EIPBN
DENVER 2026

PROGRAM

THE 69TH INTERNATIONAL CONFERENCE ON

Electron, Ion and Photon Beam Technology and Nanofabrication

Hyatt Regency at the Convention Center

May 26 - 29, 2026

Focus: Precision Nanomanufacturing and Metrology

eipbn.org

Table of Contents

A Letter from the EIPBN 2026 Conference Chair

Dear EIPBN Community,

Welcome to the 69th International Conference on Electron, Ion, Photon Beam Technology and Nanofabrication (EIPBN or 3-Beams). I hope you have a memorable time in Denver at the Hyatt Regency Denver at Colorado Convention Center sharing your impactful scientific research and technological breakthroughs and building long-lasting professional connections and life-long friendships. Our banquet this year is at beautiful Coors Field, home of the Colorado Rockies with great food, music, tours of the ball field, and use of the jumbotron as we celebrate the accomplishments of our community members and share plans for the future. Our attendees come from 18 countries, including 102 first timers, and 52 students.

I first attended EIPBN in 2004 in San Diego tasked as a new Member of Technical Staff at Sandia National Laboratories to investigate all the latest devices coming out of EIPBN. I soon realized that EIPBN was the premiere gathering for expert scientists, physicists, and engineers across academia, industry, government, and National Laboratories to share their findings and meet lifelong colleagues and friends. EIPBN has been my favorite conference ever since. I am honored 22 years later to continue the excellence of EIPBN, providing a venue for deep, long-lasting connections between nanofabrication experts from around the world.
The layout of our parallel sessions adjacent to the exhibit hall, where access to the sessions is through the exhibit hall should prove to enhance quality interactions between our attendees and our gracious commercial sponsors. Thank you to our Diamond Sponsor KLA; Gold Sponsors AllResist and STS-Elionix; Silver Sponsors GenISys and Raith; and Bronze Sponsor Heidelberg Instruments; and all our exhibitors and sponsors: AJA International, Angstrom Engineering, Crestec, DisChem, JEOL, Montana Tech Nanotechnology Laboratory, Nabu Optical Systems, NuFlare, Pozzetta Products, SAES, University of Pennsylvania Singh Center for Nanotechnology, Vistec Electron Beam, Beamfox, Colorado School of Mines, University of Colorado Boulder COSINC, FabuBlox, Ionoptika, Jenoptik, Lab 14, Nanoscribe, scia Systems, and Tescan. I also want to thank our society sponsor AVS. Note that contributions to and/or sponsorship of any event does not constitute departmental or institutional endorsement of the specific program, speakers, or views presented.

Program Chair Rajesh Menon has developed a phenomenal program focused on “Precision Nanomanufacturing and Metrology.” We are honored with three superbly accomplished plenary speakers on Wednesday: Professor Henry Smith (Massachusetts Institute of Technology), Professor Martin Wegener (Karlsruhe Institute of Technology), and Nackieb Kamin (United States Space Force). Rajesh will lead our plenary speakers in an engaging panel immediately following the plenary presentations. Carla Perez-Martinez will lead our Thursday plenary focused on maximizing AI and human efforts towards precision nanomanufacturing and metrology with a panel of experts. I am very thankful to have Rajesh as our Program Chair and for the high-quality and engaging set of speakers he has arranged for EIPBN 2026.

EIPBN is run by a dedicated group of volunteer steering committee members working year-round to ensure a successful conference. I am grateful for the dedication by the 2026 Steering Committee: Aimee Price, Wei Wu, James Owen, Rick Silver, Gina Adam (Commercial Session), Ming Lu, Guy DeRose, and Carla Perez-Martinez (WIN and Short Course). Thanks to John Randall (Micrograph Contest and Financial Trustee) and Gerald Lopez (Mentor Lunch and Operations Trustee) for their institutional support and guidance. We could not run the conference without our organizational team: Jonni Adams (Conference Coordinator); Nichole Ballard and Yes Events (Registrar); Photographer Michael Huson; and Nicki Davis (Website and Whova App Manager). Thanks also to the program committee and other volunteers. Finally, I want to express my immense gratitude to our Advisory Committee for chairing EIPBN before us so that we can stand on their shoulders and continue their legacy today.

Thanks for being part of our 3-Beams Community and making lasting connections and memories in Denver at EIPBN 2026!

Jack L. Skinner, Conference Chair and CEO, EIPBN 2026
Dean, Lance College of Mines and Engineering, Montana Technological University

A Letter from the EIPBN 2026 Program Chair

Dear EIPBN Community,

It is my great pleasure to welcome you to EIPBN 2026 in Denver. For nearly seven decades, EIPBN has brought together the scientists and engineers who develop the tools, processes, and measurements that make the nanoscale useful. That mission has never felt more important or more exciting. The focus of this year's conference, Precision Nanomanufacturing and Metrology, captures a defining challenge for our field. We are no longer concerned only with making smaller features. We are learning to fabricate with atomic, molecular, and three-dimensional control; to measure complex structures with greater confidence; and to combine human expertise with automation, modeling, and AI to accelerate discovery and manufacturing.

That breadth is reflected throughout the program. Selected presentations highlight photonics-enabled quantum memory, superconducting through-silicon vias, STM-based and mechanosynthetic approaches to atomically precise fabrication, electron-enhanced ALD and ALE, additive manufacturing toward the atomic scale, large-area metasurfaces, automated SEM metrology, and AI-enabled FIB–SEM workflows. Together, these contributions show a field advancing simultaneously in resolution, placement accuracy, materials control, throughput, and measurement fidelity.

Our plenary program reinforces this vision, with perspectives spanning science and technology strategy, 3D laser nanoprinting, and lensless lithography. The conference-wide panel, "Maximizing AI and Human Efforts Towards Precision Nanomanufacturing and Metrology," will provide an important forum for discussing how computational tools can strengthen the creativity, judgment, and experimental rigor of our community.

EIPBN is also a community, and I am especially proud of the continued emphasis on students and early- career researchers. The Student Mentor Lunch, Best Student Paper Awards, poster sessions, and many informal discussions give the next generation opportunities not only to present excellent work, but also to find mentors, collaborators, and a professional home. The Women in Nanofabrication Luncheon, Micrograph Contest, inaugural FabuBlox Design Contest, Commercial Session, and banquet at Coors Field further add to the energy and openness that make EIPBN unique.

I would like to thank the Conference Chair, Steering Committee, Advisory Committee, session chairs, reviewers, invited speakers, panelists, sponsors, exhibitors, authors, students, and all attendees for making this program possible. Your contributions continue to make EIPBN the premier forum for beam technology and nanofabrication.

Welcome to EIPBN 2026. I look forward to an inspiring week of technical excellence, new ideas, and renewed connections.

Sincerely,
Rajesh Menon
EIPBN 2026 Program Chair

About EIPBN

Electron, Ion and Photon Beam Technology and Nanofabrication

The International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication (EIPBN), affectionately known as "3–beams," is the premier gathering of scientists and engineers who are dedicated to electron, ion and photon lithography, imaging, and analysis; atomically precise fabrication; nanofabrication process technologies; related emerging technologies; and their applications in a broad spectrum of fields. This is the 69th meeting of the EIPBN, where top researchers from academia, government laboratories, and industry from around the world meet to present and discuss recent trends and future directions in these technologies.

EIPBN
3-BEAMS CONFERENCE FOR NANOFABRICATION

EIPBN is incorporated as a nonprofit organization in the state of New Jersey. The ten-member Steering Committee serves as the corporate Board of Directors. Each year, two distinguished members from the EIPBN community are elected to serve a five-year term. New members participate in the organization of the conference for the first two years. In the third year, they run the meeting as either the Conference or Program Chair. In the final two years, they assist the successor chairs in their duties. Upon completion of their five year term, Steering Committee members become permanent members of the Advisory Committee.

The 2026 Steering Committee Members are Jack Skinner, Rajesh Menon, Gina Adam, Ming Lu, Guy DeRose, Carla Perez-Martinez, James Owen, Richard Silver, Aimee Bross Price, and Wei Wu.

EIPBN is sponsored by the American Vacuum Society.

The special events at this year's conference are highlighted below.

Short Courses

Tuesday, May 26, 8:30 am – 2:20 pm

This event features four lectures given serially by leading authorities in their field of expertise and is a perfect opportunity to further your knowledge of nanofabrication processes and applications.

Welcome Reception

Tuesday, May 26 , 7:00 pm – 9:00 pm

The Welcome Reception will feature small hot bites and drinks, and an opportunity to relax, mingle, get reacquainted with colleagues and make new friends. The reception is located in Centennial A-C.

Women in Nanofabrication Luncheon

Thursday, May 28, 12:10 pm - 1:40 pm

Women in Nanofabrication (WIN) is a networking event that brings together women in science and engineering from around the world. This luncheon enhances the fields of lithography and nanotechnology through diversity and inclusion.

Panel Discussion:

Maximizing AI and human efforts towards precision nanomanufacturing and metrology

Thursday, May 28, 4:00 pm – 5:15 pm

Panelists for this year's discussion include: Ralph Nyffenegger, Scott Lewis, Martin Wegener, Rober Wolkow, and J. Alexander Liddle. Moderated by Carla Perez Martinez.

EIPBN Banquet

Thursday, May 28, 7:00 pm – 10:00 pm

Join us for the 2026 Conference Banquet at Coors Field in Denver, home of the Colorado Rockies baseball team. Enjoy a memorable evening of dining, networking, and celebration in one of Denver's most iconic landmarks! Prizes, and the 2027 venue will be announced at the Banquet.

Student Mentor Lunch

Friday, May 29, 12:10 pm – 1:20 pm

The Student Mentor Lunch gives students a chance to hear from professionals in academia, government labs and industries. They can learn beneficial information that will help guide them as they grow in their fields. It's a chance to hear from the experts why they chose their field, what it takes to get there, and what it's really like once they arrived. The Student Mentor Lunch also features a speaker who provides an expert "how to" discussion on a new topic each year. RSVP required to ensure enough meals.

EIPBN Best Student Paper Awards

This annual competition highlights outstanding student contributions and posters the next generation of leaders in the EIPBN community. The competition includes two categories: The Best Student Poster Award and The Best Student Presentation Award.

Micrograph Contest

EIPBN holds an annual micrograph contest to highlight the importance of micrographs. Micrographs need not be related to research or to any paper or topic presented at the conference. Submissions may be purely for their beauty and ability to excite curiosity. Sponsored by Zyvex Labs.

FabuBlox Design Contest

Share your FabuBlox process in this year's inaugural FabuBlox Design Contest. FabuBlox is a state-of-the-art design & data management tool for micro & nano fabrication processes. Sponsored by FabuBlox.

Conference App

Join us on our official event app!

We're using Whova as our official event app. Join our event app to access:

- Event announcements
- Personalized agenda, session details
- Speaker & attendee profiles
- Networking, meet-ups, messages
- Event documents
- Faster check-in

How to join:

1. Scan the QR code and download Whova from the App Store or Google Play.
2. Sign in or create an account with the email you registered with.

Having trouble joining? Search for our event and enter the invitation code: 6jl9d2fq17

Program at a Glance

Tuesday, May 26

Time	Session	Location
7:00 am–6:00 pm	Registration	EIPBN Registration Desk
8:00 am–12:00 pm	Exhibit Setup	Exhibit Hall
8:30 am–2:20 pm	Short Course Sessions	Capital 4
9:00 am–3:00 pm	GeniSys User Meeting – Register with GenISys	Capital 1–3
10:15–10:50 am	Coffee Break - Sponsored by AJA International Inc. and SAES	North Corridor
12:00–4:00 pm	Exhibitors Booth Setup	Exhibit Hall
4:00–7:00 pm	Commercial Exhibit	Exhibit Hall
4:00–6:00 pm	Exhibitor Reception	Exhibit Hall
7:00–9:00 pm	Welcome Reception - Sponsored by KLA & STS - Elionix	Centennial A-C

Wednesday, May 27

Time	Session	Location
6:45–7:30 am	Session Chair Breakfast	Mineral A
7:00 am–5:00 pm	Registration	Centennial Foyer
7:30–8:00 am	Coffee And Tea - Sponsored by Nabu Optical Systems	Exhibit Hall
8:00–11:30 am	Plenary	Centennial A-C
10:10–10:30 am	Coffee Break - Sponsored by RAITH America, Inc.	Exhibit Hall
10:00 am–7:00 pm	Commercial Exhibit	Exhibit Hall
11:00 am–12:00 pm	Plenary Panel	Centennial A-C
12:00 pm–1:30 pm	Poster Session	Exhibit Hall
12:30–1:30 pm	JEOL Lunch (invitation only)	Mineral BC
1:30–3:10 pm	Session 1A – Nanofabrication for Quantum 1	Centennial A
	Session 1B – Metamaterials, Flat Optics & Nanophotonics 1	Centennial B
	Session 1C – Additive Nanomanufacturing 1	Centennial C
3:20–3:50 pm	Coffee Break - Sponsored by GenISys, Inc	Exhibit Hall
3:50–5:40 pm	Session 2A – Nanofabrication for Quantum 2	Centennial A
	Session 2B – Metamaterials, Flat Optics & Nanophotonics 2	Centennial B
	Session 2C – Industrial Highlights	Centennial C
5:45–7:00 pm	Poster Session Reception - Sponsored by Allresist GmbH & KLA	Exhibit Hall
6:00–10:00 pm	JEOL Dinner (by invitation only)	Mineral BC
7:00–10:00 pm	Raith Reception (by invitation only)	Mineral A
7:00–10:00 pm	STS-Elionix Reception (by invitation only)	Capital 1

Thursday, May 28

Time	Session	Location
6:30–7:45 am	Steering Committee Meeting Breakfast	Mineral A
7:00 am–5:00 pm	Registration	Registration Desk
7:30–8:00 am	Coffee And Tea - Sponsored by Allresist GmbH	Exhibit Hall
8:00–9:50 am	Session 3A – Nanofabrication for Quantum 3	Centennial A
	Session 3B – Metamaterials, Flat Optics & Nanophotonics 3	Centennial B
	Session 3C – 3D Nano & Micro Fabrication	Centennial C
9:50–10:20 am	Coffee Break - Sponsored by Nuflare Technologiy, Inc. and Vistec Electron Beam GmbH	Exhibit Hall
10:00 am–1:00 pm	Commercial Exhibit	Exhibit Hall
10:00 am–1:00 pm	Posters Available for Viewing	Exhibit Hall
10:20 am–12:10 pm	Session 4A – Microscopy & Metrology 1	Centennial A
	Session 4B – AI & Nanofabrication	Centennial B
	Session 4C – Advances in Nanofabrication	Centennial C
12:10–1:30 pm	Women in Nanofabrication (WIN) Luncheon (sign up required) Sponsored by Heidelberg Instruments, Inc. and RAITH America, Inc.	Mineral BC
1:00–4:00 pm	Clear out Exhibit hall and Posters	Exhibit Hall
1:30–3:20 pm	Session 5A – Atomic Fabrication	Centennial A
	Session 5B – Nanofabrication for Biology, Nanomedicine & Implantable Devices 1	Centennial B
	Session 5C – Additive & 3D Nanomanufacturing 2	Centennial C
3:20–3:50 pm	Coffee Break - Sponsored by GenISys, Inc	Exhibit Hall
4:00–5:15 pm	Panel Discussion: Maximizing AI and human efforts towards precision nanomanufacturing and metrology	Centennial A-C
5:00–5:30 pm	Thank You Toast for Exhibitors - by invitation	Agate A-C
7:00–10:00 pm	Banquet - Bar Sponsored by RAITH America, Inc.	Coors Field

Friday, May 29

Time	Session	Location
7:00 am–12:00 pm	Registration	Registration Desk
7:00–8:00 am	Coffee And Tea	Exhibit Hall
8:00–9:50 am	Session 6A – Atomically Precise Fabrication / STM	Centennial A
	Session 6B – Nanofabrication for Biology, Nanomedicine & Implantable Devices 2	Centennial B
	Session 6C – Directed Self-Assembly	Centennial C
9:50–10:20 am	Coffee Break - Sponsored by GenISys, Inc	Exhibit Hall
10:20 am–12:10 pm	Session 7A – Applications of Nanofabrication	Centennial A
	Session 7B – Electron/Ion Sources & Optics 1	Centennial B
	Session 7C – EUV 1	Centennial C
12:10–1:20 pm	Student Mentor Lunch (RSVP required) - Sponsored by Allresist GmbH	Agate A-C
1:20–3:10 pm	Session 8A – Nanophotonics, Micro-optics, Plasmonics.	Centennial A
	Session 8B – Electron/Ion Sources & Optics 2	Centennial B
	Session 8C – EUV 2	Centennial C
3:10–3:40 pm	Ice Cream Break - Sponsored by GenISys, Inc	Centennial Foyer
3:40–5:30 pm	Session 9A – Nanoimprint Lithography	Centennial A
	Session 9B – Electron Beam Lithography	Centennial B
	Session 9C – EUV 3	Centennial C
6:00–10:00 pm	JEOL Dinner (by invitation only)	Mineral BC

Generous Support for this Conference is Provided By

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Commercial Session

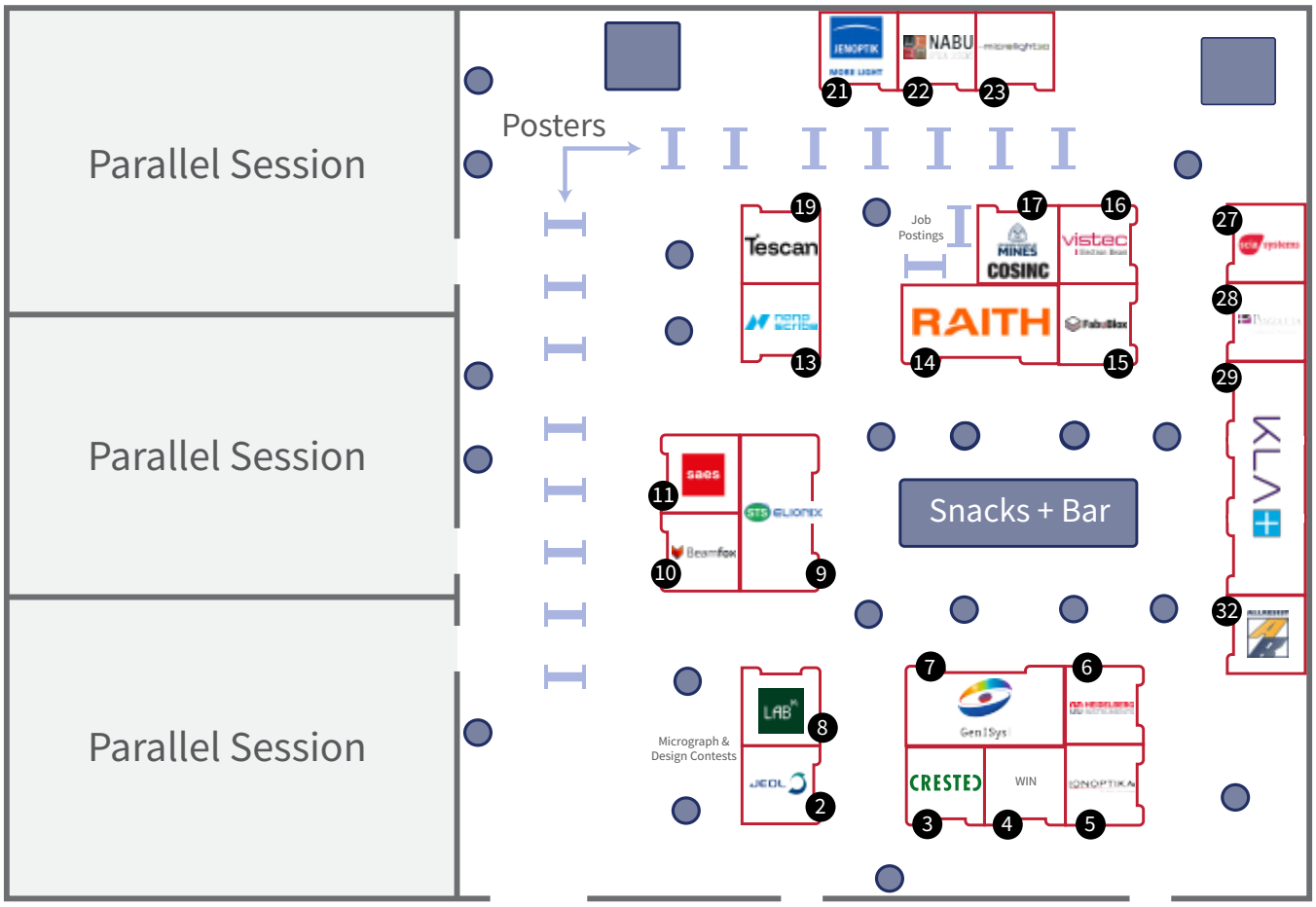
Tuesday, May 26–29

The Commercial Session features material and equipment vendors which are relevant to the to our community. This year's session will be held in the Exhibit Hall and features 26 exhibitor booths. In the centre of the room, we have created a social area with snacks and a bar There are some high tables to gather round. There are also booths for WIN and the job postings.

The Commercial Session provides opportunity to meet with vendors who are eager to discuss their latest lithography systems, materials, characterization instruments and related products. Make sure to check out Industrial Highlights Session 2C on Wednesday, May 27, at 3:50 pm for in-depth discussions about the research being done by our exhibitors. Don't miss the chance to engage the speakers during the Commercial Session to ask questions or continue the discussion.

Commercial Session Dates & Times:

- Tuesday, May 26
  4:00 pm – 7 pm
- Wednesday, May 27
  10:00 am – 7 pm
- Thursday, May 28
  10:00 am – 1 pm



Short Courses

Tuesday, May 26, 8:30 am–2:20 pm

The Short Courses event features five lectures given serially by leading authorities in their field of expertise and is a perfect opportunity to further your knowledge of nanofabrication processes and applications.

Scott Lewis

From Electrons to Photons: Decoding the Secrets of Tomorrow's Photoresist Design

Scott Lewis is a Research Professor at Caltech with expertise in the development of metal-organic resist materials for electron/ion beam and extreme ultraviolet (EUV) lithography. He is the creator of Excalibur, a 3D Monte Carlo simulation suite.

Qiangfei Xia

Emerging Memory-Centric AI Hardware: Materials, Integration, and System on a Chip

Qiangfei Xia is the Dev and Linda Gupta Professor of Electrical and Computer Engineering at UMass Amherst and head of the Nanodevices and Integrated Systems Lab. He spent three years at Hewlett-Packard Laboratories, where he demonstrated the first memristor/CMOS hybrid chip.

J. Alexander Liddle

Inkjet Nanoimprint Lithography: Technology and Applications

J. Alexander Liddle is Vice President of Research and Development at Canon Nanotechnologies. Before joining Canon Nanotechnologies, he spent two decades at NIST, most recently as chief of the Microsystems and Nanotechnology Division. His research has focused on lithography and directed self-assembly for the creation and manufacture of advanced devices.

Robert Wolkow

Making and Characterizing Error-Free Atom-Defined Silicon Devices

Robert Wolkow is a Physics Professor and iCORE Chair at the University of Alberta, Fellow of the Royal Society of Canada, Fellow of the American Physical Society and CTO of Quantum Silicon Inc. He received his BSc from Waterloo, his PhD from Toronto and did postdoctoral work at the IBM TJ Watson Research Centre before becoming a staff scientist at Bell Laboratories.

Ralph Nyffenegger

Hybrid Inspection and Electron-Beam Massive Metrology for Advanced Semiconductor Manufacturing Technology and Nanofabrication

Ralph Nyffenegger is Vice President of Engineering for the electron beam product line at KLA Corporation, where he leads the development of e-beam review and inspection systems. Prior to KLA, he worked in the development of scanning probe microscopes.

Plenary

Wednesday, May 27, 8:00 am – 12:00 pm

The Plenary Session begins on Wednesday, May 27, at 8:00 am with opening remarks by the Conference and Program Chairs. This is followed by three Plenary Talks by leading visionaries and a Plenary Panel Discussion.

Nanomaterial Manufacturing and the Futures We Choose

Nick Kamin

Nackieb ("Nick") Kamin serves as the Technical Director at the Headquarters Space Force Science, Technology and Research Directorate in Washington, DC. In this role, he develops long-term military requirements for the Space Force and interacts with other principals, operational commanders, combatant commands, acquisition, and international communities to address cross-organizational science and technical issues and solutions. He represents U.S. Space Force science and technology on decisions, high-level planning, and policy, building coalitions and alliances throughout the U.S. government, industry, academia, the international community, and other scientific and technology organizations. He also advises Space Force's Chief Science Officer in space research and development strategies.

3D Laser Nanoprinting: From Fast to the Speed-of-light Limit

Martin Wegener

Martin Wegener is spokesperson of the Cluster of Excellence 3D Matter Made to Order. His research interests comprise ultrafast optics, (extreme) nonlinear optics, optical laser lithography, photonic crystals, optical, mechanical, electronic, and thermodynamic metamaterials, as well as transformation physics. He spent two years as a postdoc at AT&T Bell Laboratories in Holmdel (U.S.A.). From 1990-1995 he was professor (C3) at Universität Dortmund (Germany), since 1995 he is professor (C4, later W3) at Institute of Applied Physics of Karlsruhe Institute of Technology (KIT). Since 2001 he has a joint appointment as department head at Institute of Nanotechnology (INT) of KIT, from 2016-2022 he was one of three directors at INT. From 2001-2014 he was the coordinator of the DFG-Center for Functional Nanostructures (CFN) at KIT.

Lensless Lithography

Henry I. Smith

Henry I. Smith is Emeritus Professor of Electrical Engineering at MIT. He, his students and co-workers have contributed a number of innovations to nanoscale science and engineering, including: x-ray lithography, the phase-shift mask, the attenuating phase-shift mask, achromatic-interference lithography, zone-plate-array lithography, interferometric mask alignment and graphoepitaxy. Prof. Smith is a member of the National Academy of Engineering and a Fellow of the American Academy of Arts and Sciences, the IEEE, Optica, and the National Academy of Inventors. He is a recipient of a number of awards including: the IEEE Robert N. Noyce Medal and the Cledo Brunetti Award, the SPIE Frits Zernike Award and the Baccus Award.

Panel Discussion

Thursday, May 28, 4:00 pm – 5:15 pm

Maximizing AI and Human Efforts Towards Precision Nanomanufacturing and Metrology

Nanomanufacturing and metrology demand ever higher tolerances, greater complexity, and faster innovation cycles. Artificial intelligence is emerging as a powerful tool for process optimisation and data analysis. This panel will explore how AI can most effectively augment nanomanufacturing and metrology, where AI-driven methods can deliver the most impact, and where human judgement and effort remain essential -- or even superior.

Moderated by:

Carla Perez Martinez
Associate Professor and UKRI Future Leaders Fellow,
London Centre for Nanotechnology at University College London

Panelists:

Scott Lewis

J. Alexander Liddle

Ralph Nyffenegger

Martin Wegener

Robert Wolkow

Women in Nanofabrication (WIN)

WIN is a networking event that brings together women (and non-binary) professionals in science and industry from around the world to exchange ideas through diversity and inclusion to advance the fields of lithography and nanotechnology.

This luncheon enhances the fields of lithography and nanotechnology through diversity and inclusion. There is no charge to participate in this event, but RSVPing strongly encouraged.

Martha Sanchez

This year, WIN is honoring **Martha Sanchez** for her long-term contributions to EIPBN from technical advancement to conference leadership and mentorship.

For more information about the WIN community, please join the EIPBN Women in Nanofabrication Group.

The WIN Luncheon is generously sponsored by:

HEIDELBERG INSTRUMENTS

RAITH

WIN Monthly Meetings

The WIN meetings were launched virtually through EIPBN Gather Town during EIPBN 2021 and are ongoing. Currently, we are hosting monthly ZOOM meetings on the first Friday of each month at 3:10 PM London time. They are open for all women and non-binary scientists interested in nanofabrication. Look below for a complete list of meeting dates and speakers.

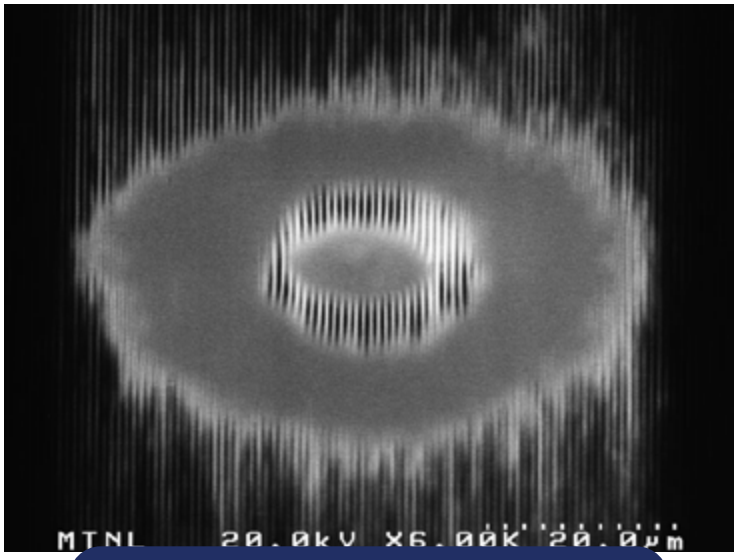
Please contact Carla Perez Martinez at carla.perezmartinez@ucl.ac.uk if you want the link to attend or if you are interested in presenting a technical talk about your research.

The WIN Lecture Series is generously sponsored by **Heidelberg Instruments**.

Micrograph Contest

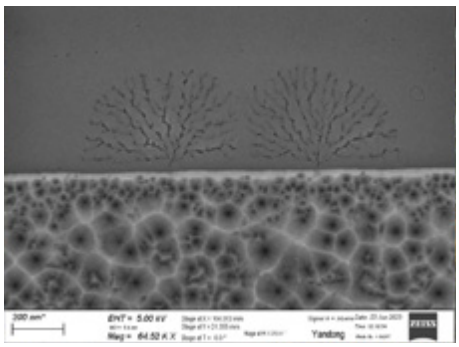
The fields of research covered by this conference are at the forefront of the drive to develop technology to make smaller and smaller structures. We have ventured into size regimes where we are often dependent on microscopes and the skill of microscopists to see the results of our work (and often what went wrong).

To highlight the importance of micrographs, EIPBN holds an annual micrograph contest. Submissions are sought from our community. Micrographs need not be related to research or to any paper or topic presented at the conference.



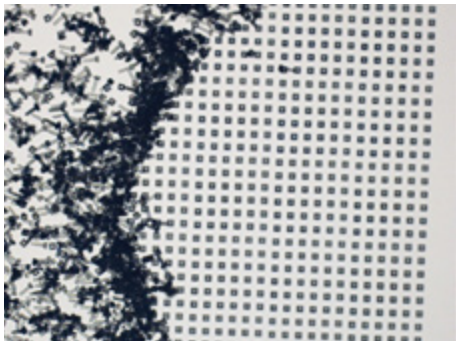
2025 Grand Prize, Luke Suttey and Sam Triepke, Montana Tech Nanotechnology Lab

Submissions may be purely for their beauty and ability to excite curiosity. Awards will be announced at the Thursday Night Banquet.



There is still time to take your shot at joining the elite company of the winners who have gained Micro-Fame and Nano-Fortune.

Entries must be of a single image taken with a microscope and shouldn't be significantly altered.



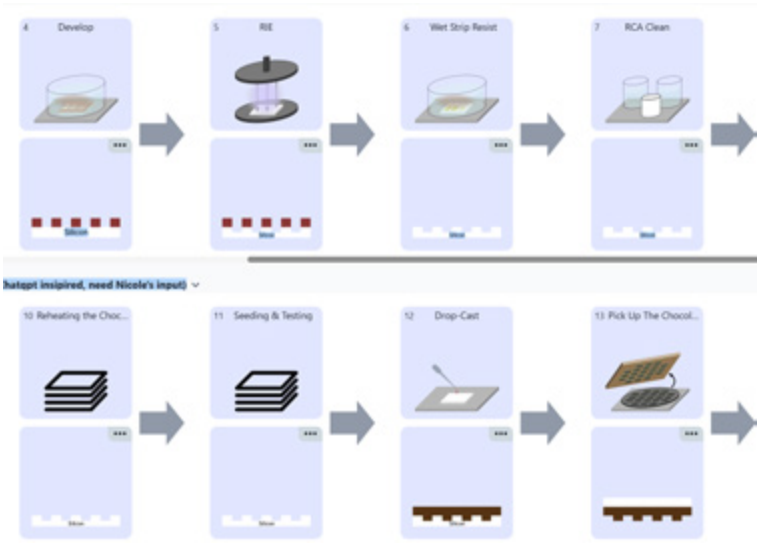
There are micro-cash prizes for the winners of each category. For additional information, contest entry forms, contest rules, and past winners, go to eipbn.org.

The Micrograph Contest is sponsored by:

zyvex™ LABS

FabuBlox Process Design Contest

Introducing the inaugural FabuBlox Process Design Contest. FabuBlox is a state-of-the-art design & data management tool for micro & nano fabrication processes. If your abstract is accepted and you have a FabuBlox process, join our group to share it with this year's attendees. Enter the contest by filling out the form and become eligible to win up to a $250 cash prize announced at the banquet with the micrograph contest!



Your process will be judged on the following criteria:

- Impact of fabricated devices
- Difficulty (pushing resolution limits, fabrication techniques used, etc)
- Complexity of process flow/fabricated devices
- Completeness of documentation including
- metrology images and data
- Creativity in problem solving (e.g. use of novel techniques, workarounds for traditional limitations

Contest Steps

1. Have or create a FabuBlox account (create FabuBlox account).
2. Create a process or enable sharing to an existing process.
3. Complete the form at eipbn.org to be considered for the contest.

Deadline: 6:00 pm Mountain Time on Wednesday, May 27, 2026

EIPBN Best Student Paper Award

The EIPBN Best Student Paper Award is an annual competition that highlights outstanding student contributions and fosters the next generation of leaders in the EIPBN community. The competition includes two categories:

The **Best Student Poster Award** will be given to the best poster presentation based on technical content, visual organization, and Q&A.

The **Best Student Presentation Award** will be given to the best oral presentation based on technical content, clarity, and Q&A.

All student presenters are automatically entered into the competition. A team of judges, selected by the Steering Committee, will evaluate the presentations and posters of the finalists during the conference. The **Best Student Poster Award winner** will be announced during the banquet, and the **Best Student Presentation Award winner** a week after the conference. The winning paper in each category will each receive a $500 prize and an award plaque.

This year, the Best Student Paper Award is generously sponsored by **STS - Elionix**.

Hotel & Banquet

Hyatt Regency Denver at Colorado Convention Center

650 15th Street, Denver, CO 80202
Tel: (303) 436-1234, Website: hyatt.com

Standing 36 stories high, sleek and contemporary in design, the Hyatt Regency Denver is adjacent to the Colorado Convention Center and just one block from the 16th Street Mall.

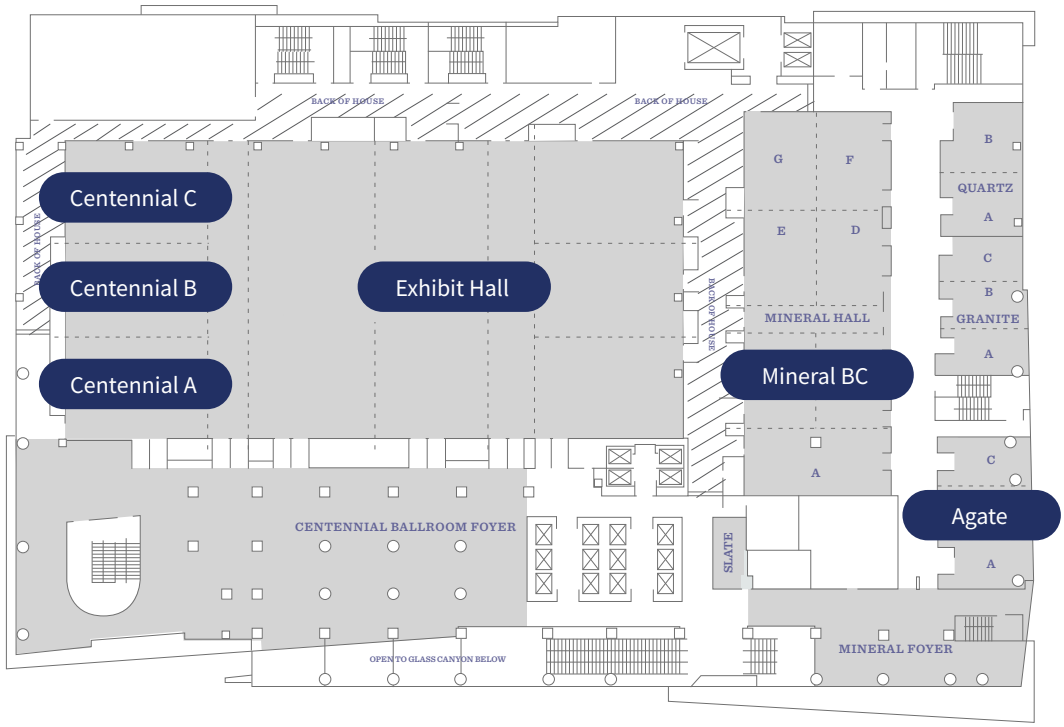
The guest rooms were designed with a décor that captures the essence of being where the mountains meet the plains. A 6,700 square foot fitness center, with windows overlooking the 14th Street Theater District, includes Peloton bikes, an indoor lap-pool, and outdoor sun deck and whirlpool. In addition to Former Saint Craft Kitchen and Taps with a daily breakfast buffet, lunch, and dinner, Hyatt Regency Denver houses the 27th floor Peaks Lounge which captures sweeping views of the Rocky Mountains.

Banquet at Coors Field

Join us for the 2026 Conference Banquet on May 28 at Coors Field in Denver, home of the Colorado Rockies baseball team. Enjoy a memorable evening of dining, networking, and celebration in one of Denver's most iconic landmarks!

Hotel Floorplan

Third Floor



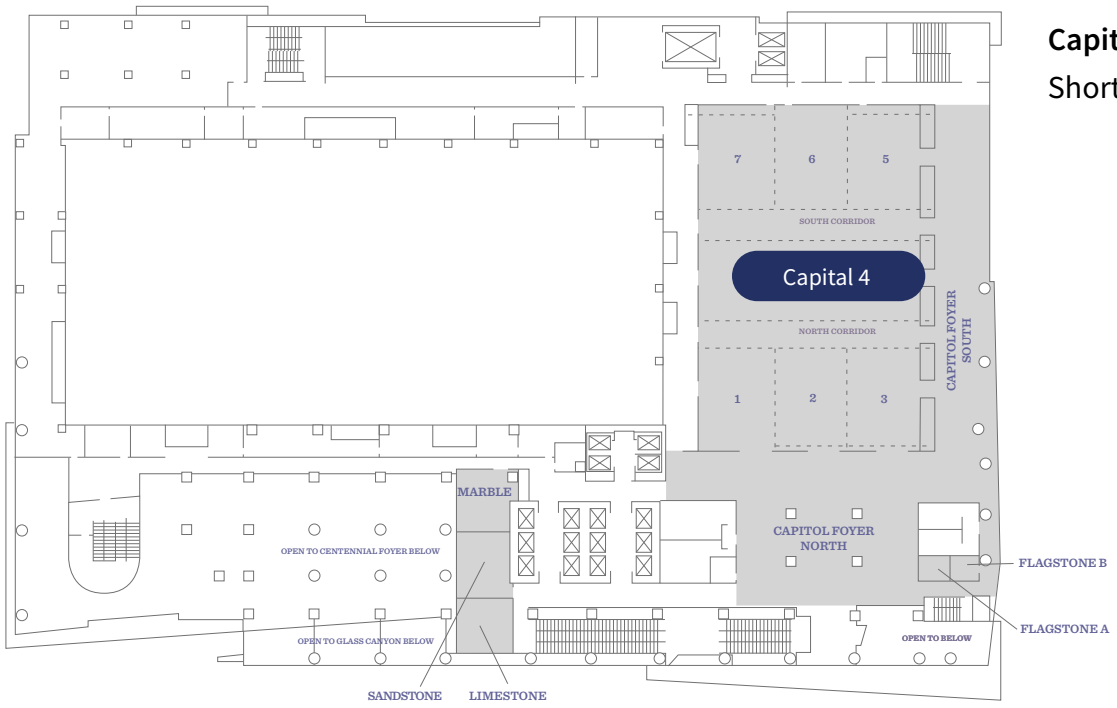
Centennial A–C
Welcome Reception
Plenary
Parallel Session
Panel Discussion

Exhibit Hall
Posters
Commercial Session

Mineral BC
Women in Nanofabrication

Agate A–C
Mentor Lunch

Fourth Floor



Capital 4
Short Courses

JVST B
Journal of Vacuum Science & Technology B

AVS

Congratulations to the winners of the 2025 JVST B Best Journal Paper Award!

"Photoresist characterization using a tabletop extreme ultraviolet source at 30 nm wavelength"

by Ethan Flores, Saurav Mohanty, Richard Mitchell, Andrew Tunell, Mehmet Kepenekci, and Chih-Hao Chang

Read the winning paper FREE for 2 years!

JVST B
Journal of Vacuum Science & Technology B

AVS

Special Topic Collection - Call for Papers

Papers from the 69th International Conference on Electron, Ion and Photon Beam Technology and Nanofabrication

Submit Here!

Submit by **November 15, 2026!**

URL: https://imnc.jp/2026/

Sponsored by The Japan Society of Applied Physics

MNC 2026

Hotel New Otani Hakata, Fukuoka, Japan

November 10-13, 2026

ABSTRACT DEADLINE

July 1st

SECTION

1-1: Advanced Lithography and Patterning
1-2: Electron and Ion Beam Technologies
1-3: Patterning Materials
2-1: Nanocarbons & 2D Materials
2-2: Nanodevices
2-3: Nanofabrication
2-4: Inorganic Nanomaterials
2-5: Organic Nanomaterials
2-6: Nano Surfaces, Interfaces, and Advanced Nano Metrology
3: Nanoimprint, Hybrid-NIL, Biomimetics, and Functional Surfaces
4: BioMEMS, Lab on a Chip, and Nanobiotechnology
5: Microsystem Technology and MEMS
6: Atomic Layer Processing (ALP)

PLENARY SPEAKERS

Dr. Seigo Tarucha, RIKEN, Japan
Prof. Chihaya Adachi, Kyushu Univ., Japan
Dr. Geert Vandenberghe, imec, Belgium
Prof. Wilfred van der Wiel, Univ. of Twente, The Netherlands

SYMPOSIUM

Symp. A:
AI × High-NA EUV × Novel Materials × Sustainability
Symp. B:
Process and Device Technologies for Quantum Computing IV
Symp. C:
Artificial Intelligence and Machine Learning in Biomedical Research and Applications

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MNE 2026

52nd MICRO + NANO Engineering Conference

INTERLAKEN, SWITZERLAND SEPTEMBER 21-24, 2026

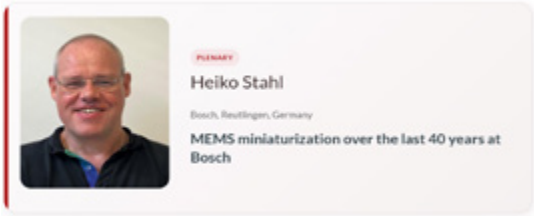
MNE is a major annual international conference, devoted to **micro** and **nano engineering**, held in a European country every September.

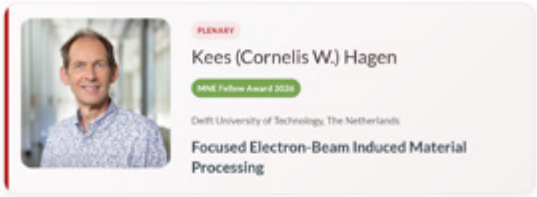
The conference brings together engineers and scientists from across the world to discuss recent progress and future trends in the fabrication, manufacturing, operation and application of micro and nano-structures and devices.

Applications in electronics, magnetics, photonics, electromechanics, environment and life sciences.

- **Parallel sessions - oral and posters**
- **Expecting 350+ abstract submissions**
- **Invited Keynotes + Plenary speakers**
- **Tutorials / short courses on Sept. 20**
- **Commercial Exhibition (almost full!)**
- **700+ participants**

PLENARY SPEAKERS

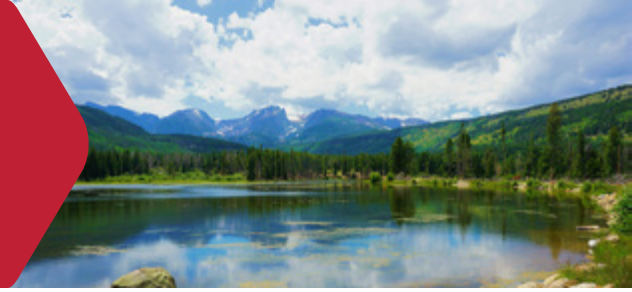




https://mne2026.imnes.org/scientific-tracks/

Oral Presentations

Wednesday, May 27



1A: Nanofabrication for Quantum 1

Centennial A, 1:30 pm – 3:10 pm

Session Chairs: Mathieu Durand, John N. Randall

Invited: Quantum Spin Defects for Sensing: Magnetic Imaging and Ion-Processed Nanoscale Platforms

Luca Basso, Center for Integrated Nanotechnologies, Sandia National Laboratories

This talk presents quantum sensing using NV centers in diamond and VB- centers in hBN. I will detail wide-field magnetic imaging from DC to GHz frequencies and discuss engineering nanoscale diamond membranes and 2D materials via targeted ion implantation to enable quantum platforms.

First-Principles Study of Graphene/Blue Phosphorus/Graphitic-ZnO van der Waals Heterostructures: Optoelectronic Enhancement and Mn Doping Effects

Hao Zhang, Institute for Integrated Micro and Nano Systems, School of Engineering, University of Edinburgh, Scottish Microelectronics Centre, Edinburgh

Two-dimensional van der Waals heterostructures, including G/Blue-P/g-ZnO and Mn-doped variants, exhibit tunable electronic and optical properties. DFT results show improved interface stability and solar cell efficiency up to 26.6%. Mn doping modifies band structure, reducing efficiency to 7.6%, offering insights for designing advanced optoelectronic materials.

Metasurface Gratings as Flat Optics for Magneto-Optical Trap Beam Delivery

Wenqi Zhu, Zi Wang, and Amit Agrawal, National Institute of Standards and Technology

We explore metasurface gratings as flat optics to prepare and deliver optical beams required for MOT configurations. We present a number of designed metasurface optics that work as beam deflectors, retroreflectors, polarizations optics, multi-functional grating couplers, eliminating the need for bulk optics for MOT.

Nanometric Tips for 2D Materials Quantum Dots

Adi TIHIC (1, 2), Dipti UMED SINGH (1, 2), François FILLION-GOURDEAU (3, 4), Pierre LEVESQUE (3), Steve MacLEAN (3), Paul G. CHARETTE (1, 2), Dominique DROUIN (1, 2), and Serge ECOFFEY (1, 2), (1) Institut Interdisciplinaire d'Innovation Technologique, Université de Sherbrooke, (2) Laboratoire Nanotechnologies Nanosystèmes, Université de Sherbrooke, (3) Infinite Potential Laboratories, (4) INRS-Énergie, Matériaux et Télécommunications

We present a fabrication process for nanometric silicon tips designed to induce quantum dots (QD) in 2D materials. Using E-beam lithography, plasma etching, and oxidation sharpening, we achieved sub 10 nm tips apex embedded in planarized SiN. These architectures, now topped with transferred 2D layers, are ready for QD characterization.

1B: Metamaterials, Flat Optics & Nanophotonics 1

Centennial B, 1:30 pm – 3:10 pm

Session Chairs: Noah Rubin, Volker Deckert

Invited: Monolithically integrated terahertz optoelectronics

Mona Jarrahi, UCLA

We present a Monolithically Integrated Terahertz Optoelectronics platform, which leverages QW structures to integrate all terahertz photonic system components onto a single chip. Utilizing photomixing in QW PIN photodiodes, we demonstrate frequency-tunable terahertz generation and detection with significantly improved power efficiency and sensitivity compared to previous devices.

Holographic Metasurface Nanolithography for Volumetric Vat Photopolymerization

T. Yap, K. Singh, X. Chen, C. O'Dea, K. Bae, N. K Crawford, G. Stafford, Z. Page, and M. Cullinan, The University of Texas at Austin

This work adapts metasurface holography and its inverse design for vat photopolymerization, taking into account the light dosage / exposure to cure ratio.

Versatile Flat Optics enabled by Grayscale Lithography: Applications from Astrophotography to Microscopy

Apratim Majumder (1), Tina M. Hayward (1), John A. Doughty (1), Alexander Ingold (1), Henry I. Smith (2), Nicole Brimhall (3), and Rajesh Menon (1, 3) (1) Department of Electrical and Computer Engineering, University of Utah, (2) Department of Electrical Engineering & Computer Science, Massachusetts Institute of Technology, (3) Oblate Optics, Inc.

We will report on our recent demonstrations of flat optics, enabled by grayscale lithography, across a wide field of applications, such as astrophotography, microscopy, document security, and extended focusing for metrology and laser-machining. We will discuss the design and fabrication processes and present device characterization and application results.

Invited: 3D Printing at the Interface of Cells and Soft Photonics

Uroš Jagodič (1), Maruša Mur (1), Aljaž Kavčič (1, 2), Rok Podlipec (1), Jaka Pišljar (1, 2), Miha Škarabot (1, 2), Igor Muševič (1, 2), and Matjaž Humar (1, 2, 3), (1) Department of Condensed Matter Physics, J. Stefan Institute, (2) Faculty of Mathematics and Physics, University of Ljubljana, (3) CENN Nanocenter

Two-photon polymerization enables high-resolution 3D printing inside living cells and in soft photonic materials. Intracellular fabrication yields complex, cytocompatible microstructures, while direct laser writing produces reconfigurable soft photonic architectures with controlled optical anisotropy, light propagation, and emission, bridging cellular environments and functional microphotonics.

1C: Additive Nanomanufacturing 1

Centennial B, 1:30 pm – 3:10 pm

Session Chairs: Sourabh K. Saha, Zak Page

Invited: Two-Photon Grayscale Lithography for Advanced Research and Industrial Manufacturing

Martin Hermatschweiler, Nanoscribe GmbH & Co. KG

Direct Atomic Layer Processing for Spatially Selective Multi-Material Nanofabrication

Mira Baraket, Maksym Plakhotnyu, ATLANT 3D Nanosystems

ATLANT 3D presents Direct Atomic Layer Processing (DALP®), a digitally controlled nanofabrication technology enabling spatially selective, multi-material deposition with atomic-scale precision. DALP supports rapid prototyping of complex heterostructures and interfaces, and, when combined with data-driven experimentation, accelerates nanoscale materials discovery and device development.

Micrometer-resolution color printing via room-temperature, photochemical deposition of metallic structures

Abdulla Al Mamun (1, 2), Jiawei Zuo (1), Muhammad Fasih (1, 2), Dongyao Wang (3), Yu Yao (1), and Chao Wang (1, 2), (1) School of Electrical, Computer and Energy Engineering, Arizona State University, (2) Biodesign Center for Molecular Design and Biomimetics, Arizona State University, (3) Material Science and Engineering, Arizona State University

This works demonstrates relay-optics-enhanced DLP (DLP-relay) based low-cost, room-temperature polymer-assisted photochemical deposition (PPD) of metal printing with feature size down to 1.3 µm and its use in color display which have a potential application in imaging, photonic devices, metasurfaces, sensors, and advanced colorimetric technologies.

Invited: Volumetric Photopatterning of Thick Photoresist

Robert McLeod, University of Colorado Boulder

We introduce a scanning one photon direct write tool that exposes the entire thickness of a thick photoresist to create complex 3D structure using a continuously changing conical light field controlled by a DMD.

2A: Nanofabrication for Quantum 2

Centennial A, 3:50 pm – 5:40 pm

Session Chairs: Luca Basso, Robert Wolkow

DRIE Defects and Mitigation with Plasma Smoothing for Superconducting Through-Silicon Vias

C. Wehner, Emilio Nanni, SLAC National Accelerator Laboratory

Smooth sidewalls are critical for fabrication of superconducting TSVs. We identify DRIE defects, including underreported ‘blowout’ that emerges with low active etch area. We also present a smoothing etch chemistry comparison showing CF_4/O_2 provides the greatest improvement in surface morphology and a wide process window, ideal for superconducting TSV fabrication.

Towards photonics-enabled quantum memory: integrating high-reflectivity mirrors and Ta2O5 waveguides

W.M. Martinez (1), K. Musick (1), A. Fischer (1, 2), J. Kronz (1), R. Reyna (1), T. Young (1), T. Cigeroglu (3), P. Rakich (3), and N.T. Otterstrom (1), (1) Sandia National Laboratories, (2) Center for Quantum Information and Control, Department of Physics and Astronomy, University of New Mexico, (3) Department of Applied Physics, Yale University

We report ongoing efforts to develop cavities that integrate high-reflectivity mirror coatings with Ta2O5 rib waveguides for quantum applications. With mirrors fabricated from 16.5-periods of Ta2O5/SiO2, configured as a Fabry-Perot cavity, we demonstrate >99.996% reflectivity. We also demonstrate 0.9 dB/cm losses in waveguides fabricated from Ta2O5 on SiO2 clad.

Invited: A Mechanosynthesis Platform for Atomically Precise Fabrication

Mathieu Durand, Canadian Bank Note Nanotechnologies

Inverted-Mode Scanning Tunneling Microscopy: A New Method in Atomically Precise Fabrication

Marco Taucer, Eduardo Barrera, and Bheeshmon Thanabalasingam, Canadian Bank Note Nanotechnologies

This talk will present a new method in scanning tunneling microscopy that reverses the conventional roles of the tip and sample. It provides exceptional control over both sides of the tunnel junction, enabling mechanically controlled chemical reactions and paving the way for a new approach to atomically precise fabrication.

Exploiting Shadowing Effects to Fabricate Low-Loss Lumped Element Capacitors for Quantum Superconducting Circuits

R. Li (1), J. Pomeroy (2), K. Cicak (3), and R. W. Simmonds (1), (1) University of Maryland, (2) NIST Gaithersburg, (3) NIST Boulder

A high-throughput, single-step lithography process is discussed for fabricating on-chip capacitors using Manhattan-style double angle deposition utilizing in-situ plasma oxidation. Such capacitors are planned to be incorporated into the superconducting LC circuit with intent to characterize microwave losses at single photon levels.

2B: Metamaterials, Flat Optics & Nanophotonics 2

Centennial B, 3:50 pm – 5:40 pm

Session Chairs: Qiangfei Xia, Murat Yessenov

Invited: Metasurface-enabled astronomical polarimetry

Noah Rubin, Department of Electrical and Computer Engineering at UC San Diego

Metasurface optics have attracted significant interest for a variety of applications. Here, we provide one of the first science-grade demonstrations of an advantage presented by metasurface optics to the field of astronomical instrumentation. In particular, we develop the Solar Imaging Metasurface Polarimeter for imaging magnetic fields in the solar atmosphere.

Evolution of a Centimeter-Scale Torsional Oscillator: Fabrication and Characterization at 100 nm Thickness

Tina M. Hayward (1), Dongchel Shin (2), Rajesh Menon (1), and Vivishek Sudhir (2), (1) Department of Electrical and Computer Engineering, University of Utah, (2) Department of Mechanical Engineering, Massachusetts Institute of Technology

We developed high-sensitivity SiN torsional oscillators for enhanced angular motion readouts. Together with an optical cavity, these oscillators will help advance the tools for probing weak forces and potential quantum aspects of gravity. In particular, we fabricated two SiN ribbons (different thicknesses) with lithography, RIE, and KOH etching.

Invited: A Flexible Sb-BDCA "Photo"-Resist Platform for High-Index Sb_2S_3 Flat Optics and Freeform 3D Nanophotonics

Volker Deckert, Friedrich Schiller University Jena

Compact flat optics require high-index materials that can be patterned with geometric freedom and process simplicity. Antimony trisulfide (Sb_2S_3) is an attractive option in this context as it offers a high refractive index, low optical loss and phase-change functionality. However, practical device fabrication is still limited by the complexity of the process and the low index of conventional resist platforms.

Invited: Bridging 3D Printing and Self-Assembly for Programmable Nanocomposite Metamaterials

Abhishek Saji Kumar (1), Shuai Feng (1), Jaewoo Park (1), Jahan Bruce (2), Blake Povilus (1), and Sui Yang (1, 3, 4), (1) Materials Science and Engineering, School for Engineering of Matter, Transport and Energy (SEMTE), Arizona State University, (2) Department of Physics, Arizona State University, (3) Biodesign Center for Molecular Design and Biomimetics, Arizona State University, (4) Center for Photonics Innovation, Arizona State University

We demonstrate a 3D printing approach for plasmonic metamaterials. By controlling nanoparticle geometry, plasmonic coupling, and orientation through integrated printing–assembly, we achieve tunable optical primitives and polarization states, key features for the metamaterial behaviors. Further coupling with fluorescent dyes enables precise control of light absorption and emission enhancement.

Session 2C – Industrial Highlights

Centennial B, 3:50 pm – 5:40 pm

Session Chairs: Gina C. Adam, Guy deRose

From Electron Physics to Manufacturing Insight: Advancing Electron Microscopy at KLA

Ralph Nyffenegger, KLA

KLA advances research and development in electron microscopy by translating fundamental understanding of electron–matter interactions into high performance, manufacturable instrumentation. Through sustained innovation in electron sources, electron optics, detector design, and signal modeling, KLA has expanded the capabilities of electron beam systems for nanoscale imaging, inspection, and metrology. These efforts emphasize precise control of beam energy, probe formation, interaction volume, and signal collection to extract physically meaningful information from complex device structures with high sensitivity and repeatability. Beyond conventional electron microscopy, KLA integrates advances in computation, data analytics, and system architecture to extend electron based techniques from localized measurements to wafer scale, statistically robust characterization. By bridging fundamental electron physics with system level engineering and manufacturing requirements, KLA enables new research pathways while supporting the continued scaling and complexity of advanced semiconductor technologies.

Latest Raith Innovations Driving Advanced Nano- and Microfabrication, Process Control, and Correlative Analysis

F. Nouvertné, M. Kahl, A. Wscieklica, T. Richter, and K. Keskinbora, Raith GmbH

Recent innovations across the Raith product portfolio are showcased, including efficient EBL workflows for 50 mm metalens fabrication, single-laser lithography for 600 µm resists with steep sidewalls, and new portfolio extensions enabling advanced process control and correlative analysis.

Research to Manufacturing: Developments in Displacement Talbot Lithography (DTL) for Semiconductor Lasers

Kelsey Wooley, Zhixin Wang, Jonathan Spring, and Harun Solak, Eulitha AG \ Eulitha US

New developments in Displacement Talbot Lithography (DTL) make it a strong solution for laser patterning. DTL now enables large-area, high-resolution, and highly uniform grating fabrication, supports advanced phase-shift designs and 2D patterns, and offers a scalable, cost-efficient alternative to electron-beam lithography for laser manufacturing.

Q-One platform: Dual Source Focus Ion Beam System for Scalable, Precise, and Reliable Positioning of Colour Centres

G. Aresta, K. Stockbridge, M. Mills, K. McHardy, and P. Blenkinsopp, Ionoptika Ltd.

We introduce a newly developed a dual-source, single-column Q-One FIB system for precise, scalable implantation of nitrogen, tin, and other ions in diamond. This platform was design and engineered during the joint development project between Ionoptika Ltd, Surrey University, Fraunhofer Institute for Applied Solid State Physics (IAF), and XeedQ GmbH.

SEM as a Surface-Engineering Platform for Nanoprototyping: In Situ FEBID/FEBIE, Scripted Workflows, and Digital-Twin Process Control

Milos Hrabovsky (1), Jiri Dluhos (1), Miroslav Jurasek (1), Alexey Verkhovtsev (2), Andrey V. Solov'yov (2), Ilia A. Solov'yov (3, 4, 5), Jakub Jurczyk (6), and Amalio Fernández-Pacheco (6), (1) Tescan Group, (2) MBN Research Center, (3) Institute of Physics, Carl von Ossietzky Universität Oldenburg, (4) Research Centre for Neurosensory Science, Carl von Ossietzky Universität Oldenburg, (5) Center for Nanoscale Dynamics (CENAD), Carl von Ossietzky Universität Oldenburg, (6) Institute of Applied Physics, TU Wien

SEM-based nanoprototyping combines imaging, additive deposition, and subtractive etching in a programmable workflow for rapid fabrication of functional 3D nanostructures. Coupling FEBID/FEBIE with multiscale modelling, digital-twin concepts, and reproducible scripting improves process predictability, iterative design, and in situ control of geometry and material composition.

HyperFIB: Vision-Guided Closed-Loop AI for Commercial FIB–SEM Enabled by a Dedicated Python Control API

Milos Hrabovsky, Tescan

HyperFIB is an open-source AI framework for commercial FIB–SEM that combines planning, orchestration, and computer vision for closed-loop automation. On Tescan systems, it automates preparation and milling via a stable programming interface, improving reproducibility, adaptability, and transferability of microscopy workflows across laboratories.

FabuBlox: From Process Design to Enabling the Next Generation of Intelligent, AI-Powered, High-Flexibility Fab Ecosystems

Jan Tiepelt, FabuBlox

FabuBlox is a unified platform for process design and intelligent fab management. Enhanced by early-stage agentic AI capabilities, FabuBlox Facility Portals streamline operations, reduces tool downtime, and improves reproducibility in high-flexibility fab environments. This is achieved by standardizing process onboarding, managing tool capabilities and calibrations, and automating contamination control.

3A: Nanofabrication for Quantum 3

Centennial A, 8:00 am – 9:50 am

Session Chairs: Carla Perez-Martinez, James Owen

Nanoscale Patterning of Niobium Nitride Thin Films for Superconducting Metamaterials

D. Mondin, F. Incalza, M. Castellani, A. Simon, E. Batson, D. J. Paul, and K. K. Berggren, Research Laboratory of Electronics, Massachusetts Institute of Technology

Nanopatterned niobium nitride thin films and nanowires were fabricated using optimized electron-beam lithography and resist processing. High-resolution superconducting structures with feature sizes down to 22 nm were fabricated and characterized. We establish a robust platform for top-down fabrication of superconducting nanostructures enabling future metamaterial studies.

Atomistic Study of Beam-Tilt Control of Channeling in Low-Energy Nitrogen Implantation into Diamond

Farid Rafie, Nidal Abu-Zahra, Department of Materials Science and Engineering, University of Wisconsin-Milwaukee

We use atomistic molecular dynamics to quantify how beam tilt controls channeling, depth precision, and lattice damage in low-energy nitrogen implantation into diamond. Moderate tilt suppresses channeling and minimizes deep ballistic tails while preserving near-surface lattice quality, enabling deterministic process windows for shallow NV center fabrication.

Bubble Gate Transistors: A single electron transistor (SET) formed using a single gate with varied widths

J.M. Pomeroy, P.N. Namboodiri , N. Ebadollahi, R. Li, and M.D. Stewart Jr., National Institute of Standards and Technology

A single inversion gate with non-uniform width is used to define an electron gas that has a reservoir, an isolated island, and another reservoir; thus, forming a single electron transistor, a basic building block of silicon-based quantum information.

Fabrication and Measurement of Atom-scale Quantum Dot Arrays for Analog Quantum Simulation

Richard Silver (1, 2), Fan Fei (1, 2), Pradeep Namboodiri (1), Brian Courts (1, 2), FNU Utsav (1), Vijith Kamalon Pulikodan (1), Mark Gaunin (1, 2), and Jonathan Wyrick (1), (1) Atom Scale Device Group, National Institute of Standards and Technology, (2) Department of Physics, University of Maryland

Fabricating arrays of precisely placed dopants in silicon is a promising platform for the analog quantum simulation of solid-state physics. We use RF reflectometry to directly probe charge and spin states in a 3×3 STM-patterned dopant array. We measure individual electron occupation across the array and observe Pauli spin blockade.

Invited: From Implantation to Disorder: Ion Beam Engineering of Superconducting Quantum Circuits

Shane Cybart, University of California Riverside

Using a liquid metal alloy ion source (LMAIS), we employ targeted implantation to chemically and magnetically modify superconductors, including Si implantation in Nb and Co implantation in YBCO.

3B: Metamaterials, Flat Optics & Nanophotonics 3

Centennial B, 8:00 am – 9:50 am

Session Chairs: Apratim Majumder, Wei Wu

Inverse Design Guided Nanofabrication of Silicon Nitride Metasurface Structures for Wavelength Splitting

Muhammad Fasih (1, 2), Abdulla Al Mamun (1, 2), Eashan Chopde (1, 2), and Chao Wang (1, 2), (1) School of Electrical Computer and Energy Engineering, Arizona State University, (2) Biodesign Center for Molecular Design and Biomimetics, Arizona State University

This work presents the inverse design and nanofabrication of a compact silicon nitride wavelength splitter operating in the visible spectral range. A topology-optimization framework with fabrication constraints is demonstrated and experimentally validated using electron-beam lithography (EBL), enabling integrated photonics applications in spectroscopy, fluorescence, sensing, and imaging.

Large-Aperture Multilevel Diffractive Lenses for MWIR and LWIR Imaging

Tina M. Hayward (1), Syed N. Quadri (2), Apratim Majumder (1), Nicole Brimhall (3), and Rajesh Menon (1, 3), (1) Department of Electrical and Computer Engineering, University of Utah, (2) US Naval Research Laboratory, (3) Oblate Optics, Inc.

Mid-wave infrared (MWIR) and long-wave infrared (LWIR) optics have many important applications, but components designed for these wavelengths can be heavy, small, or difficult to fabricate. We designed, fabricated, and tested large-aperture (up to 150 mm) multilevel diffractive lenses for both MWIR and LWIR using inverse design and grayscale lithography.

Invited: Disordered Metasurface Platform for Predictable Spatial-Spectral Mixing

Mooseok Jang, Department of Bio and Brain Engineering, Korea Advanced Institute of Science and Technology (KAIST)

This talk will explore ways to predictably mix and demix optical information in a random fashion using a disordered metasurface, with application examples in both spatial and spectral domains.

Invited: The Montgomery Effect as a Platform for Sub-Micron Spot Arrays via Dielectric Metasurfaces

Murat Yessenov, Harvard John A. Paulson School of Engineering and Applied Sciences, Harvard University

The Montgomery effect, an aperiodic self-imaging phenomenon, offers an underexplored route for structured light engineering. I will present a spatially structured Montgomery effect generated by dielectric metasurface, demonstrating one-dimensional arrays of up to 50 tightly localized sub-micron spots, opening pathways to scalable optical trapping, nanoscale lithography, and multiplane microcopy.

3C: 3D Nano & Micro Fabrication

Centennial C, 8:00 am – 9:50 am

Session Chairs: Michael Cullinan, Robert McLeod

Metrology of Three-Dimensional Nanostructures using Scatterometry

K.S. Lee (1), L.A. Aguirre (1), B. Groh (1), S. Venkatesan (2), M. Baldea (2), M. Cullinan (1), and C.-H. Chang (1), (1) Walker Department of Mechanical Engineering, The University of Texas at Austin, (2) Mcketta Department of Chemical Engineering, The University of Texas at Austin

We investigate the high-throughput metrology of 3D periodic nanostructures using hyperspectral scatterometry measurements. We show that variations in structural geometry produce distinct reflectance responses and that enable accurate structural reconstruction of through optical simulations.

Proportional 3D grayscale lithography and plasma etching of fused silica

G. Malvicini, C. J. Thalakkottoor, and H. Schift, Laboratory for Nano and Quantum Technologies, Paul Scherrer Institute

A grayscale lithography / ICP-RIE process enabling 1:1 selectivity transfer of continuous 3D structures into fused silica is demonstrated. Controlled $CHF_3/CF_4/O_2$ plasma chemistry achieves 5µm-thick profile replication with nanometre-scale surface roughness, and potential for thicker structures, supported by data-driven machine learning optimization for efficient process tuning.

Fabrication of Near-Unity Index Hollow-Core Nanopillar Arrays with Tunable Optical Anisotropy

Dokyung Kyeong, Chih-Hao Chang, Walker Department of Mechanical Engineering, The University of Texas at Austin

We demonstrate scalable interference lithography based fabrication of hollow core nanopillar arrays with near-unity effective refractive index and tunable optical anisotropy. Birefringence can be systematically adjusted with duty cycle and shell thickness. The results agree with FDTD, validating reproducibility and uniformity of the fabrication process.

Inverse-design of 3D computer generated holograms for additive manufacturing of micron-scale geometries

E. Wadsworth, A. Majumder, D. Lin, and R. Menon, Department of Electrical and Computer Engineering, University of Utah

We explore microscale additive manufacturing (AM) through projecting 3D computer generated holograms into UV-resin, curing entire geometries simultaneously. We demonstrate phase-only 3D holograms with features as small as 10µm, and discuss the development of the method for use in AM technologies, creating cured geometries from these holograms.

Invited: Rapid and low-cost digital 3D nanolithography enabled by optical projection

Sourabh K. Saha, Georgia Institute of Technology

4A: Microscopy & Metrology 1

Centennial A, 10:20 am – 12:10 pm

Session Chairs: Chih-Hao Chang, Henry I. Smith

Invited: Smaller, darker, faster: how physics embedded in machine learning can make imaging systems more powerful

George Barbastathis, MIT

Ultrafast Laser Delayering with In Situ LIBS for Sub Micron Depth-Resolved Metrology

Parisa Mahyari, Hongbin Choi, Wesley Roser, Marcus Emanuel, Matthew Maniscalco, Mohammad Taghi Mohammadi, Pouya Tavousi and Sina Shahbazmohammadi, University of Connecticut

Establishing an ultrafast laser-LIBS workflow, we achieve sub-micron 3D spatial mapping of heterogeneous stacks. Benchmarking pulse energy and scan speed enables controlled delayering with removal increments below one micrometer. Real-time spectral monitoring facilitates interface tracking and 3D chemical reconstruction of complex layered structures.

Self-Calibration with Fiducial Gratings

V. Logan, T. Hastings, Department of Electrical and Computer Engineering, University of Kentucky

This work demonstrates a novel self-calibration technique which utilizes a fiducial grating instead of an array of discrete marks.

Mechanically robust antireflection sapphire surfaces via nanopillar arrays

Mehmet Kepenekci, Natalia Andrea Rueda Guerrero, Kun-Chieh Chien and Chih-Hao Chang, The University of Texas at Austin

We investigate the mechanical and optical properties of nanostructured sapphire to establish the link between geometry and performance for designing mechanically robust, multifunctional surfaces. Preliminary results indicate that the sapphire sample with shorter pillars exhibits higher hardness and indentation modulus while maintaining transmittance comparable to the sample with taller pillars.

4B: AI & Nanofabrication

Centennial B, 10:20 am – 12:10 pm

Session Chairs: Niels Wijnaendts, Wei Wu

Invited: The Lithography Research Cluster Tool. An automated platform for AI-enabled process development

Dr. Thomas Stempel Pereira, Niels Wijnaendts van Resandt, LAB14 GmbH

In this work, we present a conceptual architecture for a lithography research cluster that transfers principles from automated fabrication into a platform that can be adapted for scientific needs. The design focuses on a robotic handling system with flexible recipe execution, allowing serial and parallel process routes under controlled conditions.

A Stochastic Analog SAT Solver for Intrinsic Stitch Optimization in Multiple Patterning Lithography Layout Decomposition

Ting-Hao Hsu, Nishat Tasnim Hiramony, Himaddri Roy and Wei Wu, University of Southern California

This work presents a hardware-based multiple patterning layout decomposition with intrinsic stitch optimization using a modified stochastic analog 3-SAT solver. By encoding coloring conflicts as hard clauses and stitch insertion as soft clauses, the approach optimizes stitch placement intrinsically, efficiently resolving non-decomposable layouts with minimal redundant stitches.

Slicing-Aided Hyper Inference for Defect Inspection in Hexagonal Contact Hole Arrays Using Voltage Contrast Metrology

Bappaditya Dey (1), Shubhankar Das (1), Victor Blanco (1), Sandip Halder (1), Ke Han (2), Jiangping Wang (2), Lingling Pu (2), and Roger Lahaye (2), (1) imec, (2) ASML

Defect detection at advanced nodes is challenging, especially for buried EUVL defects. This work applies the SAHI framework to VC-SEM images of hexagonal contact holes, improving nanoscale defect detection across varying CDs, pitches, and FoVs. Integrated with YOLO models and a UI, the method offers distortion-invariant, model-agnostic, robust ADCD performance.

Mitigating Catastrophic Forgetting in Advanced Node Semiconductor Defect Inspection Using YOLOv5 with Elastic Weight Consolidation

Ester Devlieghere (1), Bappaditya Dey (1), Victor Blanco (1), Sandip Halder (1), Ke Han (2), Jiangping Wang (2), Lingling Pu (2), and Roger Lahaye (2), (1) imec, (2) ASML

Shrinking wafer patterns make SEM defect detection increasingly challenging. Conventional deep learning suffers from catastrophic forgetting. Implementing Elastic Weight Consolidation (EWC) in YOLOv5 on ADI and AEI datasets improves knowledge retention without storing large datasets, enabling scalable continual learning for high-volume manufacturing.

Physics- and AI-based Scanning Electron Microscopy

András E. Vladár, Hyeokmin Choe, Pushkar Sathe, and Peter Bajcsy, National Institute of Standards and Technology

The tight integration of AI with the physics of signal generation is revolutionizing SEM. Developing AI methods requires large, relevant image sets. Results from AI-SEM integration, sparse scanning, and NIST methods for accurate Monte Carlo simulation and fast analog simulation of SEM image sets for AI will be presented.

4C: Advances in Nanofabrication

Centennial C, 10:20 am – 12:10 pm

Session Chairs: Stella Pang, Elena Pinilla Cienfuegos

Electrostatic Charge Elimination in Ionized Air-driven Electrospinning

H.W. Pearson-Nadal, C.T. Baumstarck, I.J. Gilfeather, J.M. Andriolo, J.L. Skinner, Montana Tech Nanotechnology Laboratory, Montana Technological University

Traditional electrospinning (ES) is used to produce nanometer to micrometer sized fibers. The electrostatic air-driven (EStAD) ES device is particularly attractive for on-demand use in the field for medical applications. It is critical that we address concerns related to treatment delivery in a variety of environmental conditions.

Integrated Si(111) Cantilevers with GaN optically pumped nanowires for Scanning Probe Metrology, Lithography, and Near-field Spectroscopy

Tito Busani, Isaac Stricklin, University of New Mexico

We report scalable GaN nanowire probes integrated on Si(111) cantilevers for AFM, STM, SPL, and NSOM. Compared to silicon and W tips, GaN probes show superior durability, reduced slope artifacts, enhanced lateral and deep-trench resolution, STM-equivalent performance, and pathways toward optically pumped UV-emitting multifunctional scanning probes.

Effects of Cell Density and Coculture on Cell Traversal through Channels

W. H. Li (1, 2), X. Hong (1, 2), and S. W. Pang (1, 2), (1) Department of Electrical Engineering, City University of Hong Kong, (2) Center for Biosystems, Neuroscience, and Nanotechnology, City University of Hong Kong

Microwells with channels were developed to study migration of nasopharyngeal epithelial (NP460) and carcinoma (NPC43) cells. NP460 traversing probability increased and plateaued with cell density, and was enhanced by coculture with NPC43 cells. These findings provide insights into NPC cell migration behaviors.

Carbon Nanomembranes: 2D materials for nanofluidic separation technology

Armin Gölzhäuser, Physics of Supramolecular Systems and Surfaces, Bielefeld University

Carbon Nanomembranes (CNMs) are 2D materials having sub-nm pores of a density of one per square nanometer. CNMs are well suited to separate water from mixtures with other molecules. In investigation the transport process, adsorption-controlled permeation is found and an Anti-Arrhenius behavior during the passage of gaseous molecules.

Advanced micro-lithography for Wafer-scale Array Nanostructures for Wide Range Applications: from Hydrophobic to Hydrophilic

Jinn P. Chu, Department of Materials Science and Engineering, National Taiwan University of Science and Technology

This presentation highlights the wafer-scale fabrication of highly ordered nanostructure arrays using semiconductor-based lithography and sputter deposition techniques. We have successfully produced diverse array architectures, including nanotube array, pillar array, disk array, and mesh, which can be integrated with nanomaterials like ZnO nanowires to form hybrid nanostructures.

Design and fabrication of dual-helicity orbital angular momentum zone plates for nano- angle-resolved photoemission spectroscopy

B. Luttgenau (1), C. Jozwiak (1), A. Bostwick (1), K. A. Goldberg (1), and W. Chao (2), (1) Advanced Light Source, Lawrence Berkeley National Laboratory, (2) Center for X-Ray Optics, Lawrence Berkeley National Laboratory

Single-chip +1 and −1 orbital angular momentum (OAM) Fresnel zone plates were designed and nanofabricated to generate helicity-controlled soft X-ray beams for OAM-resolved nARPES, enabling rapid switching between opposite OAM states and reproducible, side-by-side comparison of orbital-sensitive photoemission.

5A: Atomic Fabrication

Centennial A, 1:30 pm – 3:30 pm

Session Chairs: Gregor Hlawacek, John N. Randall

Invited: Electron-Enhanced Atomic Layer Deposition (ALD) and Atomic Layer Etching (ALE)

Steven M. George, Zachary C. Sobell, and Michael A. Collings, Dept. of Chemistry, University of Colorado

Electrons can be employed to enhance atomic layer deposition (ALD) and atomic layer etching (ALE). Titanium carbonitride EE-ALD will be described using sequential exposures of tetrakis(dimethylamino) titanium (TDMAT) and low energy electrons. Molybdenum EE-ALE will be discussed using alternating O2 and HCl pressures with simultaneous electron exposures.

Mechanosynthetic, atom-by-atom fabrication based on inverted-mode scanning tunneling microscopy and molecular tools

B. Blue, Z. Ahmed, D. Allis, A. Bottomley, D. Cheng, R. Cranston, C. Imperiale, C. Mackie, T. McCallum, M. Morin, A. Powell, S. Rohe, L. Sandoval, CBN Nano Technologies Inc

We demonstrate the use of “molecular tools” and inverted-mode scanning tunneling microscopy with custom, atomically clean “probe chips” at 4K in UHV for atomically-precise fabrication. Transferring individual carbon and silicon atoms to/from the tools and probe without applied bias is used to highlight the potential of this approach.

Additive Manufacturing Toward the Atomic Scale

S. Ben-David, W. Zhu, N. Ngoh, and F. Niroui, Massachusetts Institute of Technology

We extend additive manufacturing toward the atomic scale and develop a platform for direct writing of halide perovskite quantum dots with single emitter control down to sub-5 nm in size and with deterministic spatial placement, opening new opportunities for applications in photonic quantum technologies.

Fabrication of nanostructured silicon standards for Atom Probe Tomography

S. Poddar, K. DeRocher, F. Meisenkothen, and M. McLean, Materials Measurement Laboratory, National Institute of Standards and Technology (NIST)

The work describes the development of potential reference materials for assessing the fidelity of 3-D Atomic Probe Tomography reconstructions using simple-to-fabricate structures with known geometry and relevant materials for modern FEOL device structures.

Invited: Pico Perfect Placement: The Era of Atom Precise Manufacturing Has Begun

Robert Wolkow, Quantum Silicon Inc and University of Alberta

Remarkably, a creep free scanner has been developed with the effect of greatly speeding up scanned probe operation. In particular, atom precise fabrication can now proceed thousands of times faster enabling practical manufacture of devices of moderate complexity.

5B: Nanofabrication for Biology, Nanomedicine & Implantable Devices 1

Centennial B, 1:30 pm – 3:30 pm

Session Chairs: Eider Berganza, Haogang Cai

Invited: High-Resolution Nanoparticle Patterning via Soft Lithography: Methods and Applications

Elena Pinilla-Cienfuegos, Lucas Mascaró-Burguera, Daniel Arenas-Ortega, Alejandro Martínez, Laura Mercadé, Nanophotonics Technology Center (NTC), Universitad Politécnica de Valencia

Nanoparticle (NP) patterning with nanoscale precision is a key enabler for next-generation nanophotonic devices, yet scalable and cost-effective fabrication strategies remain limited. I will present a versatile soft lithography approach for the controlled patterning of single NPs over large areas with high fidelity, as well as the deterministic positioning of individual NPs onto photonic nanostructures. The method employs elastomeric stamps to transfer and organize NPs into well-defined architectures, enabling the controlled, single-step deposition of individual entities. I will discuss the fundamental fabrication principles, optimization of key process parameters, and the method's compatibility with a wide range of material systems. The resulting NP patterns exhibit tailored optical responses, with applications in surface-enhanced spectroscopy, metasurfaces, and engineered light–matter interactions. This approach provides a scalable and flexible route for integrating NP assemblies into advanced nanophotonic platforms.

Integrated Hierarchical Surface Restructuring of Assembled Electrode Arrays for Next-Generation Neural Interfaces

Alexander Blagojevic, Wesley Roser, Wesley Seche, Shahram Amini, Pouya Tavousi, and Sina Shahbazmohamadi, University of Connecticut

This work demonstrates hierarchical surface restructuring (HSR) as a post-fabrication surface treatment to significantly enhance the performance of fully assembled, neural interfacing, paddle electrodes. This enables substantial improvements to their electrochemical performance, without any alterations to existing manufacturing processes, significantly improving the cost-effective and scalable production of miniaturized, high-performance electrodes.

Microfabricated Impedance Sensor for Single Cell Migration Monitoring and Differentiation

X. Hong (1, 2) and S. W. Pang (1, 2), (1) Department of Electrical Engineering, City University of Hong Kong, (2) Center for Biosystems, Neuroscience, and Nanotechnology, City University of Hong Kong

A microfabricated impedance sensor with miniaturized electrodes and protein-functionalized microchannels for single cell migration monitoring was developed. The impedance signals captured single cell passage across electrodes and revealed cell migration speed, spreading area, and cell types, demonstrating potential for label-free single cell characterization.

Sapphire Supported AlN Membrane Solid State Nanopore for Low-Noise and High-Resolution Biomolecule Sensing

Abdulla Al Mamun (1, 2), Nimapreet K. Bamrah (1, 2), Pengkun Xia (1, 2), Md. Ashiqur Rahman Laskar (1, 2), Faizan Ahmed (1, 2), Eashan Chopde (1, 2), and Chao Wang (1, 2), (1) School of Electrical, Computer & Energy Engineering, Arizona State University, (2) Biodesign Center for Molecular Design & Biomimetics, Arizona State University

This work demonstrates sapphire-supported AlN membrane nanopores with ultra-low capacitance (<5 pF), reduced noise, and high stability. Compared to SiN, AlN nanopores achieve higher SNR and resolve closely spaced DNA origami features, enabling high-resolution, low-noise single-molecule sensing.

Wafer-Scale Fabrication of Silicon Nitride Membrane Chips on Sapphire with Noninvasive Resonant Optical Cavity-Based Colorimetric Thickness Monitoring

Eashan Chopde (1, 2), Muhammad Fasih (1, 2), Nimarpreet Kaur Bamrah (1, 2), and Chao Wang (1, 2), (1) School of Electrical, Computer and Energy Engineering, Arizona State University, (2) Biodesign Center for Molecular Design and Biomimetics, Arizona State University

To address the need for precise thickness control and characterization during fabrication of micrometer-sized suspended transparent membranes, we propose and demonstrate a wafer-scale fabrication approach with integrated non-destructive colorimetric thickness monitoring capable of visual and spectral differentiation of ~10nm membrane thickness variations.

5C: Additive & 3D Nanomanufacturing 2

Centennial C, 1:30 pm – 3:30 pm

Session Chairs: Sourabh K. Saha, Dan Congreve

Invited: Assessing approaches to light modulation for volumetric additive manufacturing

Hayden Taylor, Department of Mechanical Engineering, University of California, Berkeley

This talk will discuss efforts to expand the printing volume in volumetric additive manufacturing while maintaining target minimum feature sizes, through a combination of projection optics design and optimized projection pattern computation.

Single-exposure Volumetric Photolithography Producing Ultra-high Aspect Ratio Microstructures

Dajun Lin (1), Brian Baker (2), and Rajesh Menon (1), (1) Department of Electrical & Computer Engineering, University of Utah, (2) Utah Nanofab, University of Utah

We demonstrate a single-exposure volumetric photolithography strategy that reconstructs inverse- designed 3D UV intensity distribution in SU-8, enabling high-aspect-ratio structures with a theoretical 4 µm resolution. With ~20 s exposure, it achieves aspect ratios >120:1 and throughputs up to 0.36×10^6 voxels s^{-1}, outperforming existing volumetric additive manufacturing methods.

Invited: Nanofabrication via Photon Upconversion

Dan Congreve, Stanford University

Photon upconversion allows us to generate one high energy photon from two incident low energy photons. Using nanoscale encapsulation to add upconversion to a 3D printing resin, we can circumvent the layer-by-layer nature of traditional 3D printing and print without supports or resin flow constraints. Finally, we can utilize this process for nanofabrication, opening new windows in the manufacturing of materials for biological, photonic, and mechanical systems.

Enhanced Penetration for Metallic 3D Lithography Using Self-Healing Bessel Beams Generated by Micro-Axicons

Zhichao Li, Natalya K. Crawford, Timothy Yap, Kyubin Bae, Gavin H. Stafford, Michael Cullinan, and Chih-Hao Chang , Walker Department of Mechanical Engineering, The University of Texas at Austin

We demonstrate enhanced curing depth in metal-containing resins using self-healing Bessel beams generated by micro-axicons. Compared to Gaussian illumination, this approach improves metallic feature continuity and enables thicker, more complex 3D metallic structures for photon-based lithography.

6A: Atomically Precise Fabrication / STM

Centennial A, 8:00 am – 9:50 am

Session Chairs: Richard M. Silver, John N. Randall

Optimizing Electrical Contacts to Atomically Precise Quantum Devices

Mark-yves Gaunin (1, 2), Jonathan Wyrick (1), Utsav (1), Vijith Kamalon Pulikodan (1), Fan Fei (1, 2), Brian Courts (1, 2), Andras Vladar (1), Richard Silver (1), and Pradeep Namboodiri, (1) (1) National Institute of Standards and Technology (NIST), (2) University of Maryland, Joint Quantum Institute (JQI)

A scanning tunneling microscope (STM) can be used to fabricate devices on a hydrogen passivated silicon surface with atomic precision. Automated STM patterning is used to create large leads branching out from the devices, and precise depth control of silicide formation is studied to optimize electrical contacts.

Characterization of Leakage in Metallic Contact Leads for Silicon Quantum Devices

Brian Courts (1, 2), Fan Fei (1, 2), Utsav (1), Mark-yves Gaunin (1, 2), Vijith Kamalon Pulikodan (1), Jonathan Wyrick (1), Pradeep Namboodiri (1), and Richard Silver (1), (1) National Institute of Standards and Technology (NIST), (2) University of Maryland, Joint Quantum Institute (JQI)

Large gate ranges are a requirement for effective manipulation and characterization of silicon-based quantum devices. Presently, devices are limited due to small effective gate ranges of approximately ±350 mV. By sequentially varying the processing steps, we demonstrate two potential methods which increase the effective gate range to over ±1 V.

STM-Fabricated Single-Dopant Boron and Phosphorus Structures in Silicon

Jonathan Wyrick (1), Mark-yves Gaunin (1, 2), Pradeep Namboodiri (1), Utsav (1), Vijith Kamalon Pulikodan (1), Fan Fei (1, 2), Brian Courts (1, 2), and Richard Silver (1), (1) (NIST), (2) University of Maryland, Joint Quantum Institute (JQI)

We present progress with STM-based single-atom fabrication of dopant structures in silicon, extending previous work for phosphorus incorporation to the development of techniques for boron. We show results from adsorption of boron precursors into bare dimer patches on the H-Si(100) surface and compare with DFT simulated STM images.

Invited: Beyond Ga: Source and detector development for quantum and semiconductor applications

Gregor Hlawacek, Helmholtz-Zentrum Dresden-Rossendorf

6B: Nanofabrication for Biology, Nanomedicine & Implantable Devices 2

Centennial B, 8:00 am – 9:50 am

Session Chairs: Elena Pinilla Cienfuegos, Aimee Bross Price

Correlative Laser–FIB/SEM Workflows for Metrology, Inspection, and Characterization of Advanced Microelectronics Packages

Mohammad Taghi Mohammadi Anaei (2), Nicholas May (1), José Rodrigo Delgadillo Blando (1), Wesley Roser (2), Matthew Maniscalco (1, 2), Hongbin Choi (2), Adrian Phoulady (2), Parisa Mahyari (2), Herve Mace (1), Peyman Ahmadi (1), Sina Shahbazmohamadi (1, 2), and Pouya Tavousi (1, 2), (1) Tescan Group, (2) University of Connecticut

We present an end-to-end correlative characterization framework for advanced packaging that couples CT/optical/confocal navigation with ultrafast-laser access (decapsulation, delayering, cross-sections, and access holes) and targeted FIB/SEM refinement. The workflow preserves multiscale context, improves throughput, and yields microscopy-ready surfaces for reliable inspection and metrology of buried structures.

Invited: Multi-Modal Nanofabrication of Bioactive Interfaces for Spatial and Magnetomechanical Control of Cell Fate

J.A. Lopez-Solaiman (1), A. Asenjo (1), E. Berganza (1), A. Cruz (2), C. Tavares (2), G. Mathew (3), J. Aghassi-Hagman (3), M. Hirtz (3), Enrico Domenico Lemma (4), and Dalila Fontana (4), (1) Material Science Institute of Madrid, (2) Universidad Autonoma de Madrid, (3) Karlsruhe Institute of Technology, (4) Università Campus Bio-Medico di Roma

We present a dual-nanofabrication approach combining TPL and SPL to engineer 3D microenvironments with nanoscale biochemical precision for selective fibroblast anchoring. Additionally, a magnetostrictive nanoparticle interface was developed using Terfenol-D to remotely actuate human astrocytes. Both methods demonstrate precise control over cell fate, confluence, and functional network formation.

i-NanoOcuCare: A Nanostructure- and AI-Enabled Platform for Continuous In-Eye Sensing, Diagnostics, and Closed-Loop Drug Delivery

Stephen Y. Chou, Department of Electrical and Computer Engineering, Princeton University

i-NanoOcuCare is a new nanostructure and AI-enabled platform for continuous in-eye biomarker sensing, diagnostics, and drug delivery, forming a closed-loop ocular therapeutic system.

Invited: Integrated wafer-scale process for batch-fabricating electron microscopy grids with tunable cell guidance

Amit Avrahami, Noa Ben Asher, and Leeya Engel, Israel Institute of Technology

We present an integrated, wafer-scale process to batch-fabricate all-gold cryo-EM grids (~600 per 4″ wafer) with model-guided electroplating for reproducible thickness control. Second-generation anisotropic porous gold foils guide endothelial cell elongation and alignment, enabling customizable, low-motion, biocompatible supports for mechanobiology cryo-ET studies.

6C: Directed Self-Assembly

Centennial C, 8:00 am – 9:50 am

Session Chairs: Ricardo Ruiz, Daniel Sunday

Coordination-Driven, Room-Temperature Formation of Inorganic Hard Masks for Block Copolymer Pattern Transfer

Shaghayegh Abtahi, Department of Materials Science and Engineering, Iowa State University

Block-copolymer self-assembly can generate scalable nanoscale patterns, but pattern transfer to etch-resistant features is a key barrier. Conventional methods require high-temperatures, reactive precursors, and multiple steps. We demonstrate room-temperature, atmospheric coordination-driven vapor infiltration:Group14 precursors selectively infiltrate P4VP domains via N→Si coordination, forming hypercoordinate polymer-inorganic hybrids that act as hard masks.

Nanofabrication of Electrospun PAN-Derived High Surface Area Activated Carbon Nanofibers for Energy Storage

Ved Prakash Joshi, Mason Mrachek, Jack L. Skinner, and Jessica M. Andriolo, Montana Technological University

This work focuses on developing hollow nanofiber of activated carbon with high surface area for efficient energy storage at cold temperatures. The methodology involves electrospinning polyacrylonitrile (PAN) to create hollow fibers filled with electrolyte that enables capacitance at extremely low temperatures, reinforced with cellulose nanocrystals to maintain integrity.

Wide Neutrality Window for Block Copolymer Vertical Orientation Using Incongruent Homopolymer Blended Brushes

Sharif Tasnim Mahmud, Kaitlyn Hillery, Nayanathara Hendeniya Ava Huth Caden Chittick Shaghayegh Abtahi Boyce S. Chang

Incongruent homopolymer blended brushes provide an unprecedented wide neutrality window for vertical block copolymer orientation. A 6:10 PS–PMMA system enables lamellar and cylindrical alignment independent of composition via a proposed canopy effect. Extending this strategy, we explore electrospray deposition of PS-b-P2VP to achieve controlled high-χ self-assembly for nanoscale patterning applications.

Lithographically Generated 2D Bi_2Se_3 Grid Patterns as Physical Reservoir Computing Network Devices

Xiaoqiu An, Guanyu Lu, and Xiaogan Liang, Mechanical Engineering Department, University of Michigan

We systematically investigate Bi_2Se_3 memristive networks as physical reservoir computing devices. By comparing network densities and channel dynamic responses, we reveal how structural complexity governs nonlinearity and memory effects of reservoir devices, providing mechanistic insight into memristive reservoir dynamics and guidelines for neuromorphic hardware design.

Invited: Block copolymer self-assembly strategies for semiconductor device fabrication

M. Fernandez-Regulez, IMB-CNM, CSIC

Block copolymer self-assembly offers a cost-effective and scalable alternative to advanced lithography for semiconductor fabrication. This contribution presents recent directed self-assembly strategies and their integration into micro and nanofabrication process flows for semiconductor device fabrication, with applications in MEMS/NEMS, thermoelectric thin films, and emerging quantum and nanoelectronic devices.

7A: Applications of Nanofabrication

Centennial A, 10:20 am – 12:10 pm

Session Chairs: Ming Lu, Wei Wu

Ultrahigh Dielectric Strength and Energy Density in Ultrathin Polymer Films via Confinement and Interface Engineering

Gabriel Mogbojuri, Department of Materials Science and Engineering, Iowa State University

Ultrathin polymer films can deliver record breakdown fields and device-level energy storage, not only in glassy PMMA but also in soft PDMS. Using non-destructive EGaIn contacts and Weibull statistics, we reveal an interface-dominated scaling law and demonstrate high-efficiency nanocapacitors with ferroelectric-like energy density and million-cycle stability.

Peptoid-Guided Formation of Metallic Filaments in Memristive Devices

Xirong Liu, Xiaoqiu An, and Xiaogan Liang, Mechanical Engineering Department, University of Michigan

This work demonstrates a peptoid-guided memristive device in which sequence-defined peptoid nanostructures direct metallic filament formation, enabling spatially controlled nucleation, reduced switching stochasticity, and highly repeatable low-voltage resistive switching, offering a promising route toward energy-efficient and scalable hardware-based neuromorphic computing systems.

Fabrication Controlled Droplet Transport on Femtosecond-Laser Microstructured Metal Surfaces

K. Misiiuk (1), S. Lowrey (1), and A. Sommers (2), (1) Department of Physics, University of Otago, Dunedin, New Zealand(2) Department of Mechanical & Manufacturing Engineering, Miami University

Coating-free femtosecond-laser micro/nanofabrication is used to control droplet motion on aluminium, titanium, and stainless steel surfaces. Geometry-defined pitch and curvature enable superhydrophobicity, spontaneous droplet transport, and curvature-biased recoil, demonstrating fabrication-controlled wetting landscapes for passive fluid manipulation.

Radiation Effects in CdTe Solar Cells with Micro/Nanoscale Point Back Contacts

A. Mamun, E. Roy, and H. Yoon, Department of Electrical and Computer Engineering, University of Utah

We present the development of Al2O3 point contacts on CdTe solar cells. Patterning was optimized using laser lithography and etching to achieve high-fidelity CdTe back contact reflectors. Challenges arising from surface roughness were addressed, and neutron-induced damage was partially recovered through post-radiation annealing.

7B: Electron/Ion Sources & Optics 1

Centennial B, 10:20 am – 12:10 pm

Session Chairs: Steven Randolph, Carla Perez-Martinez

Invited: Ion-Induced Chemistry of Pt Precursors: Precursor Reactions and Spontaneous Formation of Multi-Layered PtCx Films

Lisa McElwee-White (1), Johnathon M. Johnson (1), D. Howard Fairbrother (2), and Patrick Eckhert (2), (1) Department of Chemistry, University of Florida, (2) Department of Chemistry, Johns Hopkins University

A UHV surface science approach employing in situ XPS and MS has been used to study how the identity of incident ions Z+ (Z = He, Ne, Ar, H2 or D2) influences ion-induced deposition from adsorbed MeCpPtMe3 and sputtering of the resulting PtCx films.

Invited: Isotopically Resolved Focused Ion Beam Systems for Quantum Technologies

Maddison Coke Mason Adshead, and Richard J. Curry, Photon Science Institute, Department of Electrical and Electronic Engineering, University of Manchester

Researchers demonstrate advanced use of focused ion beams via the P-NAME to engineer quantum materials. New ion sources enable deterministic single-ion doping, precise Sb pair placement in silicon, and isotopic enrichment, improving spin coherence. Applications include diamond single-photon emitters, spintronic nanodevices, doped quantum dots, supported by theory and imaging studies.

Invited: So simple, yet so difficult – towards reliable FIB milling of variable surface topographies

Katja Höflich, Ferdinand-Braun-Institut (FBH)

Focused ion beam processing is ideal for the prototyping of high-fidelity 3D components, particularly for quantum applications. However, the actual identification of suitable beam and patterning parameters still relies on personal talent and experience. In my lab, we aim to removing these hurdles by implementing calibration-based and physics-informed pattern generation.

Gallium Nitride Micro-Pyramids as Coating-Free Negative Electron Affinity Photocathodes

S. Marinoni (1), N. Tappy (2), V. Piazza (1), A. Fontcuberta i Morral (1, 3), and C. Monachon (2), (1) LMSC, Institute of Materials, EPFL, Lausanne, Switzerland, (2) Attolight SA, Ecublens, Switzerland, (3) Institute of Physics, EPFL, Lausanne, Switzerland

We present a novel electron source where negative electron affinity is induced by electric field concentration on p-doped GaN micro-pyramids, eliminating the need for surface caesiation. Demonstrating linear near-bandgap photoemission, this virtual source combines high brightness with semiconductor scalability, offering a robust solution for next-generation focused electron beam equipment.

7C: EUV 1

Centennial C, 10:20 am – 12:10 pm

Session Chairs: Ricardo Ruiz, Danilo De Simone

Invited: Metal Imidazolate Films for Lithography Applications

Michael Tsapatsis, John Hopkins University

This talk is about a class of amorphous metal organic frameworks (amorphous zeolitic imidazolate frameworks: aZIFs) and their use as resists for electron-beam lithography (EBL), extreme ultraviolet lithography (EUVL: 13.5 nm), as well as for lithography using smaller wavelengths, beyond EUV (BEUV: 6.7 nm).

Invited: Dry Patterning Solutions Enabling HighNA Lithography for Accelerated Feature Scaling

Anuja De Silva, Lam Research

Invited: High throughput MLD to screen photoresist chemistries for EUV lithography

David S. Bergsman, Department of Chemical Engineering, University of Washington

8A: Nanophotonics, Micro-optics, Plasmonics

Centennial A, 1:20 pm –3:10 pm

Session Chairs: Haogang Cai, Mooseok Jang

Scaling up nanodevice fabrication with parallelized multi-tip thermal scanning probe lithography

J. Chaaban, J. Stark, E. Clerc, A. Ubezio, A. Damyanova, F. Könemann, K. Buddha, S. Bonanni, and E. Çağın, Heidelberg Instruments Nano AG

We present high-resolution, high-throughput thermal scanning probe lithography using the NanoFrazor and its first multi-tip implementation, Decapede. By parallelizing ten tips, large-area, complex nanophotonic structures are patterned efficiently, including photonic sieves and metalenses with millions of elements, while maintaining overlay accuracy and high resolution.

Scalable Metasurfaces for Ultrasensitive Biosensing

Hao Wang (1, 2), Nanzhong Deng (1, 3), Yue Xiao (1, 3), Ashish Pandey (1, 2), and Haogang Cai (1, 2, 3), (1) Tech4Health Institute, New York University Grossman School of Medicine, (2) Department of Radiology, New York University Grossman School of Medicine, (3) Department of Biomedical Engineering, New York University

Optical metasurface-based biosensors integrated with microfluidics represent a key platform technology for biosensing and diagnostics. Here, we demonstrated scalable metasurfaces using nanosphere lithography, which enable ultrasensitive biomolecular detection (0.17 ng/mL) comparable to devices fabricated by e-beam lithography. The high throughput and low cost make them more suitable for point-of-care testing.

Interfering Dipoles: Near-Field Energy Flow Vortices and Nodal Lines

Xin Li, Trevor Winter, Millersville University

We compute the time-averaged Poynting vector for two oscillating electric dipoles and map energy flow in the x–y plane. Dipole interference creates vortices and zero-flux points, with nodal lines indicating energy redirected out of plane. Anti-parallel dipoles show a repeating, interference-driven pattern.

Vertical Integration of Graphene and Nanomaterials for Multispectral Analysis and Detection

Freddy Garcia (2), S. Ahn (1), J. Y. Shang (2), and O. Vazquez-Mena (2), (1) Korea Maritime and Ocean University, (2) Aiiso Yufeng Li Family Department of Chemical and Nano Engineering, Center for Memory and Recording Research, Material Science Program, University of California, San Diego

Herein we present a vertically stack of graphene CVD monolayers and nanomaterials sich as zinc oxide and lead sulfide quantum dots of different sizes and bandgaps, allowing for multispectral detection, with each graphene layer detecting a different spectral band.

8B: Electron/Ion Sources & Optics 2

Centennial B, 1:20 pm –3:10 pm

Session Chairs: Lisa McElwee-White, Maddison Coke

Invited: The Role of Reactive Ion Species in Plasma Focused Ion Beam Induced Deposition

S.J. Randolph (1), S. Ghosh (1) K. Sprecker (2), P.D. Rack (2), (1) Oak Ridge National Lab, (2) University of Tennessee, Knoxville

Oxygen focused ion beam induced deposition enables direct-write fabrication of Pt nanostructures with enhanced purity through concurrent oxygen implantation and reactive growth. By tuning beam and precursor parameters, Pt contents up to 63 at.% and reduced resistivity are achieved, with simulations revealing oxygen activation–sputtering balance governing composition and morphology.

Development of a Pulsed-Transmission Electron Microscope and Observation Technique for Capturing Sub-Millisecond Dynamics in Solution

Ryoya Katayama (1, 2), Tomohiro Nishitani (2), Yohei Otsuka (2), Yuta Arakawa (2), Daiki Sato (2), Tomoharu Matsumoto (1), and Akihiro Narita (1), (1) Grad. Sch. Science, Nagoya University, (2) Photo electron Soul Inc., Japan

We report a pulsed-TEM utilizing a GaN photocathode and solution cell for visualizing rapid dynamics. High-peak-current pulses successfully suppressed motion blur in moving samples, demonstrating image quality comparable to stationary conditions. This technology will enable sub-millisecond observation of molecular motion in solution, including proteins and lipids.

Using machine learning method to predict the secondary electron yield and explore its influencing factors

Chenhui Deng (1), Bohua Yin (1), Pengqian Han (2), and Li Han (1), (1) Institute of Electrical Engineering, Chinese Academy of Sciences, (2) Department of Electrical, Computer, and Software Engineering, The University of Auckland

This study develops a machine learning model to accurately predict the secondary electron yield (SEY) of metals and quantify the influence of material properties. This interpretable ML approach provides a valuable tool for understanding SEY mechanisms and guiding material selection in related nanofabrication processes.

Variable Temperature Bolometer for Sensing Neutral Atomic and Molecular Beams

Carl J. Geiger, Nolan M. Uchizono, Naval Research Laboratory

We developed a variable-temperature pyroelectric bolometer for the quantitative measurement of energy flux from photons, neutral gas flows, and mixed ion-neutral plumes in vacuum. Target applications include quantitative analysis of polydisperse molecular electrospray plumes, neutral characterization of plasma propulsion systems, and hyperthermal beam flux measurements.

Sources for focused ion beams and their potential use for single ion implantation

Amina Zid (1), Arnaud Houel (2), Anne Delobbe (2), N. Klingner (1), and Gregor Hlawacek (1), (1) Institute for Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, (2) Orsay Physics

Development of new liquid metal alloy and gas field ion sources enables spatially resolved fabrication for quantum technologies. Presented are LMAIS and xenon-based GFIS results, single-photon emitter fabrication, and a dedicated single-ion implanter, supporting advances in materials science and quantum device engineering.

8C: EUV 2

Centennial C, 1:20 pm –3:10 pm

Session Chairs: Anuja De Silva, David S. Bergsman

Invited: Navigating Stochastic Challenges in EUV Lithography: Innovations in Materials and Metrology

Ricardo Ruiz, Lawrence Berkeley National Laboratory

We examine innovative material platforms and characterization techniques to probe and eventually control sources of chemical stochastics in EUV lithography. Material platforms include polypeptoids and molecular layer deposition, alongside bottom-up strategies to enhance uniformity. Innovations in multimodal characterization of EUV and secondary electron-driven patterning will also be discussed.

Invited: Euler–Bernoulli bending theory applied to high NA EUV dense line-space patterning to characterize the line wiggling

D. De Simone, G. Lorusso, Imec

Line wiggling (LW) in sub-10 nm EUV lithography arises from mechanical instabilities during development and etching. Using Euler–Bernoulli beam theory, we identify key LW drivers: aspect ratio, material stiffness, and etching forces. Optimizing resist mechanics, stack design, and etch conditions is essential to suppress LW and ensure high pattern fidelity.

Invited: Advanced Metrology for EUV Resists

Daniel “Fed” Sunday, National Institute of Standards and Technology

Chain Scission Resists with Wide Recording Margin for Various Lithography Applications

Seiji Morita, Wisdom Pool Research Institute G.K.

Chain scission resists have excellent fine pattern resolution, however, there is a technical issue related to poor recording margin. In this time, new chain scission resists were developed. Wider recording margin of some types of resist was confirmed. Also, fine smaller pattern and impovement for carbon neutral will be reported.

9A: Nanoimprint Lithography

Centennial A, 3:40 pm –5:30 pm

Session Chairs: Mathieu Durand, J. Alexander Liddle

Reversal Nanoimprinted Highly Sensitive Plasmonic Sensor around Microposts for DNA Detection

Y. J. Cheng (1, 2) and S. W. Pang (1, 2), (1) Department of Electrical Engineering, City University of Hong Kong, (2) Centre for Biosystems, Neuroscience, and Nanotechnology, City University of Hong Kong

A three-dimensional plasmonic sensor consisting of Au nanopillars around microposts via reversal nanoimprint achieves substantially enhanced sensitivity, which could be increased from 430 to 1216 nm per refractive index unit. The scalable, high throughput reversal nanoimprint technology provides large sensing interfaces for high sensitivity, label-free biomolecular detection.

Fabrication of nm-rough 3D ellipsoidal X-ray focusing optics via grayscale lithography and selective thermal reflow

G. Malvicini (1), H. Schift (1), and S. Saxer (2), (1) Paul Scherrer Institute, Laboratory for Nano and Quantum Technologies, (2) FHNW School of Life Sciences

Reflective X-ray optics demand sub-nanometer roughness on complex 3D surfaces. We quantify roughness on grayscale-fabricated linear slopes and ellipsoids using AFM, showing reductions from ~5–6 nm to ~1–2 nm via replication into Optool GMN PS90 and PMMA and selective thermal reflow, preserving the original geometry.

High-speed moth-eye structure formation using foamed polyimide

Yoritaka Danjo, Jun Taniguchi, Department of Applied Electronics, Tokyo University of Science

Moth-eye structures can be rapidly fabricated by irradiating foamed polyimide with an oxygen ion beam.

Investigating the Mechanism of Irreversible Failure in Pt/HfO2/Ta/Pt Memristors

Nishat Tasnim Hiramony, Shafayeth Jamil, Zhiyuan Zhao, Ting-Hao Hsu, Himaddri Roy, Tanshia Tahreen Tanisha, and Wei Wu, Viterbi School of Engineering, University of Southern California

We investigate irreversible (unresettable) failure in Pt/HfO2/Ta/Pt memristors under over-compliance stress. Correlated I–V, AFM, SEM, and EDS reveal localized swelling and Pt-rich mounds at the breakdown site. Experiments and modeling support a runaway mechanism driven by current crowding, Joule heating, filament thickening, and Pt electro and thermomigration.

9B: Electron Beam Lithography

Centennial B, 3:40 pm –5:30 pm

Session Chairs: Mark Mondol, Aimee Price

Non-PFAS Biomass non-CAR for sub-15 nm SRAF Patterning on High-NA EUV Mask

Y. L. Jung (1), S. Lee (1), S. Jang (1), S. Bae (1), C. Ryu (1), C. Jeong (1), K. Morita (2), Y. Yoshikura (2), J. Choi (1), and S. Lee (1), (1) Samsung Electronics Co. Ltd., (2) Oji Holdings Corporation

To achieve the sub-15nm SRAF resolution required for high-NA EUV mask patterning, we have pioneered a novel non-PFAS, biomass-derived non-CAR in collaboration with Oji. Validated on an EUV mask using VSB and MBMW, the resist showed high potential to meet the ultimate resolution demands of next-generation semiconductor manufacturing.

A self-tuning method for laser beam compensation in Electron Beam Lithography

Botong Sun, Bohua Yin, Institute of Electrical Engineering, Chinese Academy of Sciences

A self-tuning method for laser beam compensation in Electron Beam Lithography. This method utilizes image recognition technology to achieve sub-pixel level positioning of markers. This tuning method supports compensation for rotation, displacement, and gain terms in laser compensation.

Fogging Characterization and Mitigation for Large-Format Electron-Beam Grating Exposures

R. McCurdy, J. McCoy, R. McEntaffer, F. Grisé, C. Eichfeld, and M. Labella III, Pennsylvania State University

Electron-beam lithography is a promising technique for fabricating next-generation X-ray and UV diffraction gratings. We will present ongoing work showing spatial maps of additional dose in the resist from fogging and results from creating a correction map similar to proximity effect correction to reduce the fogging dose.

Enhancement of Sub-50 nm Channel Length Definition Using Removable Dummy Structure-Assisted Electron Beam Lithography

Tsai-Ming Huang, Dang-Nhut Hao, Chia-Wei Chang, Hsu-Chun Cheng, Meiyi Li, and Chun-Chi Chen, Taiwan Semiconductor Research Institute, National Institutes of Applied Research

This study introduces an automatically removable dummy-assisted EBL technique to overcome proximity effects and pattern collapse. By homogenizing electron dose distribution, this method improves photoresist integrity and reduces critical dimensions from 60 nm to 50 nm without extra steps, offering a robust framework for next-generation device fabrication.

Improving Line Edge Roughness and Photonic Device Performance by Sleeving Exposure Method

D. K. Brown (1), S.M. Enjaviarsanjan (2), A. Adibi (2), and K. Vyas (3), (1) Institute for Matter and Systems, Georgia Institute of Technology, (2) School of Electrical and Computer Engineering, Georgia Institute of Technology, (3) GenISys, Inc.

This work investigates how to improve LER using a photonic design which fits within a 500 µm field. The design was given three treatments of single field pass, four times field multipass with no shift, and a single field pass with double sleeving, with the latter giving the best result.

9C: EUV 3

Centennial C, 3:40 pm –5:30 pm

Session Chairs: Martha Sanchez, Daniel Sunday

Invited: Imaging in the era of High NA EUV lithography

Gijsbert Rispens, ASML NV, Netherlands

Development and fabrication of an EUV, ultra-low blaze angle diffraction grating for a NASA space telescope

F. Grisé (1), J. McCoy (1), R. McEntaffer (1), E. Farr (2, 3), N. Kruczek (2, 3), B. Fleming (2, 3), K. France (2, 3), B. Indahl (2, 3), and K. Davis (2, 3), (1) Penn State University, Department of Astronomy and Astrophysics, (2) Department of Astrophysical and Planetary Sciences, University of Colorado, (3) Laboratory for Atmospheric and Space Physics

We present the fabrication of an ultra-low blaze angle EUV diffraction grating for a NASA telescope. Electron-beam lithography patterning of the VLS profile and KOH etching of precisely oriented silicon wafers achieve atomically smooth blazed facets. We discuss <111> off-axis etching and optimization strategies with applications in astronomy and beyond.

In-device overlay study using high landing-energy SEM and VC during backside patterning in CFET technology

S. K. Sarkar, R. K. Saroj, M. Hasan, T. Sarkar, A. Mingardi, and S. Halder, Imec

We are demonstrating the use of high landing energy SEM images to measure overlay right at the device feature of the backside layers of CFET and BSPDN technology. We will obtain more localized and device-relevant data (compared to traditional metrology box) and correlate voltage contrast signal to the in-device overlay.

Time-dependent charging and degradation of photoresists under low-energy electron irradiation

Peter Sun, Chang-Yong Nam, and Jerzy T. Sadowski, Brookhaven National Laboratory

We investigate the charging effects in PMMA photoresists during 5-20 eV low-energy electron exposure. We developed a dynamic energy ramping method to compensate for surface potential while maintaining a constant landing energy to study photoresist degradation.

Poster Session

Wednesday, May 27, 12:00 pm – 1:30 pm

Poster Session Reception

Wednesday, May 27, 5:45 pm – 7:00 pm

Posters Available for Viewing

Thursday, May 28, 10:00 am - 1:00 pm

2D Materials

P-160. Anisotropic Electrical Transport in Graphene Field-Effect Transistor Modulated by Sub-micron Gold Gratings

Wei-Yu Long, Yan-Yi Lin, Min-Da Yu and Chih-Ting Lin, National Taiwan University

By fabricating devices with currents flowing in different directions, we have demonstrated that periodic sub-micron gold gratings can effectively modulate the electrical properties of GFETs. This modulation induces a pronounced transport anisotropy. Ultimately, this work highlights the potential of precise nanopatterning to artificially tailor 2D materials for advanced electronic applications.

P-4. Design and Application of Titanium Dioxide Thin Films Guided Mode Resonance Filter

He Zhang, YiChen Ping, Yanli Li, Institute of Electrical Engineering, Chinese Academy of Sciences

The resonant wavelength of the device can be controlled while maintaining narrow linewidth characteristics by altering the refractive index of the titanium dioxide thin film of the optical waveguide layer. The wavelength control range spans 946.9–967.9 nm, with a full width at half maximum less than 0.8 nm.

3D Nano & Micro Fabrication

P-106. Active Stabilization of the Cassie-Baxter State for Long-term Hydrophobicity

FNU Yuqing (1), Samuel Jia (1,2), Linyi Li (1,2), Jacob Jia (1), and Ke Du (1), (1) University of California, Riverside, (2) Ohio State University

We present an active pneumatic replenishment system to combat biofouling by stabilizing the metastable Cassie-Baxter state. Utilizing closed-loop pressure control on high-resolution 3D-printed hydrophobic chips, our device prevents wetting transitions. Experiments demonstrate indefinite air-layer retention and significantly reduced algal biofilm formation, establishing a robust paradigm for long-term surface protection.

P-105. Development of 3D-Printed Hollow-Core Microneedles for Drug Delivery and Therapeutics in Mice Models

J. Waitkus, Y. Larios, H. Yuqing, K. Du, University of California at Riverside

Through 3D-printing of hollow-core microneedle patches, control over injection location and depth help to improve efficacy of injection-based drug delivery techniques. The design of a five-plane lancet needle tip aids in near-painless penetration of mice skin to deliver therapeutics directly at skin tumor sites or to inflamed muscles and joints.

P-161. High-Selectivity Ar/CF_4 Reactive Ion Etching of Colloidally Patterned Sapphire Nanostructures

N.A. Rueda Guerrero, M. Kepenekci, C.H. Chang, University of Texas at Austin

This work demonstrates a low-cost, scalable method to nanopattern sapphire using colloidal nanosphere templates, a nickel hard mask, and one-step Ar/CF4 RIE. The process achieves 300 nm-high structures with superior etch selectivity to common masks, enabling tunable, wafer-scale nanostructures for robust optical surfaces.

P-96. Laser-Assisted Fabrication and Multimodal Characterization of Si Microfunnel Structures

Jaidan Malloy, Ashif Chowdhury, Taehoon Kim, Jason Smith and Heayoung Yoon, University of Utah

Three-dimensional (3D) Si microfunnel arrays enhance light-matter interaction but face challenges in controllable fabrication and internal characterization. We demonstrate UV laser microdrilling and HNA etching with a controlled SiO2 cap, enabling tunable microfunnel evolution and quantitative 3D analysis via SEM and micro-CT for optoelectronic integration.

P-93. Rapid and Scalable Fabrication of Si Microfunnel Arrays Using Nanosecond UV-Laser and Selective HNA Etching

Ashif Chowdhury, Donggeon Kim and Heayoung Yoon, University of Utah

Perforated Si microfunnel arrays are fabricated by combining a nanosecond UV laser with isotropic HNA wet etching using a SiO2 cap. Controlled microdrilling and etch conditions tailor microfunnel geometry and optical response, enabling tunable translucent photovoltaic architectures. This approach offers a cost-effective, scalable route for diverse optoelectronic applications.

P-19. Self-Aligned Nanoscale Trench Etch In Silicon Using Mask Thickening With Convex Corner Lithography

C. Steenge (1), H. Veltkamp (1), Z. Ren (2), J.W. Berenschot (1), R.J.E. Hueting (1), N.R. Tas (1), (1) MESA+ Institute, University of Twente, Enschede, (2) Oxford Instruments Plasma Technology

This work demonstrates self aligned nanoscale trench etching in silicon by combining convex corner lithography with a thickened thermal silicon dioxide mask. Mask thickening overcomes selectivity and thickness limits, enabling the formation of nanotrenches essential for scalable three dimensional nanodevice fabrication.

Advanced Micro/Nanolithography

P-70. Curved Metalens Fabrication on Objective Lens of Si Cooke Triplet for Aberration Corrected IR Imaging

M. Risley, C. Reinke, B. Redman, C. Zheng, A. Jarzembski, D. B. Burckel, Sandia National Laboratories

EBL Fabrication of nanostructured metalenses on curved silicon refractive lens to form hybrid diffractive refractive optics on a Cooke triplet lens. Metalens integrated Cooke triplet lens for IR imaging.

P-156. Fabrication of Periodic Nanopillar Structures on Polycrystalline Diamond by Reactive Ion Etching

Dongju Lee (1), Xiang Zhang (1), Qing Zhu (2), Li Shi (2), Pulickel M. Ajayan (1), Chih-Hao Chang (2), (1) Rice University, (2) University of Texas at Austin

Vertically aligned diamond nanopillars were fabricated using interference lithography-defined photoresist patterns and SiO_2 hard mask transfer, followed by oxygen-based ICP-RIE. The process enables controlled pattern formation on polycrystalline diamond, addressing etching challenges and demonstrating a scalable route for nanostructuring diamond surfaces.

P-84. High-Throughput Ejection of Microdroplets via a Femtosecond Laser-Addressable Nanomembrane Array

Guannan Zhang and Wen-Di Li, University of Hong Kong

We propose a strategy to realize high-throughput ejection of microdroplets via a femtosecond laser-addressable nanomembrane array. A high-resolution nanomembrane array replaces conventional whole dynamically released layer (DRL) to first load microdroplets, and then these droplets are printed onto a receiving substrate using a low-energy femtosecond laser in high-throughput manner.

P-22. Refining the Fabrication of Grayscale Lithography Annealed Resin Engineering

Andrew Holterhoff, Mason Risley, Gavin C. Gee, D. B. Burckel, Sandia National Laboratories

We present insight into tuning the development process of a technique that uses a pyrolyzed grayscale resist pattern, converting it into a carbon mask, and developing the patterns on both AZ-4330 and ma-P 1275G photoresists.

AI for Nanofabrication & Nanofabrication for AI

P-32. A Machine Learning Process for Flexible Inline Critical Dimensions Measurement from Micrographs

Jiahua Fan, Ziyu Wang, Pawan Vedanti and Gyuseok Kim, University of Pennsylvania

Accurate and efficient critical dimension measurements are important for nanoscale fabrication analysis. The development of machine learning algorithms have simplified the process to delegate repetitive and labor intensive manual measurements to an automated program. Here, we present a lightweight machine learning framework for flexible measurements.

Applications of Nanofabrication

P-24. An Electron Beam-Based Micro-LED Inspection Method

Yao Liu, Yanli Li, Huibin Zhao and Li Han, Chinese Academy of Sciences

To address limitations in contact-based Micro-LED wafer inspection—such as low speed, short probe lifespan, and chip damage—this study proposes an inspection method using electron beam. By irradiating the chip and adjusting beam parameters, we successfully drive the Micro-LED and obtain its I-V characteristics, experimentally validating the method's feasibility and effectiveness.

P-52. Perovskite Photovoltaics Utilizing a Conductive PCL/CNT Polymer

Luke J. Suttey (1), Samuel D. Triepke (1), Landon Guengerich (1), Jessica M. Andriolo (1), Jack L. Skinner (1), Dennis J. Moritz (2), John J. Borkowski (2), (1) Montana Tech Nanotechnology Laboratory, (2) Montana State University

Fabrication methods and characterization of a photovoltaic cell utilizing single-walled carbon nanotubes and polycaprolactone composite electrode are presented. This work provides foundational data for the future fabrication of a triaxial electrospun perovskite solar cell consisting of the conductive polymer composite, a perovskite active layer, and a polymeric hole transport layer.

P-90. Tailoring HfOx ReRAM Switching Through Ti Interfacial Engineering

Zhijie Kong (1), Tsotne Gamsakhurdashvili (1), Daniel Sabrsula (2), Ana Cohen (1), David Barth (1), G. Karapetrov (1), and Lucas Barreto (2), (1) Department of Physics, Drexel University, (2) Singh Center for Nanotechnology, University of Pennsylvania

This work studies Ti/HfO_x interface engineering in HfO_x-based ReRAM. By varying Ti thickness and post-deposition annealing, we analyze their impact on forming voltage, switching behavior, and resistance stability, demonstrating controlled optimization of resistive switching through interfacial modulation.

Electron Beam Lithography

P-29. A Fragment-based Pattern Prediction Method for Accelerating Large-Scale Mask Simulation

Ze-An Ding, Chun-Hung Liu, Yen-Hua Tu, Yu-Lin Chung, Yu Hsi Liu, Meng Gu Tsai and Nian-Ting Wu, National Taipei University

This study proposes a fragment-based pattern prediction method to address conventional FFT-based bottlenecks. By fragmenting layouts and incorporating time complexity analysis, the method achieves up to a 42% speed-up without compromising fidelity.

P-27. A Hybrid Curvilinear Mask Process Correction Method Integrating Shape and Dose Modifications

Chun-Hung Liu, Nian-Ting Wu, Yu-Lin Chung, Sheng-Kai Wong, Ze-An Ding, Yen-Hua Tu, Huang Ting-Chun, Yu-Tang Sun, Meng Gu Tsai and Yu-Jun Zhong, National Taipei University

This study proposes a hybrid curvilinear mask process correction method integrating shape and dose modifications. By combining fast shape-based convergence with high-precision dose refinement, the approach significantly enhances both computational efficiency and pattern fidelity compared to conventional single-mode correction techniques.

P-26. Accelerated Curvilinear Mask Process Correction via Direct Energy-based Modulation

Chun-Hung Liu, Yu-Lin Chung, Nian-Ting Wu, Sheng-Kai Wong, Ze-An Ding and Meng Gu Tsai, National Taipei University

This study proposes a direct energy-based modulation method for curvilinear mask process correction (CL-MPC). By performing modulation directly in the energy domain, it reduces iterations by 65% and runtime by 64%. The approach enhances computational efficiency while maintaining high pattern fidelity and smoother dose distributions.

P-30. Application-Specific Fast Multipole Methods for Enhancing Computational Efficiency in Curvilinear Mask Pattern Prediction

Chun-Hung Liu, HSUN-MAO KUO, Ze-An Ding, Yen-Hua Tu, Huang Ting-Chun and Meng Gu Tsai, National Taipei University

An Application-Specific Fast Multipole Method and an SVD-enhanced version to accelerate pattern prediction in EBL is proposed. By optimizing field calculations and simplifying multipole processes, the proposed methods achieve linear scalability, showing a 93% runtime improvement and a 1,411% speed-up over conventional FFT method while maintaining negligible edge placement error.

P-28. Energy-based Iterative Calibration of Parametric Point Spread Functions for Curvilinear Pattern Prediction

Chun-Hung Liu, Meng Gu Tsai, Yu-Lin Chung, Ze-An Ding, Sheng-Kai Wong and Nian-Ting Wu, National Taipei University

This study proposes an energy-fitting-based method that iteratively calibrates the parametric point spread function parameters by minimizing the error in the energy image, enabling accurate pattern prediction (PP) for curvilinear patterns. The mean of edge placement error is reduced by up to 66%, confirming that energy-deposition matching improves PP fidelity.

P-39. Fabrication of Near-UV Multilevel Diffractive Lenses Using Grayscale E-Beam Lithography and TASTE

Cecilia R. Fasano, Chi C. Cheung and Marc Christopherson, Naval Research Laboratory

The evolution of grayscale lithography enables the creation of more complex 3D structures. We report on efforts to use grayscale electron beam lithography in combination with thermally activated selective topography equilibration to fabricate multilevel diffractive lenses in (PMMA) for use in the near-UV where PMMA exhibits high transmission.

P-16. Quantitative Evaluation of Patterning Resolution Capability Using Partially Resolved Regions

Aki Mukai, Yoshiyuki Negishi, Hideki Matsui, Yoshinori Kojima, NuFlare Technology, Inc.

In the conventional evaluation criteria, Isolated Space (IS) minimum resolution was evaluated whether the pattern penetrated into the bottom across the entire CD-SEM top-view image.This method is insufficient to show slight improvements. Therefore, we focused on the pattern partially resolved regions to determine a new method for quantification.

Electron/Ion Sources and Optics

P-107. Ion Implantation into Semiconductors using Ionic Liquid Ion Sources

Shaun Boodram, Alex Storey, Aydin Sabouri and Carla Perez Martinez, University College London

This work will present atom probe tomography (APT) data showing ion implantation into semiconductor substrates caused by irradiation with Ionic Liquid Ion Source (ILIS) beams. ILIS. ILIS are needle devices which utilise field evaporation to produce a beam of ions from ionic liquids, defined as room temperature molten salts.

P-6. Transmission Electron Gain of Si_3N_4 Thin Films

Y. Ping, Y. Li, Y. Wu, Y. Liu, H. Zhao, L. Han, Chinese Academy of Sciences

Ion Beam Lithography

P-142. Characterizing Environmental Vibration Impacts on Electron-Beam Lithography Using Exposure-Induced Pattern Signatures

Jingyu Huang, Chenhui Deng, Bohua Yin, Li Han, Chinese Academy of Sciences

We propose a process-based method to quantify environmental vibration in electron-beam lithography by extracting edge displacement from printed nanopatterns and analyzing its frequency spectrum. Correlating vibration features with LER/LWR and placement errors enables in situ monitoring, sensitivity tuning via exposure parameters, and practical vibration mitigation without dedicated sensors.

Metamaterials, Metasurfaces & Flat Optics

P-80. Enabling Rapid Nanofabrication of Large-Area Metasurfaces by Innovative Algorithmic EBL Patterning

Frank Nouvertné, Michael Kahl and Volker Boegli, Raith GmbH

Metalenses and metasurfaces enable compact flat optics but face severe EBL scaling limits due to massive GDSII data. A new algorithmic, formula-based EBL workflow generates patterns on-the-fly, drastically reducing data overhead and enabling rapid fabrication of large, complex meta- and other formula defined surfaces up to 50 mm in size.

Metrology, Microscopy

P-14. Aberration Measurement Using Imaging with Electron Beam Landing-Angle Sweeping

Zh. H. Cheng (1), S. Tanaka (1), K. Hitomi (1), H. Takayanagi (1), T. Iwatsuka (1), R. Kadoi (1), H. Dohi (2), M. Mita (2), H. Tanabe (2), (1) Hitachi, Ltd., (2) Hitachi High-Tech Corporation

A novel fast aberration measurement method that combines imaging, based on two-dimensional sweeping of the electron beam landing angle on the sample, and image processing techniques, is proposed. The method is validated experimentally through measuring the excitation sensitivity of an aberration corrector incorporated into an SEM (Scanning Electron Microscope) apparatus.

P-117. Automated SEM metrology workflows for lithography and nanofabrication

M. Chahid (1), A. Peyyety (2), P. Weber (2), S. Bauerdick (2), Z. Benes (1), (1) École Polytechnique Fédérale de Lausanne, (2) GenISys GmbH

Automated SEM-based imaging and metrology workflows are presented for wafer-scale process characterization in shared nanofabrication facilities. Combining layout-based navigation, robust autofocus, and image-to-layout matching, the approach enables rapid inspection and quantitative CD metrology across large areas, demonstrated on 4-inch wafers for EBL, etching, and optical lithography processes.

P-99. Efficiency Improvement of EUV Diffractive Optical Elements for High-Throughput Imaging

Weilun Chao, Farhad Salmassi, Sarath Samudrala, Martin Izquierdo and Eric M. Gullikson, Lawrence Berkeley National Laboratory

Diffractive optical elements (DOE) are powerful and versatile optics. In the presentation, we will discuss our long-term project of developing nanofabrication processes for EUV phase zoneplates with up to five-fold efficiency improvement.

P-56. Method and Apparatus for Defect Analysis In-line Optical Scatterometry

Juan Faria Briceno and Steve Brueck, University of New Mexico

Roughly 20% of the processes in high-volume IC fabrication focus on metrology. New fabrication techniques such as roll-to-roll (R2R) processes are being developed for manufacturing large-area nanotechnology products such as wire-grid polarizers (WGP), metal-mesh grids, and metamaterials.

P-91. Modeling Sputter Improves Particle Beam Microscopy

Chibuike Ezeokoli and John Murray-Bruce, University of South Florida

We introduce a new modeling paradigm for particle beam microscopy that incorporates sample damage due to sputtering. Novel estimators for both single and time-resolved measurement are developed and analyzed. Damage-aware estimators are shown to outperform their damage-oblivious counterparts, with the damage-aware time-resolved maximum likelihood estimator achieving the best imaging performance.

P-38. Prediction of Critical Dimensions of 3D Structures in CD SEM Metrology Based on LSTM Neural Network

Zheng Luo (1, 2), Sa Liu (1, 2), Delong Chen (1), Zhuming Liu (1), (1) Institute of Semiconductors, Guangdong Academy of Sciences, (2) School of Electronics and Information Engineering, Wuyi University

To address the challenges of measuring the critical dimensions of three-dimensional structures with critical dimension scanning electron microscopy (CD-SEM), a cascaded model based on Long Short-Term Memory (LSTM) networks, which aims to enhance accuracy, is proposed. Results indicate that the predictive method has high accuracy.

Nanoelectronics

P-135. Optimization of Zirconium doped Hafnia-Based Ferroelectric Capacitive Memories via Thermal Annealing

Ziyi Wang, Tarun Maredla, Daniel Sabrsula, Ana Cohen, David Barth, and Lucas Barreto, Singh Center for Nanotechnology, University of Pennsylvania

We investigate the impact of thermal annealing on Zr-doped Hafnia capacitors. Devices are fabricated with varying annealing temperatures and durations to study their influence on phase transformation and ferroelectric performance. We measure hysteresis loops, PUND, and endurance behavior to evaluate remanent polarization, coercive field under different annealing conditions.

Nanofabrication for Biology, Nanomedicine & Implantable Devices

P-60. Cost-Effective Antimicrobial Surfaces Patterned by Interference and Nanoimprint Lithography

S. Triepke (1), L. Suttey (1), J. Andriolo (1), J. Skinner (1), B. Burckel (2), (1) Montana Technological University, (2) Sandia National Laboratories

This work uses a custom low-cost interference lithography tool combined with nanoimprint lithography (NIL) to create surfaces that demonstrated effective antibiofouling and bactericidal properties. The pattern will be transferred to clear polycarbonate using NIL. Growth of Pseudomonas aeruginosa and Staphylococcus aureus will be quantified with confocal microscopy.

Nanofabrication for Quantum

P-18. Integration of Electron-Beam Lithography and Atomic Layer Etching for Nanoscale Fabrication

Xinwei Wu, Jeremy Clark and John Treichler, Cornell Nanoscale Facility

We investigate Atomic Layer Etching (ALE) integrated with electron-beam lithography for sub-100 nm pattern transfer. Various ALE recipes using several industry-standard e-beam resists are evaluated for etch profiles, rates, and selectivity. The results provide insights on optimizing precision, selectivity, and damage control for nanoscale patterning and fabrication.

P-43. Nanofiber Gamma Ray Sensors via Lead-Based Perovskite Quantum Dots

Chase R. Benner (1, 2), Xavier T. Vorhies (1, 3), Kiyo T. Fujimoto (4), Jack L. Skinner (1), Jessica M. Andriolo (1, 2), (1) Montana Tech Nanotechnology Laboratory, Montana Technological University, (2) Mechanical Engineering, Montana Technological University, (3) Materials Science Ph.D., Montana Technological University, (4) Idaho National Laboratory

A study on the synthesis of CsPbCl3 quantum dots through the ion substitution of chloride into CsPbBr3 PQDs. The PQDs are dispersed in a variety of solvents and electrospun into a polymer fiber matt for use as a scintillating layer for gamma ray detection.

Nanoimprint Lithography

P-125. Fabrication of Antireflective Silver Mesh Electrode with Moth-Eye Structure by Combination of Photolithography and Nanoimprint Lithography

Takuto Wakas, Jun Taniguchi, Tokyo University of Science

A novel process integrates moth-eye nanostructures into non-electrode regions of silver mesh transparent electrodes, preserving conductivity while significantly improving optical properties. Transmittance increases from 81% to 88% and reflectance decreases from 4.6% to 0.7%, enhancing visibility for touch panel and transparent electrode applications.

P-11. Fluorescence-intensity histogram characterizing uniformity of imprint resist patterns with different pattern-density distributions

Daisuke Tojima, Narumi Ono, Akiko Onuma, Masaru Nakagawa, Tohoku University

In this sturdy, fluorescent imprint patterns with different pattern-density distributions were fabricated via microprint and nanoimprint methods. The height distributions of the imprint resist patterns were visualized by fluorescence imaging. The fluorescence-intensity histograms allowed the characterization of differences in height uniformity of the imprint patterns.

P-10. Infiltration behaviors of trimethoxysilane derivatives into spin-on-carbon thin films analyzed by TOF SIMS

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In this study, we investigated the modification of spin-on-carbon (SOC) surfaces with adhesion molecules of trimethoxysilane derivatives to anchor nanoimprint resin patterns by time-of-flight secondary ion mass spectrometry (TOF-SIMS). The presence and absence of modification with 3-acryloyloxypropyltrimethoxysilane (AcPTMS) determines the feasibility of resist pattern formation.

P-83. Silicon Mold Improvement by Hydrogen Annealing for Low-loss PIC Fabrication Utilizing Nanoimprint Lithography

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We fabricated silicon mold with hydrogen annealing and analyzed pattern roughness with SEM image processing. By comparing the power spectral density of the sidewall roughness of silicon molds, we found that during hydrogen annealing process the roughness with spatial frequency between 100 to 1000 nm has been suppressed.

Nanophotonics, Micro-optics, Plasmonics

P-134. Challenges and optimization in using HSQ as etch mask for on-chip AlN waveguides fabrication for photonic devices

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Pattern transfer in AlN photonics is challenged by the material's hydroxide-based developer susceptibility and reactive ion etch resilience, which renders conventional processing methods common to silicon photonics ineffective and necessitates several mitigation strategies. These challenges are overcome by optimizing EBL dose, adding protective stacks, and leveraging chemistry-dominant ICP-RIE.

P-76. Fabrication of Waveguides on Porous Nanolattice Films for Low-Index Photonic Integration

Nayoung Ki, Chih-Hao Chang, University of Texas at Austin

To boost integrated-photonic waveguide confinement for VR/AR, we integrate mechanically robust, near-air-index porous nanolattice films beneath SU-8/SiO_2 waveguides. We fabricated waveguides on nanolattices using colloidal 3D lithography, ALD, planarization, photopatterning and controlled dry etching. We will discuss process modifications improving region targeting and etch reliability, enabling optical-loss and mode-confinement measurements.

Resists & Materials

P-63. Choline hydroxide as a non-toxic, metal-ion-free alternative developer to TMAH for photoresists and HSQ

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Tetramethylammonium hydroxide (TMAH) is the predominant metal-ion-free developer used in the manufacture of semiconductors. However, it poses significant acute toxicity and environmental disposal challenges. Choline hydroxide, a chemically similar compound, presents a non-toxic alternative. This study evaluates its performance using positive and negative photoresists, as well as hydrogen silsesquioxane (HSQ).

Simulation, Modeling, & Design Tools for Nanofabrication

P-167. Extended reality activities for nanofabrication education

Joshua W. Stoner, Zhuolin Yang and Gina Adam, The George Washington University

Using Extended Reality (XR), we are focusing on enhancing the training experience for a memristor nanofabrication process flow. Leveraging spoken instructions, segmented views of the tool, and real-time feedback on student performance, this system aims to facilitate a comprehensive and multifaceted educational experience.

P-113. Statistical Analysis of PECVD SiO_x Deposition Rate and Refractive Index Using Design of Experiments

Tarun Maredla, Rohit Surikuchi, David Barth and Lucas Barreto, Singh Center for Nanotechnology, University of Pennsylvania

A 2^4 factorial DOE was used to quantify how PECVD parameters affect SiO_x thin film deposition rate and refractive index. Significant main effects and interactions revealed strong plasma-chemistry coupling, enabling accurate regression models and improved process control beyond one factor at a time tuning.