulation of photoresist defect transfer through subsequent patterning processes**, Dominik Metzler, IBM Thomas J. Watson Research Ctr. (USA); Sagarika Mukesh, Karthik Yogendra, IBM Corp. (USA); Mohamed Oulmane, Synopsys Switzerland, LLC (Switzerland); Phil Stopford, Lawrence Melvin, Synopsys, Inc. (USA). . . . . [11329-18]

9:20 am: **Low damage etching by Inductively Coupled Plasma (ICP) and Atomic Layer Etching (ALE) of III-V materials to enable next generation device performance**, Mark Dineen, Andy Goodyear, Stephanie Baclet, Oxford Instruments Plasma Technology Ltd. (United Kingdom) . . . . . . [11329-17]

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

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 6
LOCATION: CONVENTION CENTER, ROOM 210C
WED 8:00 AM TO 10:00 AM

Multi-Beam Mask Writing

Session Chairs: **Hans Loeschner,** IMS Nanofabrication GmbH (Austria); **Ines A. Stolberg,** Vistec Electron Beam GmbH (Germany)

8:00 am: **Development and deployment of advanced multi-beam mask writer** *(Invited Paper)*, M. Chandramouli, Intel Corp. (USA); R. K. Juday, Arizona State Univ. (USA); B. Liu, B. Shamoun, F. Abboud, Intel Corp. (USA). . . . . [11324-18]

8:40 am: **Progress report on 3+ years MBMW multi-beam mask writers**, Christof Klein, Hans Loeschner, Elmar Platzgummer, IMS Nanofabrication GmbH (Austria) . . . . [11324-19]

9:00 am: **Multi-beam mask writer MBM-1000**, Hiroshi Matsumoto, Hayato Kimura, Noriaki Nakayamada, NuFlare Technology, Inc. (Japan). . . . . [11324-20]

9:20 am: **Extending deep-UV multi-beam laser writing for optical and EUV masks**, H. Christopher Hamaker, Applied Materials, Inc. (USA) . . [11324-21]

9:40 am: **Software-based optimization methods for the ULTRA semiconductor maskwriter**, Niels Wijnaendts van Resandt, Heidelberg Instruments Inc. (USA); Ulrich Hofmann, GenISys GmbH (Germany) . . . . [11324-22]

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

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 8
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
WED 8:00 AM TO 10:00 AM

3D Profile and Shape Analysis

Session Chairs: **John A. Allgair,** BRIDG (USA); **Benjamin D. Bunday,** Abeam Technologies, Inc. (USA)

8:00 am: **Looking inside buried 3D silicon structures by X-ray tomography**, Diana A. Grishina, Cornelis Harteveld, Univ. of Twente (Netherlands); Alexandra Pacureanu, Peter Cloetens, European Synchrotron Radiation Facility (France); Ad Lagendijk, Willem Vos, Univ. of Twente (Netherlands) [11325-29]

8:20 am: **Three-dimensional feature characterization by inline Xe plasma fib: delayering and deep milling implementation**, Franz Niedermeier, Agnes Fros, Max Boeckl, Wolfgang Kipferl, Michaela Braun, Albert Birner, Infineon Technologies AG (Germany); Haim Pearl, Thomas Schubert, Allen Lee, Mirko Beyer, Daniel Harel, Arie Bader, Jeffrey W. Dietz, Wolfgang Bayerl, Applied Materials, Inc. (USA) . . . . [11325-30]

8:40 am: **Immediate observation of embedded structure after top-down delayering by using "Dig and See" technology for GFIS-SIM based accurate overlay metrology**, Shinichi Matsubara, Hiroyasu Shichi, Tomihiro Hashizume, Hitachi, Ltd. (Japan); Masami Ikota, Hitachi High-Technologies Corp. (Japan). . . . . [11325-31]

9:00 am: **AFM characterization for GAA devices**, Mary A. Breton, Jennifer Fullam, Lan Yu, Dexin Kong, Daniel Schmidt, Andrew Greene, Liying Jiang, IBM Thomas J. Watson Research Ctr. (USA); Sean Hand, Jason Osborne, Bruker Nano Inc. (USA). . [11325-32]

9:20 am: **3D shape evaluation by AFM integrated on Wafer-SEM platform with high precision XY navigation stage**, Toru Ikegami, Hitachi High-Technologies Corp. (Japan); Kazuhisa Hasumi, Masakazu Kanezawa, Hitachi High-Tech Science Corp. (Japan); Kenichi Nishigata, Hajime Shimada, Ritsuo Fukaya, Hitachi High-Technologies Corp. (Japan); Andrew D. L. Humphris, Lei Feng, Matthew Tedaldi, Lawrence Mudarikwa, David Ockwell, Jenny Goulden, Infinitesima Ltd. (United Kingdom). . . . . [11325-33]

9:40 am: **A hybrid total measurement uncertainty methodology for dual beam FIB/SEM metrology**, Ardavan Zandiatashbar, Chester Chien, Western Digital Corp. (USA) . . . . [11325-34]

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

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII

SESSION 7
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C
WED 8:10 AM TO 10:00 AM

Deposition-based Patterning

Session Chairs: **Joy Y. Cheng,** Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Mark H. Somervell,** Tokyo Electron America, Inc. (USA)

8:10 am: **Deposition-based patterning by area-selective deposition: Dielectric-on-dielectric and metal-on-metal using integrated Atomic Layer Deposition and thermally-driven Atomic Layer Etching** *(Invited Paper)*, Gregory N. Parsons, North Carolina State Univ. (USA) . . . . [11326-24]

8:40 am: **Inhibitor design for area selective atomic layer deposition**, Rudy J. Wojtecki, IBM Research - Almaden (USA) . . . . [11326-26]

9:00 am: **Sacrificial hardmask ALD with hydrogen peroxide: comparative study of low temperature growth and film characteristics for TiO2 and Al2O3**, Daniel Alvarez Jr., RASIRC (USA); Keisuke Andachi, Gaku Tsuchibuchi, Katsumasa Suzuki, Taiyo Nippon Sanso Corp. (Japan); Jeff Spiegelman, RASIRC (USA) . . . . [11326-27]

9:20 am: **Direct observation of inhibitor and selective deposition on nanoscale patterned structure**, Derek Nowak, Liz Brinkman, Molecular Vista, Inc. (USA); Paul Lemaire, Lam Research Corp. (USA); Sung Park, Molecular Vista, Inc. (USA) . . . . [11326-28]

9:40 am: **Unlocking pitch scaling with EUV: complimentary EUV and DSA approach for multi-pitch grating definition**, Eungnak Han, Gurpreet Singh, Tayseer Mahdi, Florian Gstrein, Intel Corp. (USA) . . . . [11326-25]

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

CONFERENCE 11327
Optical Microlithography XXXIII

SESSION 4
LOCATION: CONVENTION CENTER, ROOM 210A
WED 8:00 AM TO 10:00 AM

Process Control, Resist Modeling

Session Chairs: **Geert Vandenberghe,** imec (Belgium); **Carlos Fonseca,** Tokyo Electron America, Inc. (USA)

8:00 am: **Resist shrinkage during development: rigorous simulations and first compact model for OPC**, Yuri Granik, Gurdaman Khaira, Mentor, a Siemens Business (USA). . . . . [11327-13]

8:20 am: **Compact resist model using single convolution kernel**, Taiki Kimura, Tetsuaki Matsunawa, Shoji Mimotogi, Kioxia Corp. (Japan). . . . . [11327-14]

8:40 am: **Rigorous simulation of implant resist on topographic wafer**, Jirka Schatz, GLOBALFOUNDRIES Dresden Module One LLC & Co. KG (Germany); Bernd Küchler, Wolfgang Hoppe, Synopsys GmbH (Germany); Dimitrios Tsamados, Synopsys GmbH (Switzerland) . . . . [11327-15]

9:00 am: **Ultrathin film (n, k, t) fitting with physics compliance**, Zhimin Zhu Sr., Brewer Science, Inc. (USA) . . . . [11327-16]

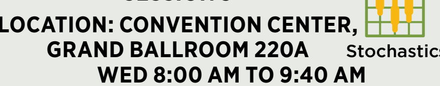
9:20 am: **Adding mask and wafer co-optimization into full chip curvilinear ILT**, Linyong Pang, Ryan Pearman, Lu Sha, Ali Bouaricha, Jeffrey Ungar, Aki Fujimura, D2S, Inc. (USA) . . . . [11327-17]

9:40 am: **Next generation ArF Laser technologies for multiple-patterning immersion lithography supporting leading edge processes**, Miwa Igarashi, Hirotaka Miyamoto, Masahide Katou, Hiroaki Tsushima, Masato Moriya, Akihiko Kurosu, Hiroshi Tanaka, Satoshi Tanaka, Takeshi Ohta, Satoru Bushida, Takashi Saitou, Hakaru Mizoguchi, Toshihiro Oga, Gigaphoton Inc. (Japan) . . . . [11327-18]

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

CONFERENCE 11328
Design-Process-Technology Co-optimization for Manufacturability XIV

SESSION 1
LOCATION: CONVENTION CENTER, ROOM 210D
WED 8:00 AM TO 10:00 AM



AI and Machine Learning

Session Chairs: **Robert Aitken,** ARM Inc. (USA); **Jason P. Cain,** Advanced Micro Devices, Inc. (USA)

8:00 am: **Augmented Reality: pushing technology in a new and disruptive direction** *(Keynote Presentation)*, Matthew Colburn, Facebook Technologies, LLC (USA) . . .[11328-1]

8:40 am: **Machine Learning using retarget data to improve accuracy of fast lithographic hotspot detection**, Wael ElManhawy, Mentor, a Siemens Business (USA); Aliaa Kabeel, Mentor Graphics Egypt (Egypt); Joe Kwan, Mentor, a Siemens Business (USA); Kareem Madkour, Mentor Graphics Egypt (Egypt); Marwa Shafee, Mentor Graphics Egypt (Egypt); Mohamed Ismail, Mentor, a Siemens Business (Egypt); Ahmed Khater, Mentor Graphics Egypt (Egypt); Asmaa Rabie, Sarah Rizk, Mentor (Egypt) . . . .[11328-2]

9:00 am: **Concurrent design rule, OPC and process optimization in EUV Lithography**, Dongbo Xu, Werner Gillijns, Ling Ee Tan, Jae Uk Lee, Ryoung-Han Kim, imec (Belgium). . . . . [11328-3]

9:20 am: **Implementing Machine Learning OPC on product layouts**, Kevin Hooker, Marco Guajardo, Hesham Abdelghany, Synopsys, Inc. (USA); Chia-Chun Lu, Synopsys, Inc. (Taiwan) . . . . [11328-4]

9:40 am: **Advanced memory cell design optimization with inverse lithography technology**, Jiro Higuchi, Weiting Wang, Takamasa Takaki, Hiromitsu Mashita, Shigeki Nojima, Kioxia Holdings Corp. (Japan); Ahmed S. Omran, Synopsys, Inc. (USA); Ken Hanafusa, Nihon Synopsys G.K. (Japan); Seung-Hee Baek, Synopsys Korea Inc. (Korea, Republic of); Ryan Chen, Synopsys, Inc. (USA); Yukio Asaka, Nihon Synopsys G.K. (Japan); Kyle Braam, Synopsys, Inc. (USA); Hironobu Taoka, Nihon Synopsys G.K. (Japan); Guangming Xiao, Synopsys, Inc. (USA). . . . . [11328-5]

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

CONFERENCE 11329
Advanced Etch Technology for Nanopatterning IX

SESSION 5
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
WED 8:00 AM TO 9:40 AM

EUV Patterning and Etch

Joint Session with conferences 11323 and 11329

Session Chairs: **Yuyang Sun,** Mentor, a Siemens Business (USA); **John Arnold,** IBM Thomas J. Watson Research Ctr. (USA); **Allen H. Gabor,** IBM Thomas J. Watson Research Ctr. (USA)

8:00 am: **0.33 NA EUV systems for high-volume manufacturing**, Ron f Schuurhuis, ASML (Netherlands); Marcel Mastenbroek, ASML Netherlands B.V. (Netherlands); Frank Bornebroek, Roel Moors, ASML Netherlands B.V. (Netherlands); Geert Fisser, Payam Tayebati, Roderik Van Es, ASML Netherlands B.V. (Netherlands) . . . . [11323-91]

8:20 am: **Extending EUV lithography for DRAM applications**, Gijsbert Rispens, Claire Van Lare, Dorothe Oorschot, Rik Hoefnagels, Shih-Hsiang Liu, Willem Van Mierlo, Ziyang Wang, Mark John Maslow, Jo Finders, ASML Netherlands B.V. (Netherlands); Roberto Fallica, Andreas Frommhold, Eric Hendrickx, imec (Belgium); Ardavan Niroomand, Scott Light, Micron Technology, Inc. (USA). . . . . [11323-25]

8:40 am: **Strategies for aggressive scaling of EUV multipatterning to sub-20 nm features**, Ashim Dutta, Jennifer Church, Joe Lee, Brendan O'Brien, Luciana Meli, Chi-Chun Liu, Saumya Sharma, Karen Petrillo, Cody J. Murray, IBM Corp. (USA); Eric Liu, Katie Lutker-Lee, Chia-Yun Hsieh, Qiaowei Lou, Jake Kaminsky, Stephanie Oyola-Reynoso, Subhadeep Kal, David O'Meara, Akiteru Ko, Aelan Mosden, Angélique Raley, Lior Huli, Dave Hetzer, Naoki Shibat, Robert Brandt, TEL Technology Ctr., America, LLC (USA) . . . . . . [11323-26]

9:00 am: **Simulation of photoresist defect transfer through subsequent patterning processes**, Dominik Metzler, IBM Thomas J. Watson Research Ctr. (USA); Sagarika Mukesh, Karthik Yogendra, IBM Corp. (USA); Mohamed Oulmane, Synopsys Switzerland, LLC (Switzerland); Phil Stopford, Lawrence Melvin, Synopsys, Inc. (USA). . . . . [11329-18]

9:20 am: **Low damage etching by Inductively Coupled Plasma (ICP) and Atomic Layer Etching (ALE) of III-V materials to enable next generation device performance**, Mark Dineen, Andy Goodyear, Stephanie Baclet, Oxford Instruments Plasma Technology Ltd. (United Kingdom). . . . . [11329-17]

9:40 am: **A novel approach to high productivity EUV patterning,** Rich Wise, Lam Research Corp. (USA) . . . . [11329-38]

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

APPLICATION TRACKS

Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences.

• **Machine Learning**

• **Stochastics**

• **Overlay**

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 8

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A

WED 10:30 AM TO 11:50 AM

Progress in EUV Sources

Session Chairs: **Jos P. Benschop,** ASML Netherlands B.V. (Netherlands); **Akiyoshi Suzuki,** AS Lithography Consulting (Japan)

10:30 am: **Progress in availably of NXE:3400B EUVL sources in the field and power scaling towards 500W** *(Invited Paper)*, David C. Brandt, Igor Fomenkov, ASML US, Inc. (USA) . . . . [11323-27]

10:50 am: **Challenge of >300W high power LPP-EUV source with long collector mirror lifetime for semiconductor HVM**, Hakaru Mizoguchi, Hiroaki Nakarai, Tamotsu Abe, Hiroshi Tanaka, Yukio Watanabe, Tsukasa Hori, Yutaka Shiraishi, Tatsuya Yanagida, George Sumangne, Tsuyoshi Yamada, Takashi Saitou, Gigaphoton Inc. (Japan) . [11323-28]

11:10 am: **Understanding EUV-induced plasma and application to particle contamination control in EUV scanners**, Mark A. van de Kerkhof, ASML Netherlands B.V. (Netherlands) . . . . [11323-29]

11:30 am: **The transition from short to long timescale pre-pulses: laser-pulse impact on tin microdroplets**, Randy Meijer, Dmitry Kurilovich, Advanced Research Ctr. for Nanolithography (Netherlands) and Vrije Univ. Amsterdam (Netherlands); Oscar O. Versolato, Advanced Research Ctr. for Nanolithography (Netherlands); Kjeld S. E. Eikema, Stefan Witte, Advanced Research Ctr. for Nanolithography (Netherlands) and Vrije Univ. Amsterdam (Netherlands) . . . . [11323-30]

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

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 7

LOCATION: CONVENTION CENTER, ROOM 210C

WED 10:30 AM TO 12:10 PM

Multi-Beam Direct Write Lithography

Session Chairs: **Ines A. Stolberg,** Vistec Electron Beam GmbH (Germany); **Hans Loeschner,** IMS Nanofabrication GmbH (Austria)

10:30 am: **Multicolumn e-beam lithography for IC traceability** *(Invited Paper)*, David K. Lam, Multibeam Corp. (USA) . . . . [11324-23]

11:10 am: **Maskless exposure for backend lithography** *(Invited Paper)*, Thomas Uhrmann, Bernd Thallner, Bozena Matuskova, Frank Bögelsack, EV Group (Austria) . . . . [11324-24]

11:50 am: **Direct write lithography for advanced packaging, MEMS, and related applications**, Markus Arendt, SUSS MicroTec Photonic Systems, Inc. (USA); Markus Schieber, Uwe Vogler, Andreas Nagy, SUSS MicroTec Lithography GmbH (Germany); Reinhard Voelkel, Klaus Ruhmer, SUSS MicroOptics SA (Switzerland); Paul Ferrari, Matthew Gingerella, Patrick Frye, Jeff Hansen, SUSS MicroTec Photonic Systems, Inc. (USA). . . . . [11324-25]

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

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 9

Stochastics

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B

WED 10:30 AM TO 12:10 PM

Scatterometry

Session Chairs: **Phillipe Leray,** imec (Belgium); **Christopher J. Raymond,** Nanometrics Inc. (USA)

10:30 am: **EUV scatterometer with multiple orders of high-harmonic generation**, Yi-Sha Ku, Industrial Technology Research Institute (Taiwan) . . [11325-35]

10:50 am: **Ruthenium direct etch scatterometry solution for self-aligning semi-damascene**, Sara Paolillo, Alain Moussa, Gayle Murdoch, Frederic Lazzarino, Anne-Laure Charley, Philippe Leray, imec (Belgium); Roy Koret, Nova Measuring Instruments Ltd. (Israel); Joey Hung, Nova Measuring Instruments Ltd. (Germany); Igor Turovets, Shay Wolfling, Avron Ger, Nova Measuring Instruments Ltd. (Israel) . . . . [11325-36]

11:10 am: **Critical-dimension grazing-incidence small angle X-Ray scattering: applications and development**, Guillaume Freychet, Brookhaven National Lab. (USA); Dinesh Kumar, Lawrence Berkeley National Lab. (USA); Isvar A. Cordova, The Ctr. for X-Ray Optics (USA); Ron J. Pandolfi, Advanced Light Source (USA); Patrick P. Naulleau, The Ctr. for X-Ray Optics (USA); Cheng Wang, Alex Hexemer, Lawrence Berkeley National Lab. (USA) . . . . [11325-37]

11:30 am: **Recent progress in nanostructure metrology by tomographic Mueller-matrix scatterometry**, Xiuguo Chen, Shiyuan Liu, Huazhong Univ. of Science and Technology (China) . [11325-38]

11:50 am: **Sensitivity analysis for the detection of pitchwalk in self-aligned quadruple patterning by GISAXS**, Maren Casfor Zapata, Nando Farchmin, Mika Pflüger, Victor Soltwisch, Sebastian Heidenreich, Konstantin Nikolaev, Christian Laubis, Michael Kolbe, Markus Bär, Frank Scholze, Physikalisch-Technische Bundesanstalt (Germany) . . . . [11325-39]

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

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII

SESSION 8

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C

WED 10:30 AM TO 12:10 PM

Novel Patterning

Session Chairs: **Raluca Tiron,** CEA-LETI (France); **Douglas J. Guerrero,** Brewer Science, Inc. (Belgium)

10:30 am: **Enabling Moore's Law with DSA** *(Invited Paper)*, Gurpreet Singh, Eungnak Han, Florian Gstrein, Intel Corp. (USA) . . . . [11326-29]

10:50 am: **Exploration of pillar local CDU improvement options for AI applications** *(Invited Paper)*, Chi-Chun Liu, Hao Tang, Yann Mignot, Ashim Dutta, Jennifer Church, Saumya Sharma, Dominik Metzler, Karen Petrillo, Michael Rizzolo, Luciana Meli, John Arnold, Nelson Felix, IBM Thomas J. Watson Research Ctr. (USA) . . . . [11326-30]

11:10 am: **Roughness study on line and space patterning with chemo-epitaxy directed self-assembly**, Hyo Seon Suh, imec (Belgium); Viktor Dudash, imec (Belgium) and Taras Shevchenko National Univ. of Kyiv (Ukraine); Gian Lorusso, imec (Belgium); YoungJun Her, EMD Performance Materials Corp. (USA) and imec (Belgium); Jin Li, Victor Monreal, Durairaj Baskaran, Boaz Alperson, Karl Skjonnemand, EMD Performance Materials Corp. (USA); Chris Mack, Fractilia, LLC (USA) . . . . [11326-31]

11:30 am: **Defect mitigation of chemo-epitaxy DSA patterns**, Makoto Muramatsu, Takanori Nishi, Yasuyuki Ido, Tokyo Electron Kyushu Ltd. (Japan); Takahiro Kitano, Tokyo Electron Ltd. (Japan) . . . . . [11326-32]

11:50 am: **Establishing a sidewall image transfer chemo-epitaxial DSA process using 193 nm immersion lithography**, Guido Rademaker, Aurélie Le Pennec, Tommaso Giammaria, Khatia Benotmane, Hanh Pham, Charlotte Bouet, Maria Gabriela Gusmao Cacho, Maxime Argoud, Marie-Line Pourteau, Anne Paquet, Ahmed Gharbi, Univ. Grenoble Alpes (France) and CEA-LETI (France); Christophe Navarro, Célia Nicolet, Xavier Chevalier, Arkema S.A. (France); Kaumba Sakavuyi, Brewer Science, Inc. (USA); Laurent Pain, Univ. Grenoble Alpes (France) and CEA-LETI (France); Paul Nealey, The Univ. of Chicago (USA); Raluca Tiron, Univ. Grenoble Alpes (France) and CEA-LETI (France) . . . . [11326-33]

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

CONFERENCE 11327
Optical Microlithography XXXIII

SESSION 5

LOCATION: CONVENTION CENTER, ROOM 210A
WED 10:30 AM TO 12:10 PM

Lithography Equipment, Focus Control

Session Chairs: **Reinhard Voelkel,** SUSS MicroOptics SA (Switzerland); **Ken-Ichiro Mori,** Canon Inc. (Japan)

10:30 am: **Divided spectrum illumination for high resolution flat panel display exposure tools**, Manabu Hakko, Canon Inc. (Japan) . . . . [11327-19]

10:50 am: **Investigating the fine line lithography process on the large-size organic panels for advanced packaging and development**, Naoya Sohara, Hirosuke Takamatsu, Ryotaro Takahashi, Ushio Inc. (Japan) . . . . [11327-20]

11:10 am: **Accuracy improvement in advance lithography focus control**, ChingHsiang Hsu, Dongyue Yang, Cassidy Dineen, Xueli Hao, Tony Joung, Young Ki Kim, GLOBALFOUNDRIES Inc. (USA) . . . . [11327-21]

11:30 am: **Multi-focal imaging for improved depth of focus; principles and application to ArFi use cases**, Will Conley, Josh Thornes, Cymer, LLC (USA); Paolo Alagna, Cymer, LLC (Belgium); Omar Zurita, Kuo-Tai Teng, Cymer, LLC (USA); Stephen Hsu, ASML San Jose (USA); Xiang-ru Xu, Sam Liu, Brion Technologies (Shenzhen) Co., Ltd. (China) . . . . [11327-22]

11:50 am: **Improving DOF for an advanced 3D NAND Via layer using Multi-Focal Imaging**, Will Conley, Cymer, LLC (USA); Yaobin Feng, Zhiyang Song, Yangtze Memory Technologies Co., Ltd. (China); Joshua J. Thornes, Cymer, LLC (USA); Paolo Alagna, Cymer, LLC (Belgium); Omar Zurita, Kuo-Tai Teng, Rahul Ahlawat, Cymer, LLC (USA); Stephen D. Hsu, ASML San Jose (USA); Jun-Wei Lu, Sam Liu, Xiang-ru Xu, ASML-Brion Technologies (China) . . . [11327-23]

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

CONFERENCE 11328
Design-Process-Technology Co-optimization for Manufacturability XIV

SESSION 2

LOCATION: CONVENTION CENTER, ROOM 210D
WED 10:30 AM TO 12:10 PM

Advanced Designs

Session Chairs: **Luigi Capodieci,** Motivo, Inc. (USA); **Lifu Chang,** MOSIS Integrated Circuit Fabrication Service (USA)

10:30 am: **Standard cell architectures for N2 node: transition from FinFET to Nanosheet and to Forkheet device**, Bilal Chehab, Pieter Weckx, Julien Ryckaert, Doyoung Jang, Diederik Verkest, Alessio Spessot, imec (Belgium) . . . . [11328-6]

10:50 am: **Approaches for full coverage physical design space exploration and analysis by synthetic layout generation**, Joe Kwan, Wael ElManhawy, Mentor, a Siemens Business (USA); Kareem Madkour, Aliaa Kabeel, Sarah Rizk, Marwah Shafee, Mentor, a Siemens Business (Egypt); SeungJo Lee, Jinhee Kim, Mentor, a Siemens Business (Korea, Republic of); Mohamed Bahnasawi, Mostafa Alaa, Sherif Hammouda, Mentor, a Siemens Business (Egypt); Mohamed N. Sabry, Mansoura Univ. (Egypt) and Nabla Advanced Systems (Egypt); Abdelrahman Abdelrazek, Nabla Advanced Systems (Egypt) . . . . [11328-7]

11:10 am: **An automated system for checking process friendliness and routability of standard cells**, I-Lun Tseng, GLOBALFOUNDRIES Singapore Pte. Ltd. (Singapore); Punitha Selvam, GLOBALFOUNDRIES Inc. (USA); Vikas Tripathi, Zhao Chuan Lee, Chun Ming Yip, Jonathan Yoong Seang Ong, GLOBALFOUNDRIES Singapore Pte. Ltd. (Singapore) . . . . [11328-8]

11:30 am: **Sequential 3D standard cell 4T architecture using design crenellation and self-aligned MOL for N2 technology and beyond**, Pieter Weckx, imec (Belgium) . . . . [11328-9]

11:50 am: **A comparative analysis of EUV sheet and gate patterning for beyond 7nm gate all around stacked nanosheet FET's**, Indira Seshadri, Praveen Joseph, Stuart A. Sieg, Tao Li, IBM Corp. (USA); Wenyu Xu, IBM Thomas J. Watson Research Ctr. (USA); Eric Miller, Dan J. Dechene, Andrew Greene, Carl Radens, Jingyun Zhang, Yann Mignot, Pietro Montanini, Mary Breton, Veeraraghavan Basker, Nelson Felix, IBM Corp. (USA) . . . . [11328-10]

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

CONFERENCE 11329
Advanced Etch Technology for Nanopatterning IX

SESSION 6

LOCATION: CONVENTION CENTER, ROOM 211B
WED 10:30 AM TO 12:10 PM

Patterning Solutions for Emerging Applications

Session Chairs: **Nihar Mohanty,** Facebook Technologies, LLC (USA); **Ricardo Ruiz,** Lawrence Berkeley National Lab. (USA)

10:30 am: **Atomic Layer Etching of III-V materials to enable next generation device performance** *(Invited Paper)*, Mark Dineen, Oxford Instruments Plasma Technology Ltd. (United Kingdom) [11329-20]

11:00 am: **Challenges for traditional and EUV Photomask etch** *(Invited Paper)*, Madhavi R. Chandrachood, Applied Materials, Inc. (USA) . . . . [11329-21]

11:30 am: **Fabrication and individual addressing of STT-MRAM bit array with 50 nm full pitch**, Lei Wan, HGST, Inc. (USA). [11329-22]

11:50 am: **Challenges in the patterning of RRAM devices for analog computing applications**, Iqbal Saraf, IBM Corp. (USA); Shyam Sridhar, Christopher Catano, Sergey Voronin, TEL Technology Ctr., America, LLC (USA); Dexin Kong, Soon-Cheon Seo, Youngseok Kim, Takashi Ando, Nicole Saulnier, Vijay Narayanan, IBM Thomas J. Watson Research Ctr. (USA) . . . . [11329-23]

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

APPLICATION TRACKS

Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences.

• **Machine Learning**

• **Stochastics**

• **Overlay**

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 9
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
WED 1:20 PM TO 3:40 PM

Progress in EUV Masks

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

1:20 pm: **EUV mask infrastructure and defects control** *(Invited Paper)*, Ted Liang, Yoshihiro Tezuka, Marieke Jager, Kishore Chakravorty, Safak Sayan, Eric Frendberg, Srinath Satyanarayana, Intel Corp (USA) . . . . [11323-31]

1:40 pm: **Development of high reflective phase shift type absorber for future generation EUV mask blank**, Yohei Ikebe, Osamu Nozawa, Takahiro Onoue, HOYA Corp. (Japan) . . . . [11323-32]

2:00 pm: **Directional and selective patterning of Ni for next generation EUV absorber**, Xia Sang, Jane P. Chang, Univ. of California, Los Angeles (USA) . . . . [11323-33]

2:20 pm: **Mask characterization studies of new alternative thin EUV absorber**, Henry H. Kamberian, Photronics Inc (USA) . . . . [11323-34]

2:40 pm: **EUV mask polarization effects on Sub-7nm node imaging**, Lilian Neim, Bruce W Smith, Rochester Institute of Technology (USA); Germain L Fenger, Mentor Graphics (USA) . . . . [11323-35]

3:00 pm: **Quantitative phase retrieval for EUV photomasks**, Stuart Sherwin, Univ. of California, Berkeley (USA); Isvar A. Cordova, The Ctr. for X-Ray Optics (USA); Laura Waller, Andrew Neureuther, Univ. of California, Berkeley (USA); Patrick Naulleau, The Ctr. for X-Ray Optics (USA) . . . . [11323-36]

3:20 pm: **Pathfinding the perfect EUV mask: the role of the multilayer**, Hazem M. S. Mesilhy, Peter Evanschitzky, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Gerardo Bottiglieri, Eelco van Setten, Timon Fliervoet, ASML Netherlands B.V. (Netherlands); Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany) . . . . [11323-37]

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

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 8
LOCATION: CONVENTION CENTER, ROOM 210C
WED 1:40 PM TO 3:00 PM

3-D Printing

Session Chairs: **J. Alexander Liddle,** National Institute of Standards and Technology (USA); **Richard A. Farrell,** TEL Technology Ctr., America, LLC (USA)

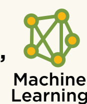
1:40 pm: **Two-photon grayscale lithography** *(Invited Paper)*, Michael Thiel, Nanoscribe GmbH (Germany) . . . . [11324-26]

2:20 pm: **Design and development of biodegradable resins for additive manufacturing** *(Invited Paper)*, Alshakim Nelson, Univ. of Washington (USA) . . . . [11324-27]

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

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 10
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
WED 1:40 PM TO 3:00 PM


Machine Learning

Machine Learning

Session Chairs: **Narender Rana,** Western Digital Corp. (USA); **Masafumi Asano,** Tokyo Electron Ltd. (Japan)

1:40 pm: **Contrasting conventional and machine learning approaches to optical critical dimension measurements**, Bryan M. Barnes, Mark-Alexander Henn, National Institute of Standards and Technology (USA) . . . . [11325-40]

2:00 pm: **Prediction of stochastic edge placement error with deep learning neural network**, Stefan Hunsche, Fuming Wang, Larry Luo, Xuefeng Zeng, ASML US, Inc. (USA). . . . . [11325-41]

2:20 pm: **Advanced machine learning eco-system to address HVM optical metrology requirements**, Padraig R. Timoney, Roma Luthra, Alex Elia, GLOBALFOUNDRIES Inc. (USA); Haibo Liu, Paul K. Isbester, Avi Levy, Nova Measuring Instruments Inc. (USA); Michael Shifrin, Barak Bringoltz, Ariel Broitman, Eitan Rothstein, Nova Measuring Instruments Ltd. (Israel). . . . . [11325-42]

2:40 pm: **Measuring local CD uniformity in EUV vias with scatterometry and machine learning**, Dexin Kong, Daniel Schmidt, Jennifer Church, Chi-Chun Liu, Mary A. Breton, Cody Murray, Luciana Meli, Liying Jiang, John Sporre, Nelson Felix, Ishtiaq Ahsan, IBM Thomas J. Watson Research Ctr. (USA); Aron J. Cepler, Marjorie Cheng, Nova Measuring Instruments Inc. (USA); Roy Koret, Igor Turovets, Nova Measuring Instruments Ltd. (Israel) . [11325-43]

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

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII

SESSION 9
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C
WED 1:40 PM TO 3:00 PM

Supplier

Session Chairs: **Christoph K. Hohle,** Fraunhofer-Institut für Photonische Mikrosysteme IPMS (Germany); **Nobuyuki N. Matsuzawa,** Panasonic Corp. (Japan)

1:40 pm: **Delivering metal oxide photoresists for EUV: overcoming challenges to scaling**, Andrew Grenville, Benjamin Clark, Peter de Schepper, Michael Kocsis, Jason Stowers, Alan Telecky, Inpria Corp. (USA) . . . . [11326-34]

2:00 pm: **Performance enhancements with the high opacity Multi-Trigger Resist**, Carmen Popescu, Greg O'Callaghan, Alexandra McClelland, Irresistible Materials Ltd. (United Kingdom); John Roth, Tom Lada, Nano-C, Inc. (USA); Alex P. G. Robinson, The Univ. of Birmingham (United Kingdom). . . [11326-35]

2:20 pm: **Stochastic effects on EUV CAR systems: Investigation of materials impact**, Katsuaki Nishikori, Kazuki Kasahara, Tetsurou Kaneko, JSR Corp. (Japan); Tomohiko Sakurai, JSR Micro, Inc. (USA); Satoshi Dei, Ken Maruyama, JSR Corp. (Japan); Rama Ayothi, JSR Micro, Inc. (USA) . . . . [11326-36]

2:40 pm: **Addressing metallic contaminants in the photochemical supply chain**, Jad Jaber, Annie Xia, James Hamzik, Nicholas Filipancic, Justin Brewster, Entegris, Inc. (USA) . . . . [11326-37]

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

CONFERENCE 11327
Optical Microlithography XXXIII

SESSION 6
LOCATION: CONVENTION CENTER, ROOM 210A
WED 1:40 PM TO 3:00 PM

Overlay

DUV and EUV Matching

Session Chairs: **Bernd Geh,** Carl Zeiss SMT GmbH (USA); **Young Seog Kang,** SAMSUNG Electronics Co., Ltd. (Korea, Republic of)

1:40 pm: **Managing edge placement errors during process definition** *(Invited Paper)*, Robert M. Bigwood, Intel Corp (USA) . . . . [11327-49]

2:20 pm: **Holistic alignment approach for on product overlay improvement on DUV and EUV Lithograph process with combined solutions**, Jigang Ma, Miao Yu, Cees Lambregts, Sotirios Tsiachris, Paul Böcker, ASML Netherlands B.V. (Netherlands); Jun-Yeob Kim, Joongeun Ha, Sunyoung Koo, Won-Kwang Ma, Sang-Jun Han, Chan-Ha Park, SK Hynix, Inc. (Korea, Republic of); Kyong-Seok Kim, Hwan Kim, Sang-Jun Park, Gwang-Gon Kim, ASML Korea Co., Ltd. (Korea, Republic of) . . . . . [11327-24]

2:40 pm: **A novel projection lens manipulator for high frequent overlay tuning**, Wolfgang Emer, Thilo Pollak, Bernd Thuering, Jörg Tschischgale, Carl Zeiss SMT GmbH (Germany); Friso Klinkhamer, Francis Fahrni, Wim Bouman, Wim de Boeij, ASML (Netherlands) . . . . [11327-25]

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

CONFERENCE 11328
Design-Process-Technology Co-optimization for Manufacturability XIV

SESSION 3
LOCATION: CONVENTION CENTER, ROOM 210D
WED 1:40 PM TO 3:10 PM

Pattern Matching

Session Chairs: **Andrew R. Neureuther,** Univ. of California, Berkeley (USA); **Neal V. Lafferty,** Mentor, a Siemens Business (USA)

1:40 pm: **DTCO acceleration to fight scaling stagnation** *(Invited Paper)*, Lars W. Liebmann, Jeffrey Smith, Daniel Chanemougame, Tokyo Electron Ltd. (USA); Chia-Tung Ho, Jonathan Cobb, Pete Churchill, Synopsys, Inc. (USA). . . . . [11328-11]

2:10 pm: **Dynamic pattern matching flow to enable low escape rate weak point detection**, Uwe Paul Schroeder, Janam Bakshi, Ahmed M. Elsemary, Fadi Batarseh, GLOBALFOUNDRIES Inc. (USA) [11328-12]

2:30 pm: **Integrating enhanced hotspot library into manufacturing OPC correction flow**, Bradley J. Falch, Linghui Wu, Synopsys, Inc. (USA); John Tsai, Synopsys Taiwan Co., Ltd. (Taiwan); Elsley Tan, Synopsys, Inc. (Taiwan); Jiunhau Fu, Tengyen Huang, Chuncheng Liao, Nanya Technology Corp. (Taiwan) . . . . [11328-13]

2:50 pm: **Layout commonality analysis for defect root cause determination**, Jason P. Cain, Moutaz Fakhry, Shraddha Bodhe, Nathan Zou, Advanced Micro Devices, Inc. (USA) . . . . [11328-14]

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

CONFERENCE 11329
Advanced Etch Technology for Nanopatterning IX

SESSION 7
LOCATION: CONVENTION CENTER, ROOM 211B
WED 1:40 PM TO 4:00 PM

Machine Learning

Advanced Patterning Integration

Session Chair: **Ying Zhang,** Applied Materials, Inc. (USA)

1:40 pm: **FEOL dry etch process challenges of ultimate FinFET scaling and next generation device architectures beyond N3** *(Invited Paper)*, Zheng Tao, Liping Zhang, Boon Teik Chan, Emmanuel Dupuy, Efrain Altamirano-Sánchez, Frederic Lazzarino, imec (Belgium) . . . . [11329-24]

2:10 pm: **Challenges and opportunities for optical neural network** *(Invited Paper)*, Arka Majumdar, Univ. of Washington (USA) . . . . [11329-25]

2:40 pm: **Isotropic plasma free Si trim for FinFET to GAA device architectures**, Subhadeep Kal, TEL Technology Ctr., America, LLC (USA); Yusuke Oniki, imec (Belgium); Cheryl Alix, TEL Technology Ctr., America, LLC (USA); Karine Kenis, Efrain Altamirano-Sánchez, Naoto Horiguchi, Frank Holsteyns, imec (Belgium); Yusuke Muraki, Daniel Chanemougame, Aelan Mosden, Kaushik Kumar, Peter Biolsi, Trace Hurd, TEL Technology Ctr., America, LLC (USA) . . . . [11329-26]

3:00 pm: **The metal gate cut development**, Shiliang Ji, Qiu-Hua Han, Haiyang Zhang, Semiconductor Manufacturing International Corp. (China) [11329-27]

3:20 pm: **Hydrocarbon layer formation and removal studies on SiN films etched in Halogen / Hydrofluorocarbon plasmas**, Luxherta Buzi, IBM Corp. (USA); John M. Papalia, IBM Thomas J. Watson Research Ctr. (USA); Mahmoud M. Khojasteh, Hiroyuki Miyazoe, Marinus Hopstaken, Steve Molis, Robert L. Bruce, Sebastian U. Engelmann, IBM Corp. (USA) . . . . [11329-28]

3:40 pm: **Improvement of self-aligned dual patterning using spin-on-carbon mandrel**, Caitlin Philippi, Sophie Thibaut, Andrew Metz, Akiteru Ko, Angélique Raley, Peter Biolsi, TEL Technology Ctr., America, LLC (USA). . . . . [11329-29]

Conference End.

APPLICATION TRACKS

Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences.

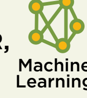
• Machine Learning

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 10

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A

WED 4:10 PM TO 4:50 PM



EUV OPC and Modeling

Session Chairs: **Lawrence S. Melvin III,** Synopsys, Inc. (USA); **Srividya Jayaram,** Mentor, a Siemens Business (USA)

4:10 pm: **Machine learning techniques for OPC improvement at the sub-5 nm node**, Changsoo Kim, Seungjong Lee, Sangwoo Park, No Young Chung, Su Yong Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Robert Boone, ASML (USA); Pengcheng Li, ASML San Jose (USA); Jiyoon Chang, YoungMi Kim, ASML (USA); MinSu Oh, ASML Korea Co., Ltd. (Korea, Republic of); Zhangnan Zhu, Rachit Gupta, Jun Ye, Stanislas Baron, ASML San Jose (USA) . . . . [11323-38]

4:30 pm: **Rigorous stochastic lithography modelling for defectivity reduction in EUV single expose patterning**, Ulrich Welling, Synopsys GmbH (Germany) . . . . [11323-39]

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A

4:50 PM TO 5:30 PM

EUV Poster Preview Speed Talks II

Session Chairs: **Nelson M. Felix,** IBM Thomas J. Watson Research Ctr. (USA); **Anna Iio,** Intel Corp. (USA)

Previews from Posters:

11323-60

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11323-62

11323-63

11323-64

11323-66

11323-73

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 9

LOCATION: CONVENTION CENTER, ROOM 210C

WED 3:30 PM TO 5:30 PM

Neuromorphic Computing

Session Chairs: **Hsinyu Tsai,** IBM Research - Almaden (USA); **Erik R. Hosler,** PsiQuantum (USA)

3:30 pm: **Device-algorithm co-design for efficient neuro-inspired computing with resistive memory devices** *(Invited Paper)*, Duygu Kuzum, Univ. of California, San Diego (USA). . . . .[11324-28]

4:10 pm: **Highly efficient neuromorphic computing systems with emerging nonvolatile memories** *(Invited Paper)*, Yiran Chen, Bonan Yan, Hai Li, Duke Univ. (USA) . . . .[11324-29]

4:50 pm: **The Semiconductor Synthetic Biology Roadmap'si implications for neuromorphic and neuronal technologies: selected challenges and opportunities** *(Invited Paper)*, Daniel J. C. Herr, The Univ. of North Carolina at Greensboro (USA) . . . .[11324-30]

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 11

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B

WED 3:30 PM TO 5:30 PM

Pattern Placement and Overlay Metrology II

Session Chairs: **Hugo Cramer,** ASML Netherlands B.V. (Netherlands); **Richard M. Silver,** National Institute of Standards and Technology (USA)

3:30 pm: **Taking the multi-wavelength DBO to the next level of accuracy, robustness and speed**, Chan Hwang, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Kaustuve Bhattacharyya, ASML Netherlands B.V. (Netherlands) . . . . [11325-44]

3:50 pm: **Run to Run and model variability of overlay high order process corrections for mean intrafield signatures**, Benjamin Duclaux, Maxime Gatefait, Olivier Mermet, Jean-Damien Chapon, STMicroelectronics S.A. (France) . . . . [11325-45]

4:10 pm: **Stitched overlay evaluation and improvement for large field applications**, Michael J. May, CEA-LETI (France); Blandine Minghetti, ASML Malta (France); Jérome Depre, ASML France S.a.r.l. (France); Pui L. Lam, ASML Netherlands B.V. (Netherlands); Céline Lapeyre, CEA-LETI-DOPT (France); Joungchel Lee, ASML Netherlands B.V. (Netherlands); Yoann Blancquaert, CEA-LETI (France) . . . . [11325-46]

4:30 pm: **Monitoring and characterization of post etch overlay performance in relation to post lithography overlay performance (non-zero offset monitoring) in DRAM HVM**, Steven Tottewitz, Qoniac GmbH (Germany); Kuoyao Chou, Harlan Hwang, Micron Technology Taiwan, Inc. (Taiwan); Patrick Lomtscher, Boris Habets, Qoniac GmbH (Germany); Afu Chiu, QONIAC Taiwan Ltd. (Taiwan) . . . . [11325-47]

4:50 pm: **Process context based wafer level grouping control: an advanced process correction designed for overlay 1z nm node in high volume manufacturing**, Albert Chen, ASML San Jose (USA); William Susanto, Linmiao Zhang, Micron Technology, Inc. (Singapore) . . . . [11325-48]

5:10 pm: **OPO metrology challenges and solutions in advanced nodes**, Yoav Grauer, KLA Corp. (Israel); Andrei V. Shchegrov, KLA Corp. (USA); Philippe Leray, imec (Belgium); Liran Yerushalmi, Efi Megged, Ido Dolev, Nir BenDavid, Yoram Uziel, KLA Corp. (Israel); Roel Gronheid, KLA Corp. (Belgium) . . . . [11325-49]

CONFERENCE 11326
Advances in Patterning Materials and Processes XXXVII

SESSION 10

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C

WED 3:30 PM TO 5:10 PM

Underlayers

Session Chairs: **Scott W. Jessen,** Texas Instruments Inc. (USA); **James F. Cameron,** DuPont Electronics & Imaging (USA)

3:30 pm: **Improvement of EUV Si hardmask performance through functionalization**, Yichen Liang, Andrea M. Chacko, Samantha Oelklaus, Jennifer Collopy, Veerle Van Driessche, Ivan Sedlacek, Stephen Grannemann, Ming Luo, Douglas Guerrero, Brewer Science, Inc. (USA) . . . . [11326-38]

3:50 pm: **Underlayer optimization method for EUV lithography**, Pieter Vanelderen, Nadia Vandenbroeck, Danilo De Simone, Geert Vandenberghe, imec (Belgium) . . . . [11326-39]

4:10 pm: **Are surfaces of silicon hardmasks adaptive?**, Xianggui (Shawn) Ye, Zhimin Zhu, Joyce Lowes, Richard Daugherty, Zhiqiang Fan, James Lamb, Tim Limmer, Srikanth Kommu, Brewer Science, Inc. (USA). . . . . [11326-40]

4:30 pm: **Planarized spin-on carbon (SOC) hardmask**, Iou-Sheng Ke, Sheng Liu, Keren Zhang, Li Cui, Suzanne Coley, Shintaro Yamada, James Cameron, DuPont Electronics & Imaging (USA) . . . . [11326-41]

4:50 pm: **Highly substituted fullerene based spin-on organic hardmasks**, Alan Brown, Alexandra McClelland, Greg O'Callaghan, Irresistible Materials Ltd. (United Kingdom); Bryan Schofield, Tom Lada, Nano-C, Inc. (USA); Warren Montgomery, Irresistible Materials Ltd. (United Kingdom); Alex P. G. Robinson, The Univ. of Birmingham (United Kingdom)[11326-42]

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220C

5:10 PM TO 5:30 PM

Poster Preview Speed Talks

Conference End.

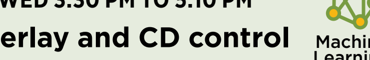
Wednesday 26 February

CONFERENCE 11327
Optical Microlithography XXXIII

SESSION 7
LOCATION: CONVENTION CENTER, ROOM 210A
WED 3:30 PM TO 5:10 PM

Overlay

Machine Learning



Overlay and CD control

Session Chairs: **Toshiyuki Hisamura,** Xilinx, Inc. (USA); **Jack Chen,** NanoPatterning Technology Co Ltd. (Taiwan)

3:30 pm: **Advanced high order field-to-field modeling for wafer edge control**, Boris Habets, Stefan Buhl, Wan-Soo Kim, Patrick Lomtscher, Holger Bald, Tobias Hoeer, Qoniac GmbH (Germany) . . . . [11327-26]

3:50 pm: **Application of Intra-field alignment to reduce wafer-to-wafer variation**, Boris Habets, Qoniac GmbH (Germany); Jang-Sun Kim, Seonho Lee, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Enrico Bellmann, Georg Erley, Holger Bald, Tobias Hoeer, Qoniac GmbH (Germany); Seop Kim, Jinseok Lee, Qoniac Korea Ltd. (Korea, Republic of) . . . . [11327-27]

4:10 pm: **Novel calculation method of OVL correction for inline alignment station(iAS)**, Takahisa Kikuchi, Nikon Corp. (Japan) . . . [11327-28]

4:30 pm: **Improvement of SADP CD control in 7nm BEOL application**, Qi Lin, Toshiyuki Hisamura, Nui Chong, Jonathan Chang, Xilinx, Inc. (USA) [11327-48]

4:50 pm: **Through-the-mask optical alignment for high volume manufacturing nanoimprint lithography systems**, Takamitsu Komaki, Yasuyuki Unno, Kazuhiko Mishima, Takahiro Matsumoto, Toshiki Iwai, Nozomu Hayashi, Tomokazu Taki, Tohru Kawashima, Satoshi Iino, Kazuhiro Takahashi, Shinichirou Hirai, Ken Minoda, Takafumi Miyaharu, Canon Inc. (Japan) . . . . [11327-30]

Conference End.

CONFERENCE 11328
Design-Process-Technology Co-optimization for Manufacturability XIV

SESSION 4
LOCATION: CONVENTION CENTER, ROOM 210D
WED 3:40 PM TO 4:40 PM

DFM by Chip Makers

Session Chairs: **Lars W. Liebmann,** TEL Technology Ctr., America, LLC (USA); **Kevin Lucas,** Synopsys, Inc. (USA)

3:40 pm: **Foundry approach for layout risk assessment through comprehensive pattern harvesting and large-scale data analysis**, Monisa Ramesh Babu, Shenghua Song, Eric Chiu, Qian Xie, Kiruthika Murali, Pouya Rezaeifakhr, Shobhit Malik, Sriram Madhavan, Joo Hyun Park, Praneetha Poluju, Panneerselvam Venkatachalam, Deborah Ryan, Haizhou Yin, GLOBALFOUNDRIES Inc. (USA) . . . . [11328-15]

4:00 pm: **Process related yield risk mitigation with in-design pattern replacement for system ICs manufactured at advanced technology nodes**, Jaehwan Kim, Jin Kim, Byungchul Shin, Sangah Lee, Jae-Hyun Kang, Joong-Won Jeon, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Piyush Pathak, Jac Condella, Frank E. Gennari, Philippe Hurat, Ya-Chieh Lai, Cadence Design Systems, Inc. (USA) . . . . [11328-16]

4:20 pm: **Electrical diagnosis aware design optimization for yield improvement of random logic layouts**, Prasad N. Atkar, Xiaochun Yu, Intel Corp. (USA); Tonghan Gu, Intel Corp (USA); Bikram Baidya, Vivek Singh, Intel Corp. (USA) . . . [11328-17]

APPLICATION TRACKS

Easily find sessions on these three important topics within the program. Each conference has grouped the applicable presentations together and do not overlap with other conferences.

• Machine Learning

• Stochastics

• Overlay

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All symposium attendees – You are invited to attend the evening Poster Session to view the high-quality posters and engage the authors in discussion. Enjoy light refreshments while networking with colleagues in your field. Authors may set up their posters between 10:00 am and 5:00 pm the day of their poster session. Attendees are required to wear their conference registration badges to access the poster session.

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

Novel high-contrast phase-shifting masks for EUV interference lithography, Bernhard Lüttgenau, Sascha Brose, Serhiy Danylyuk, RWTH Aachen Univ. (Germany) and Forschungszentrum Jülich GmbH (Germany); Jochen Stollenwerk, Peter Loosen, RWTH Aachen Univ. (Germany) and Forschungszentrum Jülich GmbH (Germany) and Fraunhofer-Institut für Lasertechnik ILT (Germany). . . . . [11323-57]

EUV patterning for DRAM 1X node: studying the throughput/defectivity trade-off of EUV illumination scenarios using massive metrology and a PPB failure rate projection model, Wallace He, Camille Xu, Daniels Bae, Kunyuan Chen, Andy Lan, Richer Yang, ChangXin Memory Technologies, Inc. (China); Samuel Xi, Bing Ye, ASML-Brion China (China); Bob Lin, ASML-HMI (USA); Kenny Zhou, Derek Shi, ASML-Brion China (China); Dezheng Sun, ASML-Brion China (USA); Sam Liu, ASML-Brion China (China); Stephen Hsu, Rachit Gupta, ASML-Brion US (USA); Abdalmohsen Elmak, Kevin Gao, Jason Liao, ASML-HMI (USA) . . . . [11323-58]

Utilization of effective dose assessment methodology for track and process applications, Cody J. Murray, Chris F. Robinson, Luciana Meli, Karen Petrillo, Anuja De Silva, IBM Thomas J. Watson Research Ctr. (USA) . . . . [11323-59]

Optimization of EUV sources by tuning laser wavelength from 1 to 10 micrometers, Tatyana Sizyuk, Ahmed Hassanein, Purdue Univ. (USA) . . . . [11323-60]

Future EUV lithography with shortening the wavelength, Takeo Watanabe, Univ. of Hyogo (Japan). . . . . [11323-61]

Investigation of source cleaning by surface wave plasma in the Illinois NXE:3100 chamber, Dren Qerimi, Gianluca Panici, David N. Ruzic, Univ. of Illinois (USA) . . . . [11323-62]

Application of alternative developer solutions for EUV Lithography, Julius Joseph S. Santillan, Osaka Univ. (Japan); Masahiko Harumoto, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Harold W. Stokes Jr., SCREEN SPE Germany GmbH (Germany); Chisayo Mori, Yuji Tanaka, You Arisawa, Tomohiro Motono, Masaya Asai, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Toshiro Itani, Osaka Univ. (Japan). . . . . [11323-63]

Novel laser effects on EUV debris characteristics and chamber contamination at high repetition rates for high volume manufacturing, Ahmed Hassanein, Purdue Univ. (USA). . . . . [11323-64]

Practical development to realize the EUV-FEL high power light source for future lithography, Hiroshi Kawata, Ryokou Kato, Hiroshi Sakai, Yosuke Honda, Kimichika Tsuchiya, Yasunori Tanimoto, Tsukasa Miyajima, Miho Shimada, Norio Nakamura, High Energy Accelerator Research Organization, KEK (Japan). . . . . [11323-65]

Additional real-time diagnostics on the EBL2 EUV exposure facility, Peter van der Walle, Jetske K. Stortelder, Chien-Ching Wu, Jochem Janssen, Norbert B. Koster, TNO (Netherlands). . . . [11323-66]

New concept of non-CAR resist using hemicellulose for EUV lithography, Kazuyo Morita, Kimiko Yamamoto, Yasuaki Tanaka, Oji Holdings Corp. (Japan); Masahiko Harumoto, Yuji Tanaka, Chisayo Mori, You Arisawa, Tomohiro Motono, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Harold W. Stokes Jr., SCREEN SPE Germany GmbH (Germany); Masaya Asai, SCREEN Semiconductor Solutions Co., Ltd. (Japan) . . . . [11323-67]

Spectral purity performance of high-power EUV systems, Mark A. van de Kerkhof, Fei Liu, ASML Netherlands B.V. (Netherlands) . . . . [11323-68]

Defect improvement for an EUV process, Harold W. Stokes Jr., SCREEN SPE Germany GmbH (Germany) . . . . [11323-69]

Advanced multilayer IBD endpoint techniques for EUV mask blanks at the 3nm node and beyond, Paul Turner, Stephen Lozowski, Katrina Rook, Narasimhan Srinivasan, Sandeep Kohli, Meng H. Lee, Veeco Instruments Inc. (USA) . . . . [11323-70]

Compact modeling to predict and correct stochastic hotspots in EUVL, Zac A. Levinson, Yudhishthir Kandel, Qiliang Yan, Makoto Miyagi, Xiaohai Li, Kevin Lucas, Synopsys, Inc. (USA) . . . . [11323-71]

A plausible approach for actinic patterned mask inspection using coherent interferometric imaging, Steven M. Ebstein, Lexitek Inc. (USA). . . . [11323-72]

Impact of EUV resist thickness on local critical dimension uniformities for <30 nm CD Via patterning, Benjamin Vincent, Coventor, SARL (France); Mark John Maslow, ASML Netherlands B.V. (Netherlands); Joseph Ervin, Coventor, SARL (France); Joost Bekaert, imec (Belgium) . . . . [11323-73]

Evaluating thermal properties of EUV pellicle composite depending on annealing condition, Seong Ju Wi, Hanyang Univ. (Korea, Republic of) . . . . [11323-74]

Update of development progress of the High Power LPP-EUV light source using a magnetic field, Gouta Niimi, Gigaphoton Inc. (Japan)[11323-75]

Analysis of trade-off relationships between resolution, line edge roughness, and sensitivity in extreme ultraviolet lithography using machine learning, Kazuki Azumagawa, Takahiro Kozawa, Osaka Univ. (Japan) . . . . [11323-76]

Clean track solutions for defectivity and CD control towards 5 nm and smaller nodes, Arnaud Dauendorffer, Takahiro Shiozawa, Keisuke Yoshida, Noriaki Nagamine, Yuya Kamei, Shinichiro Kawakami, Satoru Shimura, Kathleen Nafus, Akihiro Sonoda, Tokyo Electron Kyushu Ltd. (Japan); Philippe Foubert, imec (Belgium). . . . . [11323-77]

Predicting lifetime of pellicle through heat and mechanical distortion caused by particle defect on extreme ultraviolet pellicle, Eui Jeong Ha, Hyo Gyeong Shin, Jae-Hun Park, Eun-Sang Park, Hye Keun Oh, Hanyang Univ. (Korea, Republic of) . . . . [11323-78]

Study of mask shadowing and flare modeling and impacts on EUVL proximity effect correction flow, Jia-Syun Cai, National Taiwan Univ. (Taiwan); Sheng-Wei Chien, National Taiwan Univ (Taiwan); Chien-Lin Lee, Kuen-Yu Tsai, National Taiwan Univ. (Taiwan); Jiun-Hau Fu, Eric Huang, Chun-Cheng Liao, Chiang-Lin Shih, Nanya Technology Corp. (Taiwan)[11323-79]

Realization of thermally stable transmissive optical elements for the EUV wavelength range, Guido Hergenhan, Jochen Taubert, Daniel Grimm, Martin Tilke, Meik Panitz, Christian Ziener, JENOPTIK Optical Systems GmbH (Germany) . . . . . . [11323-80]

Impact of flare on source mask optimization in EUVL for 7nm technology node, Lisong Dong, Rui Chen, Yayi Wei, Taian Fan, Rongbo Zhao, Institute of Microelectronics (China); Yongdong Wang, Lawrence S. Melvin III, Synopsys, Inc. (USA) . . . . . . [11323-81]

Imaging performance comparison between phase shift mask and binary intensity mask with 0.55 numerical aperture, Inhwa Kang, Hanyang Univ. (Korea, Republic of). . . . . [11323-82]

Pattern dependent mask distortion with extreme ultraviolet exposure, Chung-Hyun Ban, Eun-Sang Park, Ui-Jeong Ha, Chae-Yun Lim, Hye-Keun Oh, Hanyang Univ. (Korea, Republic of) . . . . . [11323-83]

EUV OPC methodology for beyond 20nm memory cell by simulation data, Jiun-Hau Fu, Nanya Technology Corp. (Taiwan) . . . . [11323-84]

Soft x-ray absorption spectroscopy of inorganic photoresists, Najmeh Sadegh, Filippo Campi, Jarich Haitjema, Maarten van der Geest, Peter Kraus, Sonia Castellanos Ortega, A. M. Brouwer, Advanced Research Ctr. for Nanolithography (Netherlands) . . . . [11323-85]

Compressive sensing method for EUV source optimization using different bases, Jiaxin Lin, Lisong Dong, Taian Fan, Institute of Microelectronics (China); Xu Ma, Beijing Institute of Technology (China); Rui Chen, Yayi Wei, Institute of Microelectronics (China) . . . . [11323-86]

Extreme ultra violet lithography resist stochastics effects by AFM inspection, Eric Liu, Amir Hegazy, Hyeonseon Choi, Steven Grzeskowiak, Gregory Denbeaux, Robert Brainard, SUNY Polytechnic Institute (USA) . . . . [11323-87]

Particle contamination control by application of plasma, Job Beckers, Eindhoven University of Technology (Netherlands); Boy van Minderhout, Technische Univ. Eindhoven (Netherlands); Paul Blom, VDL Enabling Technologies Group (Netherlands); Gerrit Kroesen, Eindhoven University of Technology (Netherlands); Ton Peijnenburg, VDL Enabling Technologies Group (Netherlands) . . . . . . [11323-89]

EUVL mask process development and verification using advanced modeling and characterization techniques, Michael Green, Photronics, Inc. (USA) . . . . [11323-90]

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Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

Contribution ratio of process fidelity and beam accuracy in multi-beam mask writing, Rumi Ito, Yoshinori Kojima, Hiroshi Matsumoto, NuFlare Technology, Inc. (Japan) . . . . [11324-42]

Electron beam mask writer EBM-8000P for high throughput mask production, Tomohiro Iijima, NuFlare Technology, Inc. (Japan) . . . . [11324-43]

Electron beam mask writer EBM-9500PLUS for logic 7nm+ node generation, Hideki Matsui, NuFlare Technology. Inc (Japan) . . . . [11324-44]

Precision electron beam lithography with high throughput for metalens fabrication, Lan Zhang, Raith America, Inc. (USA); Janine Wilbers, Bas Ketelaars, Michiel Visser, Raith B.V. (Netherlands); Michael Kahl, Raith GmbH (Germany); Rainer Schmid, Raith America, Inc. (USA); Christiaan Zonnevylle, Hans Romjin, Raith B.V. (Netherlands) . . . [11324-46]

Patterning of high efficiency large-format X-Ray reflection gratings via electron beam lithography, Chad Eichfeld, Michael LaBella, Guy Lavallee, Bangzhi Liu, William Drawl, Randall L. McEntaffer, Fabien Grisé, Ross McCurdy, Jake McCoy, Drew Miles, Ben Donovan, The Pennsylvania State Univ. (USA) . . . . [11324-45]

Posters that are not set up by the 5:00 pm cut-off time will be considered no-shows, and their manuscripts may not be published. Poster authors should accompany their posters from 5:30 to 7:30 pm to answer questions from attendees. All posters and other materials must be removed no later than 7:45 pm. Any posters or materials left behind at the close of the poster session will be considered unwanted and will be discarded. SPIE assumes no responsibility for posters left up after the end of each poster session.

Precision fabrication of X-ray masks with helium ion beam direct-writing, Sheng-Wei Chien, Jia-Syun Cai, Chien-Lin Lee, Kuen-Yu Tsai, Jia-Han Li, National Taiwan Univ. (Taiwan); Chao-Te Lee, Taiwan Instrument Research Institute (Taiwan); Bor-Yuan Shew, National Synchrotron Radiation Research Ctr. (Taiwan); Wei-Shi Lin, Atomic Energy Council (Taiwan) . . . . [11324-47]

Model-based X-ray lithography proximity effect correction, Sheng-Wei Chien, Jia-Syun Cai, Chien-Lin Lee, Kuen-Yu Tsai, Jia-Han Li, National Taiwan Univ. (Taiwan); Chao-Te Lee, Taiwan Instrument Research Institute (Taiwan); Bor-Yuan Shew, National Synchrotron Radiation Research Ctr. (Taiwan); Wei-Shi Lin, Atomic Energy Council (Taiwan). . [11324-48]

Fabrication and characterization of a new H-shaped biohybrid nanoplasmonic device for enhanced energy conversion, Bhawna Bagra, Taylor Mabe, Jianjun Wei, The Univ. of North Carolina at Greensboro (USA) . . . . [11324-49]

Mathematical problems of holographic mask synthesis for sub-wavelength holographic lithography (SWHL), Vitaly V. Chernik, Alexei Shamaev, Vadim Rakhovskiy, Mike Borisov, Dmitriy Chelubeev, Lev Merkushov, Nanotech SWHL GmbH (Switzerland) . . . . [11324-50]

Experimental verification of sub-wavelength holographic lithigraphy (SWHL) concept, Vitaly V. Chernik, Vadim Rakhovskiy, Alexei Shamaev, Mike Borisov, Lev Merkushov, Dmitriy Chelubeev, Nanotech SWHL GmbH (Switzerland). . . . . [11324-51]

Maskless holographic schemes based on phase micromirror SLMs, Vitaly V. Chernik, Vadim Rakhovskiy, Alexei Shamaev, Mike Borisov, Lev Merkushov, Dmitriy Chelubeev, Nanotech SWHL GmbH (Switzerland) . . . . [11324-52]

A novel holographic lithography for patterning crossed two-dimensional grating structures by using a two-axis Lloyd's mirror interferometer, Xinghui Li, Haiou Lu, Gaopeng Xue, Qian Zhou, Guanhao Wu, Kai Ni, Xiaohao Wang, Liyu Lin, Qihang Zhai, Tsinghua Univ. Shenzhen International Graduate School (China) . . . . [11324-100]

Estimation of fogging effect in E-Beam direct writer for photonics device, Hideaki Komami, Advantest Corp (Japan); Hirofumi Hayakawa, Advantest Corp. (Japan) . . . . [11324-53]

CONFERENCE 11325

Metrology, Inspection, and Process Control for Microlithography XXXIV

EB metrology of Ge channel gate-all-around FET: buckling evaluation and EB damage assessment, Takeyoshi Ohashi, Hitachi, Ltd. (Japan); Kazuhisa Hasumi, Masami Ikota, Hitachi High-Tech Science Corp. (Japan); Gian F. Lorusso, Liesbeth Witters, Hans Mertens, Naoto Horiguchi, imec (Belgium) . . . . [11325-65]

Automated semiconductor wafer defect classification dealing with imbalanced data, Po-Hsuan Lee, Cho Teh, Yi-sing Hsiao, Wei Fang, ASML (USA) . . . . [11325-66]

SEM image quality enhancement: an unsupervised deep learning approach, Liangjiang Yu, Wentian Zhou, Lingling Pu, Wei Fang, ASML (USA) [11325-67]

Massive metrology for process development and monitoring applications, Kaushik Sah, KLA Corp. (USA); Sayantan Das, imec (Belgium); Shifang Li, KLA Corp. (USA); Christophe Béral, imec (Belgium); Andrew Cross, KLA Corp. (USA); Sandip Halder, imec (Belgium) . . . . [11325-68]

Stochastic model prediction of pattern-failure, John L. Sturtevant, Sophie Jin, Shumay Shang, Lianghong Yin, Kevin Ahi, Mentor, a Siemens Business (USA) . . . . [11325-69]

Enabling accurate and robust optical metrology of in device overlay, Min-Seok Kang, Chan Hwang, Seung Yoon Lee, Jeongjin Lee, Joon-Soo Park, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Christian Leewis, ASML Netherlands B.V. (Netherlands); Eun-Ji Yang, Do-Haeng Lee, James Lee, ASML Korea Co., Ltd. (Korea, Republic of); Sabil Huda, Noh-Kyoung Park, Anagnostis Tsiatmas, Giulio Bottegal, Amy Wang, Filippo Belletti, Jan Jitse Venselaar, Giacomo Miceli, Izabela Saj, Sam Chen, ASML Netherlands B.V. (Netherlands) . . . [11325-70]

Contour extraction algorithm for edge placement error measurement using machin learning, Yosuke Okamoto, Shinichi Nakazawa, Akinori Kawamura, Tsugihiko Haga, Taihei Mori, Kotaro Maruyama, Seul-Ki Kang, Yuichiro Yamazaki, NGR Inc. (Japan). . . . . [11325-71]

Color filter and numeric aperture selections for image based overlay measurement in critical recording head manufacturing process, Gavin Mathias, Yi Liu, Seagate Technology LLC (USA); Richard Schuster, KLA Corp. (USA); Aaron Bowser, Seagate Technology LLC (USA) . . . . [11325-72]

TMU reduction by machine learning in 3D-NAND, Shlomit Katz, Anna Golotsvan, Yoav Grauer, Boaz Ophir, Udi Shusterman, KLA Israel (Israel); Fiona Leung, Pek Beng Ong, Judith Yep, KLA Singapore (Singapore); Alimei Shih, Shi-Ming Wei, Jian Zhang, KLA China (China) . . . . [11325-73]

A study on improving frequency-modulation electric force microscopy using a direct digital synthesizer (DDS), ChaeHo Shin, Korea Research Institute of Standards and Science (Korea, Republic of) . . . . [11325-74]

OPO residuals reduction with imaging metrology color per layer mode, Shlomit Katz, Anna Golotsvan, Roie Volkivich, Efi Megged, KLA Israel (Israel); Do-Hwa Lee, Seong Jae Lee, Dongsub Choi, KLA Korea (Korea, Republic of); Honggoo Lee, DongYoung Lee, Jinsoo Kim, Jaesun Woo, Chunsoo Kang, Chan-Ha Park, SK Hynix, Inc. (Korea, Republic of) . [11325-75]

A trainable Die-To-Database for fast e-Beam inspection: learning normal images to detect defects, Masanori Ouchi, Masayoshi Ishikawa, Hitachi, Ltd. (Japan); Shinichi Shinoda, Ryo Yumiba, Yasutaka Toyoda, Hiroyuki Shindo, Masayuki Izawa, Hitachi High-Technologies Corp. (Japan) . [11325-76]

A novel combination of mask RCNN and image processing forms precision critical dimension measurement, Tung-Yu Wu, Chun Yen Liao, Chun-Sheng Wu, Kao-Tsai Tsai, Chao-Yi Huang, Chun-Hung Lin, Winbond Electronics Corp. (Taiwan) . . . . [11325-77]

A novel high throughput probe microscope: for measuring 3D high aspect ratio structures, designed for In-line, integrated or standalone operation, Lei Feng, Andrew D. L. Humphris, Matthew Tedaldi, Lawrence Mudarikwa, David Ockwell, Jenny Goulden, Infinitesima Ltd. (United Kingdom) . . . . [11325-78]

Trench hole inspection of VNAND flash using through-focus scanning optical microscopy (TSOM), Shin-Woong Park, Hwi Kim, Korea Univ. Sejong Campus (Korea, Republic of); Jun Ho Lee, Kongju National Univ. (Korea, Republic of) [11325-79]

OPO residuals improvement with imaging metrology for 3D-NAND, Shlomit Katz, Michael Har-Zvi, KLA Israel (Israel); Cindy Kato, KLA Japan (Japan); Yoav Grauer, Efi Megged, KLA Israel (Israel). [11325-81]

Photosensitive organic insulator photo-cell monitoring through advanced macro inspection, Andrea Corno, Annalisa Bordogna, Massimiliano Braga, Francesco Ferrario, Umberto Iessi, Paolo Canestrari, STMicroelectronics SRL (Italy); Parikshit Sharma, Parikshit Sharma, Matteo Salamone, Paolo Parisi, Thomas Groos, KLA Corp. (USA) . . [11325-82]

Enhancing the applications space of diffraction based overlay metrology, Simon Mathijssen, Herman Heijmerikx, Farzad Farhadzadeh, Marc Noot, Lineke van der Sneppen, Longfei Shen, Fei Jia, Rickye Wang, Huajun Qin, Arie Den Boef, Elliott McNamara, Kaustuve Bhattacharyya, ASML Netherlands B.V. (Netherlands); Chao Fang, Zhihu Gao, Yaobin Feng, Yangtze Memory Technologies Co., Ltd. (China) . . . . [11325-83]

Wavelength influence on the determination of subwavelength grating parameters by using optical scatterometry, Lauryna Siaudinyte, Silvania Pereira, Technische Univ. Delft (Netherlands) . . . . [11325-84]

Nano-scale molecular analysis of positive tone photo-resist films with varying dose, Michael J. Eller, California State Univ., Northridge (USA); Mingqi Li, Xisen Hou, DuPont Electronics & Imaging (USA); Stanislav V. Verkhoturov, Emile A. Schweikert, Texas A&M Univ. (USA); Peter Trefonas, DuPont Electronics & Imaging (USA) . . . . [11325-85]

Integrated strategies to enhance predictive power of OPC model, Hong Chen, HC Engineering Consultant (USA) . . . . [11325-86]

Target design for diffraction-based overlay metrology by the multi-objective genetic algorithm, Yating Shi, Kuangyi Li, Xiuguo Chen, Huazhong Univ. of Science and Technology (China); Shiyuan Liu, Huazhong Univ. of Science and Technology (China) and Wuhan Eoptics Technology Co., Ltd. (China) . . . . [11325-87]

Particle scattering calculation and analysis for dark field defect detection, Shuang Xu, Cheng Liao, Chao Liu, Jun Chen, Wuhan Univ. of Science and Technology (China) . . . . [11325-88]

Improved device overlay by litho aberration tracking with novel target design for DRAM, Yoel Feler, Katya Gordon, Diana Shaphirov, Mark Ghinovker, Gur Fabrikant, Alon Volfman, Hedvi Spielberg, KLA Corp. (Israel); Xiaolei Liu, Weiling Lin, Xindong Gao, KLA Corp. (China); Koichi Imura, Kosuke Ito, Yasuhisa Iwata, KLA Corp. (Japan). . . . . [11325-89]

OPO reduction by novel target design for 3D-NAND, Yoel Feler, Mark Ghinovker, Diana Shaphirov, Michael Har-Zvi, KLA Israel (Israel); Cindy Kato, KLA Japan (Japan); Shengxun Zhao, KLA China (China); Hiroyuki Kurita, KLA Japan (Japan); Katya Gordon, KLA Israel (Israel); Masanobu Hayashi, KLA Japan (Japan) . . . . [11325-90]

Analysis of defect perturbation in EUV mask blank, Lituo Liu, Guannan Li, Weihu Zhou, Institute of Microelectronics, Chinese Academy of Sciences (China); Xiaobin Wu, Academy of Opto-Electronics, Chinese Academy of Sciences (China); Yu Wang, Institute of Microelectronics, Chinese Academy of Sciences (China) . . . . [11325-91]

Improving metrology for advanced memory devices with high transmission attenuated phase shift mask, Henry Chen, ChangXin Memory Technologies, Inc. (China). . . . . [11325-92]

Saving scribe-lane space by using narrow alignment marks, Henry Chen Sr., ChangXin Memory Technologies, Inc. (China). . . . . . [11325-93]

POSTER SESSION

WEDNESDAY 26 FEBRUARY · 5:30 PM TO 7:30 PM
LOCATION: CONVENTION CENTER, HALL 2

All symposium attendees – You are invited to attend the evening Poster Session to view the high-quality posters and engage the authors in discussion. Enjoy light refreshments while networking with colleagues in your field. Authors may set up their posters between 10:00 am and 5:00 pm the day of their poster session. Attendees are required to wear their conference registration badges to access the poster session.

High speed roughness measurement on blank silicon wafers using wave front phase imaging, Juan Trujillp, José Manuel Rodrigues Ramos, Wooptix, S.L. (Spain); Jan O. Gaudestad, Wooptix, S.L. (USA) . . . . [11325-94]

Improving after-etch overlay performance using high-density in-device metrology in DRAM manufacturing, Ik-Hyun Jeong, SeungWoo Koo, Hyun-Sok Kim, Jung-Il Hwang, Jae-Wuk Ju, Young-Sik Kim, SK Hynix, Inc. (Korea, Republic of); Cees Lambregts, Rizvi Rahman, Marc Hauptmann, Raheleh Pishkari, ASML Netherlands B.V. (Netherlands); Kwang-Young Hu, ASML Korea Co., Ltd. (Netherlands); Paul Böcker, ASML Netherlands B.V. (Netherlands); Kang-San Lee, Minsub Hank Han, ASML Korea Co., Ltd. (Korea, Republic of) . . . . [11325-95]

Improving Mask Tape Out productivity and accuracy in verification step, Guillaume Landie, Charlotte Beylier, STMicroelectronics S.A. (France); Raphael La Greca, Laurent Depre, ASML France S.a.r.l. (France); Mark Simmons, Jen-Yi Wuu, Peigen Cao, Yi-Hsing Peng, Terrence Yang, Shibing Wang, ASML San Jose (USA). . . . . [11325-96]

The application of a Rapid Probe Microscope (RPM) for investigating 1D and 2D structures from EUV lithography, Lei Feng, Andrew D. L. Humphris, Jenny Goulden, Infinitesima Ltd. (United Kingdom)[11325-97]

The improvement of measurement accuracy of SADP pitch walking issue, Pei Liu, Cheng-Zhang Wu, Hung-Wen Chao, Wenzhan Zhou, Shanghai Huali Integrated Circuit Corp. (China); Masami Ikota, Hitachi High-Tech Science Corp. (Japan); Yujie Xu, Hitachi High-Technologies Corp. (China) . . . . [11325-98]

Metrology of 3D-NAND structures using machine learning assisted fast marching level-sets algorithm, Umesh P. S. Adiga, Derek Higgins, Aditee Shrotre, Sang Hoon Lee, Mark T. Biedrzycki, Dan Nelson, Thermo Fisher Scientific Inc. (USA)[11325-99]

Deep Learning denoising of SEM images of lithographic patterns, Eva Giannatou, Nanometrisis P.C. (Greece); Vassilios Constantoudis, George Papavieros, NCSR Demokritos (Greece) and Nanometrisis P.C. (Greece); Harris Papagrorgiou, Institute for Language and Speech Processing (Greece); Gian Lorusso, imec (Belgium); Evangelos Gogolides, NCSR Demokritos (Greece) and Nanometrisis P.C. (Greece). . . . . [11325-103]

Noise fidelity in SEM simulation, Benjamin D. Bunday, Consultant (USA). . . . . [11325-104]

Charging phenomenon and charge mitigation for EUV resist in ultra-low voltage SEM, Daisuke Bizen, Fumiya Ishizaka, Hitachi High-Technologies Corp. (Japan); Makoto Sakakibara, Hitachi, Ltd. (Japan); Makoto Suzuki, Hitachi High-Technologies Corp. (Japan); Toshiyuki Yokosuka, Hitachi, Ltd. (Japan); Hideyuki Kazumi, Hitachi High-Technologies Corp. (Japan). . . . . [11325-50]

CONFERENCE 11326 Advances in Patterning Materials and Processes XXXVII

EUV

Consideration of missing defect suppression technique in EUV hole patterning, Arisa Hara, Soichiro Okada, Satoru Shimura, Tokyo Electron Kyushu Ltd. (Japan); Hidetami Yaegashi, Tokyo Electron Ltd. (Japan) . . . . [11326-47]

After-development rinse solutions and processes for EUV Lithography, Julius Joseph S. Santillan, Osaka Univ. (Japan); Masahiko Harumoto, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Harold Stokes Jr., SCREEN SPE Germany GmbH (Germany); Chisayo Mori, Yuji Tanaka, You Arisawa, Tomohiro Motono, Masaya Asai, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Toshiro Itani, Osaka Univ. (Japan). . . . . [11326-54]

Spin on films for patterning applications, Alex Hubbard, Anuja De Silva, Dominik Metzler, IBM Corp. (USA); Makoto Muramatsu, Tokyo Electron Kyushu Ltd. (Japan); Eri Makimura, Tokyo Electron America, Inc. (USA); Lior Huli, TEL Technology Ctr., America, LLC (USA) . . . . [11326-59]

Focusing on nanoparticles based photomultiplier in n-CARs, Satinder Sharma, Indian Institute of Technology Mandi (India) . . . . [11326-65]

Reactivity of α-Halo substituted antimony carboxylate photoresists, Michael Murphy, Maximilian Weires, SUNY Polytechnic Institute (USA); Philip Schuler, IPG Photonics Corp. (USA); Gregory Denbeaux, Robert L. Brainard, SUNY Polytechnic Institute (USA) . . . . [11326-69]

Directed Self-Assembly

Fast annealing block copolymers with a fluoro-block for 5 nm DSA patterning application, Hai Deng, Le Dai, Hui Cao, Zhilong Li, Xuemiao Li, Fudan Univ. (China) . . . . [11326-43]

Poly(Styrene)-b-Poly (methyl methacrylate) (PSt-b-PMMA) block copolymers for DSA by using anionic polymer coupling technology in flow micro reactor, Hisakazu Tanaka, Youki Kou, DIC Corp. (Japan) . . . . [11326-50]

Computational study of block-copolymer self-assembly with electrohydrodynamic jet printing, Sang-Kon Kim, Hongik Univ. (Korea, Republic of) . . . . [11326-55]

Relaxation of layout decomposition constraints for contact layers using Directed Self-Assembly, Joydeep Mitra, Cadence Design Systems, Inc. (USA); David Z. Pan, The Univ. of Texas at Austin (USA) . . . . [11326-62]

Block copolymer line roughness measurement via PSD: application to fingerprint and chemoepitaxy samples, Aurélie Le Pennec, CEA-Grenoble (France); Jérôme Rêche, Patrick Quéméré, Guido Rademaker, CEA-Grenoble (France); Charlotte Bouet, Romain Jarnias, CEA-Grenoble (France); Célia Nicolet, Xavier Chevalier, Christophe Navarro, Arkema S.A. (France); Maxime Argoud, CEA-Grenoble (France); Raluca Tiron, CEA-Grenoble (France) . . . . [11326-66]

Expanding DSA process window with atmospheric control, Nathalie Frolet, SCREEN SPE France S.a.r.l. (France) . . . . [11326-103]

Understanding and mitigating microbridge defects in block copolymer directed self-assembly through computational materials design and optimization, Jakin B. Delony, Univ. of South Florida (USA); Peter J. Ludovice, Georgia Institute of Technology (USA); Clifford L. Henderson, Univ. of South Florida (USA) . . . . [11326-104]

Underlayers

Fabrication property of Hemicellulose spin on carbon hardmask, Kazuyo Morita, Kimiko Yamamoto, Hiroki Tanaka, Yasuaki Tanaka, Oji Holdings Corp. (Japan); Masahiko Harumoto, Yuji Tanaka, Chisayo Mori, You Arisawa, Tomohiro Motono, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Harold Stokes, SCREEN SPE Germany GmbH (Germany); Masaya Asai, SCREEN Semiconductor Solutions Co., Ltd. (Japan) . . . . [11326-45]

New poly-maleimide resin for SOC hardmask with high thermal stability, Hiroaki Yamamoto, Junya Horiuchi, Tadashi Omatsu, Takashi Makinoshima, Shinichi Nagao, Masatoshi Echigo, Mitsubishi Gas Chemical Co., Inc. (Japan) . . . . [11326-52]

Design considerations for high etch resistance spin-on carbon underlayers, Li Cui, Iou-Sheng Ke, Anton Chavez, Keren Zhang, Paul LaBeaume, Suzanne Coley, Shintaro Yamada, Jim Cameron, DuPont (USA) . . . . [11326-57]

Development of planarizing spin-on carbon material for high-temperature processes, Runhui Huang, Brewer Science, Inc. (USA). . . . . . [11326-61]

Superplanarizing material for trench and via fill applications, Runhui Huang, Brewer Science, Inc. (USA) . . . . [11326-64]

Defect mitigation and characterization in silicon hardmask materials, Vineet Alexander, Brewer Science, Inc. (USA); Mona Bavarian, Pall Corp. (USA); Shyam Paudel, Brewer Science, Inc. (USA); Rao Varanasi, Pall Corp. (USA); Tim Limmer, Brewer Science, Inc. (USA); Michael Mesawich, Glenn Dado, Pall Corp. (USA); Nick Brakensiek, Levi Gildehaus, Brewer Science, Inc. (USA) . . . . [11326-68]

Development of ion exchange purification for advanced materials contain siloxane polymer, Takumi Oya, Nissan Chemical Corp. (Japan). . . . . [11326-71]

Fundamentals

Study of lithographic characteristics due to differences in novolac resin structure, Atsushi Sekiguchi, Litho Tech Japan Co., Ltd. (Japan). . . . . [11326-44]

Expeditious solution-free self-patterning of sol-gel metal-oxide thin-films by using reusable surface energy modification stamp, Do-Kyung Kim, Vincent Premkumar, Jin-Hyuk Bae, Kyungpook National Univ. (Korea, Republic of). . . . . [11326-48]

Local condensation of TMAH developer at photoresist/glass interface analyzed by using confocal laser scanning microscope (CLSM), Hiromu Takemi, Akira Kawai, Nagaoka Univ. of Technology (Japan). . . . . [11326-56]

Adhesion improvement of photoresist; destruction mode analysis, Keita Hasegawa, Akira Kawai, Nagaoka Univ. of Technology (Japan) . . . [11326-60]

Fundamental study on lithographic characteristics of metal oxo clusters for KrF, ArF, and electron beam lithography, Hiroki Yamamoto, Yasunari Maekawa, National Institutes for Quantum and Radiological Science and Technology (Japan). . . . . [11326-105]

Integration

A novel filter screening methodology for Si hardmask materials in EUV lithography, Tetsu Kohyama, Kozue Miura, Nihon Entegris K.K. (Japan). . . . . [11326-49]

Point-Of-Use filtration of non-CAR resists for EUV lithography, Aiwen Wu, Entegris, Inc. (USA); Harvey Tang, Entegris Singapore Pte Ltd. (Singapore); Hareen Bayana, Entegris GmbH (Germany); Gregg Conner, Entegris, Inc. (USA) . . . . [11326-53]

Improving EUV underlayer coating defectivity using Point-Of-Use filtration, Aiwen Wu, Entegris, Inc. (USA); Hareen Bayana, Entegris GmbH (Germany); Philippe Foubert, imec (Belgium); Douglas Guererro, Andrea M. Chacko, Brewer Science, Inc. (USA) . . . . [11326-58]

CD uniformity improvement for sub 20 nm DRAM process with negative tone development, Yu-Chen Lin, Mifong Wu, Le Wang, ChangXin Memory Technologies, Inc. (China); Sun Baijun, Ohtaguro Hiroki, Tokyo Electron (Shanghai) Ltd. (China); Shimoaoki Takeshi, Yusaku Hashimoto, Koichi Hontake, Tokyo Electron Kyushu Ltd. (Japan) . . . . [11326-63]

aquaSAVE™: antistatic agent for electron beam lithography, Takahiro Mori, Mitsubishi Chemical Corp. (Japan). . . . . [11326-67]

Posters that are not set up by the 5:00 pm cut-off time will be considered no-shows, and their manuscripts may not be published. Poster authors should accompany their posters from 5:30 to 7:30 pm to answer questions from attendees. All posters and other materials must be removed no later than 7:45 pm. Any posters or materials left behind at the close of the poster session will be considered unwanted and will be discarded. SPIE assumes no responsibility for posters left up after the end of each poster session.

Marangoni effect-based under-layer for a Dual Damascene via-first approach: a scalable solution to the unwanted photoresist swing effect, Valentina Dall'Asta, Emma Litterio, Nicoletta Corneo, STMicroelectronics SRL (Italy); Jakub Koza, Brewer Science, Inc. (USA); Jonathan Jeauneau, Brewer Science, Ltd. (France); Pietro Cantu, STMicroelectronics SRL (Italy) . . . . [11326-70]

Mechanism study of wafer surface charge during dual damascene process and an effective removal method using functional rinse, Heguang Shi, Semiconductor Manufacturing International Corp (China); Weihua Sang, Semiconductor Manufacturing International Corp. (China); Jingan Hao, Semiconductor Manufacturing International Corp (China) . . . . [11326-100]

Critical dimension uniformity improvement of negative toned developing process for hole type pattern, Zhang Ruilin, Semiconductor Manufacturing International Corp. (China). . . . . [11326-101]

Defectivity modulation in EUV resists through advanced filtration technologies, Lucia D'Urzo, Pall Corp. (Belgium); Toru Umeda, Nihon Pall Manufacturing Ltd. (Japan); Rao Varanasi, Rajan Beera, Pall Corp. (USA); Philippe Foubert, Jelle Vandereyken, Waut Drent, imec (Belgium)[11326-102]

CONFERENCE 11327
Optical Microlithography XXXIII

Design and fabrication of UVLED array aligner for proximity and soft contact exposure, Jiun-Woei Huang, Taiwan Instrument Research Institute (Taiwan) . . . . [11327-31]

Source and mask optimization with semi-implicit level-set method, Yijiang Shen, Fei Peng, Guangdong Univ. of Technology (China); Zhenrong Zhang, Guangxi Univ. (China) . . . . [11327-32]

A methodology for EPE reduction: iSMO, Kunyuan Chen, ChangXin Memory Technologies, Inc. (China) . . . . [11327-33]

Advanced E95 spectral engineering: performance of high repetition excimer laser measured with high accurate spectrometer, Takahito Kumazaki, Masakazu Hattori, Yosuke Fujimaki, Takehito Kudo, Toshihiro Oga, Junichi Fujimoto, Hakaru Mizoguchi, Gigaphoton Inc. (Japan) . . . . [11327-34]

Approach for lightsource utilization improvement by extending Preventive Maintenance (PM) cycle along with performance monitoring feature, Futoshi Sato, Sophia Hu, Gigaphoton Inc. (Japan) [11327-35]

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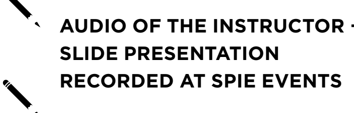

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Critical pattern selection method for full-chip source mask optimization, Lufeng Liao, Sikun Li, Xiangzhao Wang, Shanghai Institute of Optics and Fine Mechanics (China); Libin Zhang, Pengzheng Gao, Yayi Wei, Institute of Microelectronics (China) . . . . [11327-36]

A methodology for model extreme performance with turn-around-time reduction by accurate metrology measurement and modeling, Kunyuan Chen, ChangXin Memory Technologies, Inc. (China) . . . . [11327-37]

Comparison of different lithographic source optimization methods based on compressive sensing, Xu Ma, Zhiqiang Wang, Beijing Institute of Technology (China); Rui Chen, Institute of Microelectronics, Chinese Academy of Sciences (China); Gonzalo Arce, Univ. of Delaware (USA); Lisong Dong, Yayi Wei, Institute of Microelectronics, Chinese Academy of Sciences (China) . . . [11327-38]

Imaging performance enhancement by improvements of spectral performance stability and controllability on the cutting-edge "GT66A" ArF-i lightsource, Miwa Igarashi, Gigaphoton Inc. (Japan). . . . . [11327-39]

Pattern contour calculation based on Neural Network, Pengzheng Gao, Institute of Microelectronics (China) and Univ. of Chinese Academy of Science (China); Libin Zhang, Institute of Microelectronics (China); Yayi Wei, Tianchun Ye, Institute of Microelectronics (China) and Univ. of Chinese Academy of Science (China) . . . . [11327-40]

Model based cell-array OPC for memory chips to improve performance and consistency of RET solutions, Srividya Jayaram, Sherif Hany, Ashutosh Rathi, Pat LaCour, Mentor, a Siemens Business (USA); Zhenguo Zheng, Mentor, a Siemens Business (China); Lei Zhang, Yaobin Feng, Jun Yao, Yangtze Memory Technologies Co., Ltd. (China) . . . . [11327-41]

Numerical method of integral transfer function for scanning image in lithographic tool, Zhiyong Yang, Xiuguo Chen, Huazhong Univ. of Science and Technology (China) . . . . [11327-42]

Target recovery process optimization to improve image based overlay performance for critical recording head manufacturing processes, Yi Liu, Aaron Bowser, Dan Yu, Seagate Technology LLC (USA) . . . . [11327-43]

KrF excimer laser-based patterning system for dual applications in both lithography and ablation, Julius Joseph S. Santillan, Osaka Univ. (Japan); Nobutaka Uemori, Hiroshi Yamaoka, Marubun Corp. (Japan); Toshiro Itani, Osaka Univ. (Japan) [11327-45]

Evaluating and correcting pattern variability induced by OPC within regular array layout, Christian Gardin, Guillaume Landie, STMicroelectronics S.A. (France); Raphael La Greca, Laurent Depre, ASML (France) . . . . [11327-46]

Absorptance and thermally induced wavefront deformations in DUV lithography optics, Klaus Mann, Uwe Leinhos, Markus Muchow, Bernd Schäfer, Laser-Lab. Göttingen e.V. (Germany) . . . . [11327-47]

Reducing lens heating effects on high mileage projection lenses used in optical lithography, Steven D. Mayer, Skyworks Solutions, Inc. (USA) . . . . [11327-50]

CONFERENCE 11328 Design-Process-Technology Co-optimization for Manufacturability XIV

Exploring patterning limit and Enhancement techniques to improve printability of 2D shapes in 3nm node, Rehab Kotb Ali, Mentor, a Siemens Business (Egypt); Ahmed Hamed Fatehy, Mentor Graphics Egypt (Egypt); James Word, Mentor, a Siemens Business (USA). . . . . [11328-33]

An advanced and efficient methodology for process setup and monitoring by using process stability diagnosis in computational lithography, Lijun Chen, Shanghai Huali Microelectronics Corp. (China); Abhishek Vikram, Anchor Semiconductor, Inc. (USA); Jun Zhu, Xuedong Fan, Haichang Zheng, Xiaolong Wang, Yancong Ge, Yu Zhang, Shanghai Huali Microelectronics Corp. (China); Guojie Cheng, Hui Wang, Qing Zhang, Wenkui Liao, Anchor Semiconductor, Inc. (China) . . . . [11328-34]

Via optimization methodology for enhancing robustness of design at 14/12nm technology node, Xiaojing Su, Yayi Wei, Rui Chen, Yajuan Su, Lisong Dong, Institute of Microelectronics (China); Chunshan Du, Qijian Wan, Xinyi Hu, Mentor Graphics (Shanghai) Electronics Technology Co., Ltd. (China) . [11328-35]

N2 node process assumption options and design rules, Yihan Chang, imec (Belgium) . . . . . [11328-36]

Explore process weak patterns for manufacturing friendly design, Qijian Wan, Chunshan Du, Zhengfang Liu, Xinyi Hu, Mentor Graphics (Shanghai) Electronics Technology Co., Ltd. (China). . . . . [11328-39]

Patterning cost of ownership and sensitivity analysis on advanced logic technology nodes, Jiahui Wang, Darko Trivkovic, Yihan Chang, Arindam Mallik, Ryoung-Han Kim, imec (Belgium) . [11328-40]

VIA design optimization for fast yield ramping in advanced nodes, Xinyi Hu, Qijian Wan, Zhengfang Liu, Chunshan Du, Mentor Graphics (Shanghai) Electronics Technology Co., Ltd. (China) . [11328-41]

An electrical characteristics estimation method for vertical nanowire FETs with non-circular wires due to lithography distortion, Xin-Yang Zheng, Jia-Syun Cai, Sheng-Wei Chien, Chien-Lin Lee, Kuen-Yu Tsai, National Taiwan Univ. (Taiwan) . . . . [11328-42]

Early detection of Cu pooling with advanced CMP modeling, Ethan Wang, Cadence Design Systems, Inc. (Taiwan); Single Hsu, United Microelectronics Corp. (Taiwan); Eason Lin, Cadence Design Systems, Inc. (Taiwan); Tamba Gbondo-Tugbawa, Aaron Gower-Hall, Brian Lee, Jansen Chee, Ya-Chieh Lai, Cadence Design Systems, Inc. (USA) . . . . [11328-43]

CMP simulation guided dummy fill optimization, Zhengfang Liu, Chunshan Du, Xinyi Hu, Qijian Wan, Zhixi Chen, Mentor Graphics (Shanghai) Electronics Technology Co., Ltd. (China). . . . . [11328-44]

An efficient way to accelerate litho hotspot checking, Qijian Wan, Xinyi Hu, Zhengfang Liu, Chunshan Du, Mentor Graphics (Shanghai) Electronics Technology Co., Ltd. (China). . . . . [11328-45]

Kissing corner handling in advanced nodes, Harold Mendoza, GLOBALFOUNDRIES Inc. (USA); Gazi Huda, Mentor, a Siemens Business (USA) [11328-46]

DFM: "Design for Manufacturing" or "Design Friendly Manufacturing" How to convert extra EPE budget into design freedom by SMO, Wenzhan Zhou, Hung-Wen Chao, Yu Zhang, Chan-Yuan Hu, Shanghai Huali Integrated Circuit Corp. (China); QiXin Xu, Quan Gan, Ao Chen, Gen-Sheng Gao, Mentor Graphics (Shanghai) Electronics Technology Co., Ltd. (China) . . . . [11328-47]

Fast OPC repair flow based on Machine Learning, Zhongli Shu, Mentor Graphics Corp. (USA) [11328-48]

A comprehensive standard cell library qualification to prevent lithographic challenges, Qijian Wan, Xinyi Hu, Zhengfang Liu, Chunshan Du, Mentor Graphics (Shanghai) Electronics Technology Co., Ltd. (China) . . . . [11328-49]

Implementing Machine Learning for OPC retargeting, Kevin Hooker, Marco Guajardo, Synopsys, Inc. (USA); Nai-Chia Cheng, The Univ. of Southern California (USA) . . . . [11328-50]

A feature selection method for weak classifier based hotspot detection, Hidekazu Takahashi, Hiroki Ogura, Shimpei Sato, Atsushi Takahashi, Tokyo Institute of Technology (Japan); Chikaaki Kodama, KIOXIA Corp. (Japan) . . . . [11328-51]

Optimal triple patterning layout decomposition, Wei Li, Yuzhe Ma, Wang Wei, The Chinese Univ. of Hong Kong (Hong Kong, China); Yibo Lin, Peking Univ. (China); Bei Yu, The Chinese Univ. of Hong Kong (Hong Kong, China). . . . . [11328-52]

Deep learning based CD-SEM image segregator for OPC and process window estimation, Bappaditya Dey, Dorin Cerbu, imec (Belgium); Kasem Khalil, Univ. of Louisiana at Lafayette (USA); S. M. Yasser Sherazi, imec (Belgium); Magdy A. Bayoumi, Univ. of Louisiana at Lafayette (USA); Ryoung Han Kim, imec (Belgium) . . . . [11328-53]

CONFERENCE 11329 Advanced Etch Technology for Nanopatterning IX

Cleaning chamber walls after ITO plasma etching process, Salma Younesy, STMicroelectronics S.A. (France); Camille Petit-Etienne, Lab. des Technologies de La Microélectronique (France); Sébastien Barnola, CEA-LETI (France); Pascal Gouraud, STMicroelectronics S.A. (France); Gilles Cunge, Lab. des Technologies de La Microélectronique (France) . . . . [11329-30]

Realization of high aspect ratio silicon nano-needles by using nano-lithographic Al mask, Xuecou Tu, Qingyu Meng, Qi Chen, Danfeng Pan, Xiaoqing Jia, Qing-Yuan Zhao, La Bao Zhang, Jian Chen, Lin Kang, Peiheng Wu, Nanjing Univ. (China) . . . . . . [11329-31]

Machine Learning assistant technology to facilitate Fin and 3D memory measurements on SEM and TEM images, Sergio Martinez, Julien Baderot, Guilhem Bernard, Alexandre Derville, Johann Foucher, POLLEN Metrology (France) . . . . [11329-32]

Model-based process optimization for high aspect ratio trench etch with cyclic etching, Roger T. Bonnecaze, Meghali Chopra, Leandro Medina, Bryan Sundahl, Kara Kearney, SandBox Semiconductor (USA) . . . . [11329-33]

Accelerated optimization of multilayer trench etches using model-based experimental design, Meghali Chopra, Kara Kearney, Bryan Sundahl, Leandro Medina, Roger T. Bonnecaze, SandBox Semiconductor (USA) . . . . [11329-34]

Intra-field etch induced overlay penalties, Richard van Haren, Oktay Yildirim, Orion Mouraille, Leon van Dijk, ASML Netherlands B.V. (Netherlands); Kaushik Kumar, Yannick Feurprier, Tokyo Electron Ltd. (Japan); Jan Hermans, imec (Belgium) . . . . [11329-35]

Effects of pulsed inductively coupled Cl2/Ar plasma for the etching of Si nanostructure, Yeji Shin, Sungkyunkwan University (Korea, Republic of); Kyowun Kim, Heeju Kim, Jisoo Oh, Geunyoung Yeom, Sungkyunkwan Univ. (Korea, Republic of) [11329-36]

Etch characteristics of Magnetic Tunnel Junction (MTJ) materials by reactive ion beam, JU EUN KIM, Sungkyunkwan University (Korea, Republic of); Doo San Kim, You Jung Gill, Geun Young Yeom, Sungkyunkwan Univ. (Korea, Republic of) [11329-37]

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CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 11
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
THU 8:00 AM TO 10:20 AM

Stochastics

EUV Resist Fundamentals

Session Chairs: **Sonia Castellanos Ortega,** Advanced Research Ctr. for Nanolithography (Netherlands); **Kurt G. Ronse,** imec (Belgium)

8:00 am: **Advanced characterization techniques for nanoscale photoresist structure** *(Invited Paper)*, Miquel Salmeron, Lawrence Berkeley National Laboratory (USA). [11323-40]

8:20 am: **One metric to rule them all: new k4 definition for photoresist characterization**, Jara Garcia Santaclara, ASML Netherlands B.V. (Netherlands); Bernd Geh, Carl Zeiss SMT Inc./ASML TDC (USA) (USA); Anthony Yen, Timothy A. Brunner, ASML US, LP (USA); Danilo De Simone, Joren Severi, imec (Belgium). . . . . [11323-41]

8:40 am: **EUV sensitization mechanisms of carboxylic acids used as ligands of metal oxide nanocluster resists**, Takahiro Kozawa, Yusa Muroya, Osaka Univ (Japan) . . . . [11323-42]

9:00 am: **Measurement of latent image in resist using scanning probe techniques**, Luke Long, Andrew Neureuther, Univ. of California, Berkeley (USA); Patrick Naulleau, The Ctr. for X-Ray Optics (USA) . . . . [11323-43]

9:20 am: **Determination of secondary electron attenuation length to characterize electron blur**, Oleg Kostko, Jonathan H. Ma, Patrick Naulleau, Lawrence Berkeley National Lab. (USA) . . [11323-44]

9:40 am: **An application study on the stochastic effect of EUV photons**, Jongsu Kim, Hyekyoung Jue, Hyungju Ryu, Sang-Jin Kim, Joon-Soo Park, Kyoungsub Shin, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Eun-Soo Jeong, Sang-Yil Chang, Jung-Hoe Choi, Synopsys Korea Inc. (Korea, Republic of); Ulrich Welling, Jürgen Preuninger, Ulrich Klostermann, Hans-Jürgen Stock, Wolfgang Demmerle, Synopsys GmbH (Germany) . . [11323-45]

10:00 am: **Understanding secondary electron driven EUV chemistry**, Jonathan H. Ma, Patrick Naulleau, The Ctr. for X-Ray Optics (USA); Andrew Neureuther, Univ. of California, Berkeley (USA) . . . . [11323-46]

Coffee Break . . . . Thu 10:20 am to 10:50 am

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/ NEMS and MOEMS 2020

SESSION 10
LOCATION: CONVENTION CENTER, ROOM 210C
THU 8:00 AM TO 10:00 AM

Atomically Precise Lithography: TopDown Approach

Session Chairs: **Chi-Chun Liu,** IBM Thomas J. Watson Research Ctr. (USA); **Alan D. Brodie,** KLA Corp. (USA)

8:00 am: **Atomically precise digital e-beam lithography** *(Invited Paper)*, John N. Randall, Ehud Fuchs, James H. Owen, Zyvex Labs, LLC (USA) . . . . [11324-31]

8:40 am: **A new approach to removing H atoms in hydrogen depassivation lithography** *(Invited Paper)*, S. O. Reza Moheimani, Hamed Alemansoor, The Univ. of Texas at Dallas (USA). . . . . [11324-32]

9:20 am: **Atomic precision advanced manufacturing in silicon** *(Invited Paper)*, Shashank Misra, Daniel Ward, Aaron Katzenmeyer, Evan Anderson, Scott Schmucker, DeAnna Campbell, Lisa Tracy, Tzu-Ming Lu, Ping Lu, Xujiao Gao, Andrew Baczewski, Sandia National Labs. (USA) . [11324-33]

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

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 12
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
THU 8:00 AM TO 9:40 AM

Stochastics

Metrology for the EUV Era

Session Chairs: **Phillipe Leray,** imec (Belgium); **Narender Rana,** Western Digital Corp. (USA)

8:00 am: **More accurate, higher speed, and smarter metrology in EUV era**, Zhigang Wang, Kei Sakai, Yasushi Ebizuka, Masumi Shirai, Makoto Suzuki, Hitachi High-Tech Corp. (Japan). . . . . [11325-80]

8:20 am: **Influence and control of CD on defectivity for EUV Pitch 32 line-space**, Christophe Béral, Anne-Laure Charley, Philippe Leray, Frederic Lazzarino, Romuald Blanc, Poulomi Das, Ataklti Weldeslassie, Amir-Hossein Tamaddon, Werner Gillijns, imec (Belgium) . . . . [11325-51]

8:40 am: **EUV photo resist shrink characterization using low landing energy SEM**, Shimon Levi, Applied Materials Israel, Ltd. (Israel). . . . . [11325-52]

9:00 am: **EUV photoresist reference metrology using TEM tomography**, Mark T. Biedrzycki, Andrew Barnum, Umesh P. S. Adiga, Rose Marie Haynes, Jason Arjavac, Thermo Fisher Scientific Inc. (USA); Alain Mousa, Anne-Laure Charley, Phillipe Leray, Dmitry Batuk, imec (Belgium) . . . . [11325-53]

9:20 am: **Novel on-product focus metrology for EUV, enabling direct focus monitoring and control for EUV systems**, Inbeom Yim, Koshiba Dakeshi, Chan Hwang, Seung Yoon Lee, Jeongjin Lee, Joon-Soo Park, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Jenny Yueh, Ali Ghavami, Bart Segers, Miguel Garcia Granda, Yutao Gui, Eric Janda, Frank Staals, Se-Hui Lee, Seung-Bin Yang, Yoon-tae Lee, Se-Ra Jeon, Daniel Park, Elliott McNamara, Ewoud van West, ASML Netherlands B.V. (Netherlands) . . . . [11325-54]

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
9:40 AM TO 10:00 AM

2020 Karel Urbánek Best Student Paper Award Presentation

Session Chairs: **Ofer Adan,** Applied Materials Israel, Ltd. (Israel); **John C. Robinson,** KLA Corp. (USA)

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

CONFERENCE 11328
Design-Process-Technology Co-optimization for Manufacturability XIV

SESSION 5
LOCATION: CONVENTION CENTER, ROOM 210D
THU 8:00 AM TO 10:00 AM

Machine Learning

Design for Manufacturing

Session Chairs: **Ryoung-Han R. Kim,** imec (Belgium); **Shigeki Nojima,** Kioxia Holdings Corp. (Japan)

8:00 am: **From design for manufacturing to design for economics: coping with a maturing Moore's Law** *(Keynote Presentation)*, Nihaar Mahatme, NXP Semiconductors USA) . . . . [11328-18]

8:40 am: **Systematic DTCO flow for yield improvement at 14/12nm technology node**, Xiaojing Su, Yayi Wei, Rui Chen, Yajuan Su, Lisong Dong, Institute of Microelectronics (China) . . . . . [11328-19]

9:00 am: **Co-optimizing Design for Manufacturability (DFM) layout enhancements and their impact on circuit performance for analog designs**, Lynn T. N. Wang, Michael Simcoe, Vikas Mehrotra, Gail Katzman, Rais Huda, Zhao Chuan Lee, Janam Bakshi, Ahmed Abdulghany, Uwe Paul Schroeder, Sriram Madhavan, GLOBALFOUNDRIES Inc. (USA). . . . . [11328-20]

9:20 am: **Enabling nanoimprint simulator for quality verification; Process-design co-optimization toward high volume manufacturing**, Junichi Seki, Yuichiro Oguchi, Naoki Kiyohara, Koshiro Suzuki, Kohei Nagane, Shintaro Narioka, Takahiro Nakayama, Yoshihiro Shiode, Sentaro Aihara, Toshiya Asano, Canon Inc. (Japan) . . . . [11328-21]

9:40 am: **Process variation-aware mask optimization with iterative improvement by Subgradient method and boundary flipping**, Rina Azuma, Yukihide Kohira, Univ. of Aizu (Japan); Tomomi Matsui, Atsushi Takahashi, Tokyo Institute of Technology (Japan); Chikaaki Kodama, KIOXIA Holdings Corp. (Japan) . . . . [11328-22]

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

CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 12
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
THU 10:50 AM TO 12:30 PM

Stochastics

EUV Mask Inspection and Pellicle

Session Chairs: **Anna Tchikoulaeva,** Lasertec U.S.A., Inc. Zweigniederlassung Deutschland (Germany); **Toshio Konishi,** Toppan Printing Co., Ltd. (Japan)

10:50 am: **The EUV CNT pellicle: balancing material properties to optimize performance**, Ivan Pollentier, Marina Y. Timmermans, imec (Belgium); Marina Mariano, KU Leuven (Belgium); Cedric Huyghebaert, Emily Gallagher, imec (Belgium) . . . . [11323-47]

11:10 am: **A direct measurement of EUV mask phase on the Berkeley SHARP microscope**, Ryan H. Miyakawa, Lawrence Berkeley National Lab. (USA); Stuart Sherwin, Univ. of California, Berkeley (USA); Markus Benk, Patrick Naulleau, Lawrence Berkeley National Lab. (USA) . . . . [11323-48]

11:30 am: **Illumination control in lensless imaging for EUV mask inspection and review**, Iacopo Mochi, Ricarda Nebling, Atoosa Dejkameh, Uldis Locans, Dimitrios Kazazis, Yasin Ekinici, Paul Scherrer Institut (Switzerland) . . . . [11323-49]

11:50 am: **Optical defect inspection solution for EUV stochastics detection**, Vidya Sagar Anantha, Raghav Babulnath, KLA Corp. (USA); Kaushik Sah, KLA Corp. (Belgium); Andrew Cross, KLA Corp. (United Kingdom); Shubham Kumar, KLA Corp. (India); Hari Pathangi, Veikunth Kannan, Garima Sharma, KLA Corp. (USA); Rahul Lakhawat, KLA Corp. (India); Peter De Bisschop, imec (Belgium) . . . . [11323-50]

12:10 pm: **Enabling EUVL high-volume manufacturing with actinic patterned mask inspection**, Anna Tchikoulaeva, Lasertec U.S.A., Inc. Zweigniederlassung Deutschland (Germany); Hiroki Miyai, Tsunehito Kohyama, Kiwamu Takehisa, Haruhiko Kusunose, Lasertec Corp. (Japan). . . . . [11323-51]

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

CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 11
LOCATION: CONVENTION CENTER, ROOM 210C
THU 10:30 AM TO 12:10 PM

Stochastics

Atomically Precise Lithography: BottomUp Approach

Session Chairs: **Chi-Chun Liu,** IBM Thomas J. Watson Research Ctr. (USA); **Ricardo Ruiz,** Lawrence Berkeley National Lab. (USA)

10:30 am: **Stochastic processes in self-assembly: limits and strategies for mitigation** *(Invited Paper)*, J. Alexander Liddle, Michael Zwolak, Jacob Majikes, National Institute of Standards and Technology (USA) . . . . [11324-34]

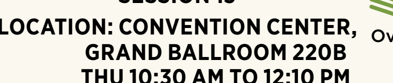
11:10 am: **Nanoengineering DNA origami for lithography**, Raluca Tiron, Marie Marmiesse, Guillaume Thomas, CEA-LETI (France); Gaetan Bellot, CNRS (France) and INSERM (France); Nesrine Aissaoui, CNRS (France); Xavier Baillin, CEA-LETI (France) . . . . [11324-35]

11:30 am: **Selective electroless plating on non-conductive materials by applying a gradient magnetic field**, Sofya Danilova, John E. Graves, Coventry Univ. (United Kingdom); Gareth V. W. Cave, Nottingham Trent Univ. (United Kingdom); Jordi Sort, Eva Pellicer, Univ. Autònoma de Barcelona (Spain); Andrew J. Cobley, Coventry Univ. (United Kingdom). . . . . [11324-36]

11:50 am: **Self-forming nanogap diodes operate beyond 10 GHz enabled via adhesion lithography**, Kalaivanan Loganathan, Emre Yengel, Hendrik Faber, Akmaral Seitkhan, Emre Yarali, Begimai Adilbekova, Shuai Yang, Weiwei Li, Azamat Bakytbekov, Atif Shamim, Thomas Anthopoulos, King Abdullah Univ. of Science and Technology (Saudi Arabia) [11324-55]

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

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV



SESSION 13
LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
THU 10:30 AM TO 12:10 PM

Overlay

Pattern Placement and Overlay Metrology III

Session Chairs: **Jason P. Cain,** Advanced Micro Devices, Inc. (USA); **John A. Allgair,** BRIDG (USA)

10:30 am: **Using e-Beam inspection and overlay as tool for identifying process weaknesses in semiconductor processing**, Kwame Owusu-Boahen, Suraj Patil, Arun Vijayakumar, Carl Han, Alex Pate, Jorg Schwitzgebel, Chulwoo Kim, David J. Moreau, SAMSUNG Austin Semiconductor LLC (USA) . . . . [11325-55]

10:50 am: **Mitigating gain, effort and cost for EOW overlay control**, Olivier Mermet, Maxime Gatefait, Didier Dabernat, Florent Dettoni, Benjamin Duclaux, Bertrand Le-Gratiet, STMicroelectronics S.A. (France) . . . . [11325-56]

11:10 am: **Optical overlay imaging metrology calibration using high voltage scan electron microscope at ADI for advance processes**, Nadav Gutman, KLA Israel (Israel); Roel Gronheid, KLA Belgium (Belgium); Inna Tarshish, Chen Dror, KLA Israel (Israel); Henning Backhauss, Detlef Michelsson, KLA Germany (Germany); Liat Levin, Vladimir Levinski, Yuri Paskover, KLA Israel (Israel); Ulrich Pohlmann, Frank Laske, KLA Germany (Germany) . . . [11325-57]

11:30 am: **High-order field distortion correction using standalone alignment technology with modeling and sampling optimization**, Takehisa Yahiro, Junpei Sawamura, Katsushi Makino, Yuji Shiba, Jun Ishikawa, Shinji Wakamoto, Masahiro Morita, Nikon Corp. (Japan); Steven Tottewitz, Boris Habets, Patrick Lomtscher, Qoniac GmbH (Germany); Jiro Hanaue, Qoniac Japan K.K. (Japan) . [11325-58]

11:50 am: **Optical Overlay measurement accuracy improvement with machine learning**, Honggoo Lee, SK Hynix, Inc. (Korea, Republic of); Jeongpyo Lee, JungTae Lee, Sanghuck Jeon, DongSub Choi, KLA Korea (Korea, Republic of); Udi Shusterman, Alexander Verner, Boaz Ophir, KLA Israel (Israel) . . . . [11325-59]

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

CONFERENCE 11328
Design-Process-Technology Co-optimization for Manufacturability XIV

SESSION 6
LOCATION: CONVENTION CENTER, ROOM 210D
THU 10:30 AM TO 12:00 PM

Device and Integration

Session Chairs: **David Z. Pan,** The Univ. of Texas at Austin (USA); **Piyush Pathak,** Cadence Design Systems, Inc. (USA)

10:30 am: **Progression of Logic Device and DTCO to enable advance scaling** *(Invited Paper)*, Satadru Sarkar, imec (Belgium) . . . . [11328-23]

11:00 am: **Efficient design of guard rings and antenna diodes to improve manufacturability of FDSOI circuits**, Chi-Min Yuan, Dave Tipple, NXP Semiconductors (USA) . . . . [11328-24]

11:20 am: **Cost-performance optimisation of fine-pitch W2W bonding: functional system partitioning with heterogeneous FEOL/BEOL configurations**, Dragomir Milojevic, Geert Van der Plas, Eric Beyne, Jane Wang, Peter Debacker, imec (Belgium) . . . . [11328-25]

11:40 am: **How utilizing curvilinear design enables better manufacturing process window**, Ryan Pearman, Don O'Riordan, Leo Pang, Aki Fujimura, D2S, Inc. (USA) . . . . [11328-26]

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

APPLICATION TRACKS

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• Machine Learning

• Stochastics

• Overlay

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CONFERENCE 11323
Extreme Ultraviolet (EUV) Lithography XI

SESSION 13

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A
THU 1:30 PM TO 3:10 PM

Stochastics

New Concepts in EUV

Session Chairs: **Luciana Meli,** IBM Thomas J. Watson Research Ctr. (USA); **Seong-Sue Kim,** SAMSUNG Electronics Co., Ltd. (Korea, Republic of)

1:30 pm: **Simulation investigation of enabling technologies for EUV single exposure of Via patterns in 3nm logic technology**, Weimin Gao, ASML Intl. Trading Co., Ltd. (China) . . . .[11323-52]

1:50 pm: **Resistless EUV lithography: patterning with EUV-induced surface reactions**, Li-Ting Tseng, Dimitrios Kazazis, Paul Scherrer Institut (Switzerland); Procopios Constantinou, Univ. College London (United Kingdom); Taylor Stock, Neil Curson, London Ctr. for Nanotechnology (United Kingdom); Steven Schofield, Univ. College London (United Kingdom); Gabriel Aeppli, Paul Scherrer Institut (Switzerland) and ETH Zurich (Switzerland) and Ecole Polytechnique Fédérale de Lausanne (Switzerland); Yasin Ekinci, Paul Scherrer Institut (Switzerland). . . . . [11323-53]

2:10 pm: **Projecting EUV photospeeds for future logic nodes**, Mark Neisser, Kempur Microelectronics Inc. (China); Harry J. Levinson, HJL Lithography (USA) . . . . [11323-54]

2:30 pm: **The evaluation method of the origin of LWR in EUV resist**, Takeo Watanabe, Tetsuo Harada, Univ. of Hyogo (Japan) . . . .[11323-55]

2:50 pm: **Probing buried structures in Inorganic-organic hybrid resists with energy-tunable X-rays**, I. A. Cordova, The Ctr. for X-Ray Optics (USA); Luke Long, Univ. of California, Berkeley (USA); G. Freychet, Brookhaven National Lab. (USA); C. Wang, Lawrence Berkeley National Lab. (USA); P. Naulleau, Univ. of California, Berkeley (USA) . . . .[11323-56]

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220A, 3:10 PM TO 3:30 PM

ASML Best Student Paper Award and Closing Remarks

Session Chairs: **Nelson M. Felix,** IBM Thomas J. Watson Research Ctr. (USA); **Anna Lio,** Intel Corp. (USA)

Presentation of the 2020 ASML-Cymer Leadership Best Student Paper Award

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CONFERENCE 11324
Novel Patterning Technologies for Semiconductors, MEMS/NEMS and MOEMS 2020

SESSION 12

LOCATION: CONVENTION CENTER, ROOM 210C
THU 1:40 PM TO 3:20 PM

MEMS/NEMS

Session Chairs: **Richard A. Farrell,** TEL Technology Ctr., America, LLC (USA); **Chandrasekhar Sarma,** Intel Corp. (USA)

1:40 pm: **Extending MEMS and NEMS operation into the nonlinear regime** *(Invited Paper)*, David Czaplewski, Argonne National Lab. (USA); Oriel Shoshani, Ben-Gurion Univ. of the Negev (Israel); Steven Shaw, Florida Institute of Technology (USA); Daniel López, Argonne National Lab. (USA)[11324-37]

2:20 pm: **Dielectric metasurfaces for shaping optical fields: from deep-UV to the terahertz** *(Invited Paper)*, Amit Kumar Agrawal, National Institute of Standards and Technology (USA). . . . . [11324-38]

3:00 pm: **Design and fabrication of microlens array homogenizer for laser beam shaping using two-photon polymerization**, Jia-Rong Wu, Hua-Yi Ni, Chien-Chung Fu, National Tsing Hua Univ. (Taiwan); Wei-Jei Peng, Ting-Ming Huang, Ming-Fu Chen, Taiwan Instrument Research Institute (Taiwan) . . . . [11324-39]

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

SESSION 13

LOCATION: CONVENTION CENTER, ROOM 210C
THU 3:50 PM TO 5:10 PM

Novel Patterning and Applications

Session Chairs: **Martha I. Sanchez,** IBM Research - Almaden (USA); **Eric M. Panning,** Intel Corp. (USA)

3:50 pm: **Sub-wavelength holographic lithography (SWHL)** *(Invited Paper)*, Vitaly V. Chernik, Alexei Shamaev, Vadim Rakhovskiy, Mike Borisov, Dmitriy Chelubeev, Lev Merkushov, Nanotech SWHL GmbH (Switzerland) . . . . [11324-40]

4:30 pm: **Radiation-particle induced deflection**, Nicolas Zani, Michael J. Zani, Digibeam Corp. (USA); Mark J. Bennahmias, Univ. of California, Berkeley (USA) . . . . [11324-41]

4:50 pm: **Exposure process windows for holographic photolithography**, Joseph Geddes III, Photia Inc. (USA) . . . . [11324-54]

Conference End.

CONFERENCE 11325
Metrology, Inspection, and Process Control for Microlithography XXXIV

SESSION 14

LOCATION: CONVENTION CENTER, GRAND BALLROOM 220B
THU 1:40 PM TO 3:40 PM

Overlay

Machine Learning

Late Breaking News

Session Chairs: **Ofer Adan,** Applied Materials Israel, Ltd. (Israel); **John C. Robinson,** KLA Corp. (USA)

1:40 pm: **Statistical local CD uniformity with novel SEM noise reduction method**, Shinji Kobayashi, Tokyo Electron Kyushu Ltd. (Japan) . . . . . [11325-60]

2:00 pm: **On-product focus monitoring and control for immersion lithography in 3D-NAND manufacturing**, Sangjun Han, Jeongsu Park, Beomki Shin, Jun-Yeob Kim, SK Hynix, Inc. (Korea, Republic of); Amine Lakcher, Ahmed Zayed, Jennifer Shumway, Jan-Pieter van Delft, Gratiela Isai, Ruxandra Mustata, Arno van den Brink, ASML Netherlands B.V. (Netherlands); Taeddy Kim, Jay Jung, Yong-Sik Shin, Soo-Kyung Lee, ASML Korea Co., Ltd. (Korea, Republic of) . . . . [11325-61]

2:20 pm: **A novel accurate and robust technique in after-etch overlay metrology of 3D-NAND's memory holes**, Yaobin Feng, Dean Wu, Pandeng Xuan, Yangtze Memory Technologies Co., Ltd. (China); Pavel Izikson, ASML Netherlands B.V. (Netherlands); Payne Qi, Huanian You, Yvon Chai, ASML Wuhan (China); Jan Jitse Venselaar, Giulio Bottegal, Gonzalo Sanguinetti, Bert Verstraeten, Koen van Witteveen, ASML Netherlands B.V. (Netherlands); Soon Thon Kian, ASML Wuhan (China); Tjitte Nooitgedagt, Babak Mozooni, ASML Netherlands B.V. (Netherlands) . . . . [11325-62]

2:40 pm: **Advanced process control loop for SAQP pitch walk with combined lithography, deposition and etch actuators**, Huan Ren, KLA China (China); Antonio Mani, KLA Corp. (Belgium); Xin Li, Sixiao Han, KLA China (China); Xuemei Chen, KLA Corp. (USA); Dieter Van den Heuvel, imec (Belgium) . . . [11325-63]

3:00 pm: **Contact Etch process control application for advanced NAND memory structures**, Roman Kris, Grigory Klebanov, Einat Frishman, Sharon Duvdevani -Bar, Jannelle Geva, Applied Materials Israel, Ltd. (Israel); Dhananjay Rathore, Daniel Rogers, Applied Materials, Inc. (USA). . . . . [11325-102]

3:20 pm: **Realizing more accurate OPC models by utilizing large field SEM contours**, Chih-I Wei, Rajiv Sejpal, Mentor Graphics Corp. (Belgium); Yunfei Deng, Ir Kusnadi, Germain Fenger, Mentor Graphics Corp. (USA); Masahiro Oya, Kotaro Maruyama, Yuichiro Yamazaki, NGR Inc. (Japan); Sayantan Das, Sandip Halder, Werner Gillijns, imec (Belgium) . . . . [11325-2]

Conference End.

CONFERENCE 11328
Design-Process-Technology Co-optimization for Manufacturability XIV

SESSION 7

LOCATION: CONVENTION CENTER, ROOM 210D
THU 1:30 PM TO 3:00 PM

DPTCO from Equipment Vendors

Session Chairs: **Ya-Chieh Lai,** Cadence Design Systems, Inc. (USA); **Michael L. Rieger,** Consultant (USA)

1:30 pm: **Full stack computational optimization through process emulation** *(Invited Paper)*, David Fried, Lam Research Corp. (USA) . . . . [11328-27]

2:00 pm: **Process and materials innovation for leading-edge technology nodes** *(Invited Paper)*, Jeffrey Smith, Tokyo Electron (USA) . . . . . [11328-28]

2:30 pm: **Holistic method for reducing overlay error at the 5nm node and beyond** *(Invited Paper)*, Bob Socha, ASML US, Inc. (USA). . . . . [11328-29]

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

SESSION 8

LOCATION: CONVENTION CENTER, ROOM 210D
THU 3:30 PM TO 5:00 PM

DPTCO from EDA Vendors

Session Chairs: **Vivek K. Singh,** Intel Corp. (USA); **Lynn T. N. Wang,** GLOBALFOUNDRIES Inc. (USA)

3:30 pm: **New approaches to physical verification closure and cloud computing come to the rescue in the EUV era** *(Invited Paper)*, John Ferguson, Mentor, a Siemens Business (USA). . . . . . [11328-30]

4:00 pm: **Pattern-based data preparation for machine learning in design for manufacturability applications** *(Invited Paper)*, Ya-Chieh Lai, Cadence Design Systems, Inc. (USA). . . . . [11328-31]

4:30 pm: **Multi-varied implementations with common underpinnings in Design Technology Co-Optimization** *(Invited Paper)*, Kevin Lucas, Tim Tsuei, Soo-Han Choi, John Kim, Synopsys, Inc. (USA) . . . . [11328-32]

Conference End.

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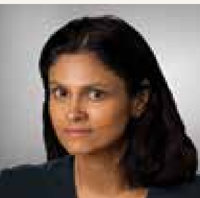

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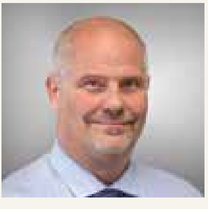

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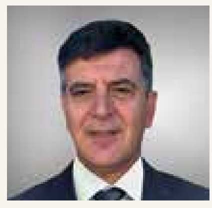

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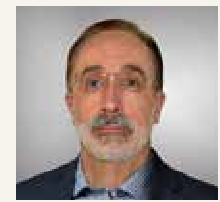

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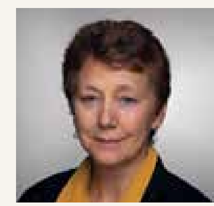

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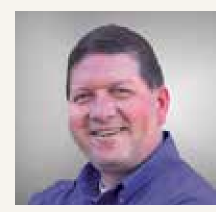

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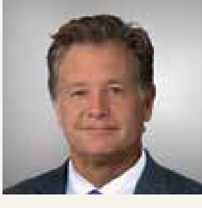

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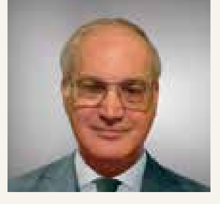

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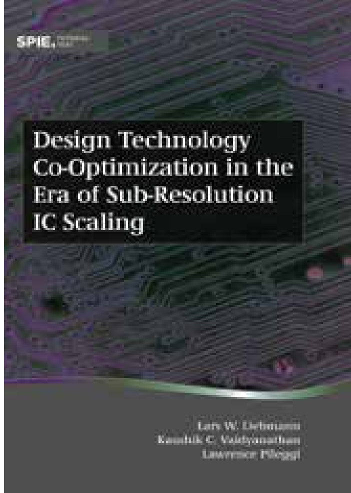

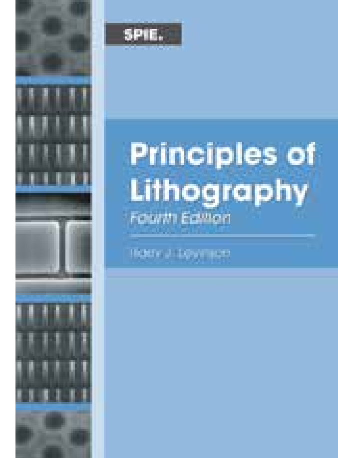

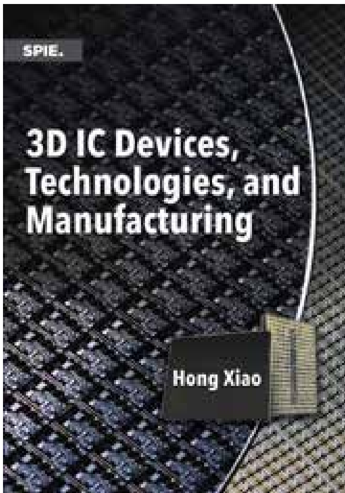

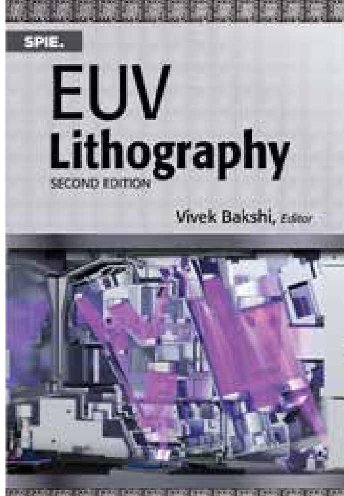

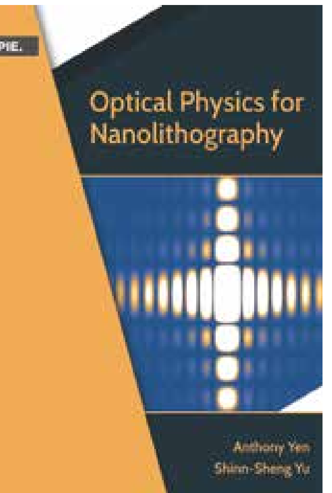

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GENERAL INFORMATION

Registration

Onsite Registration and Badge Pickup Hours

Convention Center

Sunay 23 February · 7:15 AM - 5:00 PM

Monday 24 February · 7:15 AM - 4:00 PM

Tuesday 25 February · 7:30 AM - 5:00 PM

Wednesday 26 February · 7:30 AM - 4:00 PM

Thursday 27 February · 7:45 AM - 4:00 PM

(Thursday is conference registration only)

CONFERENCE REGISTRATION

Registration includes admission to all conference sessions, plenary presentations, panels, technical events, and poster session / reception, admission to the SPIE exhibition, welcome reception, all-day coffee service, and a choice of online proceedings. Online conference registration is open throughout the meeting.

COURSE REGISTRATION

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

EXHIBITION REGISTRATION

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

PRESS REGISTRATION

- For credentialed press and media representatives only. Please email contact information, title, and organization to media@spie.org.

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 up to 60% discount off 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.

SPIE Cashier

Registration Area - open during registration hours

- Registration Payments

If you are planning to register onsite, your credit card payment will be processed at the onsite station. If you wish to pay with cash or check, register at the onsite stations and you will be directed to the Cashier once you have completed registration except final payment. If you have already registered and wish to add a course, workshop or special event, you may do so at onsite registration.

- Receipts and Certificate of Attendance

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

- Badge Corrections

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

REFUND INFORMATION

There is a $50 USD service charge for processing refunds. Requests for refunds must be received by 13 February 2020. All registration fees will be forfeited after this date. Membership dues, SPIE Digital Library subscriptions or Special Events purchased 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 Stations

Convention Center, Ballroom Concourse

Sunday 23 February · 12:00 PM - 5:00 PM

Monday 24 February · 7:30 AM - 5:00 PM

Tuesday 25 February · 7:30 AM - 5:00 PM

Wednesday 26 February · 7:30 AM - 5:00 PM

Thursday 27 February · 7:30 AM - 4:00 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

Wednesday 26 February · 10:00 AM - 5:00 PM

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

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

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

Onsite Services

Wireless Internet Access

Convention Center, Upper Level Concourse

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

West end WiFi sponsored by

East end and Exhibition Hall WiFi sponsored by

Phone Charging Station

Convention Center Concourse, Open during registration hours

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Search and browse the program, special events, participants, exhibitors, courses, and more. Build your personalized schedule and sync with the online MySchedule tool. The free SPIE Conferences and Exhibitions App is available for iPhone and Android phones. Information about restaurants and food options is also available on the app.

Ssponsored by

SPIE Bookstore

Convention Center Lobby, near Registration

Stop by the SPIE Bookstore to browse the latest SPIE Press Books and educational materials. While there, get a t-shirt or educational toy to bring home to the family.

SPIE Education Services

Course Materials Pick-up, located near Registration, open during registration hours

Sunday-Thursday: Bookstore

If you have registered to attend a course, please stop by the Bookstore after you pick up your badge. Turn in your course ticket to get your course materials and the location of your course. Browse course offerings or learn more about SPIE courses available in portable formats such as online and customized, in-company courses.

Mothers Room

Monday-Thursday, 8:00 AM - 5:00 PM
Location: Grand Ballroom Concourse

The Mothers Room is a lockable room intended for nursing mothers. Please note: there is no running water or refrigeration in this space.

Quiet Room

Monday-Thursday, 8:00 AM - 5:00 PM
Location: Room 212A

The Quiet Room is intended for silent meditation, reflection, and prayer. No mobile devices or computer use is allowed, and no food nor beverages are allowed.

Lost and Found

SPIE Cashier

Open during registration hours

Found items will be kept at SPIE Registration Cashier during the meeting and available only during registration hours. At the end of the meeting, all found items will be turned over to the San Jose Convention Center Security, 408-277-3500

Urgent Message Line

An urgent message line is available during registration hours: 408-271-6033

Complimentary Breakfast Breads

Hall 2 Concourse
Monday - Thursday · 7:30 AM - 8:30 AM

Breakfast breads will be served Monday-Thursday.

Sponsored by

Complimentary Coffee Service

Sunday
7:30 AM - 8:30 AM, Executive Ballroom Concourse, front of windows

10:00 AM - 10:30 AM, Executive Ballroom Concourse, front of windows

3:00 PM - 3:30 PM, Executive Ballroom Concourse, front of windows

Monday
7:30 AM - 4:00 PM, Hall 2 Concourse

Tuesday
7:30 AM - 9:30 AM, Hall 2 Concourse

10:00 AM - 5:00 PM, Exhibition Hall 1

Wednesday
7:30 AM - 9:30 AM, Hall 2 Concourse
10:00 AM - 4:00 PM, Exhibition Hall 1

Thursday
7:30 AM - 4:00 PM, Hall 2 Concourse

Please check the conference schedule for specific break times.

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SPIE Hosted Lunches

Convention Center Exhibition Hall
Tuesday - Wednesday · 11:30 AM - 1:00 PM

Check individual conference listings for exact times. Lunches are included with full conference registrations.

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Food and Refreshments for Purchase

There are a variety of food and drink options, including hot and cold snacks, beverages, hot entrees, deli sandwiches, salads, and pastries available for purchase. Cash and credit cards accepted.

Ballroom Concourse
Monday - Thursday · 7:30 AM - 4:00 PM

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

GENERAL INFORMATION

Child Care Services

Bay Area Sitters Unlimited, 408-452-0225, Rachael Osorio, Email: rfosorio15@gmail.com

Urban Sitter lets you hand pick your childcare provider online.

SPIE does not imply an endorsement nor recommendation of these services. They are provided on an "information only" basis for your further analysis and decision. Other services may be available.

EVENT LOCATION

San Jose McEnery Convention Center
150 West San Carlos Street
San Jose, CA 95110

AIRPORTS

San Jose International Airport

(SJC) is conveniently located approximately 4 miles from downtown hotels.

San Francisco International Airport

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

Ground transportation

TAXI SERVICE

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

METRO LIGHT RAIL

From SJC, take the FREE Airport Flyer #10 toward Metro Light Rail and transfer at Metro/Airport Light Rail Station. Go southbound on Santa Teresa Line (#901) or Winchester Line (#902) to all staff hotels near the convention center. Fare is only $2 one-way (or $1 for seniors 65+). San Jose Convention Center is adjacent to the Convention Center Station on San Carlos Street.

AMTRAK

Amtrak's Diridon Station is conveniently located in the San Jose Airport. Visit amtrak.com/deals to find the best prices for your journey to San Jose.

CAR RENTAL

Hertz Car Rental is the official car rental agency for SPIE Advanced Lithography. To reserve a car, identify yourself as an Advanced Lithography Conference attendee using the Hertz Meeting Code CV# 029B0025. Discount rates apply to roundtrip rentals up to one week prior through one week after the conference dates. Note: When booking from International Hertz locations, the CV # must be entered with the letters CV before the number, i.e. CV029B0025. Book Hertz Online

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

In Canada call 1-800-263-0600, or 1-416-620-9620 in Toronto.

In Europe and Asia call the nearest Hertz Reservation Center or travel agent.

Outside of these areas call 1-405-749-4434

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Use the SPIE Official Housing Vendor to book your room

To receive special hotel rates for this meeting, you must use the SPIE Official Housing Vendor. SPIE strongly recommends you DO NOT book housing from any company that contacts you via phone or email.

- The reservation system that SPIE uses for this event is available only via the Hotel page on the event website.
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- Our housing vendors DO NOT reach out to you with solicitations.
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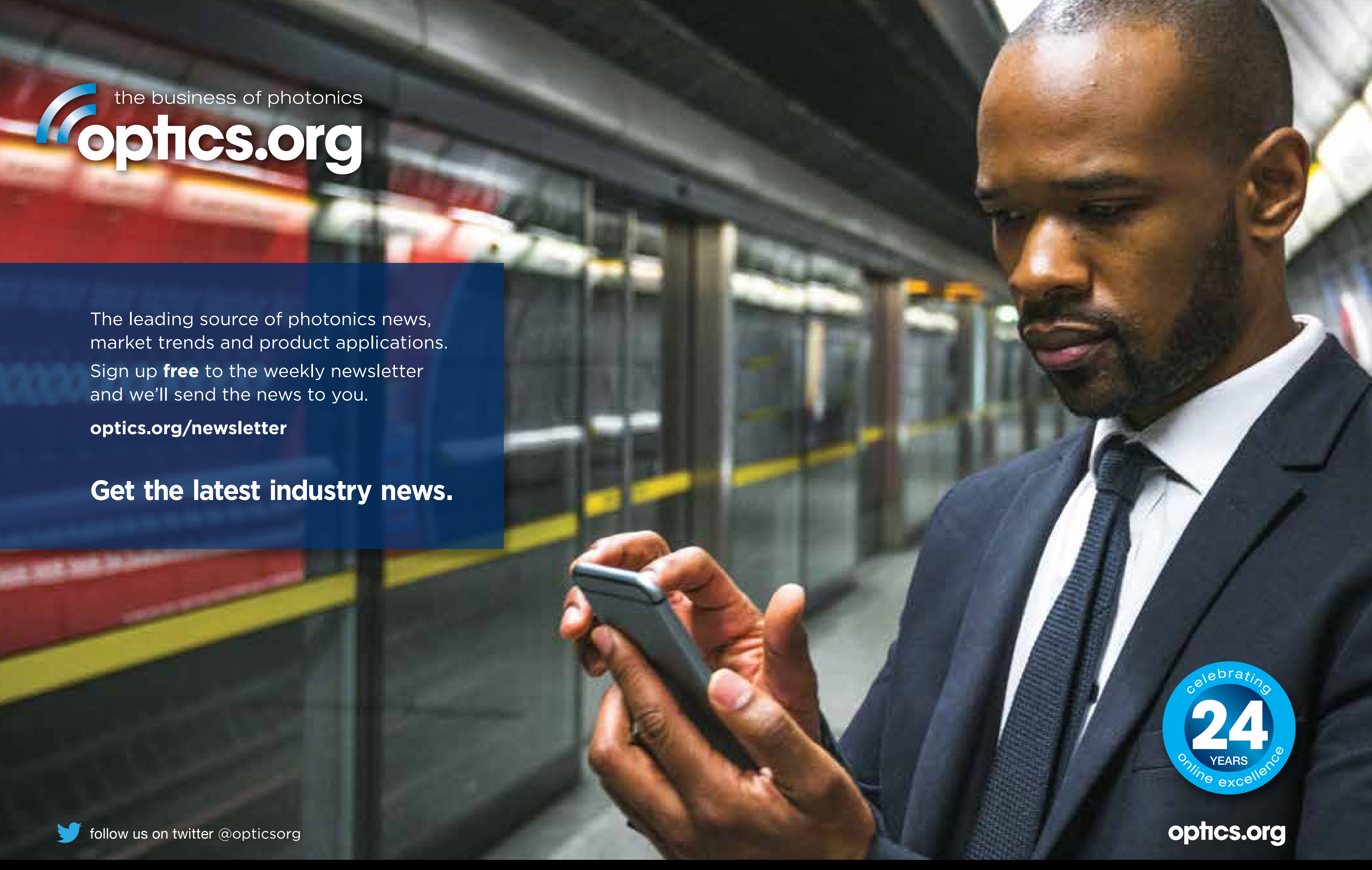

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Conference Events: All conference technical and networking events require a badge for admission. Registered attendees may bring children with them if they have been issued a badge. Registration badges for children under 18 are free and available at the SPIE registration desk onsite. Children under 14 years of age must be accompanied by an adult at all times, and guardians are asked to help maintain a professional, disturbance-free conference environment.

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To verify registered participants and provide a measure of security, SPIE will ask attendees to present a government-issued photo identification at registration to collect registration materials. Individuals are not allowed to pick up badges for other attendees. 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.

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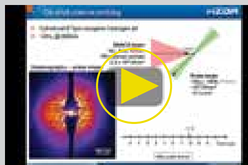

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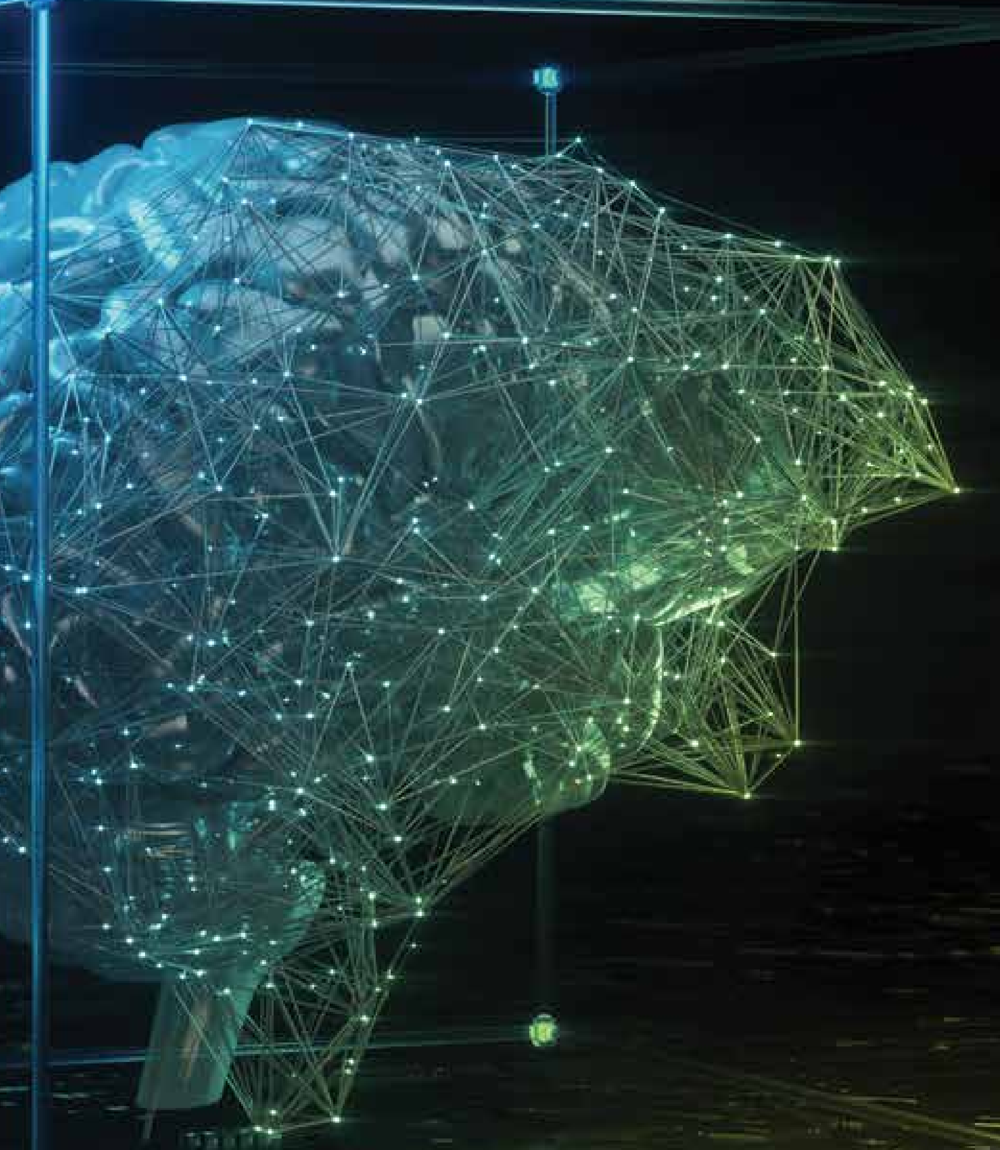

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