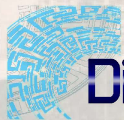
MAEBL
MEETING FOR ADVANCED E-BEAM LITHOGRAPHY

THE UNIVERSITY OF CHICAGO
PRITZKER SCHOOL OF MOLECULAR ENGINEERING

Also Accessible Online for Virtual Attendees
Tuesday-Thursday, September 12-14, 2023

Charter Sponsors



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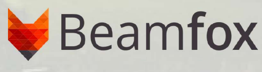
Regular Sponsors



THE 2023 MEETING FOR ADVANCED ELECTRON BEAM LITHOGRAPHY
Registration: maebl.eventbrite.com | Hotel Room Reservation: The Study at Universtiy of Chicago

Friday, April 14, 2023

Dear Colleagues:

What grew from a simple experiment, the **Meeting for Advanced Electron Beam Lithography**, affectionately known as MAEBL, is now in its *seventh consecutive year,* and our friends at the **University of Chicago** (UChicago) **Pritzker Nanofabrication Facility** (PNF) will host the hybrid meeting on **September 12-14, 2023**. This year's main program will run for 2.5 days. On the first day, attendees are invited to participate in a tour of the UChicago's PNF and a discussion segment on lab operations for those arriving early and attending in person. The event's second day will feature the MAEBL Foundations Workshop for electron beam lithography (EBL) beginners. The final component of the event is the MAEBL Core Meeting to discuss advanced state-of-the art techniques. The registration cost is the same for in-person and online attendees. Included again in this year's registration is access to our regional MAEBLx meetings along with our commemorative t-shirt. New this year is the reduced student registration rate to strongly encourage students to take advantage of this year's program. The student rate is 50% of the normal full registration fee.

Last September at Caltech, the meeting garnered a record-breaking 100+ attendees spanning 9 countries and 65 organizations, which includes 39 academic institutions, 10 industry organizations and 16 government laboratories. Most hailed from the United States followed by Australia and Canada. Others represented France, India, Romania, Saudi Arabia, Switzerland, and the United Kingdom. We received an in-person invited talk by our inaugural MAEBL Travel Award Recipient, Dr. Michael Stuiber, a process engineer at the Melbourne Centre for Nanofabrication in Australia. In addition to the hybrid meeting, two MAEBLx meetings for Asia Pacific and Europe organized before and after the meeting, respectively, fostered community growth. These *bonus meetings*, consisting of structured talks and casual discussions, were scheduled in their respective time zone to promote regional engagement. Lastly, as part of our growth, we welcomed Dr. Allison Dove, a process engineer at the Marvell Nanofabrication Laboratory at the University of California Berkeley, to our MAEBL Board of Directors. Her ideas, experience, energy and enthusiasm have been welcomed. Unwittingly, the MAEBL Board of Directors now represent tool owners of major EBL vendors: Crestec, JEOL, RAITH and STS-Elionix.

We are extremely grateful to our sponsors whose generous support helps us cover the expenses for the venue, t-shirts, food and beverages, registration assistance, and other essential services. Without their unwavering support, it would be impossible for MAEBL to continue expanding its reach and attracting as many attendees as it does. Our sponsors play an integral role in the success of our event, and we deeply appreciate their invaluable contribution. We continue to be humbled by the overwhelming appreciation and support we received from the entire community and hope to see you online or in person in the near future.

Sincerely,
The MAEBL Board of Directors

Aimee Price, President & Co-Founder, MAEBL (The Ohio State University)
Guy Derose, Vice President, MAEBL (California Institute of Technology)
Mason Risley, Secretary, MAEBL (formerly Carnegie Mellon University)
Justin Wirth, Technology Officer, (Purdue University)
Gerald Lopez, Board Chair, Treasurer & Co-Founder, MAEBL (The University of Pennsylvania)
Mark Mondol, Board Member, MAEBL (Massachusetts Institute of Technology)
Allison Dove, Board Member, MAEBL (University of California, Berkeley)

MAEBL Community Code of Conduct

MAEBL is committed to providing a safe and inclusive community environment for professional networking, an open exchange of EBL related experiences and ideas, and mutual learning and education.

In order to maintain a welcoming space and community, the following types of conduct are not tolerated at MAEBL meetings, at gatherings related to MAEBL meetings, or in MABEL community platforms:

- **Harassment**: unwelcome conduct that undermines a safe and inclusive community environment, especially based on factors of a person's identity unrelated to MAEBL's mission.
- **Sexual Harassment**: unwelcome romantic or sexual advances, behavior, or comments.
- **Discrimination**: exclusion of a person based on factors of a person's identity unrelated to MAEBL's mission.
- **Retaliation**: punitive treatment of a person for bringing attention, in good faith, to conduct that undermine a safe and inclusive community environment.

Acts of harassment, sexual harassment, discrimination, or retaliation are encouraged to be reported to a member (or members) of the MAEBL board, will be taken seriously, and will be investigated.

Substantiated instances of conduct contrary to community expectations will be handled by members of the MAEBL board addressing and challenging the conduct with the transgressing person and explaining conduct expectations. It is expected that the person will change future conduct to be mindful of and consistent with community expectations.

Repeated, bad faith, or exceptionally serious conduct may necessitate exclusion from the community for an appropriate period of time. Bad faith claims are themselves considered to be harassment; good faith claims that are not substantiated are not considered harassment and are protected from retaliation.

REGISTRATION and QUALIFICATIONS TO REGISTER

Registration helps to offset the operational costs of the meeting series. All active EBL tool owners and users from academic, industrial, or government institutions/organizations are encouraged to attend. To promote intimate dialogue, we have kindly requested that EBL hardware vendors refrain from registering as attendees. Attendance is granted to organizers, speakers, and non-EBL-hardware vendor sponsors who register to attend. Advance online sign-up is required to participate as there will be no on-site registration. Please be mindful that we are a volunteer operated non-profit organization. **A single registration is for an individual, not an organization, and is not transferable.** Anyone wishing to attend must register under their own name. An attempt to transfer registration undermines our mission and capacity to organize meetings for the international electron beam lithography community.

Attendee Registration Type	Description	Cost	Deadlines
Full Registration (Virtual or In-Person)	All access to MAEBL 2023 and MAEBLx meetings. One t-shirt is included in the cost.	**$175** per attendee online or in person	In-Person: September **6**, 2023 Virtual: September **8**, 2023
Student Registration (Virtual or In-Person)	All access to MAEBL 2023 and MAEBLx meetings. One t-shirt is included in the cost.	**$87.50** per student attendee online or in person	
Invited Speakers and Organizers	All access to MAEBL 2023 at UChicago, MAEBLx Meetings. One t-shirt is included.	**Free**	
Vendor Sponsorship	Logo on website, and other collateral material including a one page ad in the MAEBL 2023 program.	**$600** per vendor	**August 1, 2023 to be on T-Shirt**

Register at maebl.eventbrite.com. Book your stay at The Study at Universtiy of Chicago by August 11, 2023.

MAEBL 2023 PROGRAM AT-A-GLANCE

Scheduled Date	Time	Description	Online	In-Person
Wednesday, May 3, 2023	1-4p EDT	MAEBLx EBL Vendor Applications	✔	
Thursday, July 27, 2023 (PDT, CDT, EDT) Friday, July 28, 2023 (CEDT, AEDT)	2-4p AEDT	MAEBLx Asia-Pacific	✔	
Tuesday, September 12, 2023	2-5p CDT	**MAEBL 2023 Host Tour & Operations***	✔	✔
Wednesday, September 13, 2023	9a-5p CDT	**MAEBL 2023 Foundations Workshop**	✔	✔
Thursday, September 14, 2023	8a-5p CDT	**MAEBL 2023 Core Meeting**	✔	✔
Wednesday, November 15, 2023	2-4p EST	MAEBLx North America	✔	

*The host tour will not be made available online.

VENUE INFO

MEETING

University of Chicago
William Eckhardt Research Center
Room 161
5640 South Ellis Avenue
Chicago, IL 60637

HOTEL

MAEBL has room blocks reserved at **The Study at University of Chicago**
1227 E 60th St
Chicago, IL 60637

Book Your Room by:
August 11, 2023
Book Reservations Here

Booking with our hotel using the link above allows MAEBL to obtain courtesy blocks for future meetings.

CAMPUS NORTH
MAEBL
MEETING FOR ADVANCED E-BEAM LITHOGRAPHY
CAMPUS WEST
MAIN QUADRANGLES
CAL CAMPUS
The Study at University of Chicago
CAMPUS SOUTH
Charter School
S DREXEL BLVD
S ELLIS AVE
S UNIVERSITY AVE
S WOODLAWN AVE
S KIMBARK AVE
S INGLESIDE AVE

POLICIES

COVID-19 POLICY

The health and safety of the MAEBL community are our primary concern. All attendees must abide by the host institution policies for on campus engagement (https://goforward.uchicago.edu/visitor-information). If you are attending in person, the host institution may require each attendee to be fully vaccinated and boosted. All attendees have the option to wear a face-covering regardless of vaccination status. In the event of contact tracing, your information may be shared with the MAEBL Board, host, or any other responsible entities.

EBL VENDOR INDEPENDENCE

While we are strongly supported by EBL hardware vendors, MAEBL's longstanding policy limiting attendance to only their users and tool owners has allowed for open intimate conversation across platforms. As such, **we have kindly requested that EBL hardware vendors to refrain from registering as attendees**. Attendees have come to appreciate the intimate environment created for our community. It is understood that there are larger conferences with more generous schedules and bigger budgets that allow for vendor engagement through formal exhibition.

REFUND and REGISTRATION TRANSFER POLICY

No refunds will be issued. Please be mindful that we are a volunteer operated non-profit organization. **A single registration is for an individual, not an organization, and is not transferable.** Anyone wishing to attend must register under their own name. An attempt to transfer registration undermines our mission and capacity to organize meetings for the electron beam lithography community. Thank you for your cooperation and understanding of this matter.

VIDEO RECORDING POLICY

To encourage attendance and participation, there is no video recording of the MAEBL meetings. We do this to respect the privacy and confidentiality of the opinions shared in our open discussions.

PRIVACY POLICY

In case of contact tracing or room block fulfillment, your contact information may be shared with responsible entities. For all other purposes, your registration information will not be distributed without your consent.

Day 0: Host Facility Tour + Operations (Online + In Person)*

September 12, 2023 (CDT): For those arriving early in person, attendees are invited to participate in a tour of the The University of Chicago Pritzker Nanofabrication Facility and partake in discussion on lab operations.

University of Chicago, William Eckhardt Research Center, Room 161, 5640 South Ellis Avenue, Chicago, IL 60637

PDT (Sept 12)	CDT (Sept 12)	EDT (Sept 12)	CEDT (Sept 12)	AEDT **(Sept 13)**	Topic	Facilitator
12:00	**14:00**	15:00	21:00	05:00	**Pritzker Nanofabrication Facility Tour** (In-Person only)	Peter Duda, Technical Director Pritzker Nanofabrication Facility University of Chicago
13:00	**15:00**	16:00	22:00	06:00	Quick Break and Transition to Room 161	
13:10	**15:10**	16:10	22:10	06:00	Welcome	Aimee Price and Guy DeRose MAEBL Board
13:15	**15:15**	16:15	22:15	06:15	**OPERATIONAL METRICS** Insights from Lab Usage History	Gerald Lopez University of Pennsylvania
14:00	**16:00**	17:00	23:00	07:00	**EBL TRAINING** A Panel Discussion on EBL Training & Methods	Allison Dove University of California, Berkeley
14:45	**16:45**	17:45	23:45	07:45	Wrap-Up / Announcements	
15:00	**17:00**	18:00	00:00	08:00	Adjourn	

*Program is subject to change without notice.

Day 1: MAEBL Foundations Workshop (Online + In Person)*

September 13, 2023 (CDT): All e-beam lithographers are invited to participate in Day 1 to learn, brush-up or to mentor others on EBL fundamentals. Advanced attendees are encouraged to impart personal accounts and challenges to the audience to elevate the workshop experience. At the end of the meeting beginners should be conversant in EBL and are encouraged to participate in Day 2.

University of Chicago, William Eckhardt Research Center, Room 161, 5640 South Ellis Avenue, Chicago, IL 60637

PDT (Sept 13)	CDT (Sept 13)	EDT (Sept 13)	CEDT (Sept 13)	AEDT **(Sept 14)**	Topic	Facilitator
07:00	**09:00**	10:00	16:00	00:00	Light Breakfast / Coffee / Networking	
07:30	**09:30**	**10:30**	**16:30**	**00:30**	Welcome, Opening Remarks, Announcements, and Group Survey	Aimee, Guy, Peter*, Gerald, Justin MAEBL Board & UChicago*
08:00	**10:00**	11:00	17:00	01:00	**RESIST PROCESS CHARACTERIZATION** Talk 1: Contrast Curves Fundamentals Talk 2: So you think you know eta in PEC …	Leonidas Ocola IBM
09:00	**11:00**	12:00	18:00	02:00	Morning Coffee Break	
09:20	**11:20**	12:20	18:20	02:20	**TOOL SPECS AND FUNDAMENTALS** Tools, Stitching, Overlay, Placement Accuracy, etc.	David Barth University of Pennsylvania
10:00	**12:00**	13:00	19:00	03:00	Group Photo and Lunch	
11:10	**13:10**	14:10	20:10	04:10	**TOOL OPERATION** A Cross Platform Panel Discussion	Guy Derose, Caltech Vishva Ray, University of Michigan Devin Brown, Georgia Tech Fabien Grise, Penn State Allison Dove, UC Berkeley
12:50	**14:50**	15:50	21:50	05:50	Afternoon Coffee Break	
13:20	**15:20**	16:20	22:20	06:20	**RESIST OVERVIEW** EBL Resists Overview for All	Kevin Lister Consultant at kevin@eblexperts.com
14:00	**16:00**	17:00	23:00	07:00	**COMMON CHALLENGES I** Open Discussion with the Community	Mark Mondol Massachusetts Institute of Technology
15:00	**17:00**	18:00	00:00	08:00	End MAEBL Foundations	

*Program is subject to change without notice.

Day 2: MAEBL Core Meeting (Online + In Person)*

September 14, 2023 (CDT): The meeting that started it all. Engage the community's collective knowledge.

University of Chicago, William Eckhardt Research Center, Room 161, 5640 South Ellis Avenue, Chicago, IL 60637

PDT (Sept 14)	CDT (Sept 14)	EDT (Sept 14)	CEDT (Sept 14)	AEDT (**Sept 15**)	Topic	Facilitator
06:00	**08:00**	09:00	15:00	23:00	Networking, Coffee and Light Breakfast	
07:00	**09:00**	**10:00**	**16:00**	**00:00**	Welcome, Opening Remarks, Announcements	Aimee, Guy, Gerald, Justin MAEBL Board
07:30	**09:30**	10:30	16:30	00:30	Group Survey	Aimee Price The Ohio State University
07:45	**09:45**	10:45	16:45	00:45	**A Bright Idea: Understanding Contrast in Electron Beam Lithography**	Devin Brown Georgia Institute of Technology
08:15	**10:15**	11:15	17:15	01:15	**Pritzker Nanofabrication EBL Characterizations**	Peter Duda, Jered Feldman University of Chicago
08:45	**10:45**	11:45	17:45	01:45	*Morning Coffee Break / Common Challenges Survey*	
09:15	**11:15**	12:15	18:15	02:15	**Negative Resists for EBL and EUV**	Scott Lewis California Institute of Technology
09:45	**11:45**	12:45	18:45	02:45	Group Photo and Lunch	
11:00	**13:00**	14:00	20:00	04:00	**Measuring and Optimizing Ebeam System Gains and Troubleshooting System Noise**	Ivan Milosavljevic, Elias Flores HRL Laboratories
11:30	**13:30**	14:30	20:30	04:30	**Changing the Focal Plane: Electron Beam Lithography on Non-Planar Substrates**	Vishva Ray University of Michigan
12:00	**14:00**	15:00	21:00	05:00	*Afternoon Coffee Break*	
12:30	**14:30**	15:30	21:30	05:30	**Understanding and Mitigating PMMA Bubbling**	David Barth University of Pennsylvania
13:00	**15:05**	16:05	22:05	06:05	**TASTE Testing: Grayscale Lithography & Thermal Reflow for 3D Patterning**	Jake McCoy Pennsylvania State University
13:40	**15:40**	16:40	22:40	06:40	**COMMON CHALLENGES II** Open Forum Discussion of Common Issues	Guy DeRose California Institute of Technology
14:40	**16:40**	17:40	23:40	07:40	Closing Remarks - Continued Discussion and Networking	
15:00	**17:00**	18:00	00:00	08:00	End MAEBL Core	

*Program is subject to change without notice.

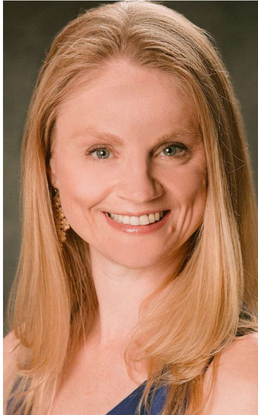
MAEBLx North America (Online Only)*

November 15, 2023 (EDT): MAEBLx EBL North America is organized in EDT. All are welcome to attend. Major participating timezone hours are listed.

PST (Nov 15)	CST (Nov 15)	EST (Nov 15)	CET (Nov 15)	AET (Nov 16)	Topic	Facilitator
10:00	12:00	**13:00**	19:00	03:00	Login and Online Networking	
11:00	**13:00**	**14:00**	**20:00**	**04:00**	Welcome, Opening Remarks, Announcements	Aimee Price and Guy DeRose MAEBL Board
11:15	13:15	**14:15**	20:15	04:15	**Accurate Measurements of the Process Point-Spread Function for Electron-Beam Lithography**	Søren Stobbe Chief Scientific Officer, Beamfox
12:00	14:00	**15:00**	21:00	05:00	**ADVANCED PROCESSING** Curved Substrate Patterning	Fabien Grisé The Pennsylvania State University
12:45	14:45	**15:45**	21:45	05:45	Discussion and Closing Remarks	
13:00	15:00	**16:00**	22:00	06:00	**Adjourn**	

*Program is subject to change without notice.

MAEBL Founders & Board of Directors



Aimee Bross Price (MAEBL Co-Founder, President, and Board Member) is the Manager for Nanofabrication at The Ohio State University Nanotech West Lab. She joined Ohio State in 2005 as a Senior Research Associate responsible for electron beam lithography (EBL). She has been a Member of Technical Staff with the Institute for Materials Research (IMR) since its inception. She has extensive experience in semiconductor device fabrication, nanofabrication, process development, and process design and troubleshooting. Aimee is passionate about training the next generation of technology experts and believes that encouraging and motivating K-12 students is crucial for continued growth in the field (and it is really fun). Aimee is the 2023 and 2023 Commercial Session Chair for the International Conference on Electron, Ion and Photon Beam Technology and Nanofabrication (EIPBN). She is also the upcoming 2024 EIPBN Conference Chair. Aimee also serves as co-founder and President of MAEBL Inc, a not-for-profit corporation focused on building and enhancing the EBL community. MAEBL hosts the Meeting for Advanced Electron Beam Lithography each year, live or virtually, in various US academic sites. Prior to her arrival at OSU, Aimee spent five years at TriQuint Semiconductor (now Qorvo) in Dallas, Texas, where she was a member of the EBL group in the Process Engineering Department. She holds a B.S. in Chemistry from The Pennsylvania State University, where she did surface chemistry research with the research groups of Professors Paul Weiss and David Allara. Her current research interests in the Professor Tyler Grassman and Steven A. Ringel groups are in the area of integrated nanostructures within III-V and III-nitride epitaxial materials.

Dr. Gerald Lopez (MAEBL Co-Founder, Board Chair, Treasurer, and Board Member) is the Director of Operations and Business Development at the University of Pennsylvania Singh Center for Nanotechnology. His role creates and executes strategies that articulate the Center's values; establish the Center's operational processes; and facilitate the Center's engagement and collaboration. His professional experience encompasses litho process development and tooling as a former manager at the Singh Center's Quattrone Nanofabrication Facility; technical sales and support in direct-write lithography at GenISys, Inc.; software engineering at SITA; his former nanotechnology consultancy, Helio Nano, LLC; and his time as a graduate researcher at the Georgia Institute of Technology. Gerald is the Board Chair and co-founder of the Meeting for Advanced Electron Beam Lithography (MAEBL). Moreover, he serves in the organization and planning leadership for the International Conference on Electron, Ion and Photon Beam Technology and Nanofabrication (EIPBN) and was the 2021 Conference Chair. Today, he is one of the coordinators in the Mid-Atlantic Semiconductor Hub, a consortium aimed to elevate the region's relevance in the CHIPS and Science Act. He is passionate about education, mentorship, and connecting the next generation to nano-enabled opportunities. Gerald received his Ph.D. and M.S. in Electrical & Computer Engineering from the Georgia Institute of Technology (under the advisement of Dr. James D. Meindl and Jeffrey A. Davis) and his B.S. in Computer Engineering cum laude from the University of Maryland, Baltimore County as a Robert & Jane Meyerhoff Scholar (M9) and a Janice A. Lumpkin Scholar.

Dr. Guy A. DeRose (MAEBL Vice President and Board Member) came to Caltech from the Air Force Research Laboratory in 1994 and is now the Associate Director of Technical Operations for the Kavli Nanoscience Institute (KNI). A core mission of the KNI is to push the state-of-the-art beyond current capabilities in nanofabrication. A large part of his daily activity includes managing two Raith EBPG electron beam lithography systems, from routine operations to training users, and coordinating maintenance with other technical staff and vendors. His research includes using electron-beam lithography and anisotropic etching to fabricate semiconductor lasers and nanophotonic systems and is pushing the envelope on new resist capabilities that go well beyond traditional polymer materials. Prior to joining Caltech, Guy earned his B.S. in Physics from Indiana University of Pennsylvania and M.S. and Ph.D. degrees in Physics from Case Western Reserve University. His graduate research used X-ray absorption techniques with synchrotron radiation to study the mechanical properties of thin metal films.

Mason Risley (MAEBL Secretary and Board Member) is an R&D Process Engineer with 10 years of experience in the semiconductor field having worked in both industry and academia. Specializing in device fabrication across the myriad of processing techniques involved with semiconductor manufacturing, Mason was the primary tool owner for the Carnegie Mellon University Nanofab E-Beam Lithography system between 2016-2020. Mason has been involved with MAEBL since its first meeting in spring of 2017 and joined the MAEBL board in 2021. Mason earned a Bachelor of Science in Chemical Engineering at the New Mexico Institute of Mining and Technology and a Master of Science in Chemical Engineering at the Georgia Institute of Technology.

Dr. Justin C. Wirth (MAEBL Technology Officer and Board Member) is a Research Engineer in the Birck Nanotechnology Center at Purdue University. He maintains and operates the North American demonstration JEOL JBX-8100FS, and over the last 10 years has also previously used Raith EBPG 5200 and Leica/Vistec/Raith VB6 EBL systems. His current work focuses on making EBL knowledge more openly accessible, enabling higher throughput exposures. and exploring safer developers. As a key member of the MAEBL Board, his role as its Technology Officer manages the technology stack used in MAEBLpedia, the MAEBL Wiki.

Mark K Mondol (MAEBL Board Member) joined Prof. Hank Smith's NanoStructures Lab at MIT in 1990. He soon took over operation of a 50keV, LaB6 tool donated by IBM's e-beam lithography research group. In 2000 he received the first Raith 150 tool in North America, making 2 tools available to MIT e-beam lithographers. In 2012 MIT purchased an Elionix 125 keV tool and a decade later a 50 keV tool, which he now manages for MIT.nano. Mark has given many talks and helped develop a wide array of e-beam fabrication processes. He has trained over 350 e-beam lithography users and helped guide them through their research. His previous experience with Ringling Bros. circus proved very useful in these tasks.

Dr. Allison Dove (MAEBL Board Member) is a Process Engineer at the Marvell Nanofabrication Laboratory at the University of California Berkeley. She operates and maintains a Crestec CABL-UH and a Crestec CABL-9000 tool, with past experience working on both a Raith e-line as well as a Nabity system. She strives to understand all things lithography, including a deep-UV photolithography stepper, direct write laser system, and contact aligners in addition to the EBL tools. Helping researchers select the best tool for their individual needs is especially fulfilling.

DisChem
CHEMISTRY FOR ADVANCED LITHOGRAPHY

DisCharge H2O

EBL ANTI-CHARGING AGENT

- Improved shape fidelity and positional accuracy for EBL resist patterning on insulating substrates such as fused silica, quartz, glass, PDMS, etc.
- Water based w/ excellent wetting properties. Spin coat application provides conductive film for anti-charging.
- Suitable for nondestructive SEM imaging of nonconductive materials.
- Easy residue free removal w/ water or IPA.
- Competitively priced. Ideal for both research and industrial applications.
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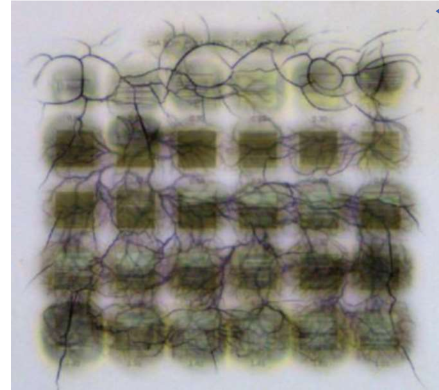
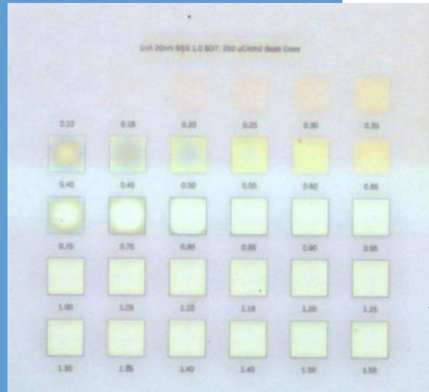


Without DisCharge: charge accumulation and sudden charge dissipation caused by exceeding the dielectric breakdown strength of the PDMS to the Si substrate resulting in significant image distortion in the resist and destruction of the PDMS surface.



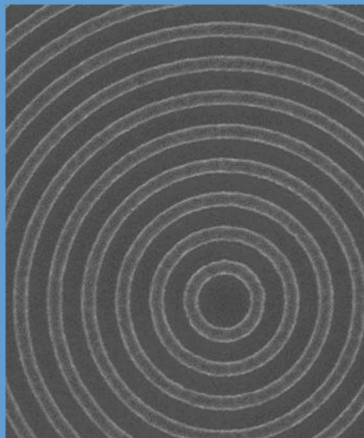
WITH DisCharge: no charge accumulation, resulting in expected image with no harm to PDMS layer.

anti-charging

H-SiQ *(hydrogen silesquioxane)*

NEGATIVE-TONE ELECTRON BEAM RESIST

DisChem H-SiQ is a negative tone hydrogen silesquioxane (HSQ) resist in MIBK carrier solvent for use in electron beam lithography (EBL). H-SiQ is characterized by excellent pitch resolution, sensitivity and etch resistance for direct write thin and thick film EBL applications. Immediate availability in quantities as low as 20 ml.

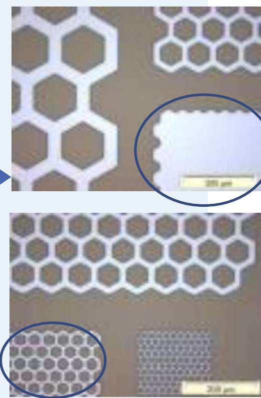


resist

SurPass

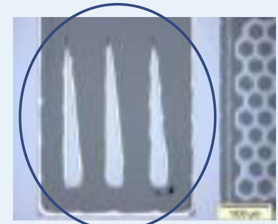
RESIST ADHESION PROMOTERS

- Improved microlithographic resist adhesion on a broad range of substrate materials.
- Improved adhesion at low doses in electron beam lithography
- Improved removal of critical substrate contaminants
- Reduced z-potential for improved resist coating properties
- Improved patterned resist mold to copper seed layer for subsequent electroforming.
- Increased adhesion of evaporated metals to substrate materials
- Non-Hazardous waterborne formulation



No Adhesion Promoter: some patterns removed during resist development.

With SurPass: Complete Precision Mask



No Adhesion Promoter Resist Mask Undercut During Etching

With SurPass: Complete Precision Mask

adhesion promotion

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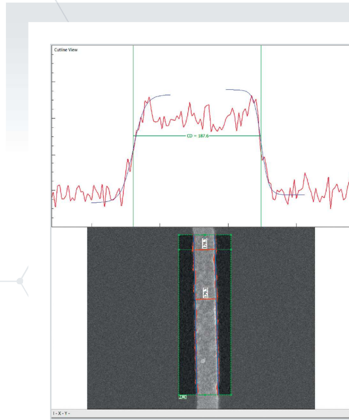
Automated Pattern & Process Metrology



Edge Detection & Contour Extraction

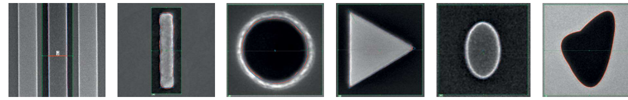
- Sigmoidal Fit
- Baseline Regression
- Parabolic Peak Fit
- Correlation-based
- Rising/falling edges

Elements & Measurements

- Lines/Spaces
- Circles, Ellipses
- Rectangles, Triangles
- Arbitrary Shapes
- Multi-edge

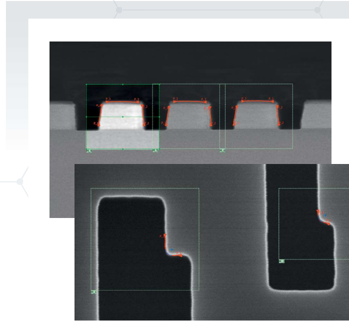
Results & Data Handling

- Results/summary tables
- User variables, formulas
- Python scripting
- Export CSV and GDS
- LER and PSD



Platform support

- Windows: 7/8/10/11, 64-bit
- Redhat/Centos Linux: 7 or 8, 64-bit
- Ubuntu Linux: 18.04 or 20.04, 64-bit



Array Measurements

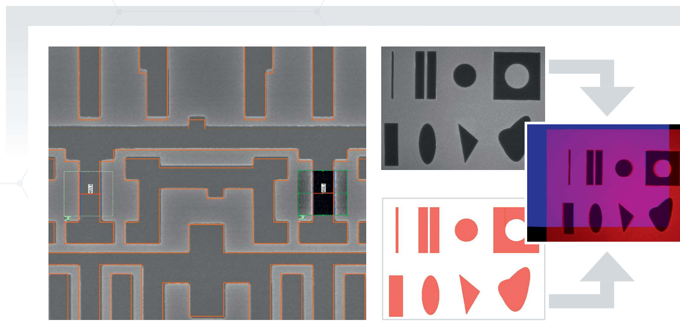
- Find similar features
- Gratings
- Rectangular arrays
- Hexagonal arrays
- Random distribution

Batch Processing

- Recipe handling
- Export and import
- User variables
- Advanced data analysis
- Plotting/reporting

Advanced Contours

- Correlation-based 2D
- Line and arc segments
- Settings per segment
- Complex calculations



Layout Formats

- GDS
- DXF
- LEDB
- OASIS
- CIF
- LTxt

Metrology support

- Lines/Spaces
- Circles, Ellipses
- Rectangles
- Auto polarity function
- Register with reference image from layout snip

Main features of SEM automated metrology

- Support of common SEM interfaces (Zeiss, Jeol, Thermofisher etc.)
- 3-point alignment of layout to sample coordinates
- Definition of combined automation & measurement list
- Automated acquisition of SEM images through ProSEM
- Automatic assignment and measurement after loading
- License at SEM and offline (PC setup on request)

Europe: **GenISys** GmbH
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82024 Taufkirchen – Germany
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Fax +49 (0)89 3309197-61
E-mail info@genisys-gmbh.com

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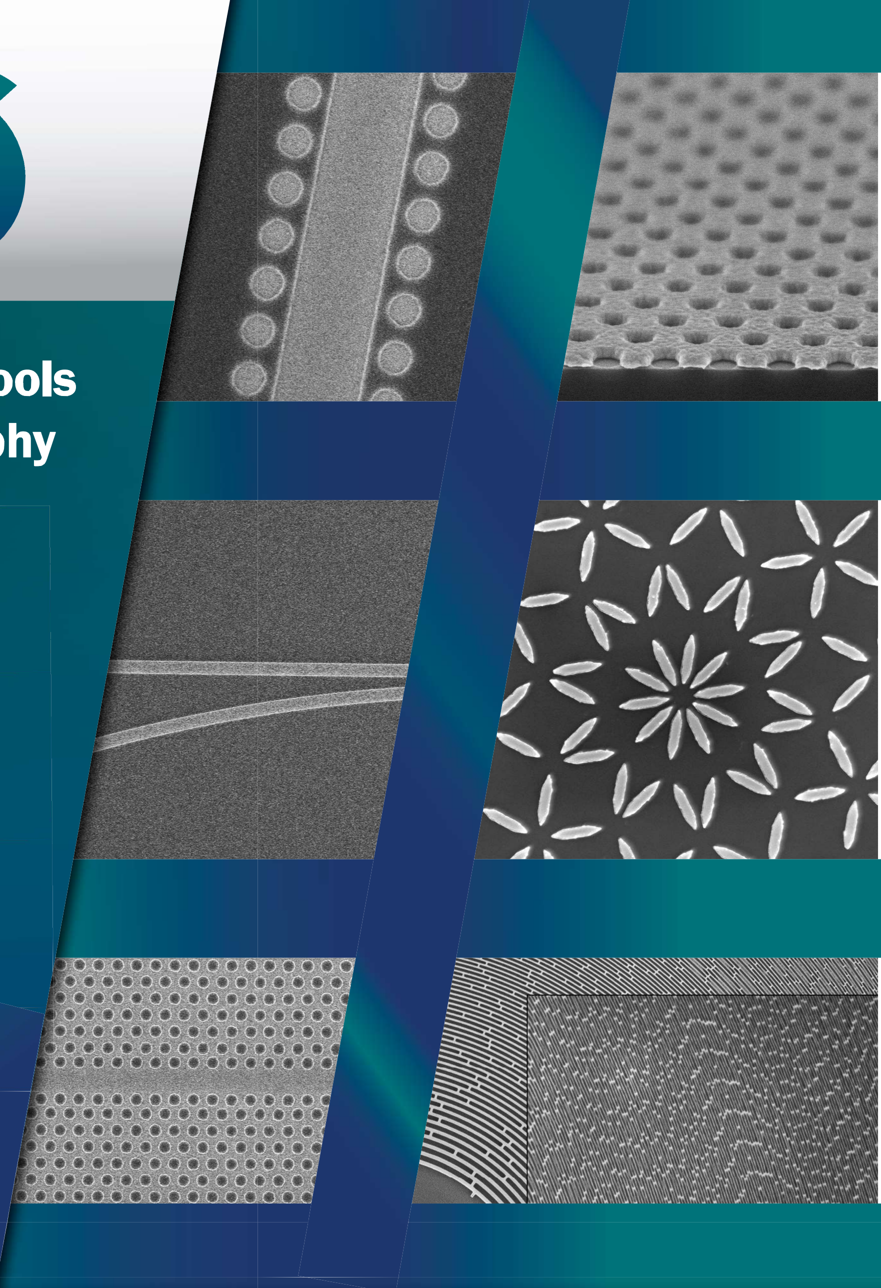

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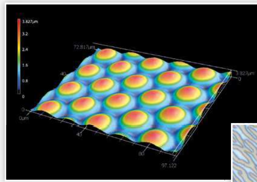
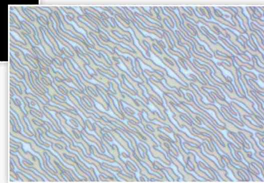
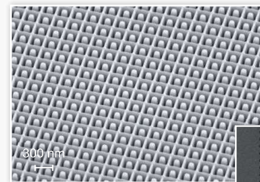
FIB



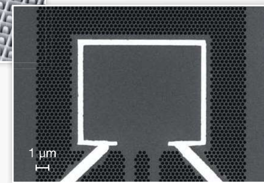
Grayscale
Lithography



Augmented/
Virtual Reality

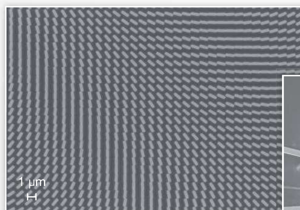


Metasurfaces

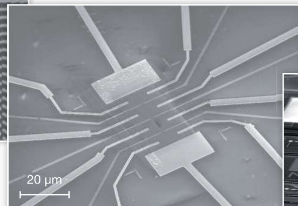


Phononic
Engineering

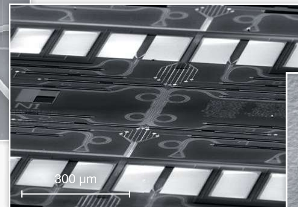
E-BEAM



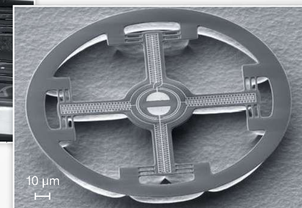
Photonics



Nanoscale
Science



Quantum
Technologies



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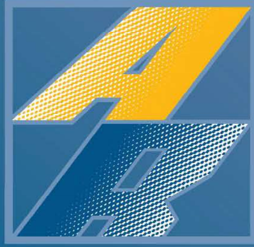

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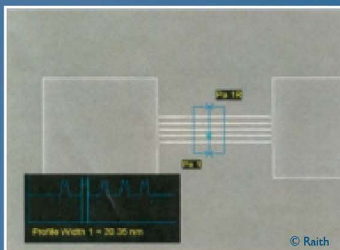
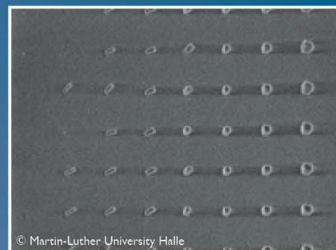
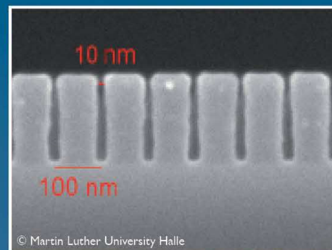


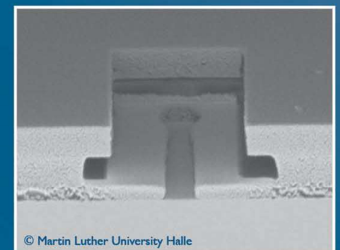
20 nm lines of HSQ, generated on quartz with Electra 92



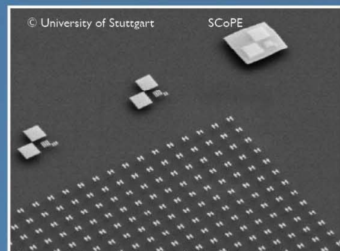
60 – 150 nm squares (height 100 nm) with AR-N 7700.08 / Electra 92 on glass



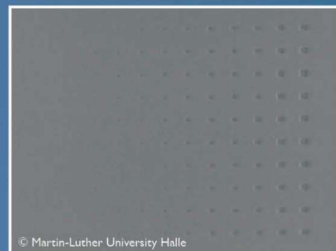
Spacing with an aspect ratio of 18; 10 nm resolution at a film thickness of 180 nm



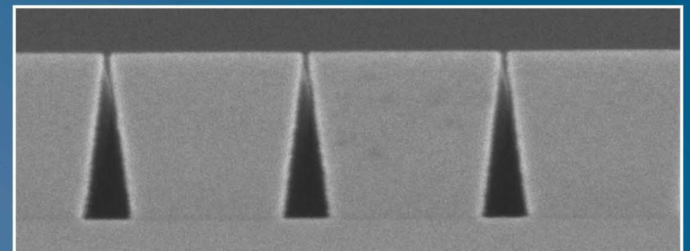
Well-defined 3D resist profile for a T-gate nanostructure with 950k PMMA (bottom) / AR-P 617 / CSAR 62



Strongly isolating polymer structures coated with Electra 92 in SEM



30 – 150 nm squares with CSAR 62 and Electra 92 on glass


Forming of lift-off structures with CSAR 62 at higher dose

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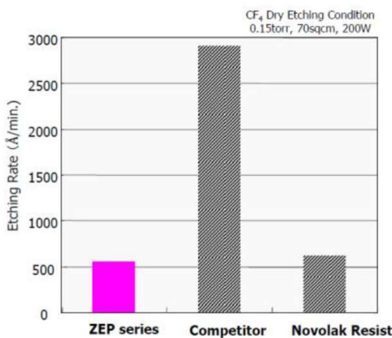
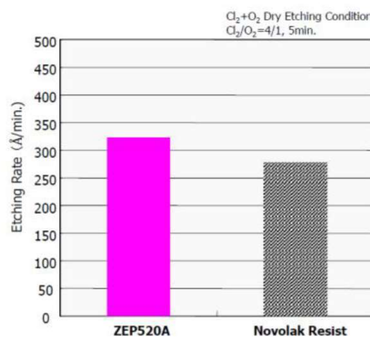
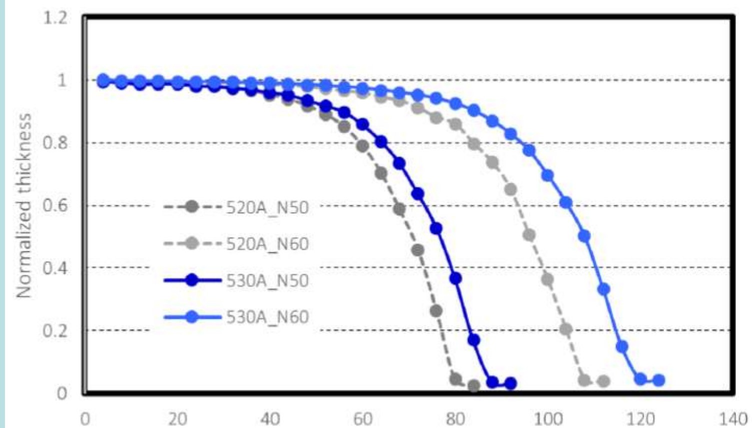
(1) CF_4 Dry Etching Rate



(2) Cl_2+O_2 Dry Etching Rate

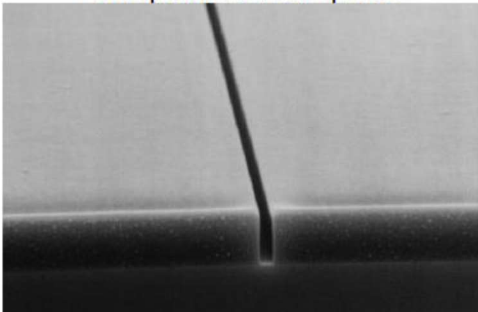


Sensitivity



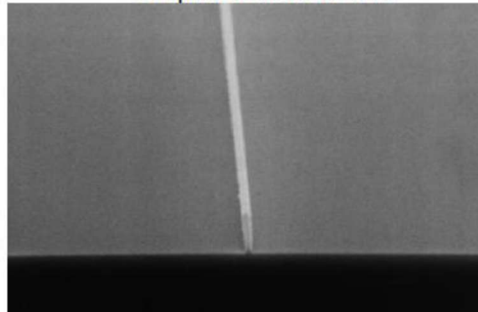
Resolution

0.15μm Isolated space



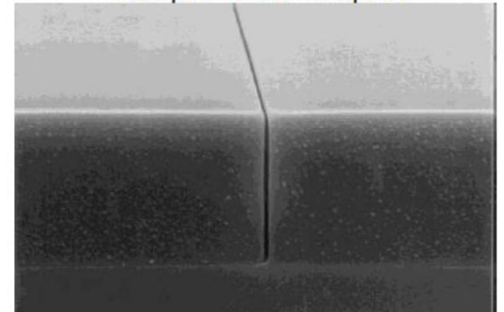
Film Thickness: 5000Å

0.1μm Isolated line



Film Thickness: 5000Å

0.05μm Isolated space



Film Thickness: 15000Å

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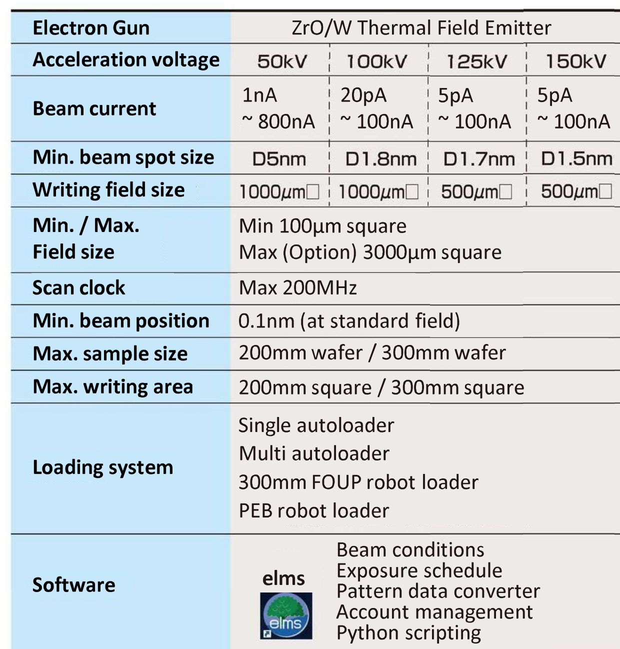

Electron Gun	ZrO/W Thermal Field Emitter			
Acceleration voltage	50kV	100kV	125kV	150kV
Beam current	1nA ~ 800nA	20pA ~ 100nA	5pA ~ 100nA	5pA ~ 100nA
Min. beam spot size	D5nm	D1.8nm	D1.7nm	D1.5nm
Writing field size	1000μm□	1000μm□	500μm□	500μm□
Min. / Max. Field size	Min 100μm square Max (Option) 3000μm square			
Scan clock	Max 200MHz			
Min. beam position	0.1nm (at standard field)			
Max. sample size	200mm wafer / 300mm wafer			
Max. writing area	200mm square / 300mm square			
Loading system	Single autoloader Multi autoloader 300mm FOUP robot loader PEB robot loader			
Software	elms: Beam conditions Exposure schedule Pattern data converter Account management Python scripting			

ELIONIX, INC.
3-7-6 Motoyokoyama-cho Hachioji Tokyo 192-0063
Japan

ELIONIX INC.

STS-ELIONIX (sts-elionix.com)
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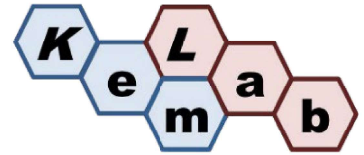
High Resolution e-Beam Positive	950K / 495K PMMA MMA (8.5) MAA	HARP™ PMMA DIRECT WRITE E-BEAM



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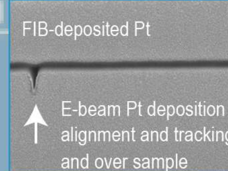

US Patent 11,261,527; other US and international patents pending

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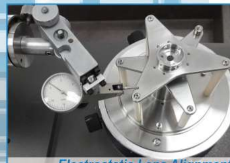

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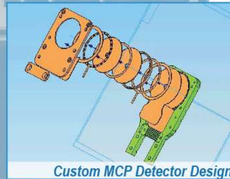
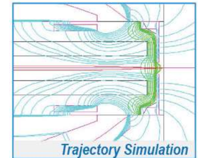
- Lenses, Deflectors, Blankers
- OEM & Custom Instrumentation
- Particle Trajectory Modeling
- Static and Dynamic Simulation



Custom MCP Detector Design

FIB Column



Trajectory Simulation

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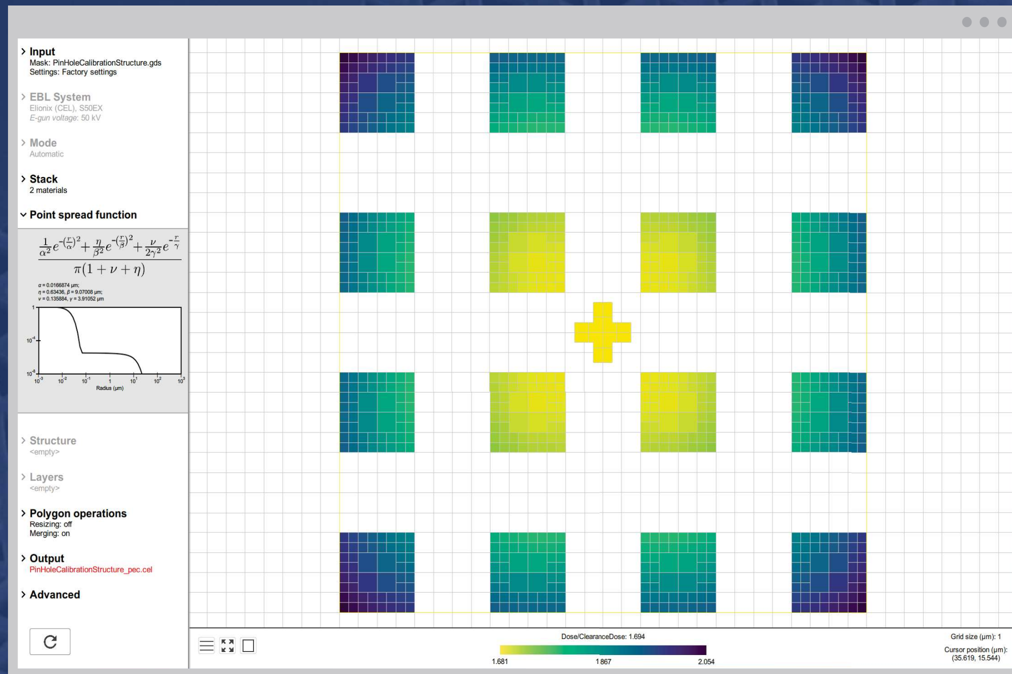

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SEM and chip design courtesy of CA Rosiek, PEC by Beamfox Proximity. See CA Rosiek et al., *Nat. Photon.* **17**, 386-392 (2023)

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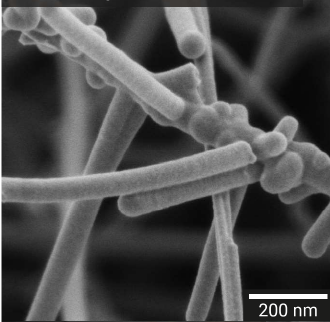
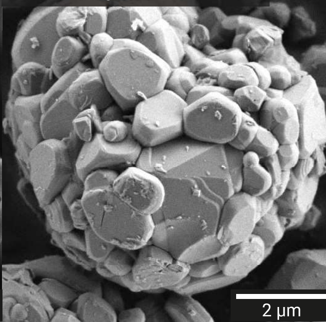
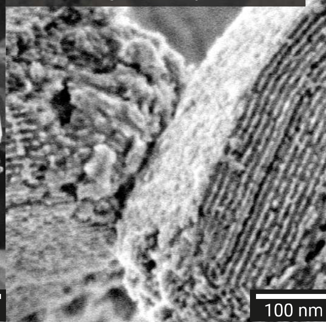


UHR SE image of Carbon Nanotubes



UHR SE image of NMC Particles



UHR SE image of Mesoporous Silica

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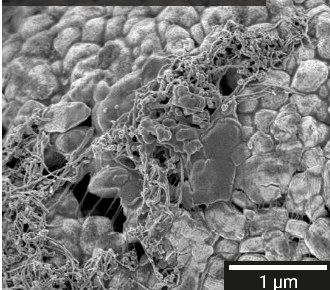

UHR SE image of the battery cathode with binder

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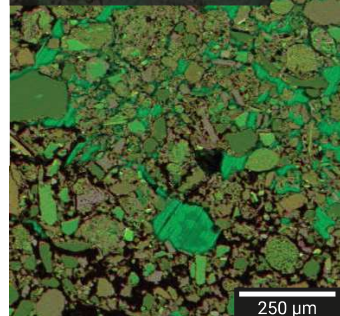
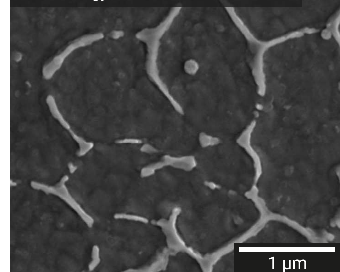
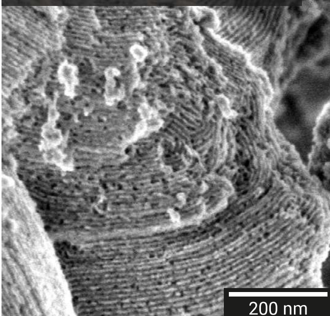


EDS map of the ancient plaster

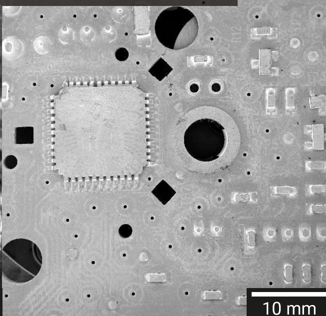
Reveal new contrast information and hidden features



UHR BSE image of grain structure in Multi-Material prepared by L-PBF Technology

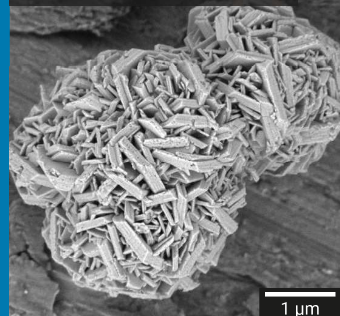


UHR SE image of Mesoporous Silica



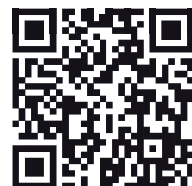
Wide Field™ image of a PCB

Obtain the right data in a short time disregard your SEM experience



UHR SE image of Li rich Ni Powder

Discover New Generation TESCAN CLARA



info.tescan.com/sem/clara

FAQ

Why aren't the talks recorded?
Engagement requires synchronous interaction which is in line with our mission. Promoting asynchronous activity by way of releasing recorded talks afterward gives rise to disengagement and poor attendance.

Why isn't there a one-day fee for admission to the event?
The answer is simple: the cost is already low compared to larger conferences. While the community of e-beam lithography is small, the community's knowledge is vast, so we encourage attendance for the entire meeting.

Can any adjustments be made on the timing of the talks and discussions with the different time zones?
The virtual registration option allows for anyone in the world to attend our meeting; however, it is not the most ideal. As an organization, we have invested time and money to leverage state-of-the-art technology to fulfill our organization's mission, especially when it comes to executing our highly interactive meetings. If you find that attending virtually is cumbersome, we encourage you to attend in person.

Why can’t EBL hardware vendors attend?
We understand there are plenty of other conferences (with bigger budgets) that have more time in their schedule to allow vendor engagement through formal exhibition. When MAEBL first started, it was vendor agnostic and time limited. This allowed for intimate discussion, one of our hallmarks and now a tradition.

I'm attending virtually and the sound quality is poor or I have trouble hearing someone, what can I do?
We've made great strides in creating an inclusive environment despite being virtual or in person or in different time zones. You need to immediately let us know using the chat that you are experiencing issues. To find out later that you couldn't hear well after the meeting is over defeats the purpose of MAEBL. Again, please let us know immediately when there's an issue.

MAEBLx EBL Vendor Applications (Online Only)*

May 3, 2023 (EDT): MAEBLx EBL Vendor Applications is organized in EDT. All are welcome to attend. Major participating timezone hours are listed.

PDT (May 3)	CDT (May 3)	EDT (May 3)	CEDT (May 3)	AEDT (May 4)	Topic	Facilitator
09:00	11:00	**12:00**	18:00	02:00	Login and Online Networking	
10:00	**12:00**	**13:00**	**19:00**	**03:00**	Welcome, Opening Remarks, Announcements	Aimee Price and Guy DeRose MAEBL Board
10:15	12:15	**13:15**	19:15	03:15	**JBX-8100FS Direct Write E-Beam Lithography System**	Shota Shimizu Technical Sales Manager, JEOL USA, Inc.
10:50	12:50	**13:50**	19:50	03:50	**Visualizing Log File Data with Python**	Robyn Seils, Ph.D. Application Scientist, Raith America, Inc.
11:25	13:25	**14:25**	20:25	04:25	Break	
11:35	13:35	**14:35**	20:35	04:35	**CABL-AP and CABL-UH: Point-Beam EBL System for Mass Production and R&D**	Hiroyoshi Sawa Technical Development Department CRESTEC Corporation
12:10	14:10	**15:10**	21:10	05:10	**Capabilities of a Python API, Case Study of Nanowire Transistors**	Lukas Stampfer, Ph.D. Application Engineer, STS-Elionix
12:45	14:45	**15:45**	21:45	05:45	Closing Remarks	
13:00	15:00	**16:00**	22:00	06:00	**Adjourn**	

*Program is subject to change without notice.

JBX-8100FS Direct Write E-Beam Lithography System

Shota Shimizu
Technical Sales Manager, JEOL USA, Inc.

JBX-8100FS direct write spot beam lithography system is suitable for a wide range of applications from research to low-volume production. The operating system has been improved to achieve simple and easy operation. This high precision compact e-beam tool is a modular and upgradeable platform, enabling you to improve the performance as your requirements progress. The acceleration voltage is upgradable to 200kV reducing the tapering effect with considerably thick resist. In exposure result, the taper effects was 150 nm at 100 kV and 85 nm at 200 kV using 5um thick PMMA resist. The taper effect of 200kV is roughly half that of 100kV.

Shota Shimizu is an application specialist for JEOL USA, Inc.. Shimizu-san is originally from JEOL Ltd.'s Spot Beam Research and Development Group in Akishima, Tokyo, after graduating from Shinshu University in Nagano, Japan, with a master's degree in physics. He was heavily involved in the final design and testing of the JBX-8100FS. He currently supports applications and training for JBX spot beam series instruments for JEOL's US and Canadian customers.

Visualizing Log File Data with Python

Robyn Seils, Ph.D.
Application Scientist, Raith America, Inc.

Electron beam lithography (EBL) tools are complex systems which require a stable environment and synchronous operation of hardware and software components to achieve high performance results. When errors are observed on a patterned wafer, it may be challenging to identify the root cause due to so many components involved, including those related to previous processing steps, resist spin coating, development, etc. Conveniently, EBL systems log numerous parameters during an exposure which may be used to understand and troubleshoot patterning errors observed post resist development. However, log files are often a lengthy text document record of various parameters which are challenging to interpret without first visualizing the data. Here we use Python scripts to parse and display relevant data recorded in an EBL exposure log file and demonstrate the utility of this data for understanding patterning outcomes.

Robyn Seils received her PhD in Materials Science and Engineering from The University of Tennessee in 2020. During her graduate studies, she spent many hours patterning nanostructures onto fragile TEM membranes in Oak Ridge National Laboratory's Center for Nanophase Materials Sciences Cleanroom facility. Electron beam lithography was a critical component of her fabrication process, and it was here that she was first exposed to EBL technology. Post PhD and with a keen interest in EBL, Robyn joined Raith America, Inc. as an Application Scientist where she primarily focuses on demonstrating the capabilities of the Raith EBPG systems for various customer applications. She is also the tool owner for the Raith EBPG5200 Plus demo system located at the Raith America International Applications Center in Troy, NY.

CABL-AP and CABL-UH: Point-Beam EBL System for Mass Production and R&D

Hiroyoshi Sawa
Technical Development Department
CRESTEC Corporation

Our CABL EBL system has advantage in writing of fine line & space Pattern with high throughput and high stability. In this talk, we describe writing performance of CABL-AP series (max. acceleration voltage of 50kV, for mass production purpose) & CABL-UH series (max. acceleration voltage of 130kV, for R&D purpose) and technology which realize such fine lithography. We also introduce the next EBL system which able to write patterns with large field size more precisely and to switch the lithography mode and the SEM mode in short time.

Capabilities of a Python API, Case Study of Nanowire Transistors

Lukas Stampfer
Application Engineer, STS-Elionix

With the emerging of more and more complex applications such as metasurfaces or superconducting qubits, it became increasingly unfeasible to design patterns by hand, thus many researchers rely now on scripting the design process through software packages in Python,Matlab or similar. Common data-preparation and process correction has also become available through a command-line interface. This lead our push to also implement a python API, which enables a lot of new options in customizing and automizing tool usage. Here we will present a short overview of our new software ELMS and its Python API. As an example of an use case we will discuss show how this Python environment can reduce processing time and steps by automizing the exposure for creating Nanowire devices such as [1], which previously suffered from considerable manual adjustments.

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MAEBL

MEETING FOR ADVANCED E-BEAM LITHOGRAPHY

THE UNIVERSITY OF CHICAGO
PRITZKER SCHOOL OF MOLECULAR ENGINEERING

Also Accessible Online for Virtual Attendees
Tuesday-Thursday, September 12-14, 2023

MAEBLx Asia-Pacific (Online Only)*

Thursday, July 27, 2023 (PDT, CDT, EDT) ⇦ **PAY ATTENTION**

Friday, July 28, 2023 (CEDT, AEDT): MAEBLx Asia-Pacific is organized in AEDT. All are welcome to attend.

PDT (Jul 27)	CDT (Jul 27)	EDT (Jul 27)	CEDT (Jul 28)	AEDT (Jul 28)	Topic	Facilitator
20:00 (Jul 27)	22:00 (Jul 27)	23:00 (Jul 27)	05:00 (**Jul 28**)	**13:00** (**Jul 28**)	Login and Online Networking	
21:00 (Jul 27)	**23:00** (Jul 27)	**00:00** (**Jul 28**)	**06:00** (**Jul 28**)	**14:00** (**Jul 28**)	Welcome, Opening Remarks, Announcements	Aimee Price and Guy DeRose MAEBL Board
21:10	23:10	00:10	06:10	**14:10**	**Optimising EBL Fabrication for Low Loss Photonics**	Elliot Cheng & Daniel Peace University of Queensland
21:35	23:35	00:35	06:35	**14:35**	**Open Discussion of Common Challenges**	
22:00	00:00	01:00	07:00	**15:00**	**EBL Baseline Process Monitoring**	Jacky He University of Sydney
22:25	00:25	01:25	07:25	**15:25**	**My Greatest EBL Failures - Part 1**	Michael Stuiber Melbourne Centre for Nanofabrication
22:50	00:50	01:50	07:50	**15:50**	Closing Remarks	
23:00	01:00	02:00	08:00	**16:00**	**Adjourn**	

*Program is subject to change without notice.