EIPBN

The 64th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication

Program

www.eipbn.org • Online June 1-4, 2021

Presentations + Posters available on-demand May 24, 2021

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A Letter from the EIPBN 2021 Conference Chair

Gerald G. Lopez, Ph.D.
EIPBN 2021 Conference Chair

Friday, May 7, 2021

Dear Colleagues:

Welcome to the 64th International Conference on Electron, Ion, Photon Beam Technology and Nanofabrication. This year's abstracts span 23 countries, highlighting "3-Beams" as the premier international conference for cutting-edge nanoscale lithography and nanofabrication research and innovation. While virtual, three outstanding plenary speakers kick-off our meeting coupled with Short Course lectures followed by exceptional invited presentations throughout the week.

This past year challenged us in ways unimaginable. Following the abrupt cancellation of the 2020 Conference, we pivoted to a virtual meeting early in the EIPBN 2021 planning process. The effort for the Virtual Conference has been both great and uncharted. While it is the first time the Conference will be online, I certainly hope it is the last for the sake of my successors. As a virtual conference, we are releasing presentations for on-demand viewing on May 24, 2021. The planned Conference activities center around the **golden minutes of engagement** which include Q&A Sessions, Poster Sessions, Exhibitor engagement and much more. This "flipped" conference allows us to deliver the same amount of content in a compressed timeframe and reduced scheduled commitment in front of a screen.

I am fortunate to have locked step with our Program Chair, Martha I. Sanchez. In our three years as Steering Committee members, she has been both a wonderful colleague and friend. Her professionalism, dedication, and conference programming experience have shone throughout the entire process. I hope you will come to appreciate the fruits of her labor as we embark on this virtual journey together. Thank you, Martha. It has been a pleasure and honor. Words honestly cannot describe how lucky I am to have served with you.

We are grateful for the generous support we have received as we carry the spirit of the conference onto its virtual platform. In particular, we'd like to thank all our sponsors; namely, our Platinum Sponsors: Heidelberg Instruments and STS-Elionix; our Gold Sponsors: Raith and GenISys; our Silver Sponsors: JEOL USA and AllResist; and the rest of our Sponsors and Exhibitors: Agilent Technologies, AJA International, Inc., ANCORP, Cornell University, DisChem, Inc., Intel Corporation, Kapteyn-Murnane Laboratories, Inc., KemLab Inc., KLA, LatticeGear, micro resist technology GmbH, Nanonex Corporation, Nanoscribe GmbH, NuFlare Technology, Inc., Oasis Materials, SAES Group, SmarAct Inc., STS-Elionix, TED PELLA INC, TEL, Tousimis, Vistec Electron Beam GmbH, Wafer World, Inc., ZEISS International, and Zyvex Labs.

Of course, Martha and I did not work alone. Thanks go out to our Steering Committee members, Shida Tan, Aaron Stein, Regina Luttge (WIN and Startup Contest), James Spallas (Student Breakfast and Mentor Lunch), Rob Ilic, Qiangfei Xia (Commercial Session Chair), and Chih-Hao Chang (Short Course Chair) for their valuable time. None of the behind-the-scenes operations would be possible without John Randall, our Financial Trustee; Denise Hayner, our Corporate Accountant; Melissa Widerkehr, our Conference Coordinator; Nichole Ballard, our Registrar at YesEvents; and Nicki Davis, our Conference Website Manager. There has also been an incredible effort by Nick Petrone, Startup Contest Communications and Chair; Gina Adam, Academic Outreach Chair; Rick Livengood, Student Breakfast Chair; and our Commercial Session Committee members: Aimee Price, Guy DeRose, Zach Russell. Finally, my final thanks go to you and all members of the EIPBN Community for keeping the conference spirit alive with us.

I am indebted to the EIPBN Steering and Advisory Committee for their continued support and dedication to the conference and the community. Thank you for the distinction and honor to serve. I look forward to seeing you again soon and in person.

Sincerely,
Gerald G. Lopez, Ph.D.
EIPBN 2021 Conference Chair

A Letter from the EIPBN 2021 Program Chair

Martha I. Sanchez
EIPBN 2021 Program Chair

Friday, May 7, 2021

Dear EIPBN Community:

We hear the term “unprecedented time” frequently now, but it is inspirational how we manage to find ways to cope and adjust. This conference is a first for EIPBN and I cannot impress on all of you how much research and effort my co-chair, Gerald Lopez, has put into bringing you a conference mimicking the technical exchange and networking that we all value in an EIPBN conference. I hope you take full advantage of the opportunities we are trying to provide you to interact with your fellow EIPBNers – attend the Short Courses (free to all attendees), actively participate in the session Q&A’s, meet in GatherTown to talk to Exhibitors, view Posters, the Start-up Contest, attend WIN, the Mentor Mixer, and Student Recruitment.

This technical exchange would not be possible without all of you willing to accept this new format and requirements and to go the extra effort of recording your presentations. I want to thank the Plenary speakers, C. Shan Xu, Sharon Weiss, and Neil Gershenfeld, and all the presenters for your contributions that will make this a successful conference. It is also exciting to see how the topics of interest change with time, and this year is no exception. There are many talks that are of new materials and in new scientific areas.

Gerald and I did not do all this alone. There are many people helping us with the logistics of not only organizing the conference, but also organizing the special events that are integral to our community. I would love to name all the contributors but there are many. I want you all to know how much I appreciate your time and enthusiasm. It is a joy to work with so many people who feel passionate about EIPBN.

Finally, I hope you enjoy the 2021 EIPBN conference. I am sure it will be memorable!

Best wishes for health and happiness,

Martha I. Sanchez
EIPBN 2021 Program Chair

About EIPBN 2021

The International Conference on Electron, Ion and Photon Beam Technology and Nanofabrication (EIPBN), affectionately known as "3-Beams," is the premier gathering of scientists and engineers who are dedicated to electron, ion and photon lithography, imaging, and analysis; atomically precise fabrication; nanofabrication process technologies and related emerging technologies; and their applications in a broad spectrum of fields. In its 64th meeting, researchers from academia, government laboratories, and industry from around the world meet to present and discuss recent and future trends in these technologies. We encourage everyone to follow the conference on LinkedIn.

For the first time in its history, EIPBN will be held virtually, presenting a tremendous opportunity to broaden the community's reach and diversity in attendance, talks, and commercial exhibition. Highlighted below are special events that will also take place during the virtual conference.

- **Tuesday Short Courses.** The popular EIPBN Short Courses will take place on Tuesday, June 1, 2021. This event features 5 lectures given by leading authorities in each field.

- **Women in Nanofabrication (WIN).** WIN is a networking event that brings together women (and other non-binary) researchers and industrial professionals from around the world with the understanding that through diversity and inclusion can the exchange of progress and ideas push the fields of lithography and nanotechnology. Join the EIPBN Women in Nanofabrication Group on LinkedIn.

- **Student Recruiting Breakfast.** The Student Recruiting Breakfast is a chance for students to learn about industry positions and opportunities. There is no charge to participate in this event.

- **The Startup Contest.** Expanding our impact on tech-transfer, the EIPBN Startup Session is a dynamic venue for entrepreneurs to share their experiences and innovations. Session opens with keynote from Larry Muray (Sr. Director, KLA and former President/CEO of Novelx). Startup Contests finalists will pitch their technological innovations live, while audience members will participate in voting to select the winner. Follow the EIPBN Startup Contest on LinkedIn.

- **Micrograph Contest.** To highlight the importance of micrographs to the field, the conference holds a micrograph contest every year. Submissions are sought from our community, and can be generated in the course of doing research, but can be submitted purely for their beauty or ability to excite curiosity, and need not be related to any paper or topic presented at the conference.

- **Student Mentor Lunch.** The Student Mentor Lunch allows students to interact with professionals in academia, industry, and government labs to explore career paths.

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We are going to launch our new next generation EBPG system!

Launch presentations at our booth:

June 1, 2021	11:00 AM (PST)		
June 2, 2021	10:00 AM (PST)	1:00 PM (PST)	2:00 PM (PST)
June 3, 2021	10:00 AM (PST)	1:00 PM (PST)	2:00 PM (PST)
June 4, 2021	10:00 AM (PST)		

Look in on the Raith contributions to the EIPBN talks

Frank Nouvertné, Raith GmbH

Cryo-Cathodoluminescence Integration, multiple Ion Species and a new EBPG: About Highlights from dedicated and multifunctional Raith EBL and FIB-SEM Systems

Torsten Richter, Raith GmbH

Universal Liquid Metal Alloy Ion Sources containing light and heavy ions for FIB and nanofabrication

› For the dates, please have a look at the EIPBN program.

EIPBN 2021

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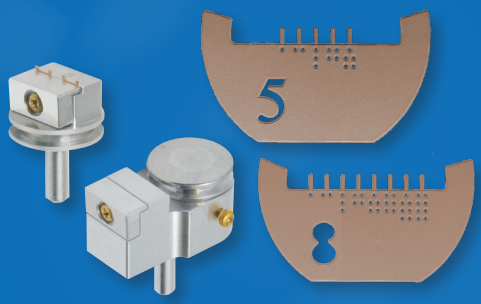
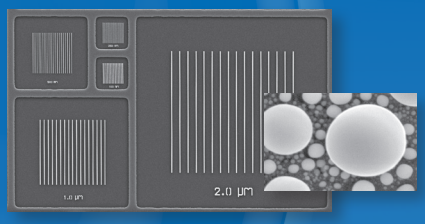
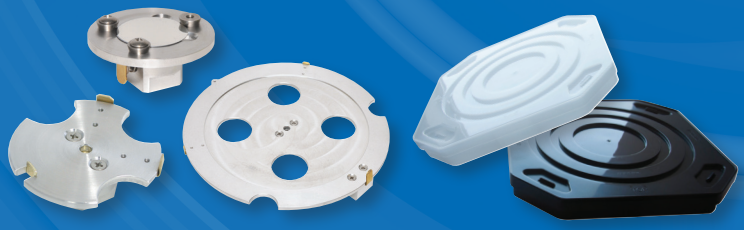


FIB Supplies
Lift-Out Grids, Probes,
FIB Mounts



Calibration Standards
Spatial XY calibration & Resolution
for LM, SEM, FESEM



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- Water based w/ excellent wetting properties. Spin coat application provides 40 nm conductive film. Available in three concentrations for wide process window.
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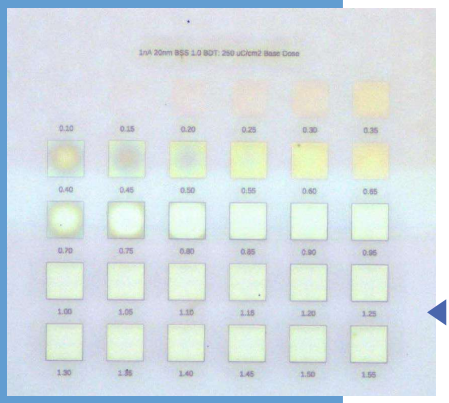
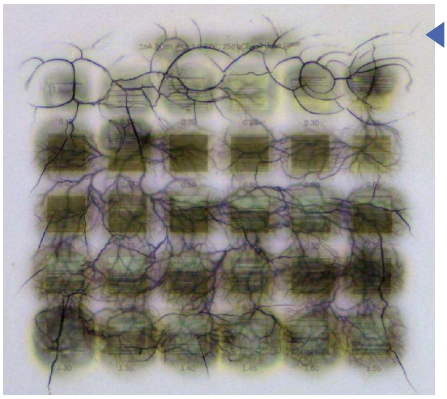


WITH DisCharge: no charge accumulation, resulting in expected image with no harm to PDMS layer.



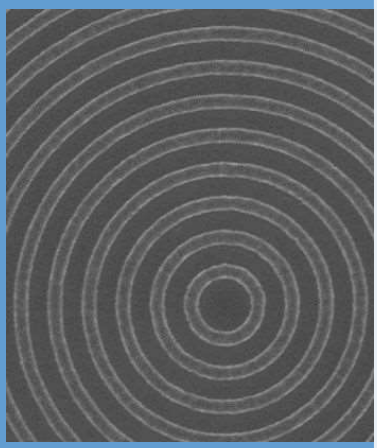
Without DisCharge: charge accumulation and sudden charge dissipation caused by exceeding the dielectric breakdown strength of the PDMS to the Si substrate resulting in significant image distortion in the resist and destruction of the PDMS surface.

anti-charging

H-SiQ *(hydrogen silesquioxane)*

NEGATIVE-TONE ELECTRON BEAM RESIST

DisChem H-SiQ is a negative tone hydrogen silesquioxane 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 film EBL applications.



resist

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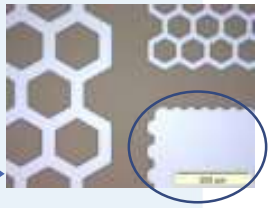
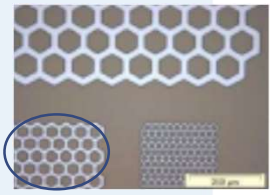
RESIST ADHESION PROMOTERS

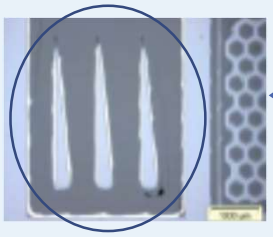
- Improved microlithographic resist adhesion on a broad range of substrate materials.
- Improved adhesion at low doses in electron beam lithography
- Improved removal of critical substrate contaminants
- Reduced z-potential for improved resist coating properties
- Improved patterned resist mold to copper 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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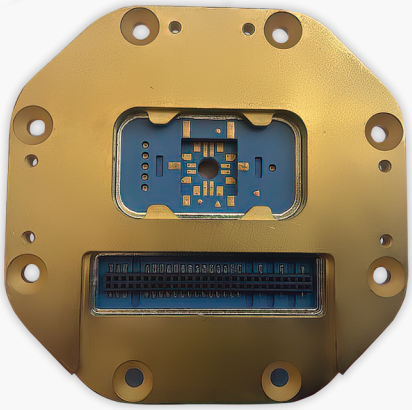
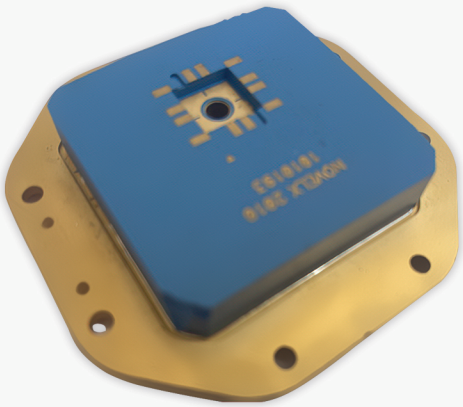
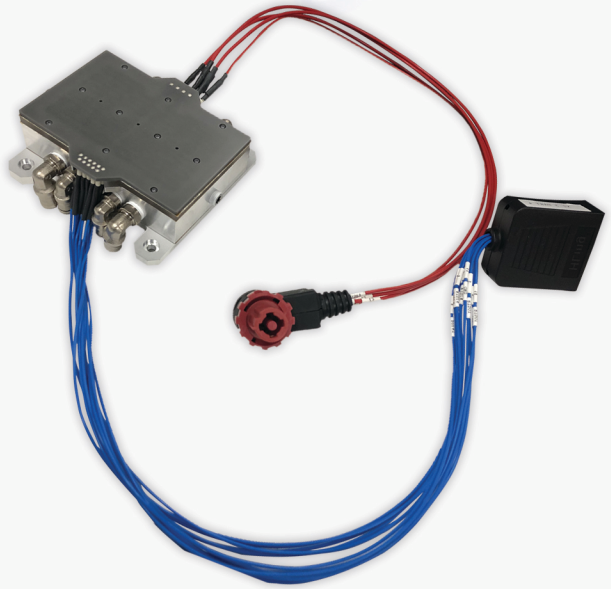
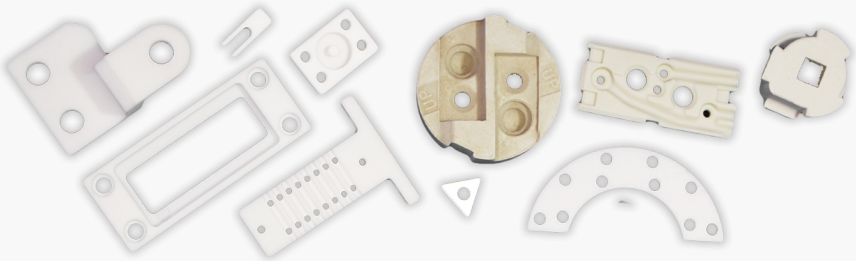




MULTI-LAYER LLTC INTERCONNECT BRAZED TO KOVAR RING FRAME



120 BY 80MM HEATER-COOLER MULTI-LAYER AND MULTI-ZONE ALN PULSE HEATER WITH INTEGRATED COOLING AND QUARTZ THERMAL BREAK



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EIPBN 2021 Program At-A-Glance

This year's program compresses the meeting by releasing videos for on-demand viewing one week prior to the agenda below. The core of the meeting comprises of the Plenary Talks on Tuesday and the parallel Q&A Sessions along with the poster sessions Wednesday through Friday, requiring a time commitment of roughly 3 hours per day for scientific engagement.

NOTE: Schedule is in Pacific Standard Time. The website will convert the schedule to your local time zone.

Pacific Time	Tuesday, June 1, 2021			Location
08:00 - 08:25	Welcome, Opening Remarks, and Announcements			Underline.io
08:30 - 9:20	Plenary Talk 1: "Using Electrons, Ions, and Photons to Comprehend Cells and Brain Circuits: Enhanced FIB-SEM Technology for Life Science" **C. Shan Xu, Ph.D.**, Howard Hughes Medical Institute			
09:20 - 10:10	Plenary Talk 2: "Advances in Integrated Photonics through Subwavelength Engineering," **Sharon M. Weiss, Ph.D.**, Vanderbilt University			
10:10 - 11:00	Plenary Talk 3 "Digital Fabrication," **Neil Gershenfeld, Ph.D.** MIT Center for Bits and Atoms			
11:00 - 12:00	**ANCORP** Coffee Break	**Commercial Session**	Poster Preview	Gather.Town Exhibition Hall
12:00 - 13:00	Short Course Lecture 1: "DNA-Directed Self-Assembly: Molecularly Precise Nanofabrication" by **J. Alexander Liddle, Ph.D.**, National Institute of Standards and Technology (NIST)			Underline.io
13:00 - 14:00	Short Course Lecture 2: From "Patterning Dopants in 2D Devices to Bone-Tissue Engineering by Thermal Scanning Probe Lithography" by **Elisa Riedo, Ph.D.**, New York University			
14:00 - 15:00	Short Course Lecture 3: Materials for Advanced Lithography by **Dario L. Goldfarb, Ph.D.**, IBM			
15:00 - 16:00	Short Course Lecture 4: "Mathematical and Technological Foundations of Neuromorphic Computing" by **Brian Hoskins, Ph.D.**, NIST			
16:00 - 18:00	Short Course Lecture 5: "Quantum Mechanics and Quantum Computing, an Introduction" by **Tim Groves, Ph.D.**, retired, State University of New York			

Pacific Time	Wednesday, June 2, 2021		Location
06:45 - 07:50	Student Recruiting Breakfast: Sponsored by STS-Elionix		Gather.Town: STS-Elionix Booth
08:00 - 08:10	Welcome, Announcements and Housekeeping		Underline.io
08:10 - 09:00	Sessions 1A Q&A - Ion Beam		
	Sessions 1B Q&A - Nanofluidic Medical Devices		
	Sessions 1C Q&A - Micro- and Nanoscale Mechanical Devices I		
09:10 - 10:00	Sessions 2A Q&A - Atomically Precise Fabrication		
	Sessions 2B Q&A - 3D Nanosculpturing		
	Sessions 2C Q&A - Nanoimprint		
10:00 - 10:30	**ANCORP** Coffee Break	**Commercial Session**	Gather.Town Exhibition Hall
10:30 - 12:00	Poster Session		
12:00 - 13:00	Women in Nanofabrication: Sponsored by Intel and Heidelberg Instruments		Gather.Town: Heidelberg Booth
13:00 - 14:30	Start-up Session and Contest: Sponsored by KemLab		Gather.Town: KemLab Booth

EIPBN 2021 Program At-A-Glance (cont'd)

Structured around the meeting core are the ANCORP Coffee Breaks, Commercial Session, Poster Sessions, Women In Nanofabrication, the Startup Contest, Student Recruiting Breakfast and the Student Mentor Lunch. The Virtual Exhibition hall never closes and is available for engagement at anytime during the week. Complete abstracts are available online at https://eipbn.org/abstracts/2021/.

NOTE: Schedule is in Pacific Standard Time. The website will convert the schedule to your local time zone.

Pacific Time	Thursday, June 3, 2021		Location
08:00 - 08:10	Welcome, Announcements and Housekeeping		Underline.io
08:10 - 09:00	Sessions 3A Q&A - Micro and Nanolithography		
	Sessions 3B Q&A - Nanophotonics and Plasmonics I		
	Sessions 3A Q&A - Biomedical Devices I		
09:10 - 10:00	Sessions 4A Q&A - Electron and Ion Beam Lithography / Post-processing / Applications		
	Sessions 4B Q&A - Materials and Pattern Transfer Techniques		
	Sessions 4C Q&A - Imaging Modeling and Characterization		
10:00 - 10:30	**ANCORP** Coffee Break	**Commercial Session**	Gather.Town Exhibition Hall
10:30 - 12:00	Poster Session		
12:00 - 13:00	Student Mentor Lunch		Gather.Town: STS-Elionix Booth

NOTE: Schedule is in Pacific Standard Time. The website will convert the schedule to your local time zone.

Pacific Time	Friday, June 4, 2021		Location
08:00 - 08:10	Welcome, Announcements and Housekeeping		Underline.io
08:10 - 09:00	Sessions 5A Q&A - Micro- and Nanoscale Mechanical Devices II		
	Sessions 5B Q&A - Biomedical Devices II		
	Sessions 5A Q&A - Electron and Ion Beam Lithography / Deposition / Etching		
09:10 - 10:00	Sessions 6A Q&A - Nanofluidic, Nanobiology and Nanomedicine		
	Sessions 6B Q&A - Nanophotonics and Plasmonics II		
	Sessions 6C Q&A - Novel Patterning		
10:00 – 11:00	**ANCORP** Coffee Break	**Commercial Session**	Gather.Town Exhibition Hall
11:00 - 12:00	Closing Remarks, Micrograph Contest Winners and 2022 Venue Announcement		Underline.io

Presentation Platform

(On-Demand on underline.io on May 24, 2021)

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Our virtual conference presentations are managed by underline.io. Read more to learn how their platform further enables the EIPBN Community.

underline is the world's first repository platform for cutting-edge scientific lectures, research, discussion and conference live-streaming. It is an online video platform custom built for scientific and academic events. They aggregate and host conference content in both a live and virtual environment, allowing presenters to reach new global audiences while also giving conference attendees the ability to watch any content they might have missed.

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"Our Mission is to digitize scientific knowledge through video, making it globally accessible and useful by enriching, preserving and aggregating conference content. Science is a global discipline, and we all need to be unified. We all need to work together now towards an open society and connected world. We need to build bridges, not barriers. Underline Science is part of that global bridge."

Alex Lazinica
Underline Science
CEO

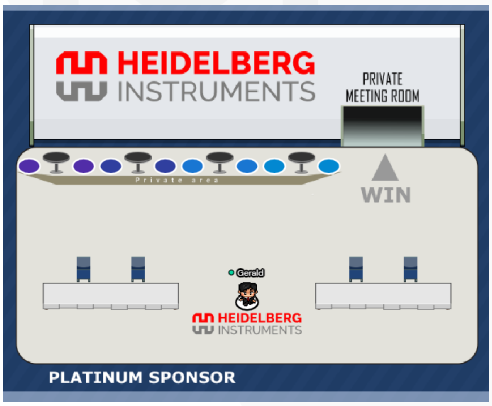
Virtual Exhibition Platform

(Vendors + Posters in Gather.Town)

Are tired from a year of Zoom rooms? So are we. The EIPBN 2021 Virtual Exhibition is powered by Gather.Town allowing participants to flow in and out of conversations naturally as in the physical world.

Gather is simply described as a proximity video chat platform launched amidst a global pandemic. It is the brainchild of Phillip Wang, Kumail Jaffer and Cyrus Tabrizi (see right image), a team of three friends and engineers. Together, they were determined to help people have better long-term relationships with the people that matter to them, no matter their location. Gather.Town is the culmination of their year-long exploration of social telepresence.

Gather.Town experienced rapid adoption in the with universities, conferences, workshops, offices, birthday parties, baby showers, and more to re-enable the dynamic interaction found in a physical world. Conferences as large as 2500 participants have been hosted on the platform. Having tested many technologies, we know Gather.Town will enhance the Virtual Conference experience for EIPBN. Access to the GatherTown-powered Virtual Exhibition Hall will be provided through the Underline.io portal.



Screen capture of an exhibition booth in Gather.Town.

Virtual Exhibition

(Vendors + Posters in Gather.Town)

About the Virtual Exhibition Hall

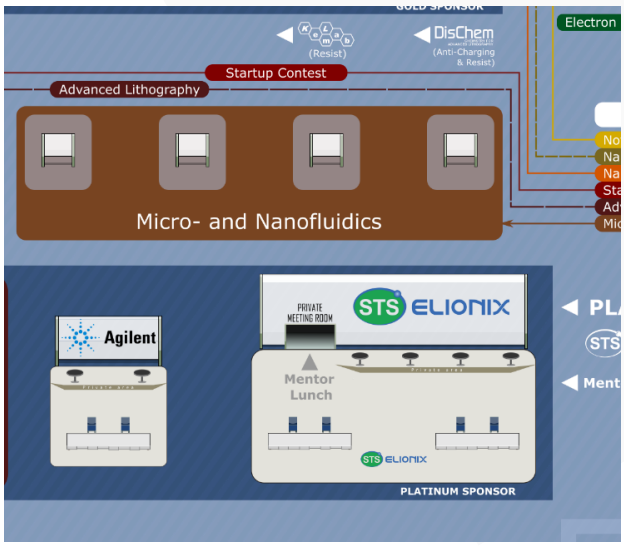
This year's exhibition features 17 booths and 70 posters. Posters are integrated throughout the exhibition hall to encourage foot traffic throughout the virtual space. Some booths are equipped with private meeting rooms or specialized booths to host events such as the:

- Women In Nanofabrication
- Startup Contest
- Micrograph Contest
- Student Recruiting Breakfast
- Student Mentor Lunch

Using Gather.Town as our exhibition platform, we hope you will find your conversations occurring naturally by simply *running into* old colleagues. Attendees are encouraged to visit our exhibitors with a chance to win a $100 grand prize. The Exhibition Hall never closes, so feel free to visit often!

$100 Grand Prize!

Sign-in at every booth during the hours of the exhibition and poster session. The attendees with the most visits will be placed into the Friday drawing!



Virtual Exhibition

(Vendors + Posters in Gather.Town)

Commercial Session and Industrial Highlights Session

The commercial session features vendors of materials and equipment which are relevant to the conference. Here is your opportunity to meet with vendors who are eager to discuss their latest lithography systems, materials, and characterization instruments and related products. In addition, be sure to check out talks from the Industrial Highlights and feel free to approach the speaker's respective booth with your questions

The commercial exhibition schedule is:

- Tuesday, June 1, 2021: 10:45 - 12:00 PST
- Wednesday, June 2, 2021: 10:00 - 13:00 PST
- Thursday, June 3, 2021: 10:00 - 13:00 PST
- Friday, June 4, 2021: 10:00 - 10:45 PST

$100 Grand Prize!

Sign-in at every booth during the hours of the exhibition and poster session. The attendees with the most visits will be placed into the Friday drawing!

Participants in this year's commercial session include:

HEIDELBERG INSTRUMENTS

STS ELIONIX

RAITH NANOFABRICATION

GenISys GmbH

ALLRESIST

JEOL

Agilent

CNF Cornell NanoScale Science and Technology Facility

DisChem Chemistry for Advanced Lithography

KLA

KMLABS Leading in Ultrafast

micro resist technology

nano scribe

saes group

SmarAct

Vistec Electron Beam

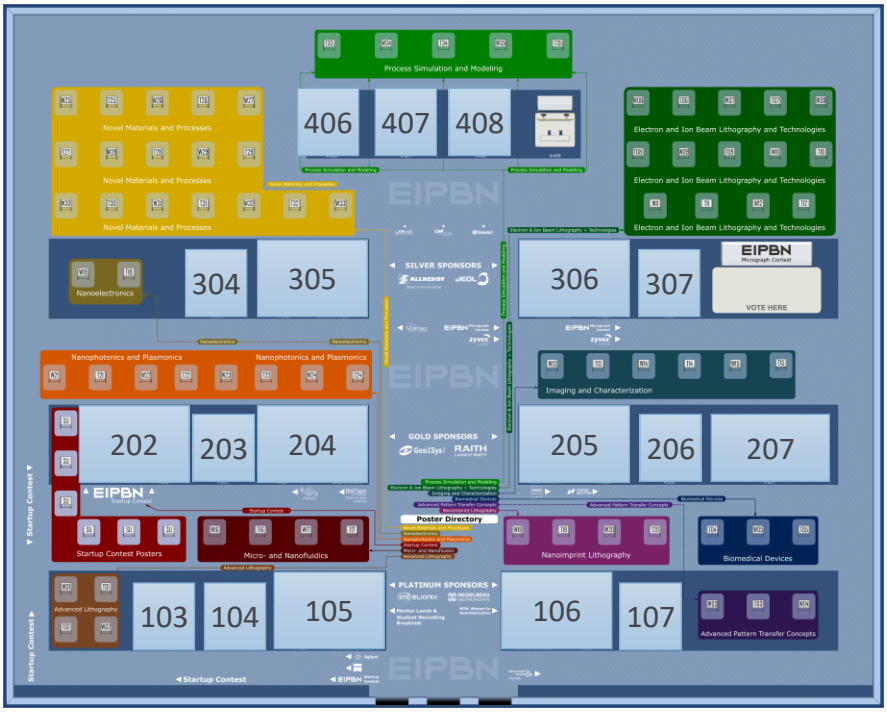
ZEISS

zyvex LABS

Virtual Exhibition Booth Locations

Lithography/Imaging/ Metrology Tools

- STS ELIONIX — 105
- HEIDELBERG INSTRUMENTS — 106
- RAITH NANOFABRICATION — 205
- GenISys GmbH — 204
- JEOL — 306
- nanoscribe — 207
- Vistec Electron Beam — 304
- SmarAct — 408
- zyvex LABS — 307
- ZEISS — 103



Nanofab

- CNF Cornell NanoScale Science and Technology Facility — 407

Laser Source

- KMLABS LEADING IN ULTRAFAST — 406

Pumps

- Agilent — 104
- saes group — 206

Resists and Coatings

- ALLRESIST — 305
- Kelab — 202
- DisChem CHEMISTRY FOR ADVANCED LITHOGRAPHY — 203
- micro resist technology — 107

Videos On-Demand: May 24, 2021

EIPBN

Online: June 1-4, 2021

www.eipbn.org

Industrial Highlights Session

Watch the videos on-demand and visit each booth in the Virtual Exhibition Hall for one-on-one Q&A

I-1 SAES Getters S.p.A. (Booth #206)
Features & Benefits of NEXTorr® pumps in e-beam systems, Andrea Cadoppi (Saes Getters S.p.A.)

Theoretical and practical aspects of NEG pumps technology will be presented, with particular focus on the unique benefits in electron microscopy and e-beam lithography: the extreme compactness; the possibility to transport the gun under vacuum in total absence of power; the extended source lifetime.

I-2 Nanoscribe GmbH & Co. KG (Booth #207)
Two-photon grayscale lithography, Benjamin Richter, Michael Thiel, Yann Tanguy, Nicole Lindenmann, Alok Tungal, Roman Rainer, Matthias Blaicher, Joerg Hoffmann, Thomas Sauter, Fabian Niesler, Tiemo Gissibl, Andre Radke (Nanoscribe GmbH & Co. KG)

Two-Photon Grayscale Lithography (2GL®) is a breakthrough innovation uniting the strengths of grayscale lithography with the precision and flexibility of Two-Photon Polymerization (2PP). This merger results in an enormous design freedom inherited from 2PP-based additive manufacturing and at the same time costeffective microfabrication of 2.5-dimensional topographies with optical-quality surfaces.

I-3 LatticeGear (Sponsor, no booth)
Wafer dicing by cleaving: A fast, clean, dry and accurate, Janet Teshima (LatticeGear)

It is often thought that cleaving can only be applied to crystalline materials such as silicon and GaAs and that it is an inherently dirty and imprecise process. Dicing by cleaving can be applied to a wide variety of wafer substrates including silicon, sapphire, GaAs, GaN, InP, SiC, and glass.

I-4 Heidelberg Instruments Nano (Booth #106)
Thermal scanning probe lithography today and tomorrow: avenues for scale-up, Emine Cagin (Heidelberg Instruments Nano)

The NanoFrazor is gaining popularity in solving complex nanofabrication challenges at research facilities worldwide. The tool enables new nanodevices, processing of highly sensitive materials (also in a glovebox) and sub-nanometer 3D lithography. We present the recent developments for scaling the technology up for ever larger areas and higher throughput.

I-5 Raith GmbH (Booth #205)
Cryo-Cathodoluminescence Integration, multiple Ion Species and a new EBPG: About Highlights from dedicated and multifunctional Raith EBL and FIB-SEM Systems, Frank Nouvertne, Torsten Richter, Christiaan Zonnevylle, (Raith GmbH)

We will highlight latest Raith innovations in the segments of dedicated and multifunctional EBL and FIB-SEM tools: a world´s first EBL system with integrated in-situ cryo-cathodoluminescence functionality, a new multiple ion species source for FIB and the release of a new EBPG Plus system with superior world class performance specs.

I-6 Zyvex Labs (Booth #307)
From STM to Lithography Tool, James Owen, John Randall, Ehud Fuchs, Moutaz Haq, Bill Owen, Robin Santini, (Zyvex Labs); Reza Moheimani, Hamed Alemansour, Afshin Alipour (The University of Texas at Dallas)

Zyvex Labs has been working to convert a Scanning Tunnelling Microscope into an Atomic-Precision Lithography Tool. We describe the various advances in STM hardware and control systems that go into making this leap.

I-7 GenISys, Inc. (Booth #204)
Meet ProSem, Richard Bojko (GenISys, Inc.)

ProSEM makes automated feature size (CD) measurements from your saved SEM images, with a user interface designed for simplicity and productivity. Powered by efficient measurement algorithms, ProSEM provides you with fast, reliable, repeatable measurements, for improved process calibration, monitoring, and day to day tasks.

I-8 Heidelberg Instruments Inc. (Booth #106)
Direct Write Lithography systems from Heidelberg Instruments, Niels Wijnaendts van Resandt (Heidelberg Instruments Inc.)

The versatility of using direct write lithography systems for micro and nano patterning has created the need for tools for a broad range of applications, all with different requirements in specifications and cost.
This talk will give an overview of Heidelberg Instruments solutions for research and industry applications.

I-9 Micro resist technology GmbH (Booth #107)
Innovations in photoresists and photopolymers for 2D / 3D micro and nano fabrication, Anja Voigt (micro resist technology GmbH)

High fidelity 2D and 3D micro and nanometer structures are facilitated by a number of fabrication methods which employ numerous concepts of lithographic patterning. In our contribution we seek to review our material innovations for scientific work where emerging nanofabrication is employed as well advanced production with industrial relevance.
Find them in other sessions:

Heidelberg Instruments
(Booth #106)

3A-3
Hybrid 2D & 3D Lithography, Dominique Collé (Heidelberg Instruments)

We investigated the combination of maskless UV lithography and 2PP (two-photon polymerization) on a standard photo-resist: SU-8. 2PP technology is known to be slow. The advantage of mixing the technologies becomes obvious when some elements of a design can be exposed faster using maskless UV lithography.

6C-2
Chip-scale fabrication of FETs by a combination of thermal scanning probe lithography and direct laser sublimation, Tero S. Kulmala, Emine Cagin, Samuel Bisig, (Heidelberg Instruments Nano); Heiko Wolf, Daniel Widmer, Ute Drechsler, Philippe Nicollier, Francesca Ruggeri, Armin W. Knoll, (IBM Research - Zurich)

Thermal scanning probe lithography can reach a resolution down to 10 nm but has a relatively modest throughput. Therefore, direct laser sublimation of resist has been introduced for significantly faster patterning of lower-resolution features. Here, we demonstrate chip-scale mix-and-match fabrication of field effect transistors via combined tip and laser patterning.

Raith
(Booth #205)

1A-3
Universal ion sources for FIB containing light and heavy ions from Liquid Metal Alloy Ion Sources, T. Richter, P. Mazarov, F. Meyer, W. Pilz (Raith GmbH); L. Bischoff, N. Klingner, G. Hlawacek (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research)

Nanofabrication requirements for FIB technologies are specifically demanding in terms of patterning resolution, stability, and the support of new processing techniques. We have extended the technology towards the stable delivery of multiple ion species selectable into a nanometer scale focused ion beam by employing a liquid metal alloy ion source.

4C-3
Focused Ion Beam Patterning for Defect-Mediated Nucleation on 2D van der Waals Materials, Vera Zarubin, Kate Reidy, (Massachusetts Institute of Technology); Yang Yu (Raith America Inc.); Ilya Charaev, Joachim Thomsen, Julian Klein, Frances Ross (Massachusetts Institute of Technology)

We use focused ion beams to create specific defects on suspended 2D materials (graphene, MoS2, WSe2). We study the extent to which the defects act as nucleation sites for Au, and tune deposition conditions and surface cleanliness to facilitate self-assembly of specific nanoisland shapes.

5C-4
Comparison of alignment markers and method for electron-beam lithography on CMOS dies, Raphaël Dawant, Serge Ecoffey, Dominique Drouin, (Université de Sherbrooke); Robyn Seils, Rainer Schmid (Raith America Inc)

CMOS back-end-of-line integration is a very promising technology for the next generations of integrated circuits. Yet, electron beam lithography and alignment on multiple underlying metal layers and structures is challenging. In this paper, we present an image correlation strategy, procedure and markers to reach alignment accuracy better than 5 nm.

Zyvex Labs
(Booth #307)

2A-1
Progress Toward 2D Nano Bipolar Junction Transistors, John Randall, James H.G. Owen, Ehud Fuchs, Robin Santini (Zyvex Labs); Nupur Navlakah (University of Texas at Austin)

Hydrogen Depassivation Lithography has been used to place donors with atomic precision in buried Si (100) planes to make quantum and atomic electronic devices. Recent demonstrations using acceptors to pair with donors enable bipolar junction transistors. These 2D-nanodevices should be extremely high-performance, low-noise, rad-hard, and capable of cryogenic operation.

2A-2
Co-deposition of B and P for Ultraprecise Bipolar devices, James Owen, Ehud Fuchs (Zyvex Labs); Hamed Alemansour (The University of Texas at Dallas); Reza Moheimani (UT Dallas); Wiley Kirk (University of Texas at Arlington)

We demonstrate the co-deposition of B and P in aligned atomic-scale patterns, in order to make bipolar junction devices. This requires the use of BCl3 and PH3 as

acceptor and donor dopant precursors, and dI/dV imaging to relocate the B electrode and align the P electrodes to it.

5A-1
MEMS-Based Scanning Tunneling Microscopy, Afshin Alipour, S. O. Reza Moheimani, (The University of Texas at Dallas); James Owen, William Owen, Ehud Fuchs, John Randall (Zyvex Labs)

We address low-throughput problem of Scanning Tunneling Microscopes (STMs) by replacing Z-axis of a commercial Ultra-High-Vacuum (UHV) STM piezotube with a high-bandwidth one-degree-of-freedom Microelectromechanical-System (MEMS) device. The MEMS device is integrated into the UHV STM system and is successfully used to take STM images of a sample surface.

Carl Zeiss
(Booth #103)

4C-6
High Resolution Imaging and Analytics for Nanoscience, Frederick Pearsall, William Harris, Fang Zhou, Carl Zeiss Microscopy

This talk will highlight classically-challenging imaging applications including magnetic, non-conductive, and beam-sensitive samples. Resolved magnetic grain structure of a hard disc platter, using low angle back-scatter detector is demonstrated. An additional sample-biasing technique, Tandem Deceleration, is also shown for comparison to visualize its usage to produce an extra boost in imaging resolution.

We are going to launch our new next generation EBPG system!

Launch presentations at our booth:

June 1, 2021	11:00 AM (PST)		
June 2, 2021	10:00 AM (PST)	1:00 PM (PST)	2:00 PM (PST)
June 3, 2021	10:00 AM (PST)	1:00 PM (PST)	2:00 PM (PST)
June 4, 2021	10:00 AM (PST)		

Look in on the Raith contributions to the EIPBN talks

Frank Nouvertné, Raith GmbH

Cryo-Cathodoluminescence Integration, multiple Ion Species and a new EBPG: About Highlights from dedicated and multifunctional Raith EBL and FIB-SEM Systems

Torsten Richter, Raith GmbH

Universal Liquid Metal Alloy Ion Sources containing light and heavy ions for FIB and nanofabrication

› For the dates, please have a look at the EIPBN program.

EIPBN 2021

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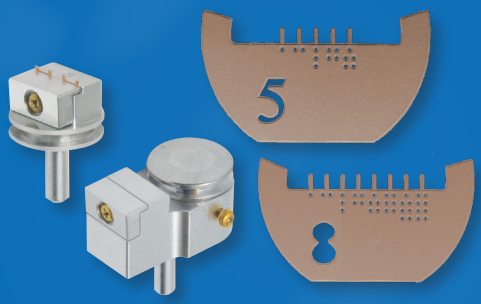
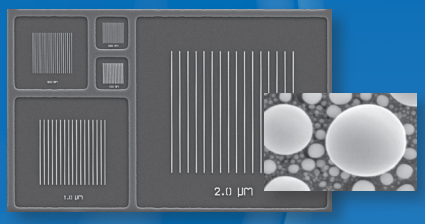
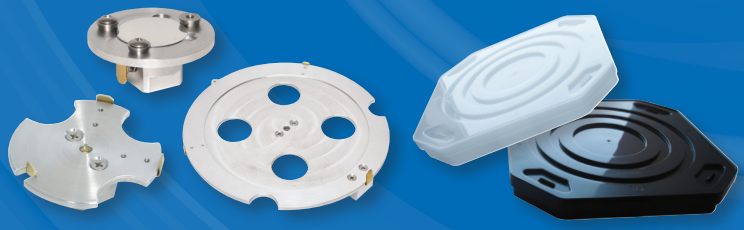


FIB Supplies
Lift-Out Grids, Probes,
FIB Mounts



Calibration Standards
Spatial XY calibration & Resolution
for LM, SEM, FESEM



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EIPBN BOOTH 203

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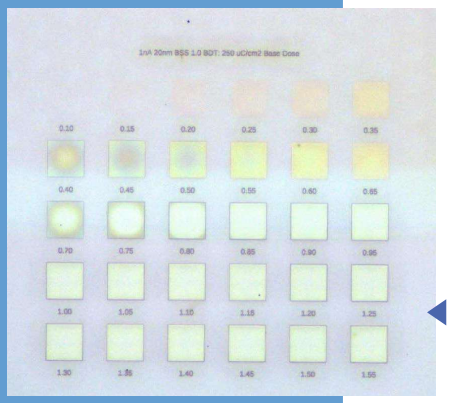
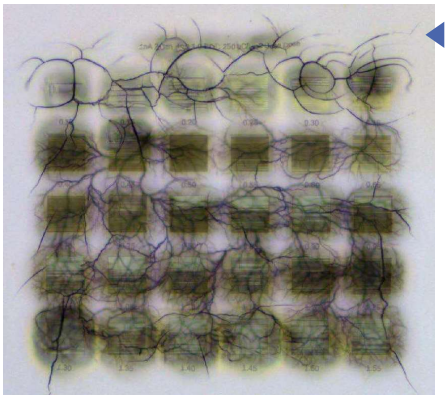
- Improved shape fidelity and positional accuracy for EBL resist patterning on insulating substrates such as fused silica, quartz, glass, PDMS, etc.
- Water based w/ excellent wetting properties. Spin coat application provides 40 nm conductive film. Available in three concentrations for wide process window.
- 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. No filtration required prior to use.



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



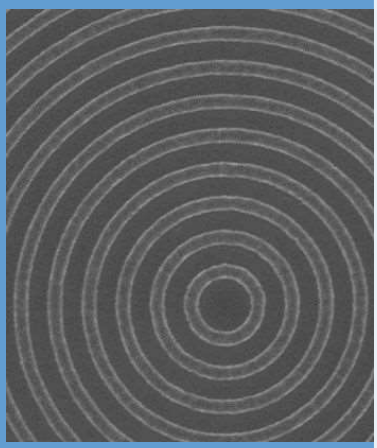
Without DisCharge: charge accumulation and sudden charge dissipation caused by exceeding the dielectric breakdown strength of the PDMS to the Si substrate resulting in significant image distortion in the resist and destruction of the PDMS surface.

anti-charging

H-SiQ *(hydrogen silesquioxane)*

NEGATIVE-TONE ELECTRON BEAM RESIST

DisChem H-SiQ is a negative tone hydrogen silesquioxane 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 film EBL applications.

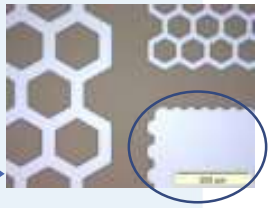


resist

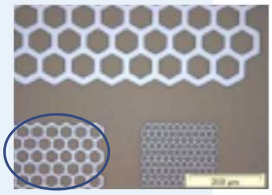
SurPass

RESIST ADHESION PROMOTERS

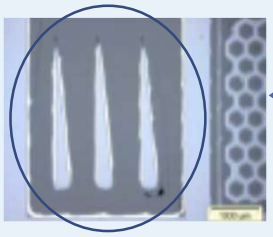
- Improved microlithographic resist adhesion on a broad range of substrate materials.
- Improved adhesion at low doses in electron beam lithography
- Improved removal of critical substrate contaminants
- Reduced z-potential for improved resist coating properties
- Improved patterned resist mold to copper 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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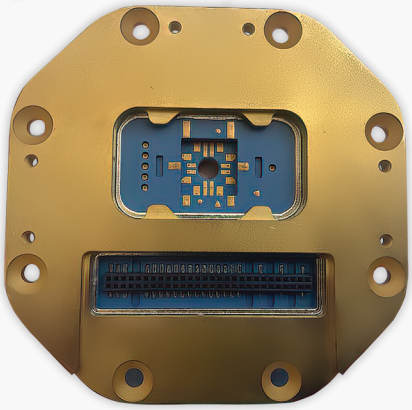
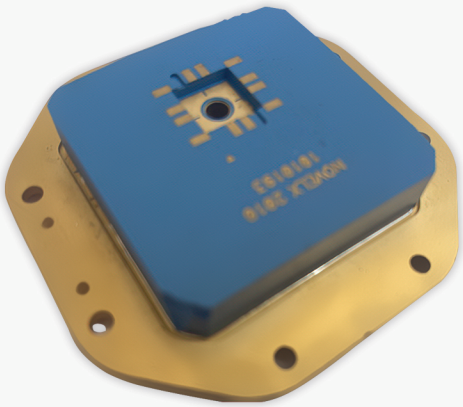
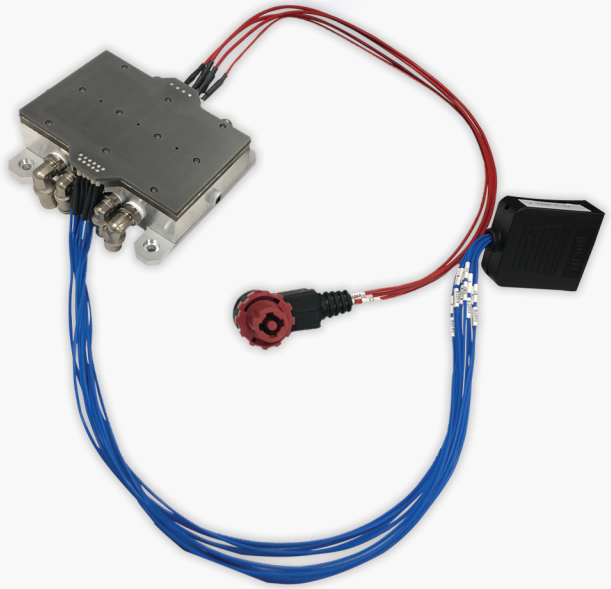
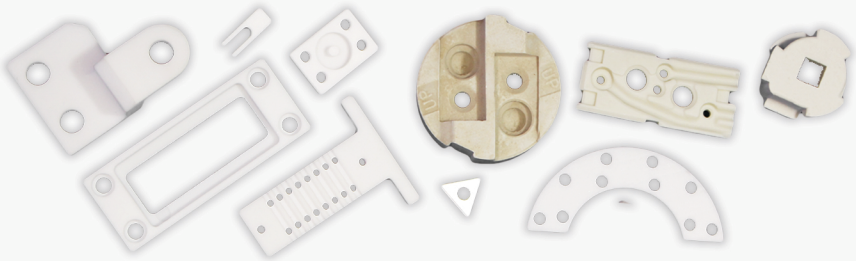




MULTI-LAYER LLTC INTERCONNECT BRAZED TO KOVAR RING FRAME



120 BY 80MM HEATER-COOLER MULTI-LAYER AND MULTI-ZONE ALN PULSE HEATER WITH INTEGRATED COOLING AND QUARTZ THERMAL BREAK



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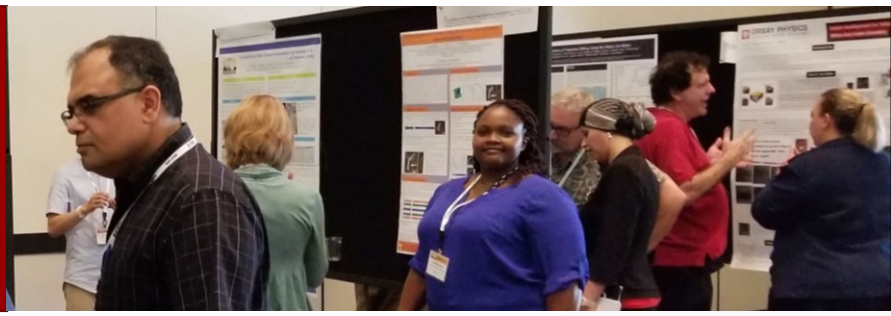
Virtual Exhibition

(Vendors + Posters in Gather.Town)

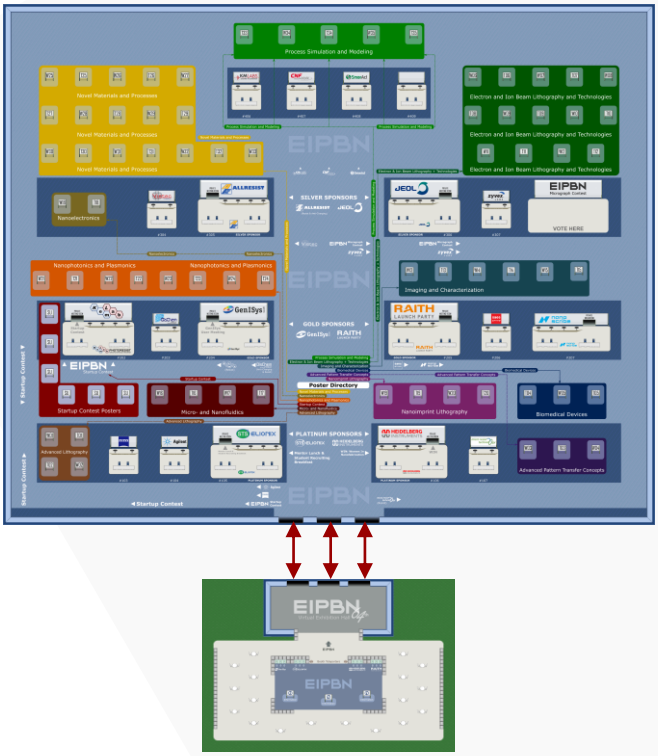


Connecting to the Exhibition

The link to the Gather.Town space will be available through the Underline.io portal. You will need either the Google Chrome or the Mozilla Firefox Browser using a modern computer equipped with a webcam. When you enter the Gather.Town site for the first time, give permission for the browser to access your webcam. Be sure to close any other conferencing software to prevent echoes or your webcam from being recognized. A short tutorial is also provided on the platform should you need it.

The Virtual Exhibition consists of two main areas, the Garden Courtyard and the Virtual Exhibition Hall. Upon entering the space for the first time, your avatar will spawn in the Garden Courtyard. There you will be greeted by volunteers to help you on your way. If not, walk north to the entrance of the Virtual Exhibition Hall.

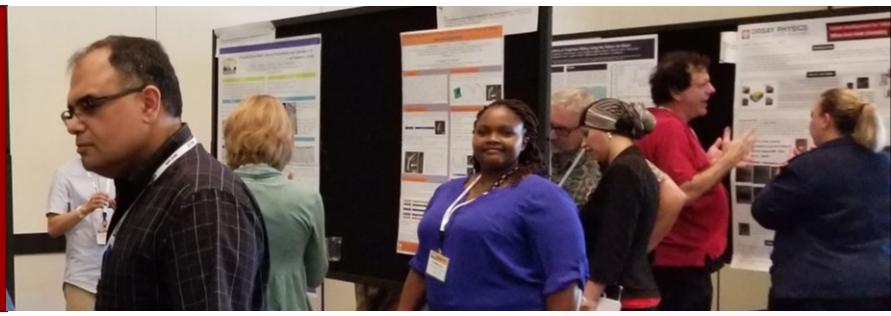
Virtual Exhibition Hall



Garden Courtyard

Virtual Exhibition

(Vendors + Posters in Gather.Town)

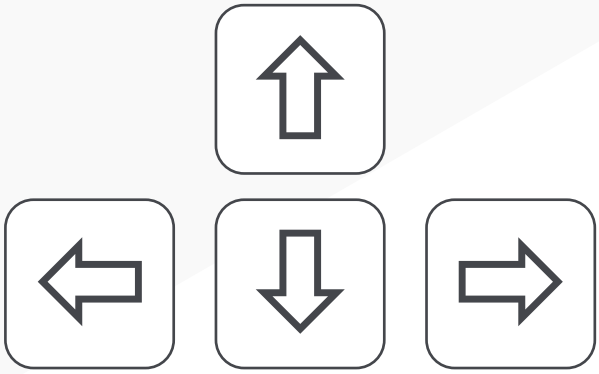


Getting Around

Throughout the Exhibition Hall, there are a variety of ways to interact with objects and others. There a few things you may want to know before you get started. You will be using a combination of your keyboard and mouse to interact with the environment.

Moving Your Avatar Around

Using the arrow keys on your keyboard, move your avatar up, down, left or right.



To view and exit content, just use:

To walk through others, hold and move:

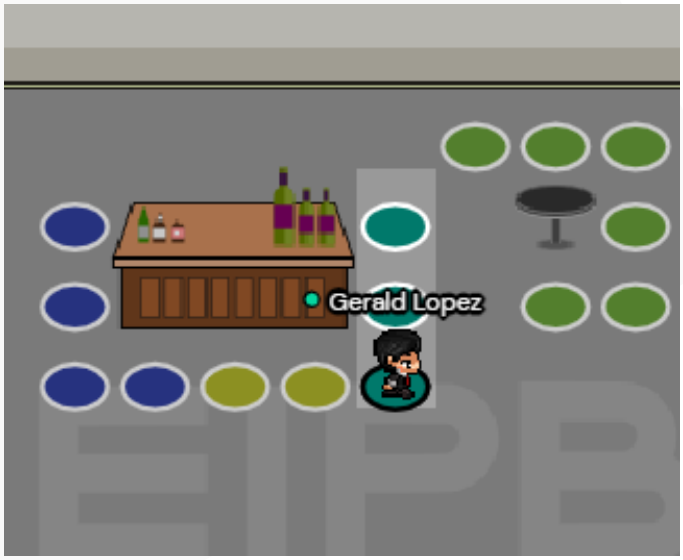
Virtual Exhibition

(Vendors + Posters in Gather.Town)

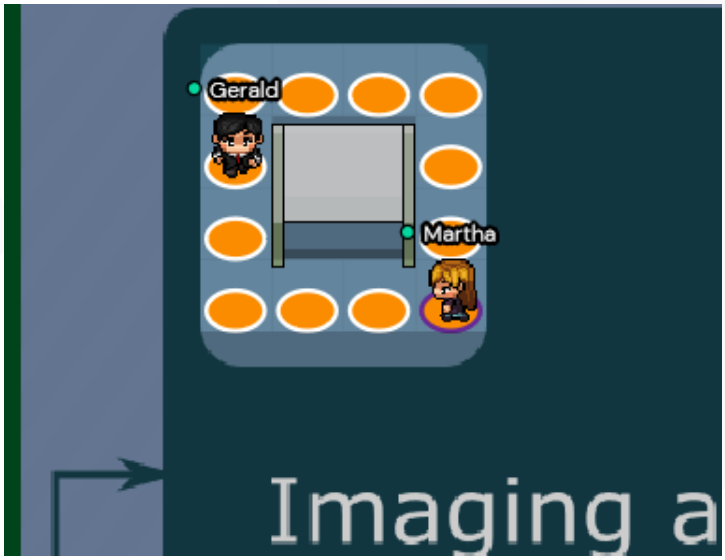
Private Conversations

To hold a private conversation with another person in the Exhibition Hall, move your avatar to a private space. These are usually denoted as same-colored circles on the ground. When you enter the space, the “lights will dim” and the conversation will be locked between you and the other person(s) in the private area. Private spaces exist for groups of 2 or more people and are placed in the Garden Courtyard, for the posters, and in each exhibitor booth.

Private spaces exist at every booth for exclusive engagements.



Private spaces inside breakrooms facilitate conversations between 2-8 people.



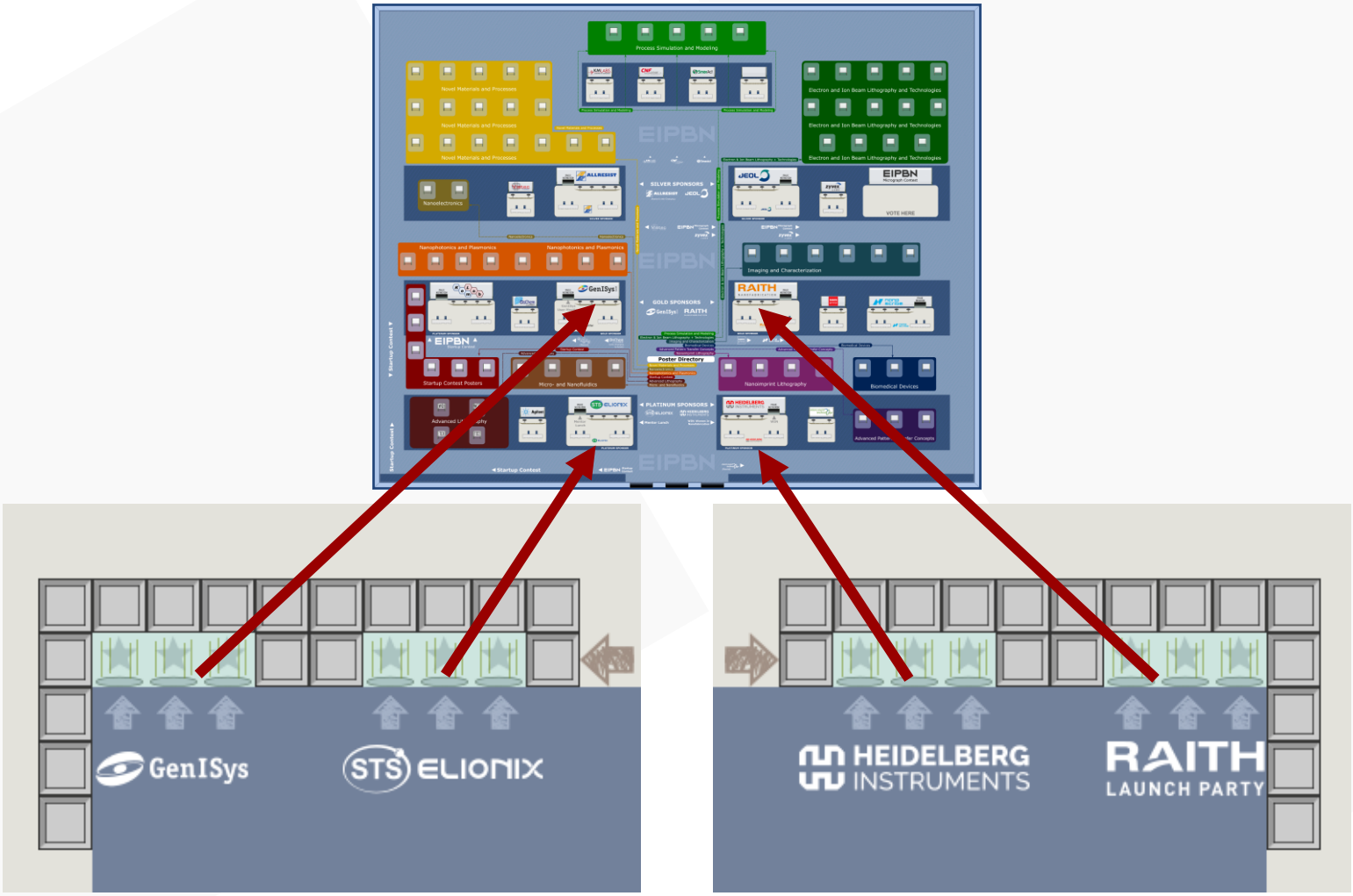
Private spaces surround every poster allowing up to 12 attendees to converse discreetly.

Virtual Exhibition

(Vendors + Posters in Gather.Town)

Teleportation

If you find yourself in the Garden Courtyard and need to get into the Virtual Exhibition quickly for any reason, use any of the teleporters near the spawn point to teleport you near to any one of the 4 exhibitor booths indicated below.



Opening Session

June 1, 2021, from 8:00 – 11:00 PST
on underline.io

The Opening Session begins at 8 am Pacific Standard Time with opening remarks by our Conference and Program Chairs. The meeting will then kick-off with three exciting plenary talks on the underline.io main stage. Afterwards, the Commercial Session will catalyze activities thereafter in the Virtual Exhibition Hall. At noon, everyone is encouraged to hop back onto the underline.io main stage for the Short Courses.

- 08:00 - 08:25: **Welcome, Opening Remarks, and Announcements**
  Gerald G. Lopez, Ph.D., EIPBN 2021 Conference Chair
  Martha Sanchez, EIPBN 2021 Program Chair

- 08:30 - 09:20: **Using Electrons, Ions, and Photons to Comprehend Cells and Brain Circuits: Enhanced FIB-SEM Technology for Life Science**
  C. Shan Xu, Ph.D., Howard Hughes Medical Institute

- 09:20 – 10:10: **Advances in Integrated Photonics through Subwavelength Engineering**
  Sharon M. Weiss, Ph.D., Vanderbilt University

- 10:10 - 11:00: **Digital Fabrication**
  Neil Gershenfeld, Ph.D., MIT Center for Bits and Atoms

Short Courses

June 1, 2021, from 12:00 to 18:00 PST on underline.io

The popular **EIPBN Short Courses** will take place on **Tuesday, June 1, 2021,** from 12:00 to 18:00 PST. This event features 5 lectures given serially by leading authorities in each field and is a perfect opportunity to further your knowledge of nanofabrication processes and applications. This year's Short Courses is included with your conference registration. This year's Tuesday Short Course topics include in the following order:

- **DNA-Directed Self-Assembly: Molecularly Precise Nanofabrication** by J. Alexander Liddle, Ph.D., Scientific Director of the Microsystems and Nanotechnology Division – NIST
- **From Patterning Dopants in 2D Devices to Bone-Tissue Engineering by Thermal Scanning Probe Lithography** by Elisa Riedo, Ph.D., Professor at the NYU Tandon School of Engineering, New York University, New York
- **Materials for Advanced Lithography** by Dario L. Goldfarb, Ph.D., Foundational Patterning Research – IBM
- **Mathematical and Technological Foundations of Neuromorphic Computing** by Brian Hoskins, Ph.D., Physicist in the Alternative Computing Group – National Institute of Standards and Technology (NIST)
- **Quantum Mechanics and Quantum Computing, an Introduction** by Tim Groves, Ph.D., retired Vice President of Academic Affairs – College of Nanoscale Science and Engineering, State University of New York

Women In Nanofabrication

(Gather.Town)

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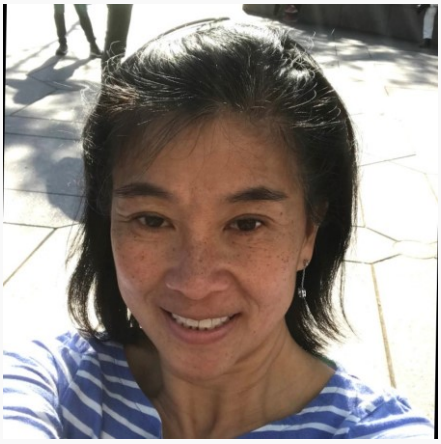
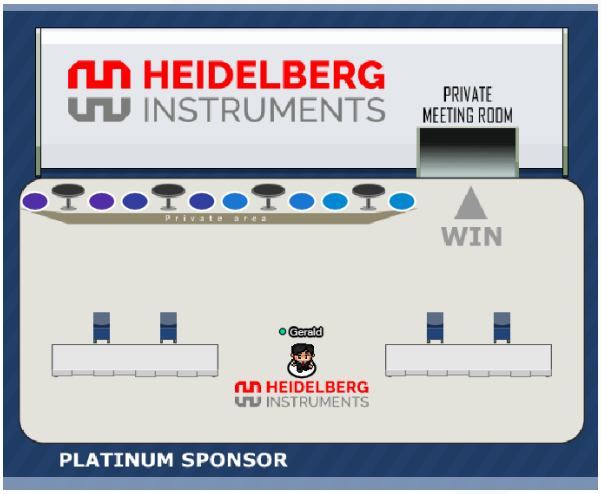
HEIDELBERG INSTRUMENTS

Women in Nanofabrication (WIN). WIN is a networking event that brings together women (and other non-binary) researchers and industrial professionals from around the world with the understanding that through diversity and inclusion can the exchange of progress and ideas push the fields of lithography and nanotechnology. There is no charge to participate in this event.



Dr. Grace Chen
Sr. Director of Next Generation Instrument
at BD Biosciences

WIN will take place in Gather.Town inside the private meeting room of the Heidelberg Instruments booth. This year's invited speaker is Dr. Grace Chen, Sr. Director of Next Generation Instrument at BD Biosciences.



Startup Contest

(Gather.Town)

Sponsored by:

Expanding our impact on tech-transfer, the **EIPBN Startup Session and Contest** is a dynamic venue for entrepreneurs to share their experiences and innovations. The session includes a talk from Dr. Larry Muray, Sr. Director at KLA and former President/CEO of Novelx, and a panel discussion with entrepreneurs currently leading hard-tech ventures. Startup Contests finalists will pitch their technological innovations live, while audience members will participate in voting to select the winner.

Dr. Larry Muray will be giving a talk entitled "Fast times at Novelx Inc."

Speaker Bio

Dr. Muray received his B.S. at Caltech and Ph.D at Cornell in Applied Physics at a time when ¼ micron gate length was considered advanced technology. After a brief post-doc at IBM Research, he went on to work in R&D at various times at Lawrence Berkeley Labs (government), Etec Systems (industry), Glimmerglass Networks (startup), Agilent Technologies (industry) and most recently KLA (industry), where he is Senior Director of Advanced Technology. Dr Muray's areas of expertise include electron optics, nanolithography, nanofabrication, and MEMS devices. Most enjoyably however, he was co-founder and CEO of Novelx, a tiny startup company in electron beam lithography which was supported by DARPA grants, angel investors and industry ; and after 8 years of independence was acquired on Christmas Eve 2010 by Agilent Technologies. Most recently, in addition to his day job, Dr. Muray serves as CEO of Inphora, Inc., another tiny startup founded by his mother in 1989. He has published 45+ papers, holds 20+ patents and has received 4 industrial awards.

Start Up Session and Contest

Wednesday, June 2
1:00 pm – 2:30 pm Pacific Time

SU
Deep learning-based techniques for image analysis on TEM and SEM imagery, Julien Baderot (POLLEN METROLOGY); Debaleena Misra (POLLEN METROLOGY); Nicolas Clement (POLLEN METROLOGY); Ali Hallal (POLLEN METROLOGY); Sergio Martinez (POLLEN METROLOGY); Johann Foucher (POLLEN METROLOGY)

The application of combined machine and deep learning-based techniques in nano-scale research and development, can lead to great efficiency in the domain of microscopy image analysis and measurement. This paper will explain and present our framework apply to selected examples from our internal data in semiconductor and non-semiconductor applications.

SU
Nanofactories of the future, Maksym Plakhotnyuk (CEO and Founder)

ATLANT 3D Nanosystems is disrupting the microfabrication industry and bringing it into the Industry 4.0 with our Nanofabricator. We want to make a paradigm shift in our civilization to more advanced smart technologies on Earth and beyond, shift to nanofabricators and smart nano factories.

SU
TERA-print - Startup Contest Application, Andrey Ivankin (TERA-print, LLC); Jared Magoline (TERA-print, LLC); Michael Jacobsson (TERA-print, LLC)

Sponsored by:

Student Recruiting

(a.k.a. "Student Breakfast" in Gather.Town)

This year's conference will host a virtual recruiting breakfast scheduled for Thursday, June 3, inside the private meeting room of the STS-Elionix Booth. The event begins at 6:45 am PST and will run 65 minutes. During this time, you will be able to engage companies in our community that are **hiring**. **Companies** include **Intel, KLA, Raith, Zyvex labs, ThermoFisher Scientific**, ***zeroK NanoTech, NuFlare, TU/e, Carl Zeiss*** and others. Check back here for a complete list of companies looking to hire. Click here if you'd like to upload your CV. Your CV will be made accessible to all attending recruiters. Please indicate when registering if you plan to attend the event.

Please contact Richard Livengood at richard.h.livengood@intel.com or James Spallas at eipbn20cc@eipbn.org if you have any questions.

Videos On-Demand: May 24, 2021

EIPBN

Online: June 1-4, 2021

www.eipbn.org

Sponsored by:

KLA

Student Mentor Lunch

(a.k.a. "Mentor Lunch" in Gather.Town)

The Student Mentor Lunch lets students pick the minds of professionals from academia, government and industry. It's a chance to hear from the experts why they chose their field, what it takes to get there, and what it's really like once they arrived. The Mentor Lunch also features a speaker who provides an expert "how to" discussion on new topic each year. This year we are pleased to announce that the legendary Professor Henry (Hank) Smith will be presenting at this year's Student Mentor Lunch:

Presenting a Memorable Talk or Poster
(How to Present Three Years of Research in 30 Minutes)

Professor Hank Smith will be giving the talk entitled "Presenting a Memorable Talk or Poster (How to Present Three Years of Research in 30 Minutes)"

Speaker Bio

Henry I. Smith is Professor of Electrical Engineering Emeritus at MIT. He's a member of the National Academy of Engineering, a Fellow of the American Academy of Arts and Sciences, the IEEE, the OSA and the National Academy of Inventors. He's a recipient of the IEEE Robert N. Noyes Medal, the Cledo Brunetti Award of the IEEE, the Baccus Award of SPIE, the Nano 50 Innovator Award, the Robert H. Hill Memorial Award, the Professional Excellence Award of the Boston College Alumni Association, and an honorary Doctor of Science from Holy Cross College. Professor Smith was 1977 EIPBN Conference Chair and is currently a member of the Advisory Committee. He's well known as an enthusiastic student mentor, and a long-time friend and contributor to the EIPBN community.

Sponsored by:

zyvex LABS

Micrograph Contest
(vote in Gather.Town)

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

To highlight the importance of micrographs to the field, the conference holds a micrograph contest every year. Submissions are sought from our community, and can be generated in the course of doing research, but can be submitted purely for their beauty or ability to excite curiosity, and need not be related to any paper or topic presented at the conference. The entries will be judged both from a technological and artistic point of view.

A panel of judges will disqualify any entry that it believes has not conformed to the rules and will select the winners. Awards will be announced on Friday at the end of the conference.

There are six categories:

- Grand Prize
- Most Bizarre
- Best Electron Micrograph
- Best Ion Micrograph
- Best Photon Micrograph
- Best Scanning Probe Micrograph
- 3-Beamers Choice Award (voted on by EIPBN attendees)

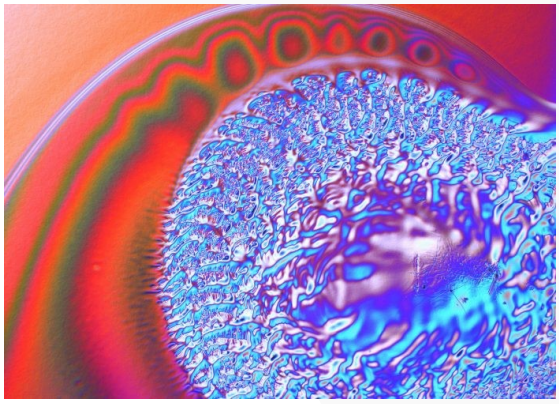
Submission Criteria

The 26th EIPBN Bizarre/Beautiful Micrograph Contest is now open to entries.

The rules include the following:

- Entries have to be of a single image taken with a microscope and should not be significantly altered.
- There is no restriction with respect to the subject matter.
- Electron and ion micrographs have to be black and white.

For submission procedures and rules, click here.



2016 Grand Prize - Devin Brown, Georgia Tech

EIPBN

The 64th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication

Oral Presentations

Abstracts Available: https://eipbn.org/abstracts/2021/

Online June 1-4, 2021

Presentations + Posters available on-demand May 24, 2021

Wednesday, June 2, 2021

Welcome and Opening Announcements
8:00 am – 8:10 am Pacific Time

Session 1A Q&A – Ion Beam
8:10 am – 9:00 am Pacific Time

Session Chairs
Shida Tan, Intel Corporation
Carla Perez Martinez, University College London

1A-1 Invited
Applications of the Cesium Low Temperature Ion Source, Adam Steele, Andrew Schwarzkopf, Brenton Knuffman (zeroK NanoTech Corporation)

This talk will review applications of the Cs+ Low Temperature Ion Source (LoTIS). This ion source enables high precision FIB imaging and machining, and also high-yield secondary ion mass spectrometry (SIMS)

1A-2 – WITHDRAWN

1A-3
Universal ion sources for FIB containing light and heavy ions from Liquid Metal Alloy Ion Sources, T. Richter, P. Mazarov, F. Meyer, W. Pilz (Raith GmbH); L. Bischoff, N. Klingner, G. Hlawacek (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research)

Nanofabrication requirements for FIB technologies are specifically demanding in terms of patterning resolution, stability, and the support of new processing techniques. We have extended the technology towards the stable delivery of multiple ion species selectable into a nanometer scale focused ion beam by employing a liquid metal alloy ion source.

1A-4
Scanning Transmission Ion Micrsocopy in the Helium Ion Microscope for nanoparticle research, Gregor Hlawacek, Eduardo Serralta, Nico Klingner (Helmholtz-Zentrum Dresden – Rossendorf), Michael Mousley, Olivier De Castro, Tom Wirtz (Luxembourg Institute of Science and Technology); Peter Gnauck (Carl Zeiss); Serge Duarte Pinto (Photonis); Falk Lucas, Cecilia Bebeacua (ETH Zürich)

After an introduction to the npSCOPE instrument and its capabilities we will introduce the new STIM detector and present first results obtained with it on single and polycrystalline samples as well biological specimen. The latter will focus on different kinds of nanoparticle samples relevant in the field of nano-toxicology.

1A-5
Probe Size and Detection Efficiency Optimization in Electrostatic Lens Systems Using Multi-Objective Genetic Algorithms, Neda Hesam Mahmoudi Nezhad, Mohamad Ghaffarian Niasar, Ali Mohammadi Gheidari, Cornelis W. Hagen, Pieter Kruit (Delft University of Technology)

Electrostatic lens system optimization is a challenge, especially for systems having many free variables with more than one objective function. An example is minimization of probe size for a primary beam, with in-lens secondary electron detection with maximum detection efficiency. This subject has been investigated here using Multi-Objective GA.

Session 1B Q&A – Nanofluidic Medical Devices
8:10 am – 9:00 am Pacific Time

Session Chairs
Rob Ilic, NIST
Daron Westly, NIST

1B-1 Invited
A microfluidic platform with integrated traction force microscopy enabling mechanobiology under controlled flow, Sertan Sukas, Jaap den Toonder (Eindhoven University of Technology); Vito Conte (Eindhoven University of Technology & Institute for Bioengineering of Catalonia)

We present the development of a platform that enables mechanobiology studies under controlled shear and hydrodynamic pressure loadings, through the integration of traction force microscopy (TFM) in a microfluidic device.

1B-2
Spatially controlled stem cell differentiation via morphogen gradients: comparing static and dynamic microfluidic platforms, Kiara Cui, Leeya Engel; Carolyn Dundes; Tina Nguyen, Kyle Loh, Alex Dunn (Stanford University)

We describe two accessible and successful microfluidic strategies to expose human pluripotent stem cells to spatial gradients of differentiation-inducing extracellular signals in vitro. In addition, coupling with a fluorescent reporter and live-cell imaging allowed us to characterize

the spatiotemporal dynamics of differentiation of our spatially patterned cell colonies.

1B-3 – WITHDRAWN

1B-4
X-Ray Compatible Cell for Liquids and Gases, Alokik Kanwal, Rob Ilic, Glenn Holland, Subhrangsu Mukherjee, Eliot H. Gann, DeLongchamp, James Liddle (National Institute of Standards and Technology)

We present a liquid cell that is compatible with Polarized Resonant Soft X-ray Scattering (PRSoXS). The cell utilizes double membranes supported with random pillars to overcome many of the challenges faced with vacuum and soft X-ray compatible liquid cells.

Session 1C Q&A – Micro- and Nanoscale Mechanical Devices I
8:10 am – 9:00 am Pacific Time

Session Chairs
Vladimir Aksyuk, NIST
Gina Adam, George Washington University

1C-1
Lithographically patterned flexible metallic micro wiring on an electrospun nano-fiber mesh, Yutika Badhe (University of Texas at Dallas); Lauren Costella (Luna Innovations Inc); Alexandra Joshi-Imre (The University of Texas at Dallas)

In this study, we have employed lithography techniques to fabricate stretchable metallic micro-wiring with potential applications in flexible and stretchable electronics. The metal is deposited directly on top of the nano-fiber mesh, and it is patterned with photolithographic techniques to demonstrate stretchable micro-wiring.

1C-2
Small footprint optoelectrodes for passive light localization by the use of ring resonators, Vittorino Lanzio (Lawrence Berkeley National Laboratory, Molecular Foundry); Alexander Koshelev (aBeam Technologies), Monica Lorenzon, Melanie West, Simone Sassolini, Scott Dhuey, Hillel Adesnik (UC Berkeley); Stefano Cabrini (Lawrence Berkeley National Laboratory)

We describe the design, fabrication, in vitro, and in vivo characterization of brain-implantable neural devices for the combined high-resolution readout and manipulation of neural activity. We integrate ring resonators and multi-wavelength components to manipulate both different types of neurons and in different brain regions.

1C-3
Fabrication of Ultra-Thin Suspended ALD Membranes, Michael Elowson, Rohan Dhall, Adam Schwartzberg, Stephanie Chang, Vittoria Tommasini, Sardar Alam, Stefano Cabrini, Shaul Aloni, (Lawrence Berkeley National Laboratory)

We demonstrate a novel fabrication process for creating ultra-thin (5+ nm) suspended membranes from a variety of ALD materials. ALD films as thin as 5 nm have been released without damage using a low-power O2 plasma. This flexible process is currently being validated through fabrication of conductive TiN TEM windows.

Session 2A Q&A – Atomically Precise Fabrication
9:10 am – 10:00 am Pacific Time

Session Chairs
Samuel Stavis, NIST
Todd Hastings, University of Kentucky

2A-1
Progress Toward 2D Nano Bipolar Junction Transistors, John Randall, James H.G. Owen, Ehud Fuchs, Robin Santini (Zyvex Labs); Nupur Navlakah (University of Texas at Austin)

Hydrogen Depassivation Lithography has been used to place donors with atomic precision in buried Si (100) planes to make quantum and atomic electronic devices. Recent demonstrations using acceptors to pair with donors enable bipolar junction transistors. These 2D-nanodevices should be extremely high-performance, low-noise, rad-hard, and capable of cryogenic operation.

2A-2
Co-deposition of B and P for Ultraprecise Bipolar devices, James Owen, Ehud Fuchs (Zyvex Labs); Hamed Alemansour (The University of Texas at Dallas); Reza Moheimani (UT Dallas); Wiley Kirk (University of Texas at Arlington)

We demonstrate the co-deposition of B and P in aligned atomic-scale patterns, in order to make bipolar junction devices. This requires the use of BCl3 and PH3 as acceptor and donor dopant precursors, and dI/dV imaging to relocate the B electrode and align the P electrodes to it.

2A-3
Atom-based Silicon Devices for Quantum Computing and Analog Quantum Simulation, Rick Silver (NIST)

NIST is fabricating atomically precise devices for use in quantum technologies, such as single/few atom transistors, few-donor/quantum dot devices, and arrayed atomic structures for analog quantum simulation. We characterize tunnel coupling in quantum dot devices, spectroscopy of few atom transistors, and quantum transport measurement of arrays of few atom clusters.

2A-4
Improving Fabrication, Data Storage, and Sensing on H:Si(100)-2x1 via Atomically Precise Chemistry, Roshan Achal, Mohammad Rashidi, Jeremiah Croshaw, Taleana Huff, Robert Wolkow (University of Alberta)

We present a method to correct fabrication errors in hydrogen lithography using atomically precise controlled reactions of individual hydrogen molecules. This technique can be used to rewrite ultra-dense atomic-scale memory arrays without the use of a scanned probe, as well as to sense isolated molecular reactions with single electron sensitivity.

2A-5
Toward atomic-scale e-beam fabrication: imaging and altering graphene-based devices, Ondrej Dyck (Oak Ridge National Laboratory); Jacob Swett (University of Oxford); Sergei Kalinin, Andrew Lupini, Stephen Jesse (Oak Ridge National Laboratory)

Wafer-scale fabrication was used to create STEM-compatible operando graphene devices that can be characterized during operation. The e-beam can be used to further alter the device design. We employ use of secondary electron e-beam induced current (SEEBIC) imaging to visualize device conductivity and examine device failure modes in extreme conditions.

Session 2B Q&A – 3D Nanosculpting
9:10 am – 10:00 am Pacific Time

Session Chairs
Rebecca Cheung, University of Edinburgh
Andrei Kolmakov, NIST

2B-1 Invited
How to implement "nano" in everyday life? Nano fabrication technologies in application oriented research and development, Mario Baum (Fraunhofer ENAS)

Nano fabrication technologies are subject of research in several fields. The development and commercialization of nano-inside products are still waiting for its break through. However, this paper will describe three examples of research workin fields of bioinspired computing, nano patterned surfaces for flexible substrates, and nano optics for spectroscopic measurement.

2B-2 Invited
A paradigm shift of focused-ion-beam machining from super-resolution to ultrahigh-throughput, Andrew Madison, John Villarrubia, Kuo-Tang Liao, Joshua Schumacher, Kerry Siebein, Rob Ilic, James Liddle, Samuel Stavis (NIST)

We report the first comprehensive study of the super-resolution effect of a sacrificial masking film in focused-ion-beam machining. Surprisingly, we find that the dominant advantage of the effect is in the temporal domain. Our study elucidates the resolution-throughput tradespace and enables a paradigm shift from prototyping to manufacturing.

2B-3
Gradient-Index Nanolattices Using Multilayer Processing, I-Te Chen (The University of Texas at Austin); Zijian Dai (North Carolina State University); Yi-An Chen (The University of Texas at Austin); Greogory N. Parsons (North Carolina State University); Chih-Hao Chang (The University of Texas at Austin)

This work is about using near-field phase lithography and ALD process repeatedly to create non-uniform nanolattices with spatially varying geometry and material composition. The proposed approach is also employed to make an antireflection GRIN surface which successfully reduces the specular reflectance by more than 60%.

2B-4
Fabrication of silica pyramids by enhanced lateral etching of hydrofluoric acid below metal films, Robert Kirchner, Volker Neumann, Felix Winkler, Carsten Strobel, Sandra Völkel, (TU Dresden); Dimitrios Kazazis (Paul Scherrer Institute); Andreas Richter, Johann Wolfgang Bartha (TU Dresden)

We demonstrate for the first time that anisotropic hydrofluoric acid etch behavior beneath certain metal pads (Ti, Au, Pt, Cr) can be controlled to create ultra-sharp 3D silica pyramids due to an interface effect.

2B-5
Electron and X-ray Beam Direct Write Lithography in Liquids: a Step Toward 3D Nanoprinting of Soft Materials, Andrei Kolmakov (NIST)

Organic soft materials, such as gels are materials of choice for a vast number of biomedical applications such as tissue engineering, soft robotics, biosensing, drug delivery, implantable electronics, etc. Here we report on

in-liquid direct write technique for 3D-sculpturing of hydrogels using focused electron and X-ray beams.

2B-6
Nanofabrication by Metal Assisted Chemical Etching of Silicon in Gas Phase, Lucia Romano, Zhitian Shi, Jefimovs Konstantins (Paul Scherrer Institute & ETH Zurich); Joan Vila Comamala, Vitaliy Guzenko (Paul Scherrer Institute); Marco Stampanoni (Paul Scherrer Institute & ETH Zurich)

High aspect ratio nanostructuring requires high precision pattern transfer with highly directional etching. In this work, we demonstrate the fabrication of structures with unprecedented ultra-high aspect ratios up to 10'000:1 in the nanoscale regime (down to 10 nm) by metal assisted chemical etching (MacEtch) of silicon in gas phase.

Session 2C Q&A – Nanoimprint
9:10 am – 10:00 am Pacific Time

Session Chairs
Laurent Pain, CEA-LETI
Qiangfei Xia, University of Massachusetts Amherst

2C-1 Invited
Nanoimprint process to mass manufacture highly-angled high-RI gratings for augmented reality combiners, Tingling Rao, Zachary Perlmutter, Emily Makoutz, Ankit Vora, Alexander Koshelev, Jessica Chau, Nihar Mohanty, Koji Yugawa, Matthew Colburn, Giuseppe Calafiore (Facebook Inc.)

In this paper we report a series of breakthroughs that led to replication of gratings with a slant angle up to 60° and an aspect ratio of 10:1 in a material with refractive index of 1.90 (RI). A study of the replication process and materials optimization will be presented.

2C-2
Internal Layered Structures of UV-Cured Thin Films after Sequential Vapor Infiltration Analyzed by X-ray Reflectivity Measurements, Kohei Chiba, Takahiro Nakamura, Shunya Ito, Masaru Nakagawa (IMRAM, Tohoku University)

Sequential vapor infiltration (SVI) with trimethylaluminum into UV-cured films visualized the presence of internal layered structures with different Al distributions dependent on chemical structure of monomers. X-ray reflectivity measurements revealed that the mixing of monomers was a positive way to homogenize the Al distributions in UV-cured films.

2C-3
Optical Metrology of Characterizing Superhydrophobic States on Patterned Substrates, Deming Meng, Yifei Wang, Hao Yang, Pan Hu, Yunxiang Wang, Buyun Chen, Boxiang Song, Tse-Hsien Ou, Zerui Liu, Yichen Gong, Ximing Zheng, Wei Wu (University of Southern California)

Until now, no in-situ, non-destructive and accurate technology has been invented, which introduces huge difficulties into the superhydrophobic surfaces research and applications. We developed an optical technology to characterize the state of superhydrophobic surface.

2C-4
Performance and Ageing of Self-Assembled Metal Electrodes, Lukas Engel, Johannes H. M. Maurer, Thomas Kister, Lola González-García, Tobias Kraus (INM - Leibniz Institute for New Materials gGmbH)

We investigated the performance and ageing of self-assembled metal electrodes. We find that the conductivity, optical transmission, and ageing behaviour depend on the imprinted nano-object and its concentration. We correlate these findings with differences in pre- and post-plasma morphology. The insights gained enabled us to develop strategies against electrode degradation.

2C-5
Hybrid structures achieved by direct writing laser lithography - tuning the contrast and surface topography of grayscale photoresist with nanoimprint lithography, Sijia Xie, Jan Erjawetz, Helmut Schift (Paul Scherrer Institut (PSI))

In direct writing laser lithography, hybrid structures such as gratings on top of resist structures can be generated by combining thermal NIL with DWL lithography. At 120 °C, it is still possible to pattern the resist into at least 4 µm depth without degrading the photosensitive component.

Thursday, June 3, 2021

Welcome and Opening Announcements
8:00 am – 8:10 am Pacific Time

Session 3A Q&A – 3D Micro and Nanolithography
8:10 am – 9:00 am Pacific Time

Session Chairs
Henry Smith, MIT
Pat Watson, University of Pennsylvania

3A-1 Invited
Breaking the Resolution & Speed Limit – Next Generation Technology for Scalable Micro Additive Manufacturing, Shih-Chi Chen (Chinese University of Hong Kong)

I will present our recent work on parallelization of the TPP process based on temporal focusing via a digital micromirror device (DMD), where programmable femtosecond light sheets are formed and used to substantially improve the rate without sacrificing resolution.

3A-2 Invited
Nanostructured Colors from Colorless Materials, Joel Yang (Singapore University of Technology and Design)

Colors produced from nanostructures of different geometries and materials in 2D and 3D made mostly using 3D printing with two-photon polymerization.

3A-3
Hybrid 2D & 3D Lithography, Dominique Collé (Heidelberg Instruments)

We investigated the combination of maskless UV lithography and 2PP (two-photon polymerization) on a standard photo-resist: SU-8. 2PP technology is known to be slow. The advantage of mixing the technologies becomes obvious when some elements of a design can be exposed faster using maskless UV lithography.

3A-4
Direct-writing of advanced 3D nano-superconductors, Rosa Cordoba (Institute of Molecular Science (ICMol), University of Valencia)

In this work, we introduce a direct-write nanolithography method based on focused ion beam technologies to fabricate at-will advanced 3D nano-superconductors. Nanotubes and nanohelices grown by this methodology become superconducting at 7 K and show large critical magnetic field and critical current density.

3A-5
Achromatic and Varifocal Metalens Doublet Fabrication by Two-photon Lithography, Fatih Balli, Mansoor Sultan, Todd Hastings (University of Kentucky)

In this work, we discuss the fabrication process for two types of low-index metalenses composed of air-spaced elements. First, we discuss the fabrication of our recently demonstrated two element hybrid achromatic metalens (HAML) that employs nanopillars. Second, we discuss a novel air-spaced, varifocal, metalens that employs nanoholes.

3A-6
Hybrid Metasurface Fabrication Using Two-photon Lithography, Mansoor Sultan, Fatih Balli, Todd Hastings (University of Kentucky)

We present 3D printed Hybrid metasurfaces that employ variable height (3D) phase plates, pillars, and holes that provide additional degrees of freedom beyond purely planar designs. These structures were 3D printed with two-photon lithography technique.

Session 3B Q&A – Nanophotonics and Plasmonics II
8:10 am – 9:00 am Pacific Time

Session Chairs
Aaron Stein, Brookhaven National Laboratory
Chih-Hao Chang, University of Texas

3B-1 Invited
Plasmonic coupling across narrow gaps, Florian Laible, Simon Dickreuter, Emre Guerdal, Fang Dai, Lisa Seitl, Otto Hauler, Kai Braun, Anke Horneber, Dai Zhang, Pierre-Michel Adam, Alfred J. Meixner, Dieter Kern, Monika Fleischer, (Eberhard Karls University Tübingen)

Illumination of metallic nanostructures that are coupled across narrow gaps can lead to high local near-fields, mode hybridization enabling their use as plasmon rulers, and tunneling effects. Different approaches for creating coupled and reversibly tunable plasmonic nanogap antennas will be shown together with their simulation and spectral properties.

3B-2
Multiplexing Rubbing-Induced Site-Selective (RISS) Method for Manufacturing MoS2 Device Arrays, Mingze Chen, Xiaogan Liang (University of Michigan)

Molybdenum disulfide, as a transition metal dichalcogenide, has attracted huge attention for its good optical properties. However, to produce corresponding arrays of nano/microscale devices, resist-based lithography and etching generate permanent contaminations and damages. Here, we report a method capable of generating arbitrary MoS2 patterns without additional lithography or etching processes.

3B-3
Direct laser writing of polymer nanowire waveguides for single-photon extraction from epitaxial quantum

dots, Edgar Perez, Kartik Srinivasan (University of Maryland)

Direct laser writing (DLW) can be used to interface with integrate photonic devices, but printing on highly reflective materials increases the local laser intensity and produces standing-waves that greatly deteriorate wavelength-scale structures. Overcoming these issues, we fabricate 800nm-diameter polymer-nanowire waveguides to collect single-photons from epitaxial InAs/GaAs QDs with high yield.

3B-4
Large Area Plasmonic Roller Lithography for High-Aspect Ratio and Sub-Diffraction Limit Patterning, Kaito Yamada, L. Jay Guo (University of Michigan)

We report a super resolution optical lithography technology which can go beyond the diffraction limit of light utilizing surface plasmon polaritons. The resolved feature size is ~60nm and can be patterned in a large (5cm wide) area continuously by a photoroller system.

3B-5
Refractory doped titanium nitride nanoscale field emitters, Alberto Nardi (IBM Research - Zurich); Marco Turchetti (Massachusetts Institute of Technology); Wesley Britton, Yuyao Chen (Boston University); Yujia Yang (MIT); Luca Dal Negro (Boston University); Karl Berggren, Phillip Keathley (Massachusetts Institute of Technology)

We developed a fabrication process to pattern nanoantennas made of doped titanium nitride with gaps of 10-15 nm, with aspect ratio of about 5. We measured turn-on voltages of a few volts, currents three orders of magnitude higher than with nearly identical Au nanoantennas, and peak quantum efficiencies of 1E-3.

Session 3C Q&A – Biomedical Devices I
8:10 am – 9:00 am Pacific Time

Session Chairs
George Tulevski, IBM
Reginald Farrow, NJIT (retired)

3C-1 Invited
Nanoparticle-Based Assay with Optoelectronic Readout for High-Sensitivity and Rapid Detection of Infectious Diseases, Chao Wang (Arizona State University); Liangcai Gu (University of Washington, Seattle)

Inexpensive and rapid diagnostics of infectious diseases is crucial to timely treatment and disease prevention. Conventional diagnostic methods such as polymerase chain reaction and enzyme-linked immunosorbent assay require skilled personnel, laboratory-hosted equipment and elaborate protocols. Here, we present a gold nanoparticle-based assay as a low-cost, simple and quantitative sensing platform.

3C-2
Fabrication of Microdevices for Thermal Stability Analysis of DNA, Sarah Robinson, Jon Askim, Christopher Montgomery (National Institute of Standards and Technology); Herman Sintim (Purdue University); Steve Semancik (National Institute of Standards and Technology)

We will discuss the development of an electrochemical microdevice platform for analyzing thermal profiles of DNA secondary structures. Each three-electrode microdevice includes an embedded platinum resistance thermometer (PRT), allowing for localized temperature control. The platform was employed for stability analyses of small-molecule drug binding to duplex DNA.

3C-3
Fabrication optimization of the photo-response characteristics of MoS2 photodetectors for biosensing applications, Seungjun Ki, Byunghoon Ryu, Younggeun Park, Katsuo Kurabayashi (University of Michigan)

In this work, we study the photo-response properties (e.g., photoresponsivity and noise equivalent power (NEP)) of in-plane MoS2 photodetectors as the function of their geometric dimensions (e.g., thickness, length, and width of photoactive layers) and fabrication conditions (e.g., doping, etching, and substrate choice).

3C-4
Electrochemical characterization of graphene gated field effect transistors: route for smart biological sensors, Juliette Simon, Adrien Hugo, Pascal Mailley (CEA); Fabienne Blanc (VetagroSup / INRAE); Thomas Alava (CEA); Chao Sun, Jason A. Mann, William R. Dichtel (Northwestern University); Grapheal (Grapheal)

CVD graphene has brought interest from the biosensors community. Previous work in our group demonstrated a unique fabrication protocol for graphene solution gated field effect transistor (SGFET). This study presents the electrochemical characterization and first biological detection campaign (using aptmamers as probe for hormone detection) of our SGFET sensors.

3C-5
Measurement and Analysis of Joule heating in localized cellular micro/nanochannel electroporation,

Junjie Pan, Xinyu Wang, Junfeng Shi, Yifan Ma, Wu Lu, Ly Lee, (Ohio State University)

This study showed a comprehensive quantification of Joule heating on a single-cell level during localized cellular electroporation. A microfluidic device was fabricated for single-cell localized electroporation.
With the cell fluorescently labeled by Rhodamine B, a temperature sensitive dye, the temperature of the cell when electroporation happened was measured and analysed.

Session 4A Q&A – Electron and Ion Beam Lithography/Post Processing/Applications
9:10 am – 10:00 am Pacific Time

Session Chairs
Alan Brodie, KLA
Rich Tiberio, Stanford University

4A-1 Invited
Extending the capability of lithography with mechanical processes, Huigao Duan, Hunan University

In this work, we will share our efforts on extending the patterning capability of electron beam lithography and focused ion beam technology by involving mechanical processes such as peeling, surface adhesion engineering and transfer printing.

4A-2
Metallic Organic Resists: Their Impact On Nano Pattern Transfer, Scott Lewis (The University of Manchester and California Institute of Technology); Guy DeRose (California Institute of Technology); Hayden Alty (The University of Manchester); Nathan Lee, Matthew Hunt (California Institute of Technology); Richard Grindell, Mark Little, Stephen Yeates, (The University of Manchester); Axel Scherer (California Institute of Technology); Richard Winpenny (The University of Manchester)

A new class of positive tone electron beam nanocomposite resists have been developed that contain metal organic components. These materials produce a high resolution of 50 nm half pitch and extraordinarily high etch selectivity of 20:1 (silicon etching) when subjected to a pseudo-Bosch inductively coupled plasma–reactive-ion etch (ICP–RIE).

4A-3
PHIDL: Intuitive GDS layout and CAD geometry creation for Python, Adam McCaughan, Alexander Tait, Sonia Buckley, Jeffrey Chiles, Sae Woo Nam (NIST)

We have developed PHIDL, an open-source GDSII-based CAD tool for Python. PHIDL allows intuitive-but-powerful generation of geometries and has a large library of premade geometry functions ready for use, including basic shapes, text, lithographic test structures, boolean operations, placement and automatic packing algorithms, superconducting nanowires, and photonic routing.

4A-4
EXCALIBUR: A Monte Carlo Simulation for the Design of Lithographic Resists, Hayden Alty, Scott Lewis (The University of Manchester); Guy DeRose (California Institute of Technology); Richard Winpenny (University of Manchester); Axel Scherer (California Institute of Technology)

The aim of this presentation is to explain the whole resist development process from simulation, using EXCALIBUR, to characterisation and the success this technique has had in developing ultra-high resolution negative tone resists for both ion and electron beam lithography and streamlining the time expensive process of characterising new resists.

4A-5
Multibeam scanning electron microscopy with transmission detection, Wilco Zuidema, Jacob Hogenboom, Pieter Kruit (Delft University of Technology); Job Fermie (DELMIC); Radim Šejnoha (Thermo Fisher Scientific)

We demonstrate the working principles and image collection in a streamlined multibeam STEM system dedicated to fast imaging of thin sections of biological material.

4A-6
Nanoscale Fabrication of Perpendicular Magnetic Tunnel Junctions with Synthetic Antiferromagnetic Free Layers, Deyuan Lyu, Onri Benally, Delin Zhang, Yang Lv, Zhengyang Zhao (University of Minnesota, Twin Cities); Daniel Gopman (NIST); Jian-Ping Wang (University of Minnesota, Twin Cities)

We report the first experimental results of nano-sized MTJs fabricated with photo/electron beam lithography and Ar+ ion milling based on SAF free layer materials.

Session 4B Q&A – Materials and Pattern Transfer Techniques
9:10 am – 10:00 am Pacific Time

Session Chairs
Mark Schattenburg, MIT

Dario Goldfarb, IBM

4B-1
Ultrahigh Aspect Ratio Silicon Nanoporous Microstructures Coated Using ALD with Nucleation Enhancement for Energy Storage and Other Applications, Donald Gardner (Stanford SLAC National Accelerator Labs); Kenan Li (SLAC National Accelerator Laboratory); William Thompson, Anne Sakdinawat (SLAC)

Ultrahigh aspect-ratio structures are important for x-ray optics, energy storage, and sensors. Atomic layer deposition with nucleation and growth enhancement was developed to coat nanoporous silicon microstructures with aspect ratios up to 500:1, an order of magnitude higher than before. Devices prepared with these structures provide integrated on-chip energy storage.

4B-2
VM Modeling of Reactive Ion Etching Based on Statistics-Based and Dynamics-Inspired Spectral Features, Kun-Chieh Chien, Chih-Hao Chang, Dragan Djurdjanovic (The University of Texas at Austin)

Virtual metrology refers to methods that employ manufacturing process related data and relevant sensor readings to predict properties of the product. The initial results examining the end-point detection of a single RIE step indicate that the approach is viable and performs better compared with traditional feature identification by user experience.

4B-3
Novel hybrid resist platform for nanolithography: Ex-situ vapor-phase infiltration into conventional organic resists, Nikhil Tiwale (Brookhaven National Laboratory); Ashwant Subramanian (Stony Brook University); Kim Kisslinger, Ming Lu, Aaron Stein (Brookhaven National Laboratory); Chang-Yong Nam (Brookhaven National Laboratory, Stony Brook university)

We demonstrate organic-inorganic hybrid resist platform featuring versatile ex-situ control of resist performance by incorporating inorganic elements into standard organic resists using vapor-phase infiltration. Along with etching resistance suitable for high-aspect pattern transfer, we report controllable EBL-EUVL performance, potentially paving the way for robust high sensitivity hybrid resists.

4B-4
Using block-copolymer nanolithography as a tool to sensitively evaluate variation in chemical dry etching rates of semiconductor materials with sub-5 nm resolution, Elizabeth Ashley, Peter Duda, Paul Nealey (University of Chicago)

Top-down image analysis of hexagonal hole arrays created in silicon using block-copolymer nanolithography was used to evaluate differences in dry etch rate between n-type, p-type, and intrinsic silicon. By analyzing the hole areas and extracting the average radius and porosity, sub-nm differences in chemical etch rate could be extracted.

4B-5
Flexible ITO electrodes employing nanostructures for crack growth retardation, Wen-Di Li, Chuying Sun, Liyang chen (the University of Hong Kong); Jingxuan Cai (Sun Yat-sen University)

The fabrication of nanostructured ITO (nano-ITO) electrodes with improved flexibility is reported. The nano-ITO electrode is simply fabricated by two steps of nanoimprint lithography and magnetron sputtering. The experimental and simulated results confirmed the nano-ITO electrodes as a promising candidate for the next generation flexible electrode.

4B-6
Identifying EUV Attenuated Phase Shifting Mask Absorber Materials using EMA Modelling, Rajiv Sejpal, Bruce Smith, Rochester Institute of Technology

Solution space for material candidates as EUV attenuated phase shifting mask absorber that can meet phase, transmission, and thickness requirements is identified using k-n plots. The selection of the potential candidates is then carried out using effective media approximation (EMA) modelling, while achieving the necessary stability and processing attributes.

Session 4C Q&A – Imaging, Modeling and Characterization
9:10 am – 10:00 am Pacific Time

Session Chairs
Amit Agrawal, NIST
Adam Steele, zeroK NanoTech

4C-1 – WITHDRAWN

4C-2
Understanding the fundamental limitations of PMMA resist for EUV exposures based on dissolution rate variations through EUV dose, Amir Hegazy, Gregory Denbeaux (SUNY Polytechnic Institute)

This study focuses on understanding the fundamental limitations of PMMA exposure to EUV that leads to LER and printing failures. We study the photon-PMMA interactions in EUV using dissolution rate as an indicator

of exposure induced change in molecular weights. Consequently, we calculated number of reactions per photon absorbed.

4C-3
Focused Ion Beam Patterning for Defect-Mediated Nucleation on 2D van der Waals Materials, Vera Zarubin, Kate Reidy, (Massachusetts Institute of Technology); Yang Yu (Raith America Inc.); Ilya Charaev, Joachim Thomsen, Julian Klein, Frances Ross (Massachusetts Institute of Technology)

We use focused ion beams to create specific defects on suspended 2D materials (graphene, MoS2, WSe2). We study the extent to which the defects act as nucleation sites for Au, and tune deposition conditions and surface cleanliness to facilitate self-assembly of specific nanoisland shapes.

4C-4
Computational Nanometrology in Line Edge Roughness Measurements: Noise and Pixelization Effects, George Papavieros, Vassilios Constantoudis, Evangelos Gogolides (Institute of Nanoscience and Nanotechnology of NCSR Demokritos)

A short overview of the mathematical and computational methods used in LER metrology,
with special emphasis on noise effects and machine learning methods as well as a mathematical modelling approach of generating synthesized SEM images in an effort to demonstrate the pixelization effects on LER measurement

4C-5
Nanometer traceability of localization microscopy, Craig Copeland, Ronald Dixson, Andrew Madison, B. Robert Ilic, Samuel Stavis (NIST)

Interest in super-resolution optical microscopy has increased dramatically over the last decade. However, localization measurements are often precise but not accurate, with systematic effects dominating random effects across an imaging field. To solve this critical problem, NIST is developing new standards and calibrations that enable traceability at the nanometer scale.

4C-6
High Resolution Imaging and Analytics for Nanoscience, Frederick Pearsall, William Harris, Fang Zhou, Carl Zeiss Microscopy

This talk will highlight classically-challenging imaging applications including magnetic, non-conductive, and beam-sensitive samples. Resolved magnetic grain structure of a hard disc platter, using low angle back-scatter detector is demonstrated. An additional sample-biasing technique, Tandem Deceleration, is also shown for comparison to visualize its usage to produce an extra boost in imaging resolution.

Friday, June 4, 2021

Welcome and Opening Announcements
8:00 am – 8:10 am Pacific Time

Session 5A Q&A – Micro-and Nanoscale Mechanical Devices II
8:10 am – 9:00 am Pacific Time

Session Chairs
David Czaplewski, Argonne National Laboratory
Mark McLean, NIST

5A-1
MEMS-Based Scanning Tunneling Microscopy, Afshin Alipour, S. O. Reza Moheimani, (The University of Texas at Dallas); James Owen, William Owen, Ehud Fuchs, John Randall (Zyvex Labs)

We address low-throughput problem of Scanning Tunneling Microscopes (STMs) by replacing Z-axis of a commercial Ultra-High-Vacuum (UHV) STM piezotube with a high-bandwidth one-degree-of-freedom Microelectromechanical-System (MEMS) device. The MEMS device is integrated into the UHV STM system and is successfully used to take STM images of a sample surface.

5A-2
Transmissive Microshutter Arrays, Li Jiang (Tuskegee University)

A two-dimensional array of transmissive microshutters is designed in which light throughput can be digitally modulated at each pixel. This function is important for certain instruments, such as the near infrared spectrometer to be carried on the James Webb Space Telescope, microscopes, telephoto lenses, or digital light processors.

5A-3
Approaching the stress-free limit in ultrathin doubly-clamped nanomechanical resonator, Jian Zhou, Nicolaie Moldovan, Liliana Stan, Haogang Cai, David Czaplewski, Daniel López (Argonne National Laboratory)

As the thickness of the vibrating structures is reduced, the built-in strain of the structural materials plays an increased

role in determining the mechanical performance of the devices. Here we demonstrate the realization of ultrathin doubly clamped nanomechanical resonators with an axial strain in the scale of 10^8.

5A-4
Electron wave front modulation in (S)TEM with patterned mirrors, Maurice Krielaart, Pieter Kruit, (Delft University of Technology)

We propose a technique based on electron mirrors that could enable the arbitrary shaping of the electron wave front inside a modified (scanning) transmission electron microscope. Possible application areas are multi pass and quantum electron microscopy, and structural hypothesis testing.

Session 5B Q&A – Biomedical Devices II
8:10 am – 9:00 am Pacific Time

Session Chairs
Leonidas Ocola, IBM T. J. Watson Research Center
Sertan Sukas, Eindhoven University of Technology

5B-1 Invited
Moonshot: Nanofabricating neural networks, Regina Luttge (Eindhoven University of Technology)

Current networks of neurons show a biology, which represents functions similar to those reported for fetal human brain. Human brain modelling on chip can shine light on in vivo-like message passing from neuron to neuron in a dish.

5B-2
Planar Figure-8 Coils For Ultra-Focal And Directional Micromagnetic Brain Stimulation., Hongbae Jeong (Massachusetts General Hospital, Harvard Medical School); Jiangdong Deng (Harvard University); Giorgio Bonmassar (Harvard Medical School)

Recently, white matter fiber tract pathways carrying neural signals through the brain were shown to follow curved, orthogonal grids. This abstract focuses on how these 3D fiber grids may be stimulated using μMS, a new type of neuronal stimulation, which generates microscopic eddy currents capable of directionally activating neurons.

5B-3
Microspheres Enhanced IMPACT Chip for Simple and Instrument-Free CRISPR Detection, Mengdi Bao, Kenneth Hass, Yu Chang (Rochester Institute of Technology); Myeongkee Park (Dong-A University); Ke Du (Rochester Institute of Technology)

In this work, we further improve the Integrated Micropillar Polydimethylsiloxane Accurate CRISPR detection (IMPACT) system developed by us into a simple platform for naked-eye fluorescence detection. Rather than using the conventional organic dyes, the microchannel patterned with high-aspect-ratio micropillars is loaded with fluorescent microspheres with a strong fluorescence emission.

5B-4
Light Activated Drug Delivery from Electrospun Bandages Using Plasmonic Dopants, Jessica Andriolo, McKenzie Joseph (Montana Technological University); Mark Griep (CCDEVCOM Army Research Laboratory); Jack Skinner (Montana Technological University)

Here, we present electrospun bandages composed of core-shell fibers that contain plasmonic dopants in the shell and microfluidic channels that carry treatment in the core. These bandages are made with biocompatible, hydrophobic polymer enabling storage and light activation when needed. Plasmonic coupling will be studied to predict bulk heating.

5B-5
Body in a Cube: A Multi-Organ Microphysiological System with Near-Physiological Amounts of Blood Surrogate, Mandy Esch (NIST); Longyi Chen (University of Maryland); Hidetaka Ueno (National Inst. of Advanced Industrial Science and Technology)

We have, developed an MPS with four physiologically scaled organ chambers (GI tract, liver, kidney, and bone marrow, and, unlike any other MPS published to date, with near-physiological amounts of blood surrogate. We show that the system is suitable for testing acute primary and secondary toxicities of small molecule drugs.

Session 5C Q&A – Electron and Ion Beam Lithography/Deposition/Etching
8:10 am – 9:00 am Pacific Time

Session Chairs
Larry Muray, KLA
Ines Stolberg, Vistec Electron Beam GmbH

5C-1
Ultrafast growth of metallic deposits by focused ion beam irradiation under cryogenic conditions (Cryo-FIBID), Jose De Teresa (CSIC-University Of Zaragoza); Alba Salvador-Porroche, Soraya Sangiao, Pilar Cea, Cesar Magen (Instituto de Nanociencia y Materiales de

Aragón); Patrick Philipp (Luxembourg Institute of Science and Technology)

Here, we will show the application of Cryo-FIBID to other precursors beyond W(CO)6, with the aim of obtaining ultrafast growth of metallic deposits, and eventually additional functional properties. In particular, we will discuss the results obtained using the (CH3)3Pt(CpCH3) precursor, which is commonly found in commercial FIB equipment.

5C-2
Novel Platinum Precursors for Focused Electron Beam Induced Deposition: PtCl2(CO)2 and PtBr2(CO)2, Aya Mahgoub, Cornelis (Kees) Hagen, (Delft University of Technology); Rachel Thorman, Howard Fairbrother (Johns Hopkins University); Hang Lu, Lisa McElwee-White (University of Florida)

The composition of material deposited by FEBID depends, partly, on the precursor molecules used. Two new platinum precursors, PtCl2(CO)2 and PtBr2(CO)2 were synthesized and successfully tested using a standard FEBID process in an SEM, and compared to deposits made in UHV. Remarkably different results were obtained.

5C-3 – WITHDRAWN

5C-4
Comparison of alignment markers and method for electron-beam lithography on CMOS dies, Raphaël Dawant, Serge Ecoffey, Dominique Drouin, (Université de Sherbrooke); Robyn Seils, Rainer Schmid (Raith America Inc)

CMOS back-end-of-line integration is a very promising technology for the next generations of integrated circuits. Yet, electron beam lithography and alignment on multiple underlying metal layers and structures is challenging. In this paper, we present an image correlation strategy, procedure and markers to reach alignment accuracy better than 5 nm.

5C-5
Nano Aperture Ion Source Fabricated Using 3D Focused Electron Beam Induced Deposition, Aya Mahgoub, Dustin Laur, Cornelis (Kees) Hagen; Pieter Kruit (Delft University of Technology)

We present the design and fabrication of a novel nano aperture ion source, based on electron impact ionization of gases. The design consists of two concentric hollow cones deposited on a double membrane using FEBID. We describe the fabrication process and the challenges in optimizing the deposition efficiency.

5C-6
Ultra-deep micro-axicons in lithium niobate by focused Xe ion beam milling, S. Gorelick, A. de Marco, Monash University

Using high current focused Xe ion beam milling we fabricated ultra-deep and high quality micro-axicons in such a challenging material for microfabrication as lithium niobate. The axicons generate sub-wavelength focused beam over extended depths of focus with potential applications in microscopy and particle trapping.

Session 6A Q&A – Nanofluidic Nanobiology and Nanomedicine
9:10 am – 10:00 am Pacific Time

Session Chairs
Saba Ghassemi, University of Pennsylvania
Chao Wang, Arizona State University

6A-1 Invited
Single molecule detection in multifunctional nanofluidic devices, Franziska Esmek, Tim Erichlandwehr, Dennis Mors, Manuel Müller, Rukan Nasri, Malte Wahmhoff, Anton Kettner, Leon Seggering, Hoan Vu, Irene Fernandez-Cuesta, (University of Hamburg)

Single use, all plastic, all transparent nanofluidic devices are used for single molecule detection. The nanochannels have lateral dimensions below 100 nm, allow for spontaneous flow, and are used for example for DNA optical mapping. In addition, integration with plasmonics or suspended structures will be shown.

6A-2
Fabrication of Silicon Micro Tips for Microbial Cell Lysis Applications, Pavani Vamsi Krishna Nittala (The University of Chicago/ Argonne National Laboratory); Abhiteja Konda, Ralu Divan (Argonne National Laboratory); Supratik Guha, Anindita Basu, (The University of Chicago)

Our goal in this paper is to demonstrate a process flow for the fabrication of silicon tips using KOH based wet etching and Cryo or Bosch based dry etching approaches.

6A-3
High Throughput DNA Optical Mapping in Real-Time on 3D Nanofluidic Devices, Franziska Marie Esmek, Irene Fernandez-Cuesta, (University of Hamburg)

We have developed a new technology for detecting single DNA molecules on-chip. A nanofluidic device was fabricated in a multi-step process to unfold the molecules

in 3D inlets and guide them inside the nanochannels. No external field is applied, allowing high throughput and generate enormous data in real-time.

6A-4
Deformable Microbeads-stacked Nanodevice for Blood Plasma Separation and Blood Cells Retrieval, Xinye Chen, Shuhuan Zhang, (Rochester Institute of Technology); Yu Gan (University of Alabama); Ruoqian Wang (Rutgers, The State University of New Jersey); Rui Liu, Ke Du, (Rochester Institute of Technology)

Blood separation and processing is a vital and essential step in numerous medical and clinical tests. We present here a unique deformable nanodevice functionalized by three-dimensional (3D) microbeads for plasma separation and blood cells retrieval.

Session 6B Q&A – Nanophotonics and Plasmonics II
9:10 am – 10:00 am Pacific Time

Session Chairs
Stefano Cabrini, Lawrence Berkeley National Laboratory
Nick Petrone, KLA

6B-1 Invited
A new label-free plasmonic imaging technique for quantitative analysis of transparent nanoscale objects approaching molecular size, Nareg Ohannesian, Wei-Chuan Shih, (University of Houston);

Label-free optical observation of transparent nano-objects is challenging. We present PlAsmonic NanO-apeRture lAbel-free iMAging (PANORAMA) to image, size, count and monitor single nanoparticle with a size limit approaching sub-10 nm. Molecular imaging is envisioned with functionalized substrates for single nanoparticle analysis for extracellular vesicles (e.g., exosomes) and pathogens (e.g., viruses).

6B-2
Omnidirectional and band-tunable light absorption in free-standing dielectric-metal core-shell resonator arrays, Hao Zhang, Boyang Ding, Richard Blaikie, (The University of Otago)

We develop a broadband and omnidirectional tunable resonators with polarization-free high light absorption by preparing a hexagonally patterned array of free-standing SiO2_Ag core-shell nanoparticles. It is the result of hybrid optical modes consisting of Plasmon modes and whispering gallery modes.

6B-3
The Fabrication of Bipartite Plasmonic Arrays for Lasing Applications, Aran Warren, Maan Alkaisi,Ciaran Moore, (University of Canterbury)

We present optically resonant bipartite metal nano-cylinder arrays fabricated using electron beam lithography. The arrays utilise two different structure sizes with diameter differences as small as 10 nm. We show that this can be achieved and that the arrays show a resonance response that agrees with electromagnetic simulations.

6B-4
Probing the Mechanisms of Strong Fluorescence Enhancement in Plasmonic Nanogaps with Subnanometer Precision, Boxiang Song; Zhihao Jiang, Zerui Liu, Yunxiang Wang, Hao Yang, Deming Meng, Buyun Chen, Pan Hu, Tse-Hsien Ou, Stephen Cronin, Stefano Cabrini (Lawrence Berkeley National Laboratory); Stephan Haas, Adam Schwartzberg (Lawrence Berkeley National Laboratory); Wei Wu (University of Southern California)

We demonstrated a technology to experimentally investigate plasmon enhanced fluorescence at the sub-nanometer scale, where strong fluorescence quenching occurs. We have experimentally identified optimal gap sizes for maximum plasmon enhanced fluorescence with tunable dielectric spacers.

6B-5
Nanofabricated Plasmonic Resonators on Optically Active Materials for Hydrogen Photocatalysis, Mohsin Ijaz, Boyang Ding, Richard Blaikie, (University of Otago)

The fabrication of large area silver nano-gratings has been reported using optical interference lithography. The coupling of these plasmonic resonators with optically active quantum dots indicates significant enhancement in photoluminescence signal. Furthermore, The coupling with WS2 monolayers and MoS2/WS2 hetro-bilayers to enhance photocatalytic hydrogen conversion will also be discussed.

Session 6C Q&A – Novel Patterning
9:10 am – 10:00 am Pacific Time

Session Chairs
Hsinyu Tsai, IBM
Wei Wu, University of Southern California

6C-1 Invited

A setup for in-situ optical, thermal and X-ray imaging of laser sintering of polymer particles, Prakhyat Hejmady, Lambèrt van Breemen, Patrick Anderson, (Eindhoven University of Technology); Ruth Cardinaels (KU Leuven)

Selective laser sintering is a 3D printing technology wherein particles are locally heated with a laser beam to be molten and sintered together. We present a setup for real-time studies of the structural evolution during laser sintering of polymer particles, using optical and thermal microscopy as well as X-ray scattering.

6C-2
Chip-scale fabrication of FETs by a combination of thermal scanning probe lithography and direct laser sublimation, Tero S. Kulmala, Emine Cagin, Samuel Bisig, (Heidelberg Instruments Nano); Heiko Wolf, Daniel Widmer, Ute Drechsler, Philippe Nicollier, Francesca Ruggeri, Armin W. Knoll, (IBM Research - Zurich)

Thermal scanning probe lithography can reach a resolution down to 10 nm but has a relatively modest throughput. Therefore, direct laser sublimation of resist has been introduced for significantly faster patterning of lower-resolution features. Here, we demonstrate chip-scale mix-and-match fabrication of field effect transistors via combined tip and laser patterning.

6C-3
A Mixed Mathematical and Experimental Model for Energy Storage in Electrospun Mn2O3 Supercapacitor Electrodes, Molly Brockway, Jack Skinner, (Montana Technological University)

Electrospun Mn2O3 supercapacitor electrodes have been fabricated and characterized. Experimental determination of system parameters, including pseudocapacitive and double layer processes, are used to derive a mathematical model describing electrochemical energy storage. The mixed theoretical and experimental model is compared to the observed system.

6C-4
An Easy-to-fabricate Testing Chip for Electrical Characterization of Nano-particles, Ming Lu (Brookhaven National Laboratory)

A new method is reported to reduce the cost and complicity of electronic property characterization of nanoparticles, using specially designed test bed chips. This method is universally usable for a broad size range of nanoparticles and the test chips are fabricated using basic microfabrication tools.

6C-5
Closed-Loop Nanopatterning of Liquids with Dip-Pen Nanolithography, Verda Saygin, Bowen Xu, Sean B. Andersson, Keith Brown, (Boston University)

We describe a closed-loop method for patterning liquid samples using Dip-Pen Nanolithography. The proposed work addresses a pervasive issue in scanning probe lithography, namely real-time closed-loop control over patterning, and scanning probe lithography of liquids as a candidate for the robust nanoscale manipulation of liquids for advanced high throughput chemistry.

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Poster Session
Wednesday, June 2

Advanced Lithography

W01
Improving the Sensitivity of Metallic Organic Resists, Ahmad Chaker, Hayden Alty, Scott Lewis, The University of Manchester, California Institute of Technology, ***Sci-Tron Ltd, Richard Winpenny, The University of Manchester, **Sci-Tron Ltd

New resists are required to advance the nanoelectronics industry to keep up the demands of Moore's law. A new class of high dry etch selectively electron beam resist materials have been developed that are based on a family of heterometallic rings.

W02
Improvements on Maskless Grayscale Lithography in thick positive photoresist, Dominique Collé, Gerda Ekindorf, Peter Heyl, Heidelberg Instruments

Maskless Grayscale lithography is a key technology to create structured surfaces in photoresist, especially for micro-optic applications. Processes of low-contrast positive resist are well known and used for thicknesses up to 60 µm. The possibility to fabricate higher structures, i.e. 80 µm, 100 µm high and beyond, are of great interest in the micro-optic world. With some double- and triple-coated layers of an experimental resist, we could make structures 83µm and 100µm tall. The triple-coated layer showed some limitations that we plan to overcome to go beyond 100µm.

Advanced Pattern Transfer Concepts

W03
Patterning of Chromium Oxide (Cr2O3) as a Hard Mask by Plasma Etching, Huseyin Ekinci, Bo Cui, Dmitry Pushin, University of Waterloo

In this work, we present a systematic investigation of plasma etching of Cr2O3 films via an inductively coupled plasma-reactive ion etching system in nanoscale. The effects of plasma composition, rf-chuck power and ICP source power on the etch rates, sidewall profile, surface roughness, selectivity and dc-bias have been systematically investigated.

W04
Investigation of reactive ion etching on diamond using electroplated nickel hardmask for fabricating x-ray diffractive gratings, Kenan Li, Yanwei Liu, Donald Gardner, Anne Sakdinawat, Stanford SLAC National Accelerator Labs,

Diamond has emerged as an essential material for x-ray diffractive optics. We used electroplated nickel as hardmask to etch diamond with oxygen-based reactive ion etching. Diamond gratings either with a high aspect ratio of up to 25 or with a high quality of etching profile and depth uniformity were achieved.

Biomedical Devices

W05 – WITHDRAWN

Electron and Ion Beam Lithography and Technologies

W06
In-situ Study of the Impact of Aberration-Corrected Electron-Beam Lithography on the Electronic Transport of Suspended Graphene Devices, Fernando Camino, Brookhaven National Laboratory, Naomi Mizuno, Xu Du, Stony Brook University

We characterize in-situ the impact of aberration-corrected electron-beam lithography (AC-EBL) on the performance of suspended graphene field-effect transistors. When AC-EBL is performed on the vicinity of a graphene channel, detrimental effects can be removed by vigorous annealing, while the damage caused by AC-EBL performed directly on a channel is irreversible.

W07
Reduction of Exposing Time in Massively-Parallel E-beam Systems, M. Nabid Hasan, Soo-Young Lee, Auburn University, Byung-Sup Ahn, Jin Choi, Joon-Soo Park, Samsung Electronics

Massively-parallel electron-beam systems are developed to improve the writing throughput. Two different methods to further decrease the writing time are investigated, i.e., reducing the maximum dose difference in a feature and utilizing empty cycles (with no beam on) in the conventional writing methods.

W08
A modular 100 keV vacuum sealed FEG, Mohamed El-Gomati, Torquil Wells, Xiaoping Zha, Richard Sykes, York Probe Sources Ltd, Richard Henderson, Chris Russo, Greg Mc Mullen, Laboratory of Molecular Biology, Medical Research Council, UK

A modular, UHV sealed FEG operational betwee 30-100 keV has been developed. This design lends itself to integration onto thermionically operated TEMs, EBL into FEG operation or in R & D applications. Graphitic carbon and gold particles have been resolved confirming a resolution of better than 0.24nm at 60-100 keV.

W09
Multiple Electron-Beam Generation from InGaN Photocathode, Daiki Sato, Haruka Shikano, Anna Honda, Atsushi Koizumi, Tomohiro Nishitani, Photo electron Soul Inc., Yoshio Honda, Hiroshi Amano Nagoya University

In this contribution, the generation of multiple electron-beam from an InGaN photocathode was demonstrated. 25 electron beams were observed by irradiating 25 lasers. The averaged diameter was 0.6 mm with a gaussian distribution. The deviation in diameter was 17%.

W10
Bend the curve: the benefit of optical proximity correction in direct writing lithography simulation and experiment, Jan Erjawetz, Sijia Xie, Vitaliy Guzenko, Helmut Schift, Paul Scherrer Institut (PSI), Daniel Ritter, Aditya Reddy, Thomas Michels, GenISys GmbH

For direct writing laser lithography, GenISys BEAMER and LAB software allows for correcting proximity effects and to achieve fast approximation of a desired shape without tedious iterations. We show the importance of parameters such as vertical focus variation on staircase structures and lens-like shapes using a Heidelberg Instruments DWL 66+.

W11
Investigation of Non-Charging Exposure Conditions for Insulating Resist Films in Electron Beam Lithography, Kentaro Kojima, Kento Kubo, Yoshinobu Kono, Masatoshi Kotera, Osaka Institute of Technology

After irradiating the electron beam, we measured the surface potential with an electrostatic force microscope (EFM). In the presentation, we will explain the measurement results using the model we devised.

W12
Surface Wetting on Micro-milled or Laser-Etched Aluminium with Ion-Beam Post-Processing, Kirill Misiiuk, Sam Lowrey, Richard Blaikie, University of Otago, Josselin Juras, Andrew Sommers, Miami University, Jérôme Leveneur, GNS Science

We investigate the surface wetting properties for a range of micro/nanofabricated topography on aluminium surfaces supported by ion-beam processing to enhance liquid-solid interaction.

Imaging and Characterization

W13
Development of Tilt-SEM for In-line 3D Measurement and Inspection of Semiconductor Devices, Nobuhiro Okai, Makoto Sakakibara, Hitachi, Ltd., Naomasa Suzuki, Yasunari Sohda, Katsunori Onuki, Hitachi High-Tech Corporation

We developed tilt-SEM which can load and tilt a wafer to observe semiconductor devices from various directions. Simulated tilt-SEM images show similar contrast with experimental ones. We demonstrate that assist electrode reduces image drift caused by electron optics less than 1 micrometer when wafer is tilted up to 55 degrees.

W14
Real-Time Metrology for Roll-to-Roll Microcontact Print Process Monitoring, Xian Du, Jingyang Yan, Rui Ma, UMass Amherst

We present a real-time imaging technique for inspecting the online R2R μCP pattern by condensation figures (CFs). The real-time desirable CFs are achieved through a controlled open condensation chamber and a synchronous imaging process.

W15
A local threshold method for measurement of nanoparticle sizes in the SEM, John Villarrubia, Natalia Farkas, András E. Vladár, John Kramar, National Institute of Standards and Technolog

For best accuracy, SEM nanoparticle size measurements should account for the e-beam/particle interaction physics, but the best models are not available for all materials. We here show that a simple threshold model's particle boundary assignments differ by tenths of a nanometer from those of a Monte Carlo dielectric function model.

Micro- and Nanofluidics

W16
Detection of network burst activity in a MEMS-based 3D neuronal cell culture system, Yagmur Demircan Yalcin (Dr.), Alex Bastiaens, Jean-Philippe Frimat, Regina Luttge, Eindhoven University of Technology

This work presents the analysis of spike, burst, and network burst activity in a microfluidic brain-on-chip. A

collection of activities in the electrophysiological recordings, measured by multielectrode arrays, provided strong clues for the maintenance of human induced pluripotent stem cells-derived cortical neuron cultures in 3D for 37 days.

W17
Fabrication of sapphire-supported nanopore sensors with reproducible micrometer membranes, Pengkun Xia, Jiawei Zuo, Pravin Paudel, Md Ashiqur Rahman Laskar, Siying Liu, Chao Wang, Arizona State University

Solid-state nanopores, have the potential to achieve high-speed and low-cost DNA detection. Here we present a novel manufacturable approach to create membranes on a crystal sapphire wafer, which completely eliminates the large capacitance from silicon. And we achieved reproducible micrometer-membrane fabrication over wafer-scale for ultra-low noise applications.

Nanoelectronics

W18
Tuning Electrical Properties of E-beam Evaporated 2D Bi and Derivatives, Hanliu Zhao, Beibei Zhu, Li Tao, School of Materials Science and Engineering Southeast University

This work explored an accessible and cost-effective way to prepare high quality 2D Bi and derivatives on SiO2/Si substrates by e-beam evaporation. The electrical and thermoelectric properties were characterized. Our study builds a platform to realize high-quality 2D Bi, which may also be suitable in other Xenes.

Nanoimprint Lithography

W19
Nanoimprinted Deposition Masks for Area Selective Atomic Layer Deposition of Aluminum Oxide, Chiaki Miyajima, Shunya Ito, Masaru Nakagawa, IMRAM, Tohoku University

In this study, we investigated whether UV-cured resin thin films modified by atomic layer deposition (ALD) could be removed completely by dry etching procedures. UV-nanoimprinted deposition masks were removed completely by sequential physical and chemical dry etching procedures, to demonstrate and area selective deposition of aluminum oxide.

W20
Low Cost Nano Imprint for Surface Enhanced Raman Scattering, Blessing Adewumi, Debsmita Biswas, Martin Feldman, Louisiana State University, Li Jiang, Naga Korivi, Tuskegee University

Long silver rods SERS layer was constructed by using fine grit (1μm) sandpaper as a template for imprinting nano-patterns. Therefore, costly nano lithographic processing was avoided. Raman spectra of R6G were obtained. The signal strength decreased linearly at reduced concentrations in logarithmic scale, as expected for SERS, down to 1nM.

Nanophotonics and Plasmonics

W21
Plasma Etching of High Aspect ratio Sapphire Antireflection Nanostructures Using Multilayer Etching Mask, Yi-An Chen, I-Te Chen, Chih-Hao Chang, University of Texas at Austin

In this work, we apply multilayer etching mask and optimize the etch process to improve etching rate and etching selectivity to pattern sapphire antireflection nanostructures. Initial results show 2-D sapphire nanostructures with 530 nm width and 470 nm height, resulting in two-fold aspect ratio enhancement over previous work.

W22
Nanotransfer printing of plasmonic nanostructures on convex lens for highly sensitive image-based biosensing, Mingxi Wu, Jingxuan Cai, Sun Yat-sen University

Plasmonic biosensors have been attracted growing attentions in recent years because of their unique properties of high sensitivity, label-free operation, and suitable for high-throughput real-time detection. Here, we proposed a facile, use-friendly and cost-effective image-based plasmonic biosensor to detect the concentration of various biomolecule.

W23
Fabrication of Dynamically Tunable Vanadium Dioxide Huygens Metasurfaces for Optical Modulation, Isaac Oguntoye, Siddharth Padmanabha, Yaping Ji, Tulane University, Adam Ollanik University of Colorado, Boulder, Matthew Escarra, Tulane University

W24 – WITHDRAWN

Novel Materials and Processes

W25

Monolayer Graphene Deposition on Copper and Silicon dioxide using NanoCVD-8G System, Md Azmot Ullah Khan, Naheem Olakunle Adesina, Jian Xu, Louisiana State University

W26
Atomic-scale Fabrication of Donor-based Quantum Devices in Silicon, Pradeep Namboodiri, Ranjit Kashid, Jonathan Wyrick, National Institute of Standards and Technology, Alessandro Restelli, 3Join Quantum Institute (JQI), University of Maryland, Xiqiao Wang, Fan Fei, Richard Silver, National Institute of Standards and Technology

Atomic scale lithography using Hydrogen-based scanning probe lithography allows fabrication of atomically precise devices for quantum information processing. This presentation covers the design, fabrication, and characterization of STM patterned SETs and development of on-chip coplanar wave guides intended for coherent manipulation of spin states of donor/dot devices.

W27 – WITHDRAWN

W28 – WITHDRAWN

W29
Lead Halide Perovskite Micro-arrays Fabricated by Reusable Metal Mesh Templates, Zhao Sun, Liyang Chen, Wen-Di Li, The University of Hong Kong

In this work, a novel patterning process for perovskite arrays is performed, where the high-resolution, large-scale metal mesh template film is adopted to pattern perovskite arrays through drop-casting.

W30 – WITHDRAWN

W31
Amperometric detection of nitro compounds using novel nanomaterial composite, Bharti Sharma, Guru Jambheshwar University Science and Technology

Electrochemical methods have stood out as the most promising since they can detect liquid-phase explosives. Moreover, they are simple, inexpensive, suitable for portable sensors, work at ambient conditions, and have high sensitivity and selectivity for nitro-compound.

W32
Fabrication of Nanowire/Nanorod Arrays via Electrodeposition in Porous Templates, Monika Nehra, Rajesh Kumar, University Institute of Engineering and Technology, Panjab University, Neeraj Dilbaghi, Sandeep Kumar Guru Jambheshwar University of Science and Technology

The electrochemical deposition technique offers accurate process control for growth of different nanostructures for a variety of materials. The different parameters and operating conditions can be optimized for electrodeposition of highly-ordered nanowires/nanorods inside the pores of anodisc template. Here, well-aligned and highly ordered Ni nanowires have been synthesized.

W33
Field-Emission Scanning Probe Lithography-based Mix-and-Match Fabrication of Si Nanowires on SOI Substrates, Mert Özden, Sepeedeh Shahbeigi, Koc University, Martin Hofmann, TU Ilmenau, Sina Zare Pakzad, Mehrdad Karimzadehkhouei, Koc University, Mohammad Nasr Esfahani, University of York, Mathias Holz, nano analytik, Ivo Rangelow, Ilmenau University of Technology, Arda Deniz Yalcinkaya, Bogazici University, B. Erdem Alaca, Koc University

The purpose is to utilize field-emission scanning probe lithography (FE-SPL) followed by cryogenic reactive ion etching in the fabrication of silicon nanowire electromechanical switches with a critical dimension of 10 nm on a silicon-on-insulator substrate. Patterning outside the active FE-SPL area is achieved through focused ion beam machining.

Process Simulation and Modeling

W34
Modeling Co-Assembly of Binary Non-Monodispersed Nanospheres, Saurav Mohanty, I-Te Chen, Chih-Hao Chang, University of Texas at Austin

In this work, a geometric model was developed using line-by-line assembly of non-monodispersed binary nanoparticles to obtain a randomly closed packed assembly structure. To validate the results from the script, a binary nanoparticle assembly was experimentally fabricated. The experimental and simulated FFT peak frequencies were compare.

W35
Identifying EUV Attenuated Phase Shifting Mask Absorber Materials using EMA Modelling, Rajiv Sejpal, Bruce Smith, Rochester Institute of Technology

Solution space for material candidates as EUV attenuated phase shifting mask absorber that can meet phase, transmission, and thickness requirements is identified using k-n plots. The selection of the potential candidates is then carried out using effective media approximation (EMA) modelling, while achieving the necessary stability and processing attributes.

Poster Session
Thursday, June 3

Advanced Lithography

T01
Optimized UV grayscale process for high vertical resolution applied to spectral imagers, Nadine Gerges, University of Grenoble Alpes, CNRS, CEA/LETI-Minatec, Grenoble INP, LTM, Cecile Gourgon, Jumana Boussey, Camille Petit-Etienne, Marie Panabiere, CNRS – LTM, Yann Ferrec, Onera - Dota

We introduce a UV greyscale lithography process combining large surface patterning with a high vertical resolution. To reach a low contrast curve slope, we studied the annealing processes Soft Bake and Post Exposure Bake. We also achieve a 50nm Si steps within our presented plasma etching process.

T02
Optimization of the Built-in Lens Mask for Three-Dimensional Photo Lithography, Tomoaki Osumi, Masaru Sasago, Masaaki Yasuda, Yoshihiko Hirai, Osaka Prefecture University

We optimized the built-in lens mask (BILM) which was shown to be able to form a three-dimensional image in a single exposure by using its multiple focus function, in order to creat the ideal target shape.

Advanced Pattern Transfer Concepts

T03
Fabrication of hard x-ray zone plates with high aspect ratio using metal-assisted chemical etching and electroless plating, Kenan Li, Chieh Chang, SLAC, Michael Wojcik, Argonne National Laboratory, Wah-Keat Lee, Brookhaven National Lab, Anne Sakdinawat, SLAC

Fresnel zone plates are widely used in x-ray microscopes. Metal-assisted chemical etching has been developed to create very high aspect ratio silicon structures that has been successfully used in fabricating x-ray zone plates. Here we developed an electroless plating process to fill in the zones between silicon zones with palladium.

Biomedical Devices

T04
Development of ICG Assisted NIR Dental Fluorescence Imaging with Mouthwash for Diagnosis of Dental Disorders, Zheng Li, Zhongqiang Li, Louisiana State University, Shaomian Yao, Louisiana State University School of Veterinary Medicine, Jian Xu, Louisiana State University

ICG assisted NIR imaging with mouthwash ICG delivery has the potential to become a new, non-ionizing radiation and efficient dental imaging system for diagnosing dental disorders

T05
A dual-chamber microelectrode array to facilitate neuronal network communication, Alyssa Andrade, Joshua Khoo, Rhonda Dzakpasu, Gina Adam, The George Washington University

The goal of this work is to build compartmentalized microelectrode arrays to assess the impact of conditioned cell culture media exchange between two initially isolated neuronal networks. The fabrication of biocompatible dual-chamber microelectrode arrays is presented, including the manufacturing and attachment of resin rings with controllable openings for fluid exchange.

Electron and Ion Beam Lithography and Technologies

T06
Ion beam lithography: resist modification volume determination and sub-10nm resolution prediction via simulation, Yane Shabelnikova, Sergey Zaitsev, IMT RAS

Width/depth and shape of volume of resist modified by ion beam as function of ion energy, exposure time and ion mass (He, Ne, Ar, Ga, Kr, Xe и Rn) is investigated by Monte-Carlo simulation. Sub-10nm resolution is found and confirmed. Analytical interpolating expressions for arbitrary ion mass, energy are submitted

T07
Presentation Of Proximity Function By Three Parameters α, β, η Based On Monte Carlo Method And Comparison With Experiment, Alexander Svintsov, Maxim Knyazev, Sergey Zaitsev, IMT RAS

In spite of M-C simulation shows strong dependence proximity function on depth (3D-PF) it is possible to find effective α, β, η parameters for two-dimensional PF using original algorithm which considers development. Good agreement with experimental data is demonstrated thus

proximity parameters now can be calculated for arbitrary layered material

T08
An hierarchical Boundary Element Method (BEM) solver for the General Particle Tracer (GPT) code, Sebastiaan van der Geer, Marieke de Loos, Pulsar Physics

Here we present a new extension to the well-established GPT simulation code that allows for the calculation of electrostatic fields in complex 3D geometries using an hierarchical Boundary Element Method (BEM) solver. Aberration analysis of an Einzel lens array and a nanotip structures demonstrate the new capabilities of the code.

T09 – WITHDRAWN

T10 – WITHDRAWN

T11
Ion beam lithography: sensitivity/contrast in IBL vs EBL., Yana Shabelnikova, Sergey Zaitsev, IMT RAS, Nazim Gusseinov, Mukhit Muratov, Al-Farabi Kazakh National University, Maratbek Gabdullin, Kazakh-British Technical University

PMMA exposure sensitivity to both electrons and gallium ions at identical conditions was measured. It was found that a positive sensitivity to gallium ions is 1000 times higher than to electrons, all at the same conditions. Original procedure allowed to measure ion contrast (~3) for highly nonuniform in depth exposure

T12 – MOVED to SESSION 4A-1

Imaging and Characterization

T13
Cellphone CMOS Camera Module for Imaging with Charged Particle Beams., Aleksei Bunevich, PhD Student, Karen Kavanagh, Simon Fraser University

Our group used cellphone CMOS camera module, based on OV5648-BSI image sensor, to image 200keV electron beam in Transmission Electron Microscope and 30keV ion beam in Helium Ion Microscope.

T14 – WITHDRAWN

T15
Determination of Residual Stress in Ultrathin Atomic Layer Deposition Films Using Curved Nanobeams

We present a methodology for the measurement of residual stress in ultrathin films obtained using ALD. Our technique, which utilizes a curved nanobeam structure assesses the film's stress by comparing the difference in the static in-plane deflection of the nanobeam's midpoint before and after the application of the ALD film.

Micro- and Nanofluidics

T16
Stretching and fixing DNA molecules on air-plasma-treated surface by using an air/water interface in a microchannel, Naoki Azuma, Kenji Fukuzawa, Shintaro Itoh, Nagoya University

In this study, we succeeded in stretching and fixing DNA molecules on an air-plasma-treated glass surface without the silane coupling agents in a microchannel. We investigated the dependence of stretching rate and number of DNAs on the velocity of air/water interface movement.

T17
Surface Charge Density of Nanofluidic Devices with TMPTA UV Resins of Different Cross-Linking Agent Concentration Fabricated by UV Nanoimprint Lithography, Dae Won Kim, Junseo Choi, Austin Saizan, Sunggun Lee, Bin Zhang, Wen Jin Meng, Sunggook Park, Louisiana State University

This work presents an improvement in the chemical and mechanical stability of a nanofluidic device formed in poly(ethylene glycol) diacrylate (PEGDA), a PEGbased UV resin for UV-NIL, by adding a cross-linking agent.

Nanoelectronics

T18
On growth technique of electromigration-based free-standing Al micro/nanowires, Yasuhiro Kimura, Nagoya University

In this work, we introduce the growth technique of EM-based free-standing Al microwire, and examine the structure analysis of wire and films to sophisticate the EM technique. Specifically, scanning electron microscope, transmission electron microscope and energy dispersive X-ray were utilized to analyze the structure of thin films and fabricated microwires.

Nanoimprint Lithography

T19
Exfoliation of Two-dimensional Bismuth Selenide Based on Nanoimprint Lithography, Dongdong Song, Beibei Zhu, Li Tao, Southeast University

This article provide a method about controlled exfoliation of 2D Bi2Se3 via nano-imprint. which could improve the yield and electrical performance. 2D Bi2Se3 with improved performance holds great promise for innovative photoelectric and thermoelectric applications.

T20
Using NOA81 in microtransfer molding of nanogrooves, Rahman Sabahi-Kaviani, Alex Bastiaens Regina Luttge, Eindhoven University of Technology

In this work, we aim to extend our BoC toolbox by microtransfer molding of NOA81 nanogrooves on glass and NOA81 substrates. The presence of such nanogroove patterns is confirmed and characterized using AFM and SEM measurements. This technique will allow us to introduce such cell guidance patterns onto bioMEMS substrates.

Nanophotonics and Plasmonics

T21
Ultra-narrow Linewidth Symmetry-breaking Silicon Metasurface for Trace Biomolecules Sensing, Guohua Li, Jingxuan Cai, Sun Yat-sen University

Resonances in most of the metasurfaces are strongly depends on the geometry of the dielectric nanostructures and requires costly high-precision nanofabrication techniques. So we propose a robust structural symmetry-breaking silicon metasurface with ultra-narrow transparency.

T22
Replicate Nanopillar Arrays by Soft Lithography for Real-time Biosensing of C. Albicans Adhesion, Bin Zhou, Jingxuan Cai, Jianhua Zhou, Sun-Yat Sen University

We report the use of localized surface plasmon resonance (LSPR) sensor for real-time, label-free monitoring the adhering process of C. albicans onto the gold nanopillar array. We also employ this sensor feature to elucidate how C. albicans' adhesion is affected by different electrical properties of the material surface.

T23
Stress reduction and wafer bow accommodation for the fabrication of thin film lithium niobate on oxidized silicon, Karan Prabhakar, Ryan Patton, Ronald Reano, The Ohio State University

We present the fabrication of ion sliced lithium niobate on oxidized silicon for integrated optics. Using structural modeling to optimize wafer thicknesses and a bonding apparatus to match wafer bows, an 817 nm thick lithium niobate film on oxidized silicon is achieved over a centimeter scale area.

T24 – WITHDRAWN

Novel Materials and Processes

T25
Optimization of cell deposition and cellulose nanofiber/alginate bioinks to improve cell survival and proliferation in cell-free 3D-bioprinting, Zhongqiang Li, Alexandra Ramos, Shaomian Yao, Jian Xu, Louisiana State University

This study reports new bioinks for the 3D bioprinting, and new cell-loading methods that could help to address the existing challenges in 3D bioprinting.

T26
Study of Electrophoretic Deposition of ZnO Nanoparticles onto Silicon Substrates and Testing Performance of ZnO/p-Si, Fawwaz Hazzazi, Alex Young, Christopher O'Loughlin, Daniels-Race, Louisiana State University

We will discuss our use of ZnO nanoparticle-based thin films synthesized and grown at room temperature and deposited via electrophoretic deposition (EPD) onto p-doped silicon substrates. Our experimentation plan includes using scanning electron microscopy to assess surface morphology and current-voltage characterization of ZnO/p-Si heterojunctions to study device performance potential.

T27
Development of Coating-free Super Water-repellent Micropatterned Aluminium for Spontaneous Droplet Motion, Kirill Misiiuk, Sam Lowrey, Richard Blaikie, University of Otago, Josselin Juras, Andrew Sommers, Miami University

We present results clearly demonstrating passive gradient-driven droplet motion on coating-free all-metal Al-surfaces, produced via laser-etching method.

T28
Highly Controlled Deposition with Multiple Electrode Electrospinning, Isaac Gilfeather, Harold Pearson-

Nadal, Jessica Andriolo, Jack Skinner, Montana Technological University

Applications of electrospinning (ES) fabrication are broad and limited by hardware. Here, we present an ES system that contains multiple high voltage power supplies and enables high control over nanofiber placement, resulting in deposition of materials that have novel structures on the mesoscale.

T29
Fabrication of Micro Chemical Vapor Deposition Chamber by Dry dry Deep Silicon and Metal-Assisted Etching Techniques, Pavani Vamsi Krishna Nittala, The University of Chicago/ Argonne National Laboratory, Kyaw Zin Latt, The University of Chicago, Ralu Divan, ANL, Supratik Guha, The University of Chicago

Our goal is to demonstrate a process flow for TSV (nozzle) on one end and another opening (reservoir) on the other end of an SOI. This silicon die will be used as a micro chemical vapor deposition (CVD) chamber, which is a critical component in the nanoscale additive writing process.

T30
Additive Manufacturing towards Color Printing via Polymer-Assisted Photochemical Deposition of Metal Thin Films, Shinhyuk Choi, Zhi Zhao, Jing Bai, Siying Liu, Yu Yao, Chao Wang, Arizona State University

We developed a versatile room-temperature metal printing technique based on polymer-assisted photochemical deposition (PPD). We demonstrate printing of metal structures with feature sizes as small as 5μm on various substrates, and prove the concept of creating metal-based color filter using PPD.

T31
Fabrication of luminescent metal-organic framework for optical detection of heavy metals, Shikha Jain, Sandeep Kumar, Guru Jambheshwar University Science & Technology

The heavy metals are poisonous due to inability to decompose and bioaccumulation hence, among the cost well-known environmental pollutant. Fluorescent based approach has gained considerable attention because of real time monitoring. Aiming at developing an ideal fluorescent sensing platform for heavy metals we synthesized bimetallic MOF for the first time.

T32
Evaluation of the impact by the electron collision on the silicon lens, Dong Hyun Baek, Geon Woo Lee, Young Bok Lee, Ho Seob Kim, Sunmoon University

In order to evaluate the effect of the physical transition of the surface due to the continuous impact, The samples that was applied 300 eV for 6 months to the aperture of the extractor analyzed the correlation between the impact distance and the intensity of the electron impact.

Process Simulation and Modeling

T33
Design of anodic alumina nanostructure for adhesive interface through stress-strain simulation, Yusuke Ebihara, Keisuke Nagato, Haruto Tendo, Masayuki Nakao, The University of Tokyo

The design of anodic alumina nanostructure is expected to increase the adhesive strength. In this study, the anchoring effect of various pore shapes was evaluated through stress-strain analysis.

T34
Magnetically Responsive Polymer Nanopillars with Nickel Cap, Zhiren Luo, University of Texas at Austin, Xu Zhang, North Carolina State University, Chih-Hao Chang, University of Texas at Austin

Here we demonstrate a new type of magnetically responsive nanostructure consisting of a polydimethylsiloxane (PDMS) nanopillar array with deposited nickel caps, that has successfully achieved such decoupling with multiple cap-geometry designs for a better actuation control.

T35
Process and material design using hybrid machine learning for direct thermal nanoimprint, Sou Tsukamoto, Ryuhei Yamamura, Hideki Tanabe, Kai Kameyama, Hiroaki Kawata, Masaaki Yasuda, Yoshihiko Hirai, Osaka Prefecture University

We have proposed a hybrid machine learning system that presents the optimum materials and process conditions for direct nanoimprint. The system applied for optimization of Glycol concentration to PVA for low temperature process and the results agree with experiments.

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Look in on the Raith contributions to the EIPBN talks

Frank Nouvertné, Raith GmbH

Cryo-Cathodoluminescence Integration, multiple Ion Species and a new EBPG: About Highlights from dedicated and multifunctional Raith EBL and FIB-SEM Systems

Torsten Richter, Raith GmbH

Universal Liquid Metal Alloy Ion Sources containing light and heavy ions for FIB and nanofabrication

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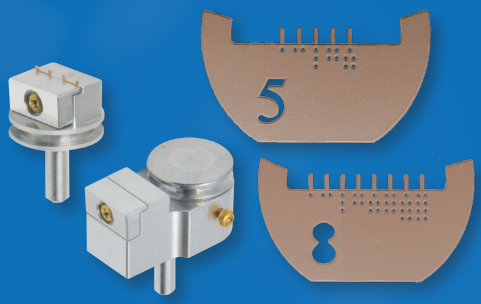

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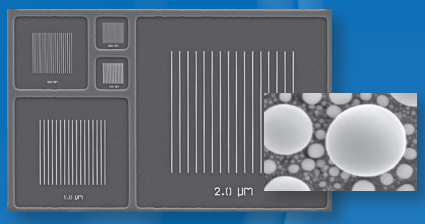

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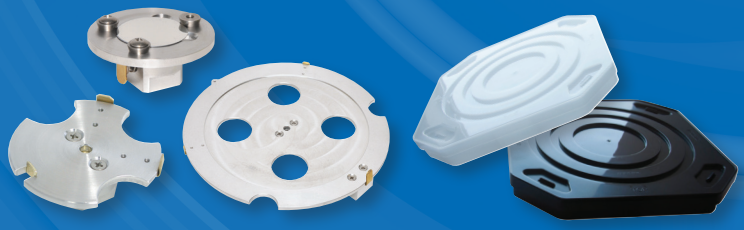

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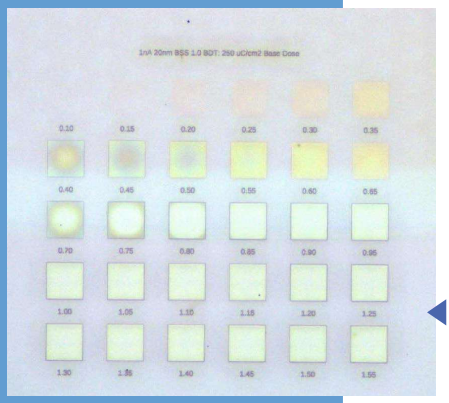
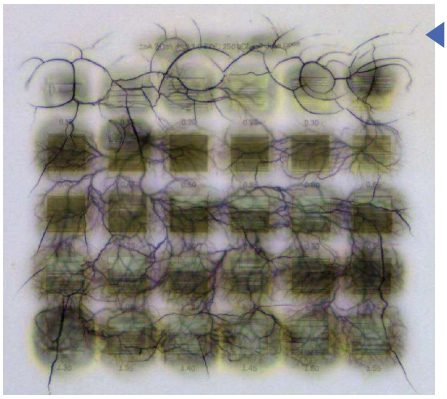


WITH DisCharge: no charge accumulation, resulting in expected image with no harm to PDMS layer.



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.

anti-charging

H-SiQ *(hydrogen silesquioxane)*

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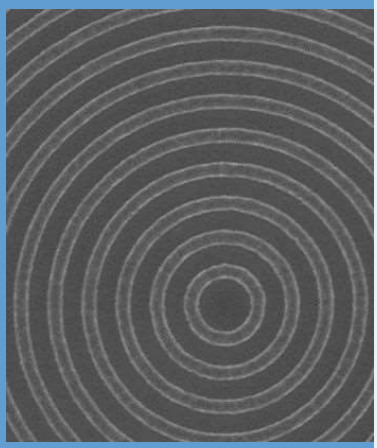

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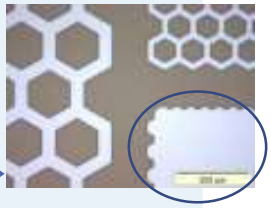
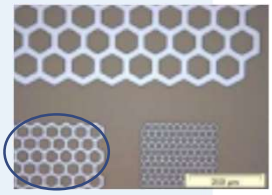
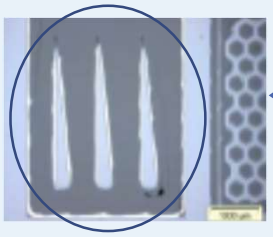
- Increased adhesion of evaporated metals to substrate materials
- Non-Hazardous waterborne formulation



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

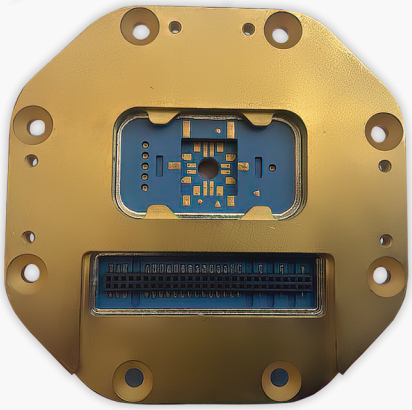
adhesion promotion

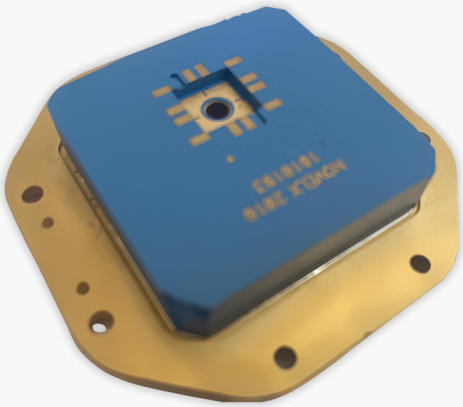
DisChem, Inc., 17295 Boot Jack Rd, Ridgway, PA 15853 USA • Tel: +1-814-772-6603 • info@dischemInc.com • www.dischemInc.com

OASISMATERIALS ● COM

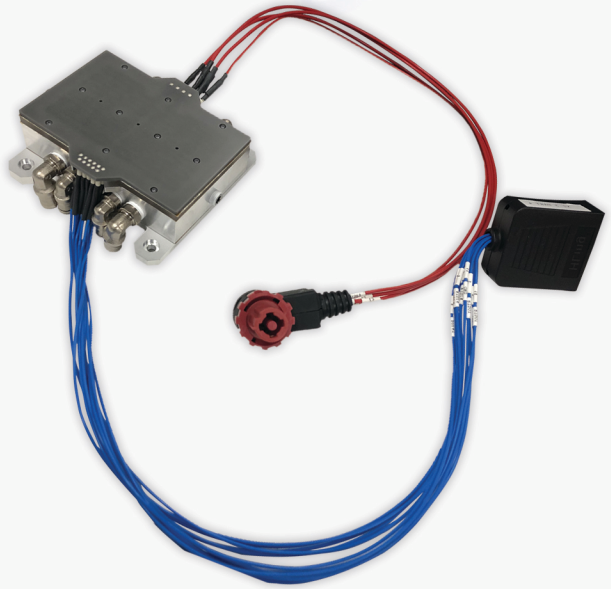
OASIS MATERIALS

A FRALOCK COMPANY

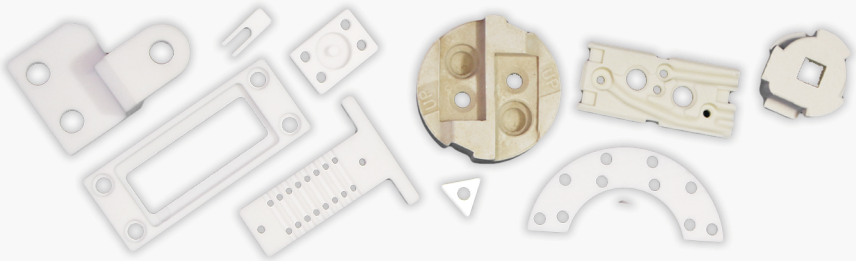




MULTI-LAYER LLTC INTERCONNECT BRAZED TO KOVAR RING FRAME



120 BY 80MM HEATER-COOLER MULTI-LAYER AND MULTI-ZONE ALN PULSE HEATER WITH INTEGRATED COOLING AND QUARTZ THERMAL BREAK



COLD ISOSTATIC PRESSING OF ALUMINA AND HARD GRINDING OF THE FOLLOWING MATERIALS:

Alumina
Zirconia
Aluminum Nitride (AlN)
SILICON Nitride (SiN)
Boron Nitride (BN)
Silicon Carbide (SiC)
Macor
Shapel
Steatite
Mullite & Cordierite

Fused Quartz
Fused Silica
Sapphire
ULE / Zerodure (low CTE glasses)
Silicon
BK7 (optical glass)
Borosilicate
Germanium

Fralock ● Career Technologies USA ● Oasis Materials ● Ceramic Tech, Inc. ● Mapson Engineering

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The 64th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication

Upcoming Related Conferences

Online June 1-4, 2021

Presentations + Posters available on-demand May 24, 2021

47th International Conference on

MICRO & NANO ENGINEERING – MNE2021

20-23 September 2021 - TORINO (ITALY) & ON-LINE

www.mne2021.org

IMPORTANT DATES

ABSTRACT SUBMISSION	ACCEPTANCE NOTIFICATION	EARLY BIRD REGISTRATION
~~**MAY 7TH**~~ **MAY 21st**	**JUNE 18TH**	**JULY 25TH**

THE MNE CONFERENCE

Micro and Nano Engineering (MNE) is the flagship event of the international Micro and Nano Engineering society (iMNEs) and the premium international conference on:

- micro/nanofabrication and manufacturing techniques;
- application of micro/nanostructures, devices and microsystems in electronics, photonics, energy, environment, chemistry and life sciences.

MNE2021 in Torino will be the **47th International Conference** in a series that started in Cambridge in 1975, and was held most recently in Braga (2017),Copenhagen (2018) and Rhodes (2019).

4 Best Poster Awards, the Young Investigator Award and the MNE Fellow Award will be assigned during MNE2021.

TOPICS OF THE MNE CONFERENCE

1. AdvancedPatterning (Lithography&Etching)
2. Nanofabrication/Manufacturing for Functional Structures/Surfaces
3.Micro-Nano Devices and Systems (MEMS/NEMS)
4. Micro & Nano Devices and Systems for Life Sciences, Chemistry, and Agrofood Sectors

VENUE: THE CONFERENCE WILL BE HELD BOTH IN PRESENCE AND ON LINE

Turin and Piedmont (ITALY)

MNE2021 is hosted for the first time in the beautiful and charming **Turin**, the capital of the Piedmont Region located in the north-west of Italy. Turin, surrounded on the West and North by the Alps and on South by the famous Langhe hills, is famous for its architectural masterpieces (castles, noble palaces, and museums) and enogastronomy, with red wines, chocolate and cheese among its excellences. The Venue of the conference is the "Centro Congressi Lingotto", the old FIAT cars warehouse.

Transportation, Passports and VISA

Owing to its position, Torino is where the major national and international communication routes converge and it can be easily reached by plane, train or car.

Visit the web site https://vistoperitalia.esteri.it/home to find out whether, depending on your citizenship, country of residence, duration and reasons for your visit, you need a visa to enter Italy and to find out which documents are required in order to apply for your visa.

COMMITTEES

Massimo De Vittorio Conference Chair
Fabrizio Pirri Co-Chair
Massimo Gentili Honorary Chair
Program co-Chairs:
Matteo Cocuzza, Andrea Lamberti, Ferruccio Pisanello
All Program Committees are listed at www.mne2021.org

CONTACTS

MNE 2021 secretariat:
Centro Congressi Internazionale srl
Headquarter: Torino (Italy), *Branch Off.*: Abu Dhabi (UAE)
Contacts:
Exhibition/sponsors: sponsor@mne2021.org
Scientific program: mne@mne2021.org
Registration/accommodation: info@mne2021.org

34th International Microprocesses and Nanotechnology Conference

MNC 2021

Micro Nano Conference

Online and On-Demand Conference

SPONSORED BY

The Japan Society of Applied Physics

ABSTRACT DEADLINE

July 20, 2021

October 26-29, 2021

WEB ADDRESS

mnc http://imnc.jp/2021/

PLENARY SPEAKERS

Masateru Taniguchi, Osaka Univ., Japan
Patrick Naulleau, Lawrence Berkeley Natl. Lab., USA
Vivek Singh, NVIDIA, USA

SCOPE, KEYNOTE and INVITED

1: Lithography and Related Technologies and Metrology
1-1: Advanced Lithography and Patterning
1-2: Electron and Ion Beam Technologies
Keynote: Masayoshi Esashi, Tohoku Univ., Japan
Invited: Sun Wei, Hitachi, Japan
1-3: Patterning Materials
2: Nanotechnology
2-1: Nanocarbon & 2D Materials
2-2: Nanodevices
Invited: Takeaki Yajima, Kyushu Univ., Japan
2-3: Nanofabrication
2-4: Inorganic Nanomaterials
2-5: Organic Nanomaterials
Invited: Yuki Nagao, JAIST, Japan
2-6: NanoTool
3: Nanoimprint, Hybrid-NIL, Biomimetics, and Functional Surfaces
Keynote: Jussi, VTT Technical Res. Centre of Finland
Invited: Akira Saito, Osaka Univ., Japan
4: BioMEMS, Lab on a Chip, and Nanobiotechnology
5: Microsystem Technology and MEMS
6: Atomic Layer Processing (ALP)
Keynote: Christian Dussarrat, Air Liquide, Japan
Invited: Chang-Yong Nam, Brookhaven Natl. Lab., USA
Invited: Mato Knez, CIC nano, GUNE BRTA, Spain

SYMPOSIUM

Symposium A: EUV Stochastics Symposium
Invited Speakers:
Toru Fujimori, FUJIFILM Holdings, Japan
Toshiyuki Hisamura, Xilinx, USA
Keiichiro Hitomi, Hitachi, Japan
Takahiro Kozawa, Osaka Univ., Japan
David Medeiros, Entegris, Japan
Hirokazu Matsumoto, ZEON, Japan
Hakaru Mizoguchi, Gigaphoton, Japan
Yusa Muroya, Osaka University, Japan
Seiji Nagahara, Tokyo Electron, Japan
Mark Neisser, Tan Kah Kee Innovation Lab. China
Takeo Watanabe, University of Hyogo, Japan
Ekinci Yasin, Paul Scherrer Institute, Switzerland

REGISTRATION FEE

Pre-Registration Deadline: **October 18, 2021**
Regular : 40,000 JPY
On-site Regular : 45,000 JPY
Student : 20,000 JPY
On-site Student : 23,000 JPY

CONFERENCE CHARS

ORGANIZING CHAIR:
Takahiro Kozawa, Osaka Univ., Japan
STEERING CHAIR:
Masao Nagase, Tokushima Univ., Japan
PROGRAM CHAIR:
Seiji Nagahara, Tokyo Electron, Japan

SECRETARIAT

c/o Secretaryart Corporation
E-mail: secretariat@imnc.jp

*Confirmed invited speakers are listed and more speakers are being invited. Please visit mnc web site to confirm the latest key note speakers and invited speakers. As of May 11, 2021

The Southeastern Microscopy Society

56th Annual Meeting (Virtual)

Thursday, June 24, 2021

Attendees must register by Tuesday, June 22, 2021

The **Southeastern Microscopy Society** (SEMS) is a Local Affiliate Society (LAS) of the Microscopy Society of America (MSA) with members ranging geographically throughout the southeastern United States. The SEMS Community is comprised of university students, faculty and staff; private sector and government staff scientists; and microscopy vendors. SEMS began in 1964 at Emory University and hosts annual meetings in various locations throughout the Southeast to promote the exchange of scientific knowledge and nest practices for laboratories and imaging facilities. SEMS 2021 will be a virtual meeting on the GatherTown platform featuring:

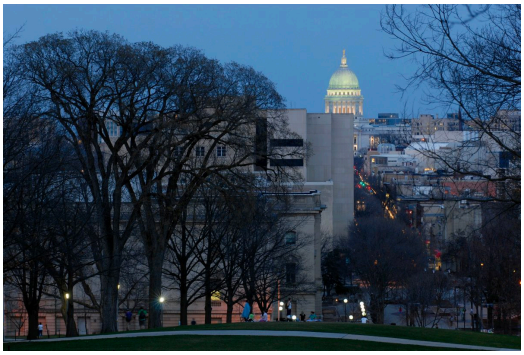
- Technical Presentations
- Vendors Exhibition and Live Demonstrations
- Ruska Student Competition
- Image Competition

Abstract Submission Deadline: **May 27, 2021**
Registration is waived for all student speakers.
SEMS membership, meeting registration and abstract submission information available at www.southeasternmicroscopy.org

Time	Event	GatherTown Location
9:00 - 9:05	Welcome by Paul Eason (SEMS President)	Auditorium
9:05 - 10:00	Keynote Speaker (MSA)	
10:00 – 12:00	Ruska Competition Session	
12:00 – 13:30	Lunch & Vendors // Ruska Judges Meeting	Exhibition Hall + Auditorium
13:30 – 15:00	Contributed Presentations (Bio) // Poster Session (Materials)	
15:00 – 15:30	Break and Visit Vendors // Short Vendor Session	
15:30 – 17:00	Contributed Presentations (Materials) // Poster Session (Bio)	
17:00 – 18:00	Ruska Awards, Image Competition Awards & Closing	Auditorium

2022 UGIM Symposium

Madison Wisconsin June 6-9, 2022



The UGIM 2022 Symposium will be held June 6-9, 2022 at the University of Wisconsin-Madison Memorial Union.

The symposium brings together educators and researchers involved in micro/nanotechnology lab management around the world, and provides a forum for exchanging information and presenting new lab operations and educational concepts. Representatives of micro/nano fabrication and characterization facilities, ranging from new labs to nationally and internationally recognized facilities, have found this symposium an excellent forum for exchanging information and networking. Typical topics include industry/university interactions, new equipment trends, best practices, collaborative research, and training efforts.

Program Topics

SAFETY
- Chemical Safety and adding new chemicals to your facility
- Safety training
- Lab buddy systems
- Managing safety in 24 hour use facilities

FINANCIAL
- Rate structures and cost recovery
- Staying compliant with federal guidelines
- Funding the deficit

OPERATIONS
- Retiring old/low utilization instruments
- Scheduling high use instruments
- Software options for laboratory management and billing
- Extending instrumentation lifetime
- Managing user behavior and interactions
- Making data driven decisions
- Managing user expectations
- Supply management

GROWING YOUR FACILITY
- Increasing external use
- Increasing internal use
- Adding new applications areas
- Funding new instrumentation
- Identifying instrumentation needed for future growth
- Getting user feedback

EDUCATION/TRAINING
- Instructional use of facilities
- On-boarding new users (internal and external)
- Training new users

STAFF
- Keeping staff happy
- Challenging staff
- Compensation
- Training/Continuing Education
- On-boarding new staff

NEW FACILITY STARTUP
- Hiring
- Instrumentation selection
- Facility design and instrument installation
- Setting charge-back rates
- Managing operations
- Software for scheduling, billing, tracking and user management

MANAGING DIFFERENT TYPES OF FACILITIES
- Mixed use facilities (Characterization and Fabrication)
- Microscopy and Analysis facilities
- Small core facilities with staff of 1 or 2
- Large core facilities
- Shared resource vs. Service Oriented vs. Research Projects

INTERACTING WITH THE ADMINISTRATION
- Defending your facility
- Bench-marking vs. other facilities
- Getting financial support
- Advisory Committees
- Institution wide coordination of core facilities

For more information see: ugim2020.wisc.edu

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The 64th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication

June 1-4, 2021

Abstracts: https://eipbn.org/abstracts/2021/