MAEBL

MEETING FOR ADVANCED E-BEAM LITHOGRAPHY

~~MAEBLx Asia Pacific~~
~~July 29, 2022, 2-4 PM AEDT~~

~~MAEBL at Caltech~~
~~September 14-15, 2022~~

MAEBLx Europe
November 15, 2022, 3-5 PM CET

2022 Program

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

Details and registration: maebl.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 15, 2022 (9:00 am - 11 am EDT), 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.

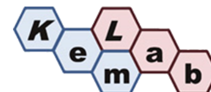
As always, we are indebted to our sponsors whose support offsets costs for the venue, t-shirts, food/beverage, registration assistance, and other services. Without their support, MAEBL could not continue to grow and reach as many attendees. In our 6th meeting, we are humbled by the overwhelming appreciation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

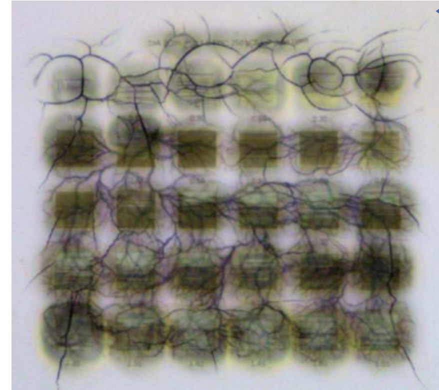
Thank you sponsors!



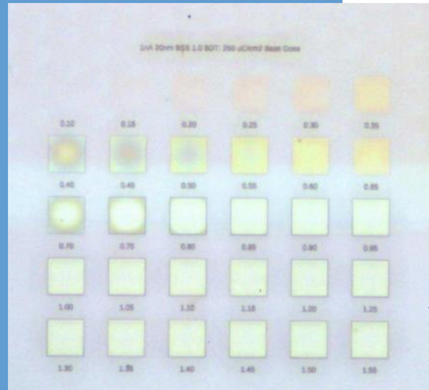
DisCharge H2O

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.



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.



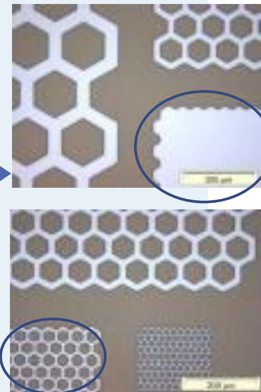
WITH DisCharge: no charge accumulation, resulting in expected image with no harm to PDMS layer.

anti-charging

SurPass

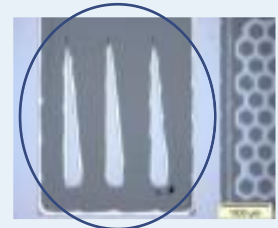
RESIST ADHESION PROMOTERS

- 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

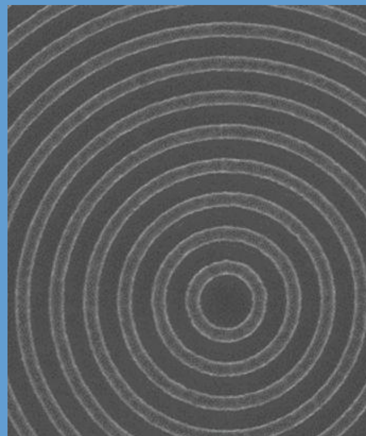
With SurPass: Complete Precision Mask

adhesion promotion

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

DisChem, Inc., 17295 Boot Jack Rd, Ridgway, PA 15853 USA • Tel: +1-814-772-6603 • info@discheminc.com • www.discheminc.com

ALLRESIST

Company for Chemical Products
for Microstructuring

Conductive Resist
Electra 92

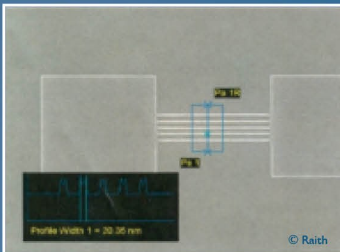
Charge dissipation, for Excellent nanostructures, top-layer for e-beam resists, easy removal with water.

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

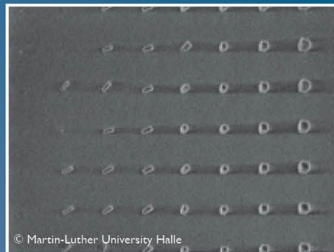
Positive E-Beam Resist
CSAR 62

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

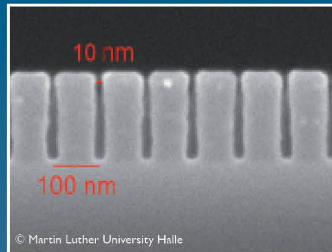
Excellent resolution at 10 nm
dose to clear: 10 µC/cm²
resist thickness: up to 1.5 µm



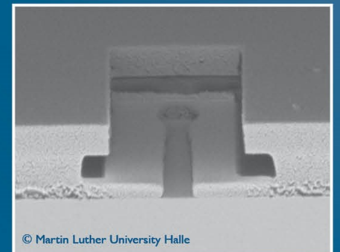
20 nm lines of HSQ, generated on quartz with Electra 92



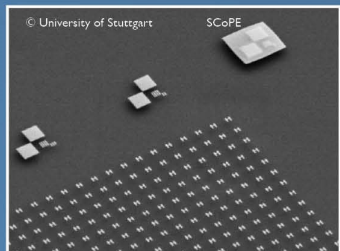
60 – 150 nm squares (height 100 nm) with AR-N 7700.08 / Electra 92 on glass



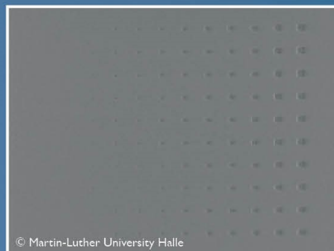
Spacing with an aspect ratio of 18; 10 nm resolution at a film thickness of 180 nm



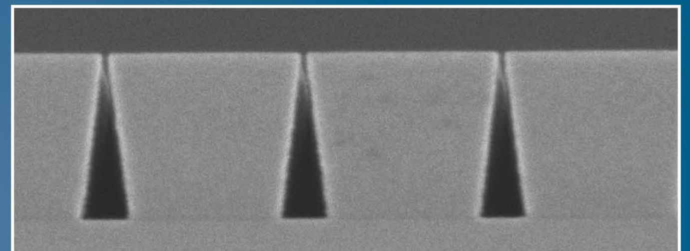
Well-defined 3D resist profile for a T-gate nanostructure with 950k PMMA (bottom) / AR-P 617 / CSAR 62



Strongly isolating polymer structures coated with Electra 92 in SEM



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

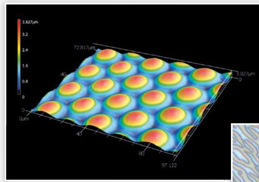


Forming of lift-off structures with CSAR 62 at higher dose

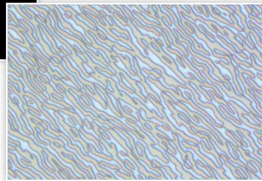
www.allresist.com

System Solutions
From Micro- to Nanofabrication

LASER

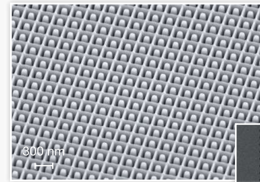


Grayscale Lithography

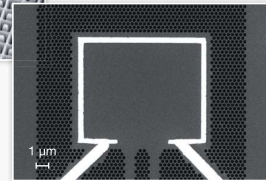


Augmented/ Virtual Reality

FIB

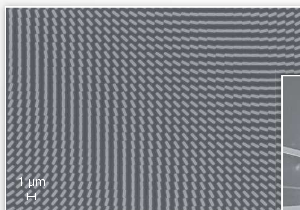


Metasurfaces

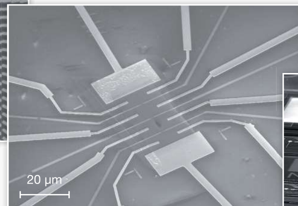


Phononic Engineering

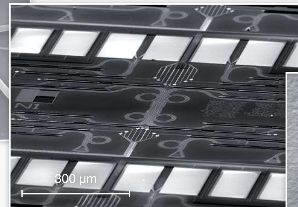
E-BEAM



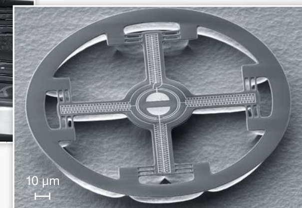
Photonics



Nanoscale Science



Quantum Technologies



Electro-Optomechanics

www.raith.com

RAITH NANOFABRICATION

H.A.R.P PMMA

High Aspect Ratio PMMA for e-beam

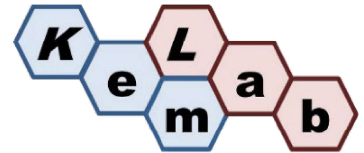
MicroVision Labs 100nm, 600uC, holes
MAG: 20.0kx

SHORT LEAD TIMES

COMPETITIVE PRICING

SOURCED & SHIPPED IN USA

Resist Type	If you are currently using…	Use this KemLab Resist Series
Negative Permanent Epoxy	SU-8™	HARE SQ™ IMPROVED TRANSPARENCY
Thick Positive Advanced Packaging	AZ® P4620 SPR™ 220-7.0	K-PRO™ EXCELLENT PROCESS LATITUDE
Negative Lift-Off	AZ® nLOF™ 2000	APOL-LO 3200 PATENT PENDING • WIDER PROCESS LATITUDE
Positive FT: 0.5-2.0 µm	MICROPOSIT™ S1800™ AZ® 1500	KL 5300 DESIGNED FOR IC FABRICATION • HIGH RESOLUTION
Positive FT: 2.5–12 µm	SPR™ 220 Series SC1827™	KL 6000 DESIGNED FOR THICK FILMS • VALUE RESIST
High Resolution e-Beam Positive	950K / 495K PMMA MMA (8.5) MAA	HARP™ PMMA DIRECT WRITE E-BEAM



PHOTORESIST
MANUFACTURING & INNOVATION

H.A.R.E SQ Negative Epoxy

High Aspect Ratio Epoxy with Superior Quality

BETTER OPTICAL TRANSPARENCY

SUPERIOR RAW MATERIALS

DESIGNED FOR MICROELECTRONICS

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ELS-BODEN

Electron Beam Lithography System

ELIONIX
Action for innovation

ELS-BODEN
Acceleration 100kV × Single autoloader

High Performance Capabilities for High Resolution and High Throughput Applications

Features

Inherits traditional Elionix technology to meet user's requirements:

- 150kV / 125kV acceleration voltages, if ultra-fine patterns are most important.
- 100kV for common applications and a wide variety of requirements.
- 50kV for high speed production.

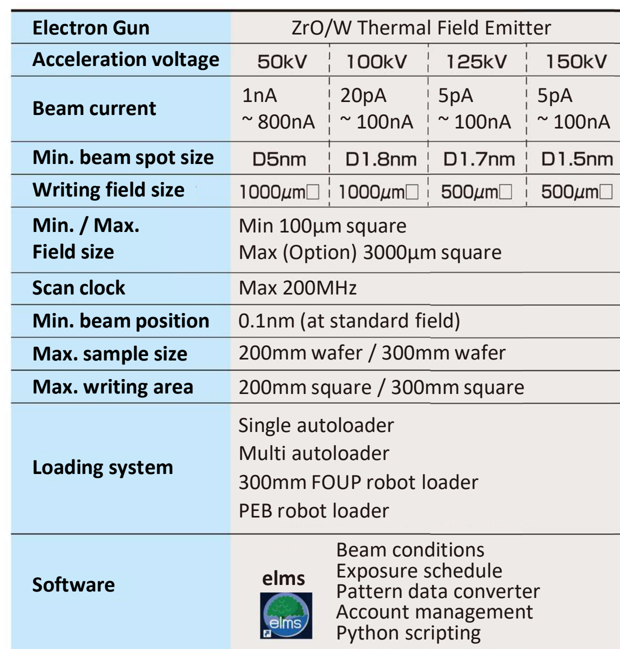
Available in 200mm and 300mm chambers:

- The first full 300mm square writing area in the marketplace.
- Sample holders from small pieces commonly used in basic research to 300mm wafers.
- Mask holders, for the 6025 and 9025 mask sizes, are also available.

Complete line of automatic loading systems:

- Single cassette autoloader, which is useful for research and development applications.
- Multiple cassette autoloader for small to medium volume production.
- Full lineup of robot loading systems

Specifications



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)
118 Cedar Street, Wellesley Hills, MA 02481 United States
Tel: 978-362-0510 Email: sales@sts-elionix.com

MAEBL Community Conduct Expectations

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.

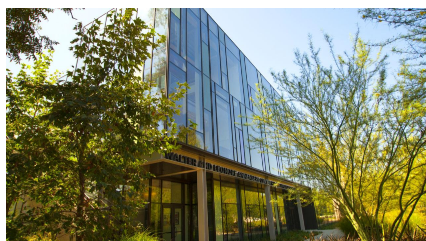
Repeated, bad faith, or exceptionally serious conduct may necessitate exclusion from the community for an appropriate period of time. Bad faith claims are themselves considered to be harassment; good faith claims that are not substantiated are not considered harassment and are protected from retaliation.

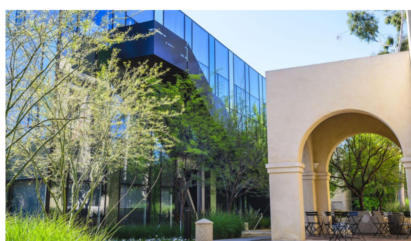
REGISTRATION and QUALIFICATIONS TO REGISTER

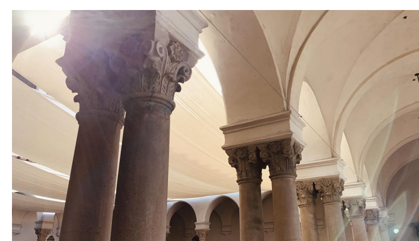
Registration helps to offset the operational costs of the meeting series. All active EBL tool owners and users from academic, industrial, or government institutions/organizations are encouraged to attend. To promote intimate dialogue, we have kindly requested that EBL hardware vendors refrain from registering. 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 participation. 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
Full Registration (Virtual or In-Person)	All access to MAEBL 2022 at Caltech, MAEBLx Asia-Pacific and MAEBLx Europe. One t-shirt is included in the cost.	**$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. No t-shirt.	**$45** per attendee for one MAEBLx Meeting
Invited Speakers	All access to MAEBL 2022 at Caltech, MAEBLx Asia-Pacific and MAEBLx Europe. One t-shirt is included.	**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







MAEBL

MEETING FOR ADVANCED E-BEAM LITHOGRAPHY

Online and in Pasadena, CA on September 14-15, 2022

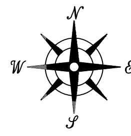
Caltech

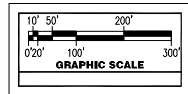
Ride/Share Drop-off

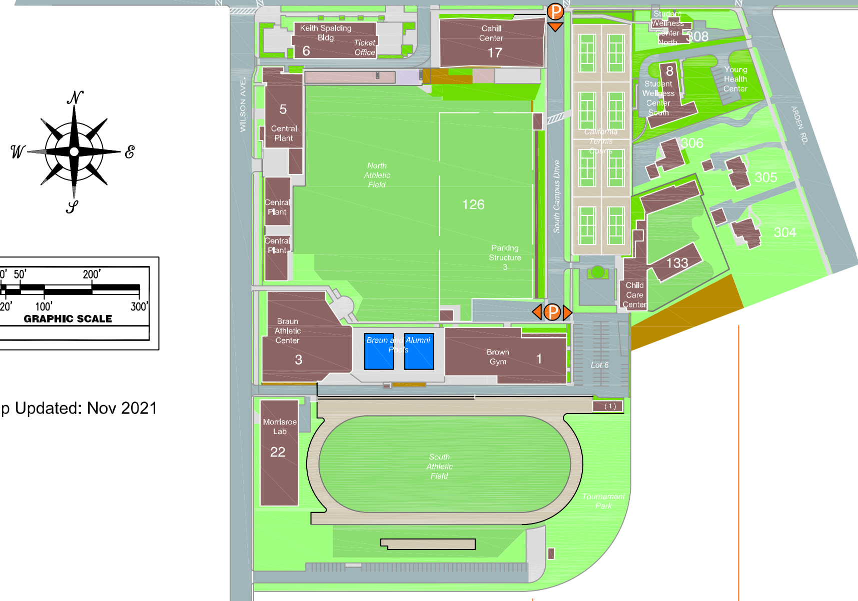
Visitor Parking

Banquet

Resnick Construction Zone







Map Updated: Nov 2021

Map Key

- Campus Building
- Building Name
- Building Number
- Athletic Track or Court Area
- Crosswalk
- Paved Walkway or Pedestrian Area
- Paved Driveway or Street
- To Parking
- Place Name
- Utility Pad
- Utility Grating
- Walls or Exterior Stairs
- Water Features or Pools
- Ground Cover: Lawn
- Ground Cover: Other Plants
- Ground Cover: Playing Field
- Ground Cover: None
- Under Construction

Caltech

2021 Campus Map Directory

Buildings by Name	Bldg No	Map Grid
255 S Hill Ave (Office of Residential Experience)	390	E1
263 S Chester (International Scholar Services)	11	D1
275 S Hill (Theater Arts (TACIT))	67	E1
287 S Hill (Rickenbaugh House)	98	E1
295 S Hill (Academic Media Technologies)	9	E2
305 S Hill (Music House)	70	E2
315 S Hill (Strategic Com (front) SFCC (rear))	71	E2
315 S Wilson (Student-Faculty Programs)	122	A2
345 S Hill (Alumni House)	97	E2
355 S Holliston (Steele House)	94	D3
363 S Hill (Einstein Papers House)	7	E3
375 S Wilson (Prufrock House)	121	A3
383 S Hill (Undergrad Admissions & Fin Aid)	90	E3
383 S Hill Annex	90A	E3
391 S Wilson (Housing Shop)	135	A3
415 S Hill Ave	220	E3
505 S Wilson (Tyson House/Caltech Y)	128	A4
515 S Wilson (Credit Union/Pkng & Security)	63	A4
525 S Wilson (U.S. Geological Survey)	39	A4
535 S Wilson (Fitzhugh House/USGS)	65	A4
551 S Wilson (Investment Office)	42	A4
565 S Wilson (Audit Svcs & Inst Compliance)	64	A4
Alles Laboratory	28	B4
Annenberg Center for Info Sci and Tech (IST)	16	D3
Arms Laboratory	25	B4
Athenaeum	61	E4
Avery House	99	D2
AWS Center for Quantum Computing	143	E2
Baxter Hall	77	C3
Bechtel Residence	14	C2-D2
Beckman Auditorium	91	C3
Beckman Behavioral Biology Labs (BBB)	76	B3-C3
Beckman Institute	74	B3
Blacker House	60	E4
Braun Athletic Center	3	B5
Braun House	88	E3
Braun Laboratories	75	B3
Bridge Annex	34	B4
Bridge Laboratory - East	33E	B4
Bridge Laboratory - West	33W	B4
Broad Café	96C	B3
Broad Center for the Biological Sciences	96	B3
Brown Gymnasium	1	B5
Building 15	15	C1
Bungalow Court	139	A3
Cahill Center for Astroscience & Astrophysics	17	B5
Caltech Childcare Center	133	C5
Caltech Hall	32	B4
Campus Housing Shop	136	A3
Catalina Graduate Housing	100-120	A2-A3
Central Engineering Services (CES)	85	D3
Central Plant (incl. Cogen & Cooling Towers)	5	B5
Chandler Dining Hall (Chandler Café)	52	D4
Chen Neuroscience Research Building	18	B2
Church Laboratory	29	B4
Crellin Laboratory	30	B4
Dabney Hall	40	D4
Dabney House	58	D4
Downs-Lauritsen Laboratories	47	C4
Facilities Building	83	D3
Firestone Laboratory	50	D4
Fleming House	57	D4
Gates Annex	26	B4
Gates-Thomas Laboratory	44	C4
Guggenheim Laboratory	45	C4
Hameetman Center	51	D4
Human Resources/Facilities Shops	84	D3
Information Management Systems & Svcs (IMSS)	10	C1
Jorgensen Laboratory	80	D3
Karman Laboratory	46	C4
Keck Center	127	B3
Keck Laboratories	78	C3
Kellogg Radiation Laboratory	38	C4
Kerckhoff Annex	27A	B4
Kerckhoff Laboratories	27	B4
LIGO (40-Meter Lab)	69	D3
Linde Hall of Mathematics and Physics	37	C4
Linde Laboratory	24	B4
Lloyd House	54	D4-E4
Marks House	89	E3
Mead Laboratory	73	B3
Moore Laboratory	93	C3
Morrisroe Astroscience Laboratory (IPAC)	22	B5
Mudd Laboratories - North	23	B4
Mudd Laboratories - South	21	B4
Noyes Laboratory	72	B3
Page House	53	D4
Parking Structure 1 (North Wilson Avenue)	123	A3
Parking Structure 2 (South Wilson Avenue)	124	A3
Parking Structure 3 (California Avenue)	126	B5
Parking Structure 4 (Holliston Avenue)	66	E3
Parsons-Gates Hall of Administration	31	B4
Powell-Booth Laboratory	79	D3
Ramo Auditorium	77	C3
Ricketts House	59	E4
Satellite Utility Plant	66B	E3
Schlinger Lab for Chemistry and Chem Engr	20	B3
Sherman Fairchild Library	43	C4
Spalding Lab (Eudora Spalding Lab)	41	C4
Spalding, Keith (Keith Spalding Building)	6	B5
Steele Laboratory	81	D3
Student Activities Center	57B	D4
Student Services, Center for (CSS)	86	E3
Student Wellness Center North	308	C5
Student Wellness Center South (Young)	8	C5
Synchrotron Laboratory	49	D4
Transportation & Grounds Operations	82	D3
Undergraduate Admissions & Financial Aid	90	E3
Venerable House	55	E4
Watson Laboratories	95	C3-D3
Young Health and Counseling Center	8	C5

Functions & Places	Bldg No or Map Grid
24-Hour Security	66
Academic Media Technologies	9
Administration	31
Admissions Office, Graduate	86
Admissions Office, Undergraduate	90
Alumni House	97
Amphitheater	C4
Annex (383 S Hill St/Admissions)	E3
Athletics (Indoors)	1-3
Athletics (Outdoors-South Athletic Fields)	B5-C5
Auditorium (Annenberg Auditorium)	16
Auditorium (Baxter Lecture Hall)	77
Auditorium (Beckman Auditorium)	91
Auditorium (Beckman Institute Auditorium)	74
Auditorium (Hameetman Auditorium)	17
Auditorium (Lees-Kubota Lecture Hall)	45
Auditorium (Norman Davidson Lecture Hall)	27
Auditorium (Ramo Auditorium)	77
Auditorium (Rock Auditorium)	96
Auditorium (Sharp Lecture Hall)	25
Auditorium (Sturdivant Lecture Hall)	72
Bechtel Mall	B4
Beckman Lawn	B3
Beckman Mall	C3
Braun and Alumni Pools	B5
Caltech Credit Union (CEFCU)	63
Caltech Pond and Plaza	C4
Caltech Ticket Office	6
Campus Programs Office	6
Card Services	51
Career Development Center	86
Corporate Relations	32
Development & Institute Relations	32
Diversity, Center for	86
Division Office (Biology & Biological Engr)	27
Division Office (Chemistry & Chem Engr)	30
Division Office (Engineering & Applied Science)	44
Division Office (Geological & Planetary Sciences)	25
Division Office (Humanities & Social Sciences)	77
Division Office (Physics, Math & Astronomy)	33
Employment	84
Engagement and Annual Programs	32
Facilities Management	83
Faculty Club (Atheneum)	61
Faculty, Officers of the	31
Fellowships and Study Abroad	86
Financial Aid	90
Food & Dining Services (*Broad Café*)	96C
Food & Dining Services (*Chandler Café*)	52
Food & Dining Services (*Convenience Store*)	51
Food & Dining Services (*Red Door Café*)	51
Foor & Dining Services (*Athenaeum* (private))	E4
Garden of Associates	C4
Gene Pool (Fountain)	B3
Governmental Relations	31
Graduate Office	86
Graphic Resources	6
Health Center	8
Human Resources	84
Humanities Reading Room	40
IMSS Help Desk	86
International Scholar Services	11
International Student Programs	86
Library (Astrophysics)	17
Library (Geology & Planetary Sciences)	23
Library (Humanities Reading Room)	40
Library (Millikan)	32
Library (Sherman Fairchild Library)	43
Moore Walk	B2-D2
Olive Walk	D4-E4
Parking Office	63
Performing and Visual Arts	67/70
Post Office/Mail Services	6
Rath Al Fresco	E4
Recreation	3
Registrar	86
Safety Office	6
Security Office	63
Staff & Faculty Consulting Center (SFCC)	71
Strategic Communications (Front)	71
Student Activities Center	57B
Student Services	86
Student Store	51
Student Wellness Center North	308
Student Wellness Center South (Young)	8
Student-Faculty Programs	86
Tech Express	54
Theater Arts (TACIT)	67
Throop Memorial Gardens	C4
Tournament Park	C5
Turtle Pond (Throop Memorial Gardens)	C4
Undergraduate Dean's Office	86

RECENT CHANGES TO THE MAP

* 255 South Hill Avenue has been converted to the **Office of Residential Experience** (Bldg 390)

* 1245 Arden Road is now the **Student Wellness Center North** (Building 308)

* The **AWS Center for Quantum Computing** (143) has been built on Holliston Ave.

* Building 24 has been renamed as "**Ronald and Maxine Linde Center for Global Environmental Science**"

* Bldg 32 has been renamed as "**Caltech Hall**"

* Bldg 52 has been renamed as "**Lee F. Browne Dining Hall**"

*Building 55 has been renamed as "**Grant D. Venerable House**"

Bldg No	Buildings by Number	Map Grid
1	Brown Gymnasium	B5
3	Braun Athletic Center	B5
5	Central Plant (incl. Cogen & Cooling Towers)	B5
6	Spalding, Keith (Keith Spalding Building)	B5
7	363 S Hill (Einstein Papers House)	E3
8	Young Health and Counseling Center	C5
9	295 S Hill (Academic Media Technologies)	E2
10	Information Management Systems & Svcs (IMSS)	C1
11	263 S Chester (International Scholar Services)	D1
14	Bechtel Residence	C2-D2
15	Building 15	C1
16	Annenberg Center for Info Sci and Tech (IST)	D3
17	Cahill Center for Astroscience and Astrophysics	B5
18	Chen Neuroscience Research Building	B2
20	Schlinger Lab for Chemistry and Chem Engr	B3
21	Mudd Laboratories - South	B4
22	Morrisroe Astroscience Laboratory (IPAC)	B5
23	Mudd Laboratories - North	B4
24	Linde Laboratory	B4
25	Arms Laboratory	B4
26	Gates Annex	B4
27	Kerckhoff Laboratories	B4
27A	Kerckhoff Annex	B4
28	Alles Laboratory	B4
29	Church Laboratory	B4
30	Crellin Laboratory	B4
31	Parsons-Gates Hall of Administration	B4
32	Caltech Hall	B4
33E	Bridge Laboratory - East	B4
33W	Bridge Laboratory - West	B4
34	Bridge Annex	B4
37	Linde Hall of Mathematics and Physics	C4
38	Kellogg Radiation Laboratory	C4
39	525 S Wilson (U.S. Geological Survey)	A4
40	Dabney Hall	D4
41	Spalding Lab (Eudora Spalding Lab)	C4
42	551 S Wilson (Investment Office)	A4
43	Sherman Fairchild Library	C4
44	Gates-Thomas Laboratory	C4
45	Guggenheim Laboratory	C4
46	Karman Laboratory	C4
47	Downs-Lauritsen Laboratories	C4
49	Synchrotron Laboratory	D4
50	Firestone Laboratory	D4
51	Hameetman Center	D4
52	Browne Dining Hall	D4
53	Page House	D4
54	Lloyd House	D4-E4
55	Venerable House	E4
57	Fleming House	D4
57B	Student Activities Center	D4
58	Dabney House	D4
59	Ricketts House	E4
60	Blacker House	E4
61	Athenaeum	E4
63	515 S Wilson (Credit Union/Parking & Security)	A4
64	565 S Wilson (Audit Svcs & Inst Compliance)	A4
65	535 S Wilson (Fitzhugh House/USGS)	A4
66	Parking Structure 4 (Holliston Avenue)	E3
66B	Satellite Utility Plant	E3
67	275 S Hill (Theater Arts (TACIT))	E1
69	LIGO (40-Meter Lab)	D3
70	305 S Hill (Music House)	E2
71	315 S Hill (Strategic Comm (front) SFCC (rear))	E2
72	Noyes Laboratory	B3
73	Mead Laboratory	B3
74	Beckman Institute	B3
75	Braun Laboratories	B3
76	Beckman Behavioral Biology Labs (BBB)	B3-C3
77	Baxter Hall	C3
77	Ramo Auditorium	C3
78	Keck Laboratories	C3
79	Powell-Booth Laboratory	D3
80	Jorgensen Laboratory	D3
81	Steele Laboratory	D3
82	Transportation & Grounds Operations	D3
83	Facilities Offices	D3
84	Human Resources/Facilities Management Shops	D3
85	Central Engineering Services (CES)	D3
86	Student Services, Center for (CSS)	E3
88	Braun House	E3
89	Marks House	E3
90	383 S Hill (Undergrad Admissions & Fin Aid)	E3
90A	383 S Hill Annex	E3
91	Beckman Auditorium	C3
93	Moore Laboratory	C3
94	355 S Holliston (Steele House)	D3
95	Watson Laboratories	C3-D3
96	Broad Center for the Biological Sciences	B3
96C	Broad Café	B3
97	345 S Hill (Alumni House)	E2
98	287 S Hill (Rickenbaugh House)	E1
99	Avery House	D2
100-120	Catalina Graduate Housing	A2-A3
121	375 S Wilson (Prufrock House)	A3
122	315 S Wilson (Student-Faculty Programs)	A2
122A	317 S Wilson	A2
123	Parking Structure 1 (North Wilson Avenue)	A3
124	Parking Structure 2 (South Wilson Avenue)	A3
126	Parking Structure 3 (California Avenue)	B5
127	Keck Center	B3
128	505 S Wilson (Tyson House/Caltech Y)	A4
133	Caltech Childcare Center	C5
135	391 S Wilson (Housing Shop)	A3
139	Bungalow Court	A3
143	AWS Center for Quantum Computing	E2
308	Student Wellness Center North	C5
390	255 S Hill - Office of Residential Experience	E1

Updated November 2021

COVID-19 POLICY

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:

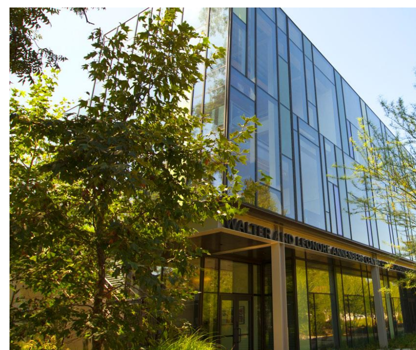
1. completed a second dose in a 2-dose series (Pfizer or Moderna vaccine) or a single-dose vaccine (Johnson & Johnson) and
2. is 2 weeks after receiving a booster.

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.

HOTELS

Since there are not enough in person attendees to reserve room blocks at a particular hotel, we are recommending the Hilton Pasadena or Sheraton Pasadena. There are of course other hotels and motels (Vagabond and Saga Inns) that are within walking distance.

MEETING VENUE



The meeting location is the **Walter and Leonore Annenberg Center for Information Science and Technology** (building #16), on the northeast side of campus. It’s a large green glass building, so it's hard to miss. The best entry point for MAEBL attendees is the west side of Annenberg; look for the MAEBL program poster outside the building. The yellow star indicates the entry closest to the Auditorium (room #105).

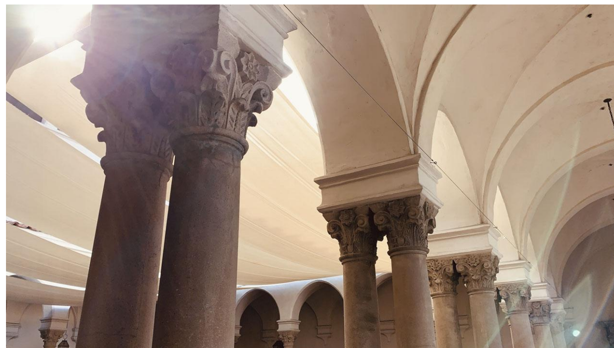
BANQUET VENUE

The Athenaeum (building #61 at the bottom right portion of the map) hosts our annual banquet at 6:30 pm PDT on September 14, 2022. The banquet is included in the registration for all In-person attendees and is made possible by the generous donations of our sponsors. Please note the Athenaeum dress code is business casual, e.g. dress shirts, slacks, blouses, leather shoes, etc.; no blue jeans and sneakers. Male guests must wear jackets. Business casual is defined as defined by Wikipedia can be found here. To repeat:

- Dress code is business casual.
- Not allowed: blue jeans, sneakers, shorts, casual/beach-wear sandals and flip-flops.
- ~~Males must wear jackets;~~ coat and tie are always appropriate. Coat is not required.
- Proper attire includes the option of wearing collared shirts with dress slacks, suits, dresses, or dressy blouses/shirts with skirt or pants.
- Shoes are required throughout The Athenaeum and should be clean and appropriate for the occasion.

ARRIVAL BY RIDE SHARE

For Uber/Lyft/ride share, participants should get dropped off at the Holliston Ave circle. Participants arriving by ride share can be dropped off at the "round about" on South Holliston shown on the map as "Drop off". Walk down the main pathway (East Moore Walk) and turn left (south) at the small walkway between Annenberg and Moore.



PARKING

Parking information for visitors can be found at: https://parking.caltech.edu/parking-info/visitor-parking. The closest parking is Parking Structure #4 (building 66 on the map) on South Holliston Avenue in any unnamed space. Parking is $6 day using the kiosk on the second level. Parking Structure #2 (building 124) on South Wilson Avenue is also an option. Avoid parking spots designated as carpool or named parking spaces reserved for the permit holder's exclusive use.

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 Europe (Online only)

November 15, 2022 (CET): MAEBLx Europe is scheduled to allow regional attendees to participate during a reasonable hour in their respective time zone. Major participating timezone hours are listed.

PST	EST	CET	AET	Topic	Facilitator
05:00	08:00	14:00	22:00	Connect to GatherTown + Online Networking	
06:00	09:00	15:00	23:00	Welcome, Opening Remarks and MAEBLpedia (www.maebl.org)	
06:20	09:20	15:20	23:20	**EFFECTIVE BLUR** Connecting the Process Window to the Effective Blur	Gerald Lopez University of Pennsylvania
07:05	10:05	16:05	00:05	**COLD DEVELOPMENT** A Discussion on the Setup and Process	Mark Mondol Massachusetts Institute of Technology
07:50	10:50	16:50	00:50	Closing Remarks	
08:00	11:00	17:00	01:00	Adjourn	

Abstracts

Connecting the Process Window to the Effective Blur

Scaling limits in electron beam lithography (EBL) are physically connected to the tooling, environment, pattern density, resist resolution, and downstream processes. In this talk, we'll discuss steps to characterize an EBL resist process and a high-level overview of the theory connecting the resist process window to the effective blur. We'll show how environmental factors like temperature can influence exposure latitude and present techniques in determining the effective blur will be demonstrated.

Cold Development: Setup and Process

Cold process development in EBL has long been shown to improve contrast and overall lithographic fidelity. Previous work has demonstrated cold development for both PMMA and ZEP520A. In this talk, we'll discuss equipment that worked and that didn't work for a new setup to support cold process development at MIT.nano including model numbers and cost.

MAEBLx Asia Pacific (Online only)

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	EDT	CEDT	AEDT	Topic	Facilitator
20:00 (July **28**)	23:00 (July **28**)	05:00 (July 29)	13:00 (July 29)	Online Networking	
21:00 (July **28**)	00:00 (July 29)	06:00 (July 29)	14:00 (July 29)	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 (July **28**)	02:00 (July 29)	08:00 (July 29)	16:00 (July 29)	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 mm^2 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 and Light Breakfast	
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, etc.	Mark Mondol Massachusetts Institute of Technology
11:30	14:30	20:30	04:30	**PATTERN & DESIGN FUNDAMENTALS** Data Volume, Hierarchy, Shot Grid Placement, etc.	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	Coffee Break/Continued Discussion and Networking	
15:10	18:10	00:10 (Sept 15)	08:10	**PATTERN TRANSFER** Nanopatttern Transfer Using Reactive Ion Etching	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** • 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.

The California Institute of Technology
1200 E California Blvd, Pasadena, CA 91125
Also Accessible Online for Virtual Attendees
Wednesday-Thursday, September 14-15, 2022

Session II: MAEBL Core*

September 15, 2022 (PDT): The meeting that started it all. Engage the EBL community's collective knowledge.

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	**RESIST PROCESSING** An Interactive Survey with Mentimeter	Aimee Price The Ohio State University
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	**PATTERN TRANSFER** Enhancing Etch Selectivity with 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	Quick Coffee Break	
11:30	14:30	20:30	04:30	**COMMON CHALLENGES I** An Open Forum Discussion of Common Issues	Justin Wirth✦ & Venkatachalam P✣ ✦Purdue University ✣India Institute of Science
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	**ALIGNMENT** User-defined Joy Markers	Ivan Milosavljevic HRL Laboratories
15:00	18:00	00:00 **(Sept 16)**	08:00	Coffee Break/Continued Discussion and Networking	
15:15	18:15	00:15	08:15	**TEST PATTERNS** Drift within Mainfiled and In-field Alignment (Performance Test Part II)	Michael Stuiber Melbourne Centre for Nanofabrication
16:15	19:15	01:15	09:15	**COMMON CHALLENGES II** Open Forum Discussion of Common Issues	Guy Derose California Institute of Technology
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.

Board of Directors

The Founders and Board Members

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 2022 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. 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.

Mark K Mondol (MAEBL Vice President and 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.

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. Guy A. DeRose (MAEBL 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. Guy joined the MAEBL Board in 2020, and is very excited to be hosting the event in-person at Caltech in September 2022.

Justin C. Wirth, PhD, (MAEBL 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.

MAEBL Community Conduct Expectations

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.

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