

MAEBL

MEETING FOR ADVANCED E-BEAM LITHOGRAPHY

MAEBLx Asia Pacific
July 29, 2022, 2-4 PM AEST

MAEBL at Caltech
September 14-15, 2022

MAEBLx Europe
November 2022 CET

2022 Program

www.maabl.org • Online + In-person September 14-15, 2022
California Institute of Technology

Details and registration: maabl.eventbrite.com

Dear Colleagues:

We are delighted to invite the entire electron beam lithography community to the **6th Meeting for Advanced Electron Beam Lithography**, affectionately known as MAEBL. Last year, 80 registered attendees spanning eight countries (Australia, Canada, France, India, Saudi Arabia, Switzerland, the United Kingdom and the United States) participated in the meeting's two-day event to discuss best practices, common challenges, and state-of-the-art techniques for fine feature patterning in EBL. The fluid situation brought by the pandemic reminds us to remain flexible and therefore function as a hybrid (in-person and online) meeting.

This year, the **California Institute of Technology** (Caltech) will host the hybrid meeting on **September 14-15, 2022**. Included in this year's registration in addition to the hybrid meeting is a drop-shipped t-shirt and two MAEBLx meetings for Asia Pacific and Europe, which will take place on July 29, 2022, 2:00 pm - 4:00 pm AEST (12:00 am - 2:00 am EDT) and in November 2022 (date/time TBD), respectively. The registration cost is the same for in-person and online attendees. We hope you will take advantage of this opportunity to meet with users from around the world.

As always, we are indebted to our sponsors whose support offsets costs for the venue, t-shirts, food/beverage, registration assistance, and other services. Without their support, MAEBL could not continue to grow and reach as many attendees. In our 6th meeting, we are humbled by the overwhelming appreciation and support we received from the entire community.

We look forward to seeing you online and in person soon.

Sincerely,
The MAEBL Steering Committee

Aimee Price, President, The Ohio State University
Mark Mondol, Vice President, Massachusetts Institute of Technology
Mason Risley, Secretary, Carnegie Mellon University (former)
Gerald Lopez, Board Chair & Treasurer, The University of Pennsylvania
Guy Derose, California Institute of Technology
Justin Wirth, Purdue University
Kevin Lister, Meta Platforms



Thank you sponsors!





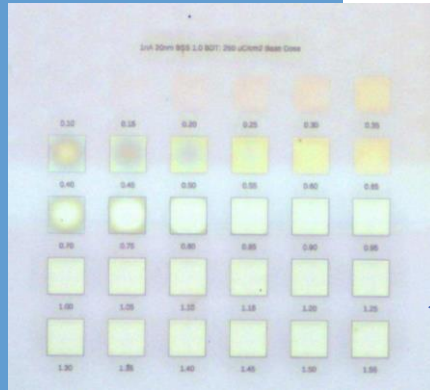
DisChem

CHEMISTRY FOR ADVANCED LITHOGRAPHY

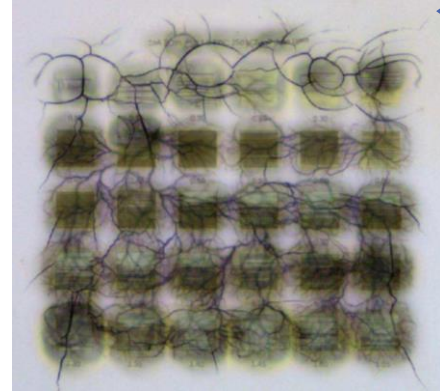
DisCharge H2O

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.
- Two-year shelf life at room temp. Highly stable permanently charged non-polymer formulation.
- Ready to use. No filtration required prior to use.



anti-charging



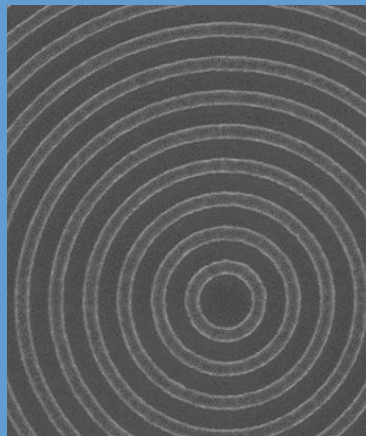
Without DisCharge: charge accumulation and sudden charge dissipation caused by exceeding the dielectric strength of the PDMS to the Si substrate resulting in significant image distortion in the resist and destruction of the PDMS surface.

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

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.



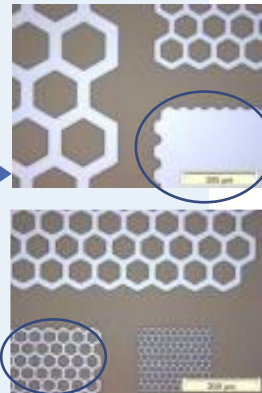
resist

SurPass

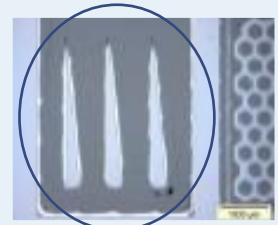
RESIST ADHESION PROMOTERS

- 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



ALLRESIST

Company for Chemical Products
for Microstructuring

Conductive Resist Electra 92

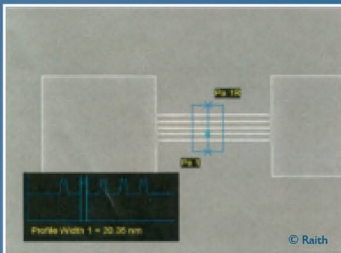
Charge dissipation, for Excellent nanostructures, top-layer for e-beam resists, easy removal with water.

Electra 92 on different e-beam resists and insulating substrates:

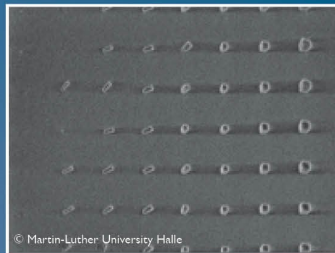
Positive E-Beam Resist CSAR 62

High resolution, highly sensitive, excellent plasma etch resistance, improvement to ZEP-resists

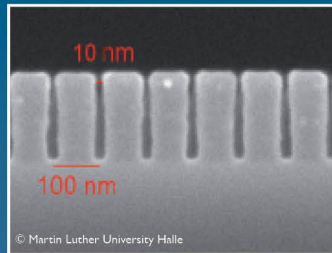
Excellent resolution at 10 nm dose to clear: $10 \mu\text{C}/\text{cm}^2$ resist thickness: up to $1.5 \mu\text{m}$



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



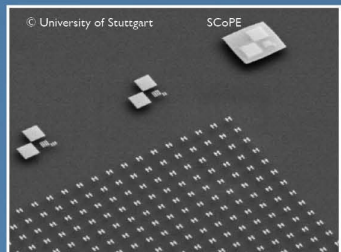
60 – 150 nm squares (height 100 nm) with AR-N 7700.08 / Electra 92 on glass



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



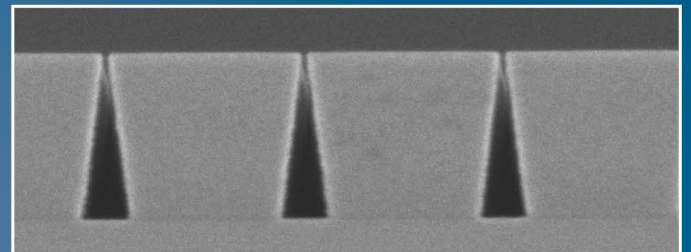
Well-defined 3D resist profile for a T-gate nanostructure with 950k PMMA (bottom) / AR-P 617 / CSAR 62



Strongly isolating polymer structures coated with Electra 92 in SEM



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

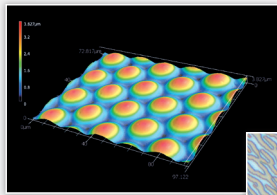


Forming of lift-off structures with CSAR 62 at higher dose

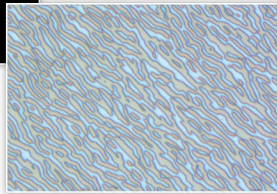
System Solutions

From Micro- to Nanofabrication

LASER

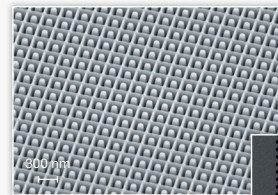


Grayscale
Lithography

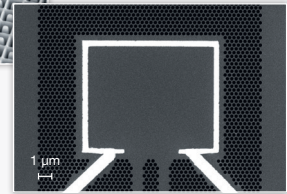


Augmented/
Virtual Reality

FIB

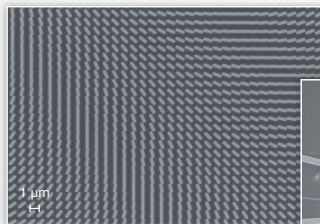


Metasurfaces

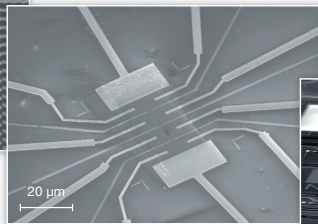


Phononic
Engineering

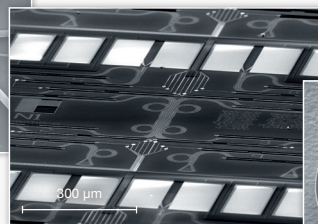
E-BEAM



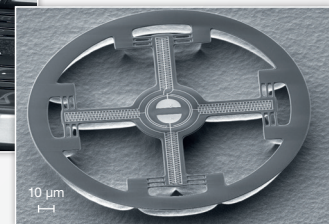
Photonics



Nanoscale
Science



Quantum
Technologies



Electro-Optomechanics

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, industry, or government institutions are encouraged to attend. To promote intimate dialogue, we have kindly requested that EBL hardware vendors refrain from registering. Automatic attendance is granted to organizers, speakers, and non-EBL-hardware vendor sponsors. Advance online sign-up is required to participate as there will be no on-site registration. This year Caltech is permitting up to 50 in-person attendees to be on campus. Please see <http://together.caltech.edu/> for further guidance for on-campus participating. Thank you for your cooperation and understanding. A single registration is not for an organization; it is for an individual and is not transferrable.

Attendee Registration Type	Description	Cost
Full Registration (Virtual or In-Person)	All access to MAEBL 2022 at Caltech, MAEBLx Asia-Pacific and MAEBLx Europe	\$165 per attendee online or in person
Registration for MAEBLx Only	Access to one MAEBLx meeting only. Additional access to MAEBL 2022 at Caltech is the cost of a Full Registration (\$165) should you decide to attend at a later date.	\$45 per attendee for one MAEBLx Meeting
Invited Speakers	All access to MAEBL 2022 at Caltech, MAEBLx Asia-Pacific and MAEBLx Europe	Free
Vendor Sponsorship	Logo on T-shirt, website, and other collateral material including a one page ad in the MAEBL 2022 program.	\$500 per vendor

Register at maebl.eventbrite.com

ATTENDING IN PERSON

The health and safety of the MAEBL community are our primary concern. Caltech's policies for on campus engagement are outlined at <http://together.caltech.edu/>. If you are attending in person, Caltech requires each attendee to be fully vaccinated and boosted. Everyone must be ready to show proof of vaccination upon request. Again, this means an in-person attendee:

1. completed a second dose in a 2-dose series (Pfizer or Moderna vaccine) or a single-dose vaccine (Johnson & Johnson) and
2. is 2 weeks after receiving a booster.

All attendees are required 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.

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 the event of contact tracing, your contact information may be shared with the University or any other responsible entities. For all other purposes, your registration information will not be distributed without your consent.

MAEBLx Asia Pacific

July 29, 2022 (AEDT): MAEBLx Asia Pacific is a regionally organized online event held at an appropriate hour in the regional time zone. All are welcome to attend. Major participating timezone hours are listed.

PDT (July 28)	EDT (July 28)	CEDT (July 29)	AEDT (July 29)	Topic	Facilitator
20:00	23:00	05:00	13:00	Online Networking	
21:00	00:00	06:00	14:00	Welcome, Opening Remarks and Announcements	
21:15	00:15	06:15	14:15	TEST PATTERNS A Comprehensive Performance Test Mask for EBL	Michael Stuiber Melbourne Centre for Nanofabrication
22:00	01:00	07:00	15:00	EMF CANCELLATION A Ghost Hunting Story in the EBL Facility	Elliot Cheng & Ron Rash Centre for Microscopy and Microanalysis, The University of Queensland
22:45	01:45	07:45	15:45	Closing Remarks	
23:00	02:00	08:00	16:00	Adjourn	

Abstracts

A Comprehensive Performance Test Mask for EBL

The Melbourne Centre for Nanofabrication (MCN) owns the largest open access cleanroom environment in the Southern Hemisphere. It is home to many state of the art micro- and nanofabrication tools which are heavily utilised by all 6 major Universities located in Melbourne and by MCN staff members. It is also home of the first 100 keV EBL system installed in Australia, a Raith (formerly Vistec) 5000plus tool.

Due to Australia's remoteness (difficult to bring an EBL service engineer) and the EBL tools large user cohort with a broad range of applications a need arose to monitor the tool performance and critical parameters in between service engineer visits or after software updates.

In this presentation, I will share the development process of the performance test mask, the ideas behind some of the test patterns and show some exposure results. Since this mask was specifically designed to be used on a Raith (formerly Vistec) tool with 1 mm² main field size I will try to present ways how to alter the mask to be used on other systems such as Elionix or JEOL.

A Ghost Hunting Story in the EBL Facility

Electron beam lithography instruments rely on the use of high precision electromagnetic and electrostatic systems to control the beam quality and deflection for long hours of writing. Any presence of Electron Magnetic Field (EMF) above the accepted noise threshold at various frequencies could have detrimental effects towards the quality of the final lithography patterns. Since the refurbishment of our new microscopy centre we have noticed several types of defects during our routine fabrication in the cleanroom. We have undergone a long journey to survey and pinpoint (ghost hunting) potential EMI sources around the building, leading to the installation of a new double coil EMF cancellation system inside the cleanroom. In this talk we will share our experience in finding common source of noises, the required instrumentation and techniques using for field detector, as well as establishing a test set up and the installation of an EMF cancellation system.

Session I: MAEBL Foundations Workshop*

September 14, 2022 (PDT): All e-beam lithographers are invited to participate in Session I 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 Session II.

PDT (Sept 14)	EDT (Sept 14)	CEDT (Sept 14)	AEDT (Sept 15)	Topic	Facilitator
09:00	12:00	18:00	02:00	Registration, Networking, Coffee	
09:30	12:30	18:30	02:30	Welcome, Opening Remarks and Speaker Introductions	
10:00	13:00	19:00	03:00	EBL TOOL ANATOMY Tool vendors, the tools and their terminology	Mason Risley Carnegie Mellon University (former)
10:45	13:45	19:45	03:45	SPECIFICATIONS AND WHAT THEY MEAN Stitching, Overlay, Placement Accuracy	Mark Mondol Massachusetts Institute of Technology
11:30	14:30	20:30	04:30	PATTERN & DESIGN BASICS Data Volume, Hierarchy, Shot Grid Placement Accuracy	Gerald Lopez University of Pennsylvania
12:00	15:00	21:00	05:00	Group Photo, GatherTown Networking, Lunch	
13:15	16:15	22:15	06:15	PROXIMITY EFFECT CORRECTION What Is It, How It Works and When You Need It	Marvin Zai GenISys, Inc.
13:40	16:40	22:40	06:40	RESIST PROCESSES (PMMA, ZEP520A, HSQ, etc.) Baseline Processes + Spin Curve Fundamentals	Allison Dove [†] & Leo Ocola [‡] [†] University of California, Berkeley, [‡] IBM T.J. Watson Research Center
14:40	17:40	23:40	07:40	Break/Continued Discussion and Networking	
15:10	18:10	00:10	08:10	PATTERN TRANSFER VIA ETCH A discussion on pattern transfer using etch	Nikhil Tiwale Brookhaven National Laboratory
15:40	18:40	00:40	08:40	Break/Continued Discussion and Networking	
16:00	19:00	01:00	09:00	Breakout: General Q&A Session (may include but is not limited to) <ul style="list-style-type: none"> Resist Processes / Anti-Charging Pattern Transfer: Deposition and Etch Considerations / Lift-Off Processes Data Preparation and Proximity Effect 	
17:15	20:15	02:15	10:15	Breakout Summary	
17:30	20:30	02:30	10:30	End MAEBL Foundations	

*Program is subject to change without notice.

Session II: MAEBL Core*

September 15, 2022 (PDT): The core meeting is what started it all. Be part of the conversation and engage the collective knowledge of the electron beam lithography community.

PDT (Sept 15)	EDT (Sept 15)	CEDT (Sept 15)	AEDT (Sept 16)	Topic	Facilitator
08:30	11:30	17:30	01:30	Networking, Coffee and Light Breakfast	
09:00	12:00	18:00	02:00	Welcome, Opening Remarks and Announcements	
09:30	12:30	18:30	02:30	INVITED TALK	Daniel Wilson Jet Propulsion Laboratory (JPL)
09:45	12:45	18:45	02:45	RESIST PROCESSING Why I hate PMMA and you should too	Allison Dove University of California, Berkeley
10:15	13:15	19:15	03:15	Coffee Break/Continued Discussion and Networking	
10:30	13:30	19:30	03:30	ACHIEVING HIGH ETCH SELECTIVITY Infiltration Synthesis	Nikhil Tiwale Brookhaven National Laboratory
11:00	14:00	20:00	04:00	PATTERN & DESIGN CONSIDERATIONS Orderings, Split and Bury, Bulk-Sleeve, Multipass, etc.	Gerald Lopez University of Pennsylvania
11:20	14:20	20:20	04:20	Coffee Break/Continued Discussion and Networking	
11:30	14:30	20:30	04:30	COMMON CHALLENGES I An Open Forum Discussion of Common Issues	Guy Derose California Institute of Technology
12:30	15:30	21:30	05:30	Group Photo, GatherTown Networking, Lunch	
14:00	17:00	23:00	07:00	3D STRUCTURES Ternary Developer + Trilayer Process Enabled T-Gates	Leonidas Ocola IBM T.J. Watson Research Center
14:30	17:30	23:30	07:30	INVITED TALK	Ivan Milosavljevic HRL Laboratories
15:00	18:00	00:00	08:00	Coffee Break/Continued Discussion and Networking	
15:15	18:15	00:15	08:15	INVITED TALK	Michael Stuibler Melbourne Centre for Nanofabrication
16:15	19:15	01:15	09:15	COMMON CHALLENGES II Open Forum Discussion of Common Issues	Justin Wirth Purdue University
17:15	20:15	02:15	10:15	Closing Remarks - Continued Discussion and Networking	
18:00	21:00	03:00	11:00	End MAEBL Core	

*Program is subject to change without notice.