UGIM 2024

MIT.nano

June 23 – 26, 2024

LISA T. SU BUILDING

UGIM 2024 Symposium
MIT.nano
June 23 – 26, 2024

CONTENTS

Wi-Fi Name: MIT Guest (no password required)

The UGIM 2024 conference is bound by the community guidelines of the hosting institution, MIT. Scan the QR code for more details.

UGIM Mission Statement

The mission of the biennial UGIM Symposium is to bring together leading educators and researchers from university, government, and industry around the world to promote the various exciting fields of micro/nanotechnology. Representatives of university micro/nanofabrication facilities, ranging from new labs to nationally recognized facilities, have found this symposium an excellent forum for exchanging information and presenting new research and educational concepts. Government agencies such as NSF, NIH, NIST, SEMATECH, SRC, DoD, and ONR have participated with research papers and updates on funding opportunities. Industry interactions with universities, including technology transfer, collaborative research, and training efforts are frequently presented. This is a signature opportunity for those involved in the field of micro/nanotechnology or in the operation of micro/nano cleanroom facilities.

INNOVATION THROUGH MINIATURIZATION
UGIM SYMPOSIUM
MICRO / NANO

Dear Colleagues,

Welcome to UGIM 2024 at the Massachusetts Institute of Technology. MIT.nano is honored to host the 24th annual symposium and is thrilled to bring us together in Cambridge, MA.

This symposium is made possible through generous sponsorships from leading industries in micro/nanofabrication. We offer our sincere thanks to all of you who supported UGIM 2024! Please engage UGIM sponsors at their vendor booths, which will be active throughout the conference, to learn more about new tools and opportunities for expanding your lab capabilities. See vendor schedule on page 64.

We would also like to extend our gratitude to the UGIM steering committee for their guidance and assistance in executing this gathering. Their knowledge continues to help shape the symposium while allowing each host to make this event unique to their home institution.

UGIM 2024 says farewell to two significant leaders in our community: Vicky Diadiuk and Dennis Grimard, who have been integral to UGIM and nanofabrication over many decades. Vicky, who retired from MIT in 2023, managed MIT's Microsystems Technology Labs (MTL) fabs for over three decades, building a legacy as a mentor of many lab managers across the globe. Dennis, who is retiring with this UGIM, joined MIT.nano from the University of Michigan in 2014. His long history of leadership in both industrial and academic fabs was instrumental in shaping, launching, and growing MIT.nano into the state-of-the-art facility you see today.

Broad input from our community has shaped the exciting UGIM 2024 agenda: our presenters' insights and wisdom will be collected as a lasting reference, and the discussion that will follow will enhance camaraderie and build new connections among the attendees. The best practices of our collective experience are bound to enhance all of our shared facilities. Launching the conference program will be a keynote speech by Vladimir Bulović, the founding director of MIT.nano, whose vision, innovative ideas, and cheer has defined the foundations of the novel culture and activities of MIT.nano. The UGIM Sunday program, shaped by Dennis Grimard, is also unique: focusing on the challenges and opportunities identified in the design and build of MIT.nano, as narrated through the short talks from invited experts who will highlight different aspects one has to consider along the way.

We hope that the next few days of presentations, social activities, lab tours, and networking opportunities will build an even stronger UGIM community, whose joint dedication to enabling the success of many young researchers will lead to a lasting positive impact on the World.

Thank you for joining us at MIT!

Anna Osherov
Associate Director, Characterization.nano

Jorg Scholvin
Associate Director, Fab.nano

UGIM STEERING COMMITTEE

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UC Berkeley Marvell Nanofabrication Laboratory

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Historical UGIM Hosts

1st	1975	University of Cincinnati
2nd	1977	University of South Florida
3rd	1979	Texas Tech University
4th	1981	Mississippi State
5th	1983	Texas A&M
6th	1985	Auburn University
7th	1987	Rochester Institute of Technology
8th	1989	M2C Marlborough Massachusetts
9th	1991	Florida Institute of Technology
10th	1993	Research Triangle Park
11th	1995	University of Texas at Austin
12th	1997	Rochester Institute of Technology
13th	1999	University of Minnesota
14th	2001	Virginia Commonwealth University
15th	2003	Boise State University
16th	2006	San Jose State University
17th	2008	University of Louisville
18th	2010	Purdue University
19th	2012	University of California, Berkeley
20th	2014	Harvard University
21st	2016	University of Utah
22nd	2018	University of Pennsylvania
	2020	Postponed
23rd	2022	University of Wisconsin-Madison
24th	2024	Massachusetts Institute of Technology

About the Lisa T. Su Building

MIT.nano was designed as a vessel to explore the dawn of the Nano Age. Located in the Lisa T. Su Building at MIT, we are a shared resource for the entire campus, an open-access, service-oriented facility located in the heart of MIT. Any faculty member, researcher, or student—as well as qualified users from industry, academia, and government—may bring a project or unsolved problem to our specialized environments and conduct their work supported by highly qualified technical staff.

Sharing resources through MIT.nano enables the MIT community to acquire state-of-the-art equipment that would be challenging for individual labs or departments to afford or maintain on their own. The ample size of our research facility also allows us to look beyond the present state-of-the-art by seeding dedicated lab spaces where new nanoscience and nanotechnology tools, instruments, processes, and techniques can be reinvented.

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Sunday Program

The Main Program of UGIM focuses on how to run multifaceted shared-facility spaces, while the Sunday Program adds to this by looking at how to design & build such facilities. Sunday's sessions consist of two fundamental themes: **(1) Building MIT.nano: A Journey from Concept to Reality** and **(2) Systems and Components of a Modern Lab: The Top Three Things You Really Need to Know, Consider and Understand**. The program begins with four short talks from the principal people responsible for creating MIT>nano, followed by 12 micro-talks from industry experts addressing different systems within MIT.nano. The session ends with a panel discussion featuring all Sunday speakers.

Building MIT.nano: A Journey from Concept to Reality

Building MIT.nano was a complex years-long process that involved the input of a multitude of contributors from across the MIT campus. The significant pre-build efforts resulted in a clear design intent and program that would serve the MIT community far into the future. These talks focus on results of that process, the build itself, and finally the complex start-up.

Systems of a Modern Lab: The Top Three Things You Really Need to Know, Consider and Understand

A perfect concept is nothing without skilled and experienced experts to turn those dreams into paper drawings and then into nuts and bolts. By bringing together industry experts (many of whom contributed to MIT.nano) we aim to enhance the knowledge base of UGIM participants. With the theme of "What are the three things you need to know about …," we direct our experts to focus on the critical questions rather than build-specific answers. We want the audience to leave with "at least three things" firmly in their minds. Essentially, you can't recognize a good answer if you don't know the question. In this way, we hope to prepare the audience to be able to answer those questions for themselves when their specific challenge becomes a reality.

Sunday, June 23

MIT.nano
60 Vassar Street, Building 12
Cambridge MA, 02139

10:00 — **Registration |** MIT.nano Lobby

11:00 — **Welcome |** 10-250

11:10 — **Building MIT.nano: A Journey from Concept to Reality |** 10-250

Vladimir Bulović, Director, MIT.nano; Fariborz Maseeh (1990) Professor of Emerging Technology, MIT

Travis Wanat, Director of Capital Projects, MIT

Dennis Grimard, Managing Director, MIT.nano

Nick Menounos, Associate Director of Infrastructure, MIT.nano

12:30 — **Welcome Lunch & Vendor Showcase |** Building 13 Lobby

Vendors booths open until after dinner

2:30 — **MIT.nano Tours |** Building 13 Lobby

Tours of different areas of MIT.nano, taking place throughout the afternoon. Advance sign-up is recommended

Scan the QR code for a map of MIT

Helpful hint: The first set of numbers in the location refers to the building number, followed by the room number!

Systems of a Modern Lab: The Top Three Things You Really Need to Know, Consider, and Understand | 10-250

1:30

Session 1: Core Infrastructure

Air Recirculation | Harry Scott, President, HME Sales, LLC

Exhaust Air | Abbie Gregg, CTO, AM Technical Solutions, Inc

Make-up Air | Josh Michaud, Associate Principal, BR+A Consulting Engineers

Energy | Jacob Knowles, Director of Sustainable Design, BR+A Consulting Engineers

Noise & Vibration | Jeff Zapfe, Principal, Acentech

Process Cooling Water (PCW) | Bill Neuburger, Director of Engineering, Hallam-ICS

3:00

Break & Vendor Showcase | Building 13 Lobby

3:30

Session 2: Process Chemicals & Systems

DI-Water | Glen Sundstrom, Technical Director, Xylem

Acid Waste Neutralization | Gary Broberg, President & CEO, Practical Applications

Gas Delivery | Steve Buerkel, President, Applied Energy Systems

Toxic-Gas Monitoring & Fire Alarm | Dan Maxwell, Senior Project Manager Hallam-ICS

Abatement | Chris Jones, Environment and Sustainability Manager, Edwards

Code | Jeremy Lebowitz, Market Leader – Northeast, Jensen Hughes

Sunday, June 23

MIT.nano
60 Vassar Street, Building 12
Cambridge MA, 02139

5:00 — **Break & Refreshments |** Building 13 Lobby

5:30 — **Session 3: Panel Discussion -** *Putting It All Together and Navigating Tradeoffs*
Moderated by Nick Menounos & Featuring all Sunday Speakers

6:30 — **Dinner & Vendor Showcase |** Outside MIT.nano & Lobby 13
Food Truck Options:
Red Bones BBQ
Hometown Poke
Locos Amigos Tex-Mex
The Cookie Monstah (Ice Cream Cookies)

Sunday Speaker Bios

Vladimir Bulović (MIT.nano)

Vladimir Bulović, a Professor of Electrical Engineering at the Massachusetts Institute of Technology, holding the Fariborz Maseeh Chair in Emerging Technology, is the Founding Director of MIT.nano. Bulović was the faculty member leading the construction of the 214,000-square-foot MIT.nano facility in the Lisa T. Su building, which now houses laboratories dedicated to the characterization, fabrication, and visualization of nanoscale materials, structures, devices, and processes. From 2011 to 2018 Bulović led the team designing the spaces and systems within the facility, and since 2018 he has been directing the technical and administrative teams that enabled the growth of MIT.nano. Bulović strived to design MIT.nano as the collaborative workshop that provides tools, inspires innovation, and delivers impact. Design choices his team implemented led to the designation of MIT.nano as the LEED Platinum facility that has been honored by a series of architectural design awards, including the International 2019 Lab of the Year Award for excellence in research lab design, planning, and construction. Presently MIT.nano supports over 1200 users annually from every technical discipline at MIT, and an additional 300 users from other academic institutions and over 150 multinational and startup companies.

Travis Wanat (MIT)

Travis Wanat is the Director of Capital Projects for the Department of Facilities campus construction at the Massachusetts Institute of Technology. With over 24 years of experience in the construction industry, Wanat is responsible for strategically planning and managing all phases of capital projects on campus. Oversight of budgeting, financial management, contract negotiations, engagement with project stakeholders, and leading project teams to execute and deliver capital projects at MIT.

Dennis Grimard (MIT.nano)

Dennis Grimard received his Associates of Engineering (A.E.) degree in Mechanical Engineering Technology from Vermont Technical College in 1977 and his Bachelor of Science (B.S.) degree in electrical engineering from Worcester Polytechnic Institute in 1982. His postgraduate work includes both a Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) degrees in electrical engineering (majoring in Solid-State Physics and minoring in Circuits) from The University of Michigan at Ann Arbor in 1984 and 1990, respectively. Dr. Grimard worked in both industry (Cincinnati-Milacron, Ford Motor Company, Techware Systems, and IBM) and academia (post-doc, research scientist, and Managing Director of the Lurie Nanofabrication Facility) for more than 24 years. In addition, Dr. Grimard has served as an expert witness (Kirkland & Ellis) and consultant (IBM, Applied Materials, KLA-Tencor, Pivotal Systems, Watlow, Novellus, Veeco, Intavac, and PlasmaTherm) for more than 19 years. For the past 10 years, Dr. Grimard has been the managing director of MIT.nano. Dr. Grimard has co-authored numerous peer-reviewed papers addressing the theoretical and practical limitations of RF metrology and feed-forward control of complex systems. His consultancy has produced more than 20,000 hours of technical output and 1.5 million miles of travel, resulting in more than 37 patents covering every aspect of semiconductor tool technology.

Nick Menounos PE, LEED AP (MIT.nano)

Nicholas P. Menounos received his Bachelor of Engineering (B.E.) degree in Mechanical Engineering from McGill University in 2008, LEED Associate Professional in 2009 and has held a Professional Engineering (P.E.) license in the state of Massachusetts since 2012. Over the course of his career, he has worked on a wide range of industrial, commercial, and infrastructure projects, including; nuclear, defense, biopharmaceutical, higher education R&D, and semiconductor manufacturing. Menounos was the lead process engineer on the MIT.nano building design team and officially joined MIT in 2017, to support building startup and turnover. As the Associate Director of Infrastructure for MIT.nano, he is responsible for tool installation projects within the facility, safety systems, and ensuring the environmental conditions and utilities meet the research needs of the community.

Harry Scott (HME Sales, LLC)

Harry Scott received his Associates Degree in HVAC Design from Ferris State University in Big Rapids, MI and his Associates Degree in Marketing from Grand Rapids Community College in Grand Rapids, MI. With over 35 years of experience with architectural and mechanical system designs for university, research, manufacturing, and industrial cleanrooms. Scott has worked for Comp-Aire Systems, a design/build firm, for over 12 years; Plascore, a cleanroom wall manufacturer; Performance Contracting, a large cleanroom contractor throughout the United States; and Nortek Air Solution (formally Cleanpak/Huntair), manufacturing cleanroom laminar flow equipment and air handlers. He currently is president of HME Sales, a consultant for several large semiconductor projects and a manufacturer's representative for several cleanroom product lines. His experience with university cleanroom projects across the U.S. is extensive, with projects at MIT.nano, Harvard, University of Michigan, University of Minnesota, Tulane, Notre Dame, Brown University, UMASS-Lowell, SUNY, USC, ASU, Duke, University of Delaware, University of Illinois, Northwestern, University of Iowa, UC Davis, University of Washington, Rice University, University of Arkansas, and Penn State.

Abbie Gregg (AMTS)

Abbie Gregg, Chief Technology Officer of AM Technical Solutions, is an industry expert and cleanroom consultant with more than 40 years of experience in engineering consulting. She specializes in microelectronics process analysis and the design, startup, and operations of cleanrooms, advanced laboratories, and manufacturing facilities. Gregg is a graduate of MIT and was part of the MIT.nano design team. She is a member of the SEFA Advisory board. Her previous firm, Abbie Gregg, Inc. has been a Lab of the Year Award winner three times. (MIT.nano, KAUST, AZ Biodesign) She served on the ASU Chemical Engineering Accreditation Advisory Board.

Josh Michaud PE, LEED AP BD+C (BR+A)

Josh Michaud is an Associate Principal at BR+A with over 19 years of experience in the design and engineering of HVAC systems, modification and analysis on a broad range of projects for clients nationwide. Michaud is a Registered Professional Mechanical Engineer and a LEED Accredited Professional, as well as an active member of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, and the U.S. Green Building Council. Michaud is a graduate of the University of Massachusetts, Lowell with a Bachelors in Science of Mechanical Engineering. He has expertise in a broad range of markets including laboratory, higher education, healthcare, manufacturing, infrastructure upgrades, and decarbonization projects. With a background stemming from installation of HVAC prior to attending college, he provides a hands-on, real-life perspective to the work he engineers today. Most recently, he led a team within BR+A to design the largest carbon-neutral, net-zero building in Boston at the Boston University Center for Computing and Data Sciences.

Jacob Knowles (BR+A)

Jacob Knowles is the Chief Sustainability Officer at BR+A Consulting Engineers. He has championed over sixty million square feet of carbon-neutral buildings and campus master plans. His work has resulted in numerous grants and awards, including three AIA COTE Top Ten awards. Most recently, Knowles advised the City of Boston and the State of Massachusetts in the development of zero-carbon zoning and a net-zero code, offering practical solutions so that all future buildings will be carbon neutral.

Jeff Zapfe (Acentech)

Jeffrey Zapfe is a Principal at Acentech, a world-class acoustics, noise, vibration, and technology consulting firm based in Cambridge, Massachusetts. He has more than 37 years of consulting expertise in the areas of vibration, structural dynamics, vibration-sensitive facilities and equipment, and vibration isolation. He conducts analyses of structures at the design stage and measures, analyzes, and develops vibration mitigation solutions in occupied buildings. Zapfe has worked on many prestigious research facilities across the United States, including MIT.nano and Harvard LISE. Zapfe earned a Ph.D. in Aerospace Engineering from Penn State University and a Bachelor and Master of Science from the University of Toronto. Zapfe is also the former President of Acentech and served in that role for 12 years.

Bill Neuburger (Hallam-ICS)

William Neuburger, PE is the Director of Engineering at Hallam-ICS. Neuburger joined Hallam-ICS in 2010. Previously, he worked in wind turbine manufacturing and commercial energy efficiency. He leads a group of 13 engineers in the Vermont office and is the firm's semiconductor subject matter expert with a focus on hazardous materials, specialty gas storage and distribution, liquid chemical distribution, and process infrastructure. Neuburger graduated from the University of Buffalo with a B.S. in civil engineering in 1994. He has reviewed, designed, or modified process cooling water systems at Cornell University, GE Aviation, MIT.nano, and other manufacturing facilities.

Glen Sundstrom (Xylem)

Glen Sundstrom is the UPW Technical Director for Evoqua Water Technologies (a part of Xylem). In this role, he is responsible for process development, optimization, troubleshooting, and technical support of high-purity water systems within the semiconductor, nanotechnology, and photovoltaic markets. He is also responsible for operating and maintaining an ASTM E-1.2 UPW system in the Evoqua Microelectronics Technology Suite. Sundstrom has been with Evoqua (starting with IWT) for over 40 years in various technical leadership roles responsible for developing, growing, and supporting products and technologies. These roles include Product Manager, Process Development Manager, and Applications Engineering Manager. Sundstrom holds a Bachelor of Science degree in Chemical Engineering from the University of Wisconsin, Madison, and is located at the Evoqua office in Rockford, Illinois. He is an active member of the SEMI UPW Task Force and has authored and co-authored papers on topics including nanofiltration, reverse osmosis, ultrafiltration, advanced oxidation, particle removal, system design, and sustainability for the microelectronics industry presented at the IWC (International Water Conference), UPM (Ultrapure-Micro) conferences and Institute of Electronics and Nanotechnology at Georgia Tech.

Gary Broberg (Practical Applications)

Gary Broberg is the Chief Executive Officer at Practical Applications, Inc. with over 30 years of experience in industrial water treatment, wastewater treatment, and regulatory compliance. Broberg earned a Bachelor of Science in Chemical Engineering from Northeastern University and is a Massachusetts Licensed Professional Engineer (PE) and Board Member of MassDEP Certification of Operators of Wastewater Treatment Facilities.

Steve Buerkel (Applied Energy Systems)

Steve Buerkel has been President of Applied Energy Systems, Inc. since 1985. AES, Inc. is a manufacturer of specialty gas and liquid delivery systems under the SEMI-GAS® and VERSA-GAS™ banners for the semiconductor, solar, and R&D markets. Buerkel holds a Bachelor of Science degree in mechanical engineering from Case Western Reserve University and a Masters in Business Administration from Drexel University. In 2017, AES, Inc. acquired ARM, Inc. which is a specialty gas purification company. All purifier manufacturing occurs in its Malvern, PA complex with all R&D efforts in its Colorado Springs, CO laboratory.

Dan Maxwell (Hallam-ICS)

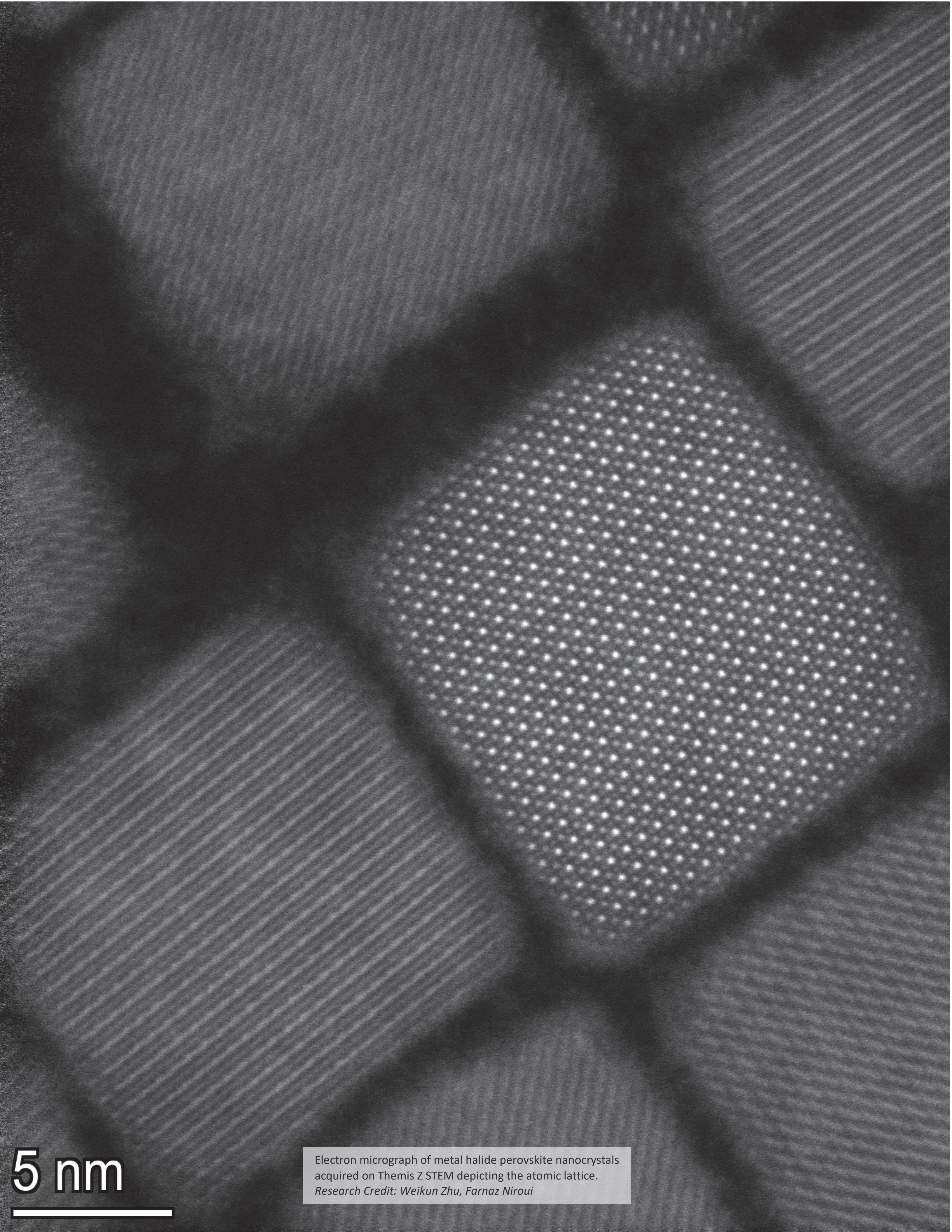
Dan Maxwell is a Senior Project Manager with Hallam-ICS. He has been with Hallam since 1999. For the past 18 years, Maxwell has led a talented group of engineers, designers, integrators, and technicians in the design and construction of toxic gas monitoring systems for research and industry. Maxwell and Hallam-ICS believe everyone who uses hazardous gases deserves a safe work environment. Sharing knowledge today is a small step towards that goal.

Chris Jones (Edwards)

Chris Jones has nearly four decades of experience in environmental protection and R&D, focusing on the semiconductor industry, among others. His work involves developing methods to maintain air and water quality and integrate sustainable practices into business operations. Currently, he is the Environmental Solutions Business Development Manager at Edwards, where he supports semiconductor fab owners in understanding and mitigating the environmental impacts of their operations. Jones is actively involved in key industry working groups dedicated to sustainability in semiconductor manufacturing. He is a chemist with a BSc and PhD from Imperial College and worked with Professor John Albery on Electroanalytical Chemistry. He has significantly contributed to environmental solutions within various industries, including semiconductors, nuclear, and defense. His illustrious career spans over 37 years. From his early days at UKAEA and AEA Technology, where he led a team developing technologies for treating nuclear and military waste, to his current position as the Environmental Solutions Business Development Manager at Edwards, Jones has been at the forefront of innovation. His pivotal role in developing tools for wastewater and air quality management, integral to semiconductor manufacturing, is a testament to his expertise. Beyond his immediate roles, his active participation in several sustainability-focused industry working groups has helped shape environmental strategies through his expertise in regulatory compliance and technology application. He is the Society of Chemical Industry Electrochemical Technology Technical Group secretary.

Jeremy Lebowitz PE (Jensen Hughes)

Jeremy Lebowitz is a market leader, specializing in laboratory and hazardous material safety. He has been with Jensen Hughes for his 16+ year career. He is a registered fire protection engineer with a background in chemical engineering which he leverages to help users identify hazards and prioritize corrective actions related to building, process, and operational safety in the industrial, laboratory, clean room, and chemical sectors. Lebowitz serves on numerous NFPA technical committees including NFPA 318 for the protection of semiconductor fabrication facilities and NFPA 30, Flammable and Combustible Liquids code. He has a master's degree in fire protection engineering and a bachelor's degree in chemical engineering, both from Worcester Polytechnic Institute.



Electron micrograph of metal halide perovskite nanocrystals acquired on Themis Z STEM depicting the atomic lattice.
Research Credit: Weikun Zhu, Farnaz Niroui

Keynote Speaker

Vladimir Bulović

Director, MIT.nano
Fariborz Maseeh (1990) Professor of Emerging Technology

Vladimir Bulović is a Professor of Electrical Engineering at the Massachusetts Institute of Technology, holding the Fariborz Maseeh Chair in Emerging Technology. He directs the Organic and Nanostructured Electronics Laboratory, and is the Founding Director of MIT.nano, MIT's nano-fabrication, nano-characterization, and prototyping facility that is the host of UGIM 2024. He is an author of over 300 research articles (cited over 70,000 times and recognized as the top 1% of the most highly cited in the Web of Science). He is a fellow of the National Academy of Inventors and an inventor of over 120 U.S. patents in areas of light emitting diodes, lasers, photovoltaics, photodetectors, chemical sensors, programmable memories, and micro-electro machines, majority of which have been licensed and utilized by both start-up and multinational companies. The start-up companies initiated from his group's research results include QD Vision, Inc. (acquired in 2016), Kateeva, Inc, Ubiquitous Energy, Inc., Swift Solar, Inc., Optigon, Inc., Active Surfaces, Inc. These presently jointly employ over 350 people. Their products and inventions have been used by millions. Bulović was the first Associate Dean for Innovation of the School of Engineering and the Inaugural co-Director of MIT's Innovation Initiative, which he co-led from 2013 to 2018. For his passion for teaching Bulović has been recognized with the MacVicar Fellowship, MIT's highest teaching honor. He completed his Electrical Engineering B.S.E. and Ph.D. degrees at Princeton University.

MIT researchers have developed a scalable fabrication technique to produce ultrathin, lightweight solar cells that can be stuck onto any surface. Research Credit: Mayuran Saravanapavanantham, Jeremiah Mwaura, Vladimir Bulović

Monday, June 24

MIT Media Lab
75 Amherst Street
Cambridge, MA 02139

8:00	**Registration & Breakfast |** MIT Media Lab
8:55	**Opening Remarks** **Anna Osherov**, Associate Director, Characterization.nano **Jorg Scholvin**, Associate Director, Fab.nano
9:00	**Keynote** **Vladimir Bulović,** Director, MIT.nano; Fariborz Maseeh (1990) Professor in Emerging Technology
9:40	**Presentations: Session 1** **Leif Steen Johansen** | Hardware Locked Wafer Cage: A Behavioral Psychology Experiment **Darick Baker** | We Were Robbed: A Heist at the Washington Nanofabrication Facility
10:20	**Break & Vendor Showcase**
11:00	**Presentations: Session 2** **Andrew Lingley** | Undergraduate Staffing at an Academic Core Facility **Sergi Lendinez** | Starting a Microfabrication Undergrad Course
11:40	**Facilities Pitch: Part 1** *A series of quick introductions to labs in the UGIM community*

12:20	**Lunch & Vendor Showcase**
1:40	**Presentations: Session 3** **Tom Pennell** | Now is Our Time to Shine: Capitalizing on the Expertise of the NNCI Network to Create the High-Tech Workforce of Tomorrow **Karen Birkelund** | The Joy of Owning a 25-Year-Old DUV Stepper Tool **Demis John** | Increasing Recruitment and Retention into Semiconductor Manufacturing at the Community College, University and Non-Academic (Re-Skilling) Education Levels **Benjamin Schmidt** | Student Engagement Programs to Assist Core Facility Staff in Research and Outreach Efforts
3:00	**Break & Vendor Showcase**
3:40	**Working Group: Staffing**
4:20	**Tour of Boston**
6:00	**Dinner |** Museum of Fine Arts
9:00	**Early Bus to MIT|** Board at Museum Entrance
9:30	**Late Bus to MIT |** Board at Museum Entrance

Tuesday, June 25

MIT Media Lab
75 Amherst Street
Cambridge, MA 02139

8:00

Breakfast | MIT Media Lab

9:00

Presentations: Session 4

Gajendra M | Establishing a Pilot Line in a Multiuser, Multi-Technology Cleanroom: Challenges and Opportunities

Ken Dixon | Selection of Materials of Construction for Nanotech Process Tools

Greg Owen | Renovating an Aged University Building to Add a Cleanroom

Leif Steen Johansen | PolyFabLab: A New ISO 7 Cleanroom for Life Science Polymer Fabrication

10:20

Break and Vendor Showcase

11:00

Presentations: Session 5

Maansi Patel | Evolving the Workhorse: Sustainable and Flexible Wet Bench Design

Berit Herstrom | Using a 3D Digital Twin to Tap Into Data Sources

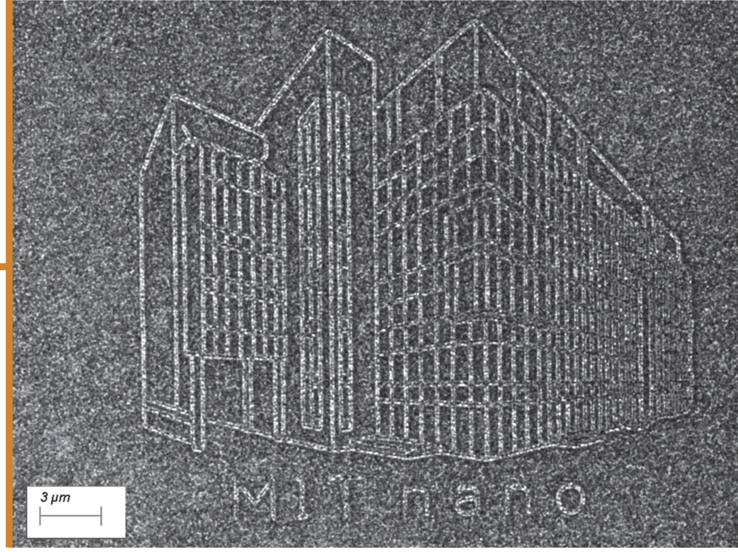
11:40

Facilities Pitch: Part 2

A series of quick introductions to labs in the UGIM community

12:20

Lunch & Vendor Showcase



Epitaxial nano-composite grown on patterned STO substrate. The bright phase is ferrimagnetic spinel phase and the dark phase is ferroelectric perovskite phase
Research Credit: Tingyu Su, Caroline Ross

1:40

Presentations: Session 6

Robert Cornwall | Business Tools and Processes to Improve Core Facility Operations

Mathieu Rampant | NEMO Lab Management and Operations Software

Samantha Roberts | Building an AI Copilot for Nanofabrication Facilities

Karen Birkelund | A Radical Approach to Manage Access to E-Beam Lithography

3:00

Break & Vendor Showcase

3:40

Presentation: Session 7

Jan Tiepelt | FabuBlox: A Visual Design & Data Management Tool for Micro- and Nanofabrication Processes

Richard Kolar | Enhancing Research Data Management and Access Through an Integrated Booking System

Dan Pulver | Carbon Footprint Reduction for a Prototyping 200mm Wafer Fab

4:40

Break & Vendor Showcase

5:20

Working Group: Process Control

6:00

Reception and Vendor Discussion Tables | MIT Museum

Wednesday, June 26

MIT Media Lab
75 Amherst Street
Cambridge, MA 02139

8:00 — **Breakfast |** MIT Media Lab

9:00 — **Presentations: Session 8**

Donghai Zhu | The Journey to Building a New Cleanroom: Preventable Issues and Why They Still Happen

David Wolff | Supply of Lab Utility Gases: Planning for a Safer, More Economical, and Decarbonized Future

Greg Owen | Silane and Other Pyrophoric Gasses

Suresha S J | Managing a High-Volume of Users in a Characterization Facility

10:20 — **Break & Vendor Showcase**

11:00 — **Presentations: Session 9**

Tatiana Pinedo Rivera, Michael Imsic (Presenter) | Sustainability at the Australian National Fabrication Facility: An Update

Dan Pulver | Workflows for Prototyping Cleanroom Management

Jiri Zita | Moodle: A Platform for E-Learning and Instrument Training

12:00 — **Closing Remarks & Raffle**

12:10 — **Grab-and-go Lunch**

1:00 — **Additional Tours of MIT.nano |** MIT.nano Lobby

Abstract Presentations

1.1 Hardware Locked Wafer Cage – A Behavioral Psychology Experiment

1.2 We Were Robbed – A Heist at the Washington Nanofabrication Facility

2.1 Undergraduate Staffing at an Academic Core Facility

2.2 Starting a Microfabrication Undergrad Course

3.1 Now Is Our Time to Shine: Capitalizing on the Exercise of the NNCI Network to Create the High-Tech Workforce of Tomorrow

3.2 The Joy of Owning a 25 -Year- Old DUV Stepper Tool

3.3 Increasing Recruitment and Retention into Semiconductor Manufacturing, at the Community College, University, and Non-Academic (re-skilling) Education Levels

3.4 Student Engagement Programs to Assist Core Facility Staff in Research and Outreach Efforts

4.1 Establishing a Pilot Line in a Multiuser, Multi-Technology Cleanroom: Challenges and Opportunities

4.2 Selection of Materials of Construction for Nanotech Process Tools

4.3 Renovating an Aged University Building to Add a Cleanroom

4.4 PolyFabLab: A New ISO 7 Cleanroom for Life Science Polymer Fabrication

5.1 Evolving the Workhouse: Sustainable and Flexible Wet Bench Design

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6.1 Business Tolls and Processes to Improve Core Facility Operations

6.2 NEMO Lab Management and Operations Software

6.3 Building and AI Copilot for Nanofabrication Facilities

6.4 A Radical Approach to Manage Access to E-Beam Lithography

7.1 FabuBlox: A Visual Design & Data Management Tool for Micro- and Nanofabrication Processes

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8.3 Silane and Other Pyrophoric Gasses

8.4 Managing a High Volume of Users in a Characterization Facility

9.1 Sustainability at the Australian National Fabrication Facility: An Update

9.2 Workflows for Prototyping Cleanroom Management

9.3 Moodle – A Platform for E-Learning and Instrument Training

Hardware Locked Wafer Cage – A Behavioral Psychology Experiment

Leif Steen Johansen, Henrik Nyholt, Anders Gregersen, Thøger Eskildsen, Jörg Hübner
DTU Nanolab, Technical University of Denmark

DTU Nanolab provides a considerable selection of standard wafer types at cost price for the ca. 450 users of its 14,500 sq ft (1,350 sq meters) ISO 4 and 5 cleanroom. For several years, users could simply pick up the wanted number of wafers from a cleanroom shelf and subsequently register this amount online in the lab management system. Their project would then automatically be billed the material cost. However, after some years with an increasing number of cleanroom users, the number of forgotten registrations also increased, peaking at a 17% loss – corresponding to approximately 50,000 USD per year.

Several solutions to minimize the loss were investigated. A manned wafer shop with cleanroom staff was considered, but deemed too costly and inflexible given the 24/7 access to the facility. Ordinary vending machines were ruled out because of their cleanroom incompatibility and risk of wafer damage. Rebuilding an old wafer handling robot into a wafer vending system was also contemplated, but the manpower needed for this would be too large, and many issues with poor handling of various substrate sizes and thicknesses could be foreseen.

In the end, a rather simple solution was chosen. All wafers were placed inside a hardware locked cleanroom compatible stainless-steel cage, and an online wafer shop was created in DTU Nanolab's lab management software. In the wafer shop, the user choses the number of wafers wanted and then presses the "Buy" button, at which point the material cost is billed to the user's project and the wafer cage is unlocked, giving the user access to the wafers. It is, of course, quite possible to take more wafers than registered, but most users tend only to remove the correct amount of substrates – an indication that the main mechanism for not registering is forgetfulness. The fact that a CCTV camera is overlooking the wafer cage probably also further encourage users to remember to pick the correct amount, since all wafer cage lock incidents are logged and can easily be correlated with CCTV footage. The losses from the wafer cage have not ceased entirely, but have been reduced to single-digit percentage levels.

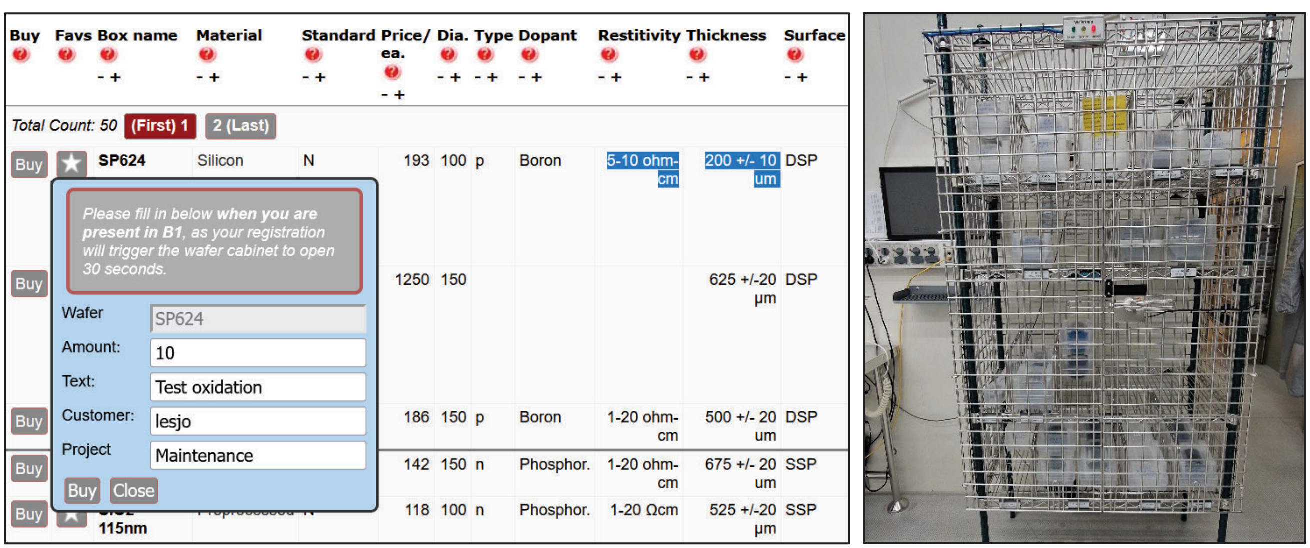


Figure 1: (Left): A screen shot from the wafer shop in the lab management system.
(Right): The hardware locked wafer cage next to the wall-mounted computer used to purchase wafers from it.

We Were Robbed—A Heist at the Washington Nanofabrication Facility

Darick Baker, N. Shane Patrick, Mark Brunson, Maria Huffman
Washington Nanofabrication Facility, University of Washington

We all have considered the consequences of the theft of precious metals, however at the University of Washington, we never expected (or prepared for) an organized heist. We learned a lot from an after-action review of this unfortunate event and had the opportunity to look closely at our mistakes and what we did right. If you haven't thought about your vulnerabilities lately, this is your wakeup call.

Risk management is everyone's job, and unfortunately that leaves the possibility of gaps between the different systems and roles. We found problems with policies covering lab access, metals storage, lab cameras, door locking, and user offboarding. I'll share the solutions we've implemented for many of these problems.

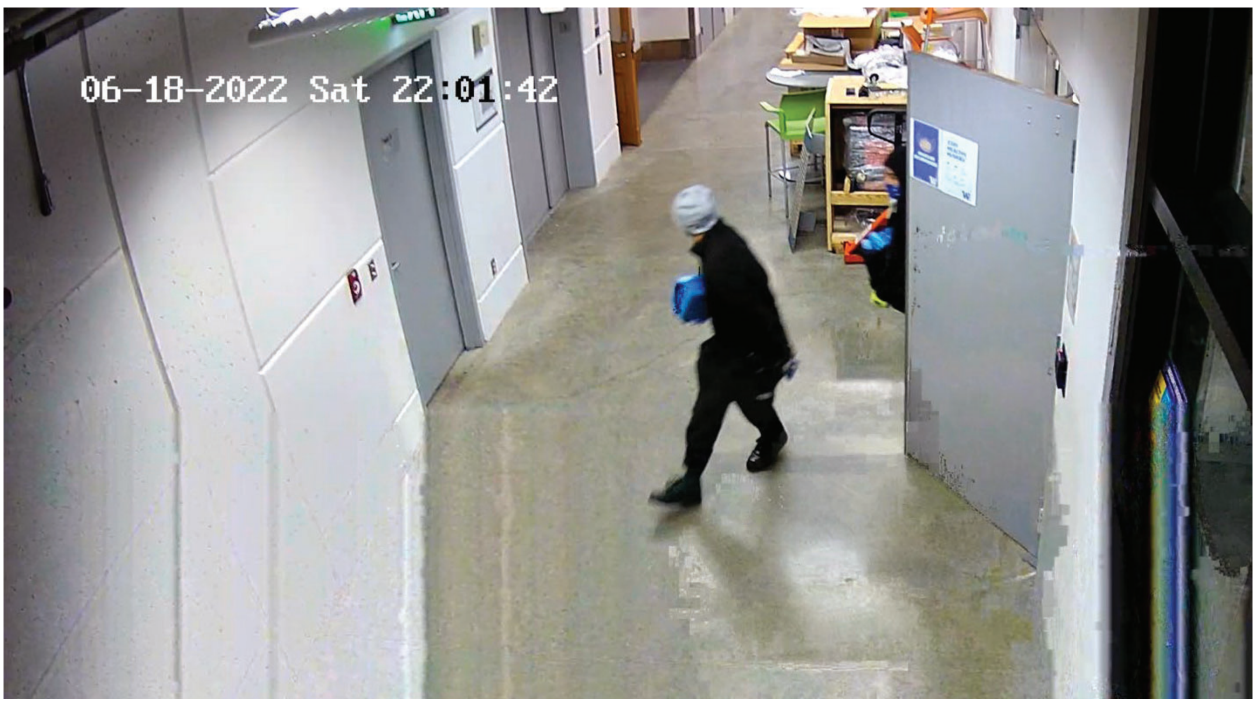


Figure 1: The perpetrators, mid-caper!

Undergraduate Employees: A Win-Win Workforce

Rea Joshi, Elijah Stuvland, Trevor Carl, and Andrew Lingley
Montana Microfabrication Facility, Montana State University

With the passage of the CHIPs Act, academic institutions around the United States are being asked to recruit and retain large numbers of STEM students for the semiconductor industry. We believe core facilities, particularly those specializing in imaging, analysis, and fabrication, are underutilized as training centers to develop a professional workforce.

At Montana State University, the Montana Microfabrication Facility staff consists primarily of undergraduate employees (currently twelve undergraduates and 1.5 full-time staff) who work together to effectively run the facility. These undergraduates, from various majors and with varying levels of experience, all have responsibilities ranging from basic stocking and lab upkeep to lithography and deposition, to full projects for external customers.

The purpose of this talk is to elaborate on the benefits of hiring undergraduate employees, provide tools to help undergraduate employees be successful, and debunk common managerial and staff concerns about hiring students to work in high tech facilities. Students benefit from unparalleled experiential learning, gaining exposure to different industries and potential future employers, and learning basic professional and organizational skills that are broadly useful. Benefits to facilities include creating more professional staff time for high-leverage activities, providing better customer service, and improving procedures and processes. With proper organizational systems, planning, and management, a cohort of undergraduates is mutually beneficial for core facilities and motivated undergraduates.

2.1 - Mon 11:00 am

Starting a Microfabrication Undergrad Course

Sergi Lendinez
Louisiana State University

With the increasing interest and investment in semiconductor fabrication in the US and the rest of the world, universities' role in the development and training of the workforce becomes even more important.

Most universities close to big semiconductor hubs already have microfabrication courses in place. However, this situation tends to change dramatically as we look at universities in areas with different resources and industry implantation, which is a missed opportunity for students and business alike.

In this talk, I will discuss the start-up of a new hands-on undergraduate-level course at Louisiana State University. I will focus not only on the contents of the course, but also on the issues encountered in the process and how we approached them.

Students from the class processing their wafers

Now Is Our Time to Shine: Capitalizing on the Expertise of the NNCI Network to Create the High-Tech Workforce of Tomorrow

Tom Pennell, Dr. Judy Cha, Dr. Allison Godwin, Ron Olson, Dr. Lynn Rathbun
Cornell NanoScale Facility

The Cornell Nanoscale Facility (CNF) and NSF funded networks have a long history of creating the cutting-edge technologies of tomorrow by providing facilities and staff expertise to the scientific research community. As part of this endeavor, we have engaged the public in micro and nanoscience via Education and Outreach (E&O) programs for the K-12 audience as a secondary activity. Recently we have seen a paradigm shift toward Workforce Development (WFD) in order to meet the needs of the rapidly expanding United States semiconductor industry. This presentation will provide insight into CNF's ***"blended"*** approach to E&O and WFD activities, the need for expansion of E&O programs across the network, new programs at CNF and strategies to capitalize on NNCI staff expertise to meet the demands of industry expansion.

3.1 - Mon 1:40 pm

The Joy of Owning a 25 Year Old DUV Stepper Tool

Karen Birkelund, Matthias Keil, Elena Khomtchenko, Meena Dhankhar, Jörg Hübner
DTU Nanolab, Technical University of Denmark, Bldg 347, Ørsteds Plads, 2800 Kgs. Lyngby, Denmark

In 2011 DTU Nanolab bought a 13 year old Canon FPA-3000 EX4 stepper tool for DUV lithography for very little money. The tool was installed and refurbished, and we have ever since had great pleasure from it. The tool is bridging the gap between UV lithography of typical 1µm resolution to e-beam lithography with a resolution down to 8nm.

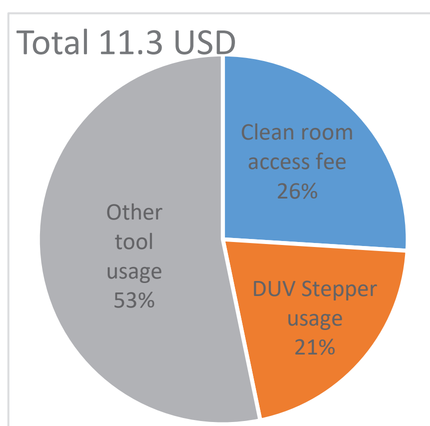
The Canon FPA-3000 EX4 is a production tool from 1998 and was designed for mass production of memory chips using 6" and 8" wafers with a throughput of up to 90 wafers/hour. It is equipped with a 248 nm Krypton Fluoride Excimer laser from Cymer. The partial coherence factor of the illumination system can be adjusted, and different off-axis illumination modes can be selected. The optical system projects the patterns from the reticle onto the wafer with a 5 times reduction. The shot size is 22mm x 22mm with a stitching better than 50nm. The specified resolution is 250 nm of arbitrary patterns in standard illumination mode.

We have through research and development been able to squeeze the resolution down to 95nm dots with a pitch of 350nm by use of dipole illumination. Line widths of 160 nm are obtained with a 380 nm pitch in 390nm thick resist. The obtained resolution is dependent on the shape of the patterns and the pitch size.

Due to high reproducibility and high throughput the DUV stepper tool has become an attractive tool for our industrial customers who use it for small-scale production. We have 12 industrial customers of which 4 are "heavy" users. The tool has also become increasingly popular in research projects going on using DUV lithography.

The decision to purchase the DUV stepper tool has turned out to be a good business case over the years. We have had a turnover of more than 2.6 mill USD in the past 11 years on the tool usage alone. We observe DUV tool customers also use other services that we offer. Besides using the DUV tool, they are spending time on other equipment in connection with their production and development and they use our commercial services regarding expertise and assistance. In addition to equipment usage, the users also pay an access fee for hours in our cleanroom while operating the tool. For the 4 largest customers, this sums up to a total turnover of 11.3 mill USD. Only about 25% of the revenue comes directly from the use of the stepper tool, leaving 75% to the usage of our general facilities and services. Without the DUV stepper tool these customers would most probably not be using our cleanroom facility at all.

DUV FPA-3000 EX4 stepper tool from Canon



Turnover from the 4 "heaviest" user at DTU Nanolab

3.2 - Mon 2:00 pm

Increasing Recruitment and Retention into Semiconductor Manufacturing, at the Community College, University and Non-Academic (Re-skilling) Education Levels

Demis D. John, PhD
Univ. of California Santa Barbara, Nanofabrication Facility

In 2021, the COVID-19 pandemic caused a shortage of microchips to global OEM manufacturers, increasing awareness of the importance of semiconductor technologies. Consequently, the U.S. Government re-designated microtechnology as a critical national security issue, and passed the CHIPS and Science Act to reinvigorate the U.S. microelectronics industry [1,2]. Despite the public investment, numerous analysts recently suggested that the biggest difficulty is the lack of a semiconductor-trained workforce [3,4,5]. This is particularly concerning because an effective workforce pipeline can take years to build and implement. The Nanofab at the Univ. of California Santa Barbara (UCSB) began to address the workforce issues in 2018 due to local industry users of the Nanofab experiencing a shortage of semiconductor technicians & engineers.

With the Santa Barbara South Coast Chamber of Commerce (SCCC) as the key unifying organization in our area, local companies identified the lack of a semiconductor workforce pipeline as a primary impediment to growth in our region [8]. We further identified that the highly local Community College population had little semi. placement due to lack of access to cleanroom facilities. In 2020 we launched an NSF-ATE funded CC-PRIME Pilot project to enable local community colleges to access a UCSB cleanroom facility, with the first cleanroom bootcamp held in August 2021 [9]. Modelled after Penn State and Univ. of New Mexico's NSF-ATE Centers [10,11], in particular Prof. Matt Pleil's 1-week long Micro-Pressure Sensor training [12], the pilot project galvanized our region to build a pathway for students to be micro-nanotech workforce-ready with CC-level (less than 4-year) technician education alone. This project, having run 3 cohorts to-date [13], has already enabled re-skilling into the local semiconductor industry, upskilling within local companies, and a significant increase in local CC student participants pursuing AA and 4-year transfer programs into the semiconductor industry.

In addition, in 2021 the Nanofab began hiring UCSB undergraduates to run process calibrations on thin-film and etch tools in the lab. These tasks had previously been performed by Nanofab staff a few times per year. Undergraduate interns presented a win-win, by enabling students to gain experience in a cleanroom environment; freeing up experienced staff to perform more complex tasks; while also increasing the frequency of data collection enabling more effective resolution of equipment problems. In the last 3 years we have "graduated" 8 interns, 6 of whom are now in the semiconductor industry at various levels (3 locally employed in industry, 3 in companies/universities elsewhere), from various departments (physics, chemical engineering, electrical engineering). We currently host 3 internships positions, with plans to scale this workforce-placement portion up to 6 interns per year, as part of the Microelectronics Commons California DREAMS Hub's workforce development efforts [14].

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Student Engagement Programs to Assist Core Facility Staff in Research and Outreach Efforts

Benjamin Schmidt, Megan Dernberger, Christina McGahan, Sarah Ross, Sharon Weiss
Vanderbilt Institute of Nanoscale Science and Engineering, Vanderbilt University, Nashville, TN

Within the Vanderbilt (University) Institute of Nanoscale Science and Engineering (VINSE), several programs have been successfully developed to engage undergraduate and graduate students as extensions of facility staff for the purposes of training, lab upkeep, and outreach efforts. Within these, incentives are provided to encourage professional development. These programs have been mutually beneficial to staff and students, reducing time burden for facility staff, while also showcasing students' skills and leadership experience.

The VINSE Undergraduate Technical Crew is a team of ~14 student workers that assist staff with cleanroom upkeep, inventory management, outreach, and process development. They specialize in various tools and processes, gaining hands-on experience and exposure to a wide range of nanotechnology applications while interacting with researchers. Approximately 5 new Tech Crew join VINSE each summer for an intensive 10 week program, and then they are able to continue providing support services during academic semesters. As needed, additional Tech Crew are also hired during the academic year. A three-level tiering system has been instituted to acknowledge skills and leadership development with commensurate promotions in title, pay, and responsibilities.

VINSE Superusers are a set of ~5 graduate students with excellent technical and interpersonal skills. They provide a close link to staff on issues related to some of the most-used equipment. They also provide initial tool training to new users on a subset of tools, allowing staff to use a more focused certification session before granting independent tool access. As an incentive, Superusers are invited to staff social activities and team lunches and are also provided a professional development stipend.

Lastly, the VINSE NanoGuides are a newly-created group of ~35 graduate student volunteers trained to lead nanoscience science and engineering experiences within the cleanroom and other VINSE core facilities. This provides a cleanroom experience for some whose research would not necessarily require it, further exposing them to facility capabilities. Continued participation is incentivized with a variety of apparel and 3D-printed collectables.

Overall, these programs have been very successful for taking workload off staff to focus on more complex repairs and process development tasks, while fostering interdisciplinary interactions, providing high-quality outreach experiences, and enhancing the nanotechnology research community at Vanderbilt. This talk will highlight lessons learned and opportunities for other facilities to consider.

3.4 - Mon 2:40 pm

Establishing a pilot line in a multiuser, multi-technology cleanroom: Challenges and Opportunities

Gajendra M[1], Raghupathy N[2], Shankar Kumar Selvaraja[1,2] and Srinivasan Raghavan[1,2]
[1]*National Nano Fabrication Centre, Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore, INDIA;* [2]*Gallium Nitride Ecosystem Enabling Centre and Incubator (GEECI), Foundation for Science Innovation and Development, Indian Institute of Science, Bangalore, INDIA*

National Nanofabrication Centre (NNFC), is a 10000 sq. ft, Class100/1000 cleanroom situated at the Centre for Nanoscience and Engineering (CeNSE), Indian Institute of Science. NNFC is a multiuser facility with National and International users and provides training and services to academic and industrial users. As the largest R&D facility in the academic space in the country, NNFC is also at the forefront of developing new technologies and prototypes for Industry and other users. In the year 2020, CeNSE was provided with funding to establish a GaN pilot line. The Gallium Nitride Ecosystem Enabling Centre and Incubator (GEECI) is a GaN technology incubator established inside NNFC, as a separate entity sharing space and Utility resources.

Establishing an end-to-end GaN wafer production for RF and power device fabrication facility inside a 24x7 cleanroom with over 80 tools and 400 users is a very ambitious task, especially since long shutdowns were not allowed. The challenges include moving in production level tools, upgrading utilities, tool hook ups and above all manpower scale-up required for the same. A mixture of outsourcing and in-house development has allowed us to build the pilot line with minimum disturbance. Strategic alignment of tool movement and utility upgrades are performed during annual maintenance of the central facility.

Currently, both the GEECI and NNFC are functioning as planned, with the first wafers out of production expected in the second quarter of 2024. We share the learning on planning and execution of such augmentation of facility utility and cleanroom utilization.

4.1 - Tue 9:00 am

Selection of Materials of Construction for Nanotech Process Tools

Ken Dixon
Air Control, Inc.

There is a significant lack of understanding in the architectural and lab planning communities with regard to which materials to specify for critical process equipment in nanotech cleanroom environments.

Plastics are generally specified for acid and most caustic chemical processing, and stainless steel for most solvent usage. However, the concentration and temperatures of the chemistries to be used are often not considered. Within the selection process of plastics, there are many materials from which to choose, each having limitations with regard to chemical resistance. For example, in general, polypropylene may be used for acids up to 65C, PVDF to 100C, Halar (ECTFE) to 140C, and Teflon (PFA) to 180C. There are exceptions to this based on concentrations and specific chemistry "recipes" an`d resulting exothermic reactions.

Many specifications call for the less expensive 304 SS for equipment not in direct contact with solvents, and 316L only for the 'wetted areas', i.e. wet process station interior work surfaces, process chemical baths, and sometimes exhaust plenums. However, in pristine nano cleanrooms, 304 SS will pit and rust over time, presenting potential contamination problems in the processing area.

The other significant factor which must be considered in the selection of process tool materials of construction is adherence to local fire and smoke propagation codes. There are essentially three levels of flammability and smoke emitting code with each influencing the selection of construction materials:

- Non-Flame Retardant
- Flame Retardant meeting UL 94 V/0
- Flame Retardant and Smoke Inhibiting meeting FM 4910

Balancing the need for the selected material of construction to have the chemical resistance needed for the expected chemistry, concentration and temperature, with the need to meet the prescribed local fire and smoke code, can be tricky. For example, some of the plastics which will meet the FM-4910 code, will not possess adequate chemical resistance to higher temperature acids, due to the high amount of Titanium Dioxide additives embedded in the material (to achieve the fire and smoke resistant properties). That same material, but the version meeting UL, not FM, could have excellent chemical resistance to that same higher temperature acid.

During the planning for the MIT.nano project, Air Control took exception to the otherwise excellent written performance specification, with regard to materials of construction for most of the wet process stations. FM-4910 had to be met, but FM polypropylene was specified for most acid benches. After carefully looking at each station bath and its expected chemistry, concentration and temperature, an FM level of PVC was suggested instead of polypropylene. 316L was suggested instead of the specified 304 SS with 316L only in the wetted areas, and tub plenums in applicable cases were lined with higher temperature acid rating PVDF as an added safety feature above and beyond the specification. All of these suggestions were accepted, and six years later materials problems at MIT.nano largely avoided.

4.2 - Tue 9:20 am

Renovating an Aged University Building to add a Cleanroom

Greg L. Owen, PE
Principal, GLO Consulting, LLC

This presentation will walk the audience through the steps necessary to evaluate an aged University Building and to determine if the proposed portion of the building is suitable for use as a cleanroom and what limitations may be imposed on the facilities intended use. The presentation will describe the key Building and Fire Code requirements that impact many Cleanrooms and provide acceptable mitigation methods that may be useful in your renovation. Key building physical limitations such as, but not limited to tool access, building clear height, Vibration stability, and floor loading will also be addressed. Energy efficient options for Air Management in a low headroom Cleanroom renovation will also be discussed. Cost implications of placing a Cleanroom in an older building will also be discussed.

4.3 - Tue 9:40 am

PolyFabLab - A New ISO 7 Cleanroom for Life Science Polymer Fabrication

Leif Steen Johansen[1], Anders Gregersen[1], Jörg Hübner[1], Yochai Ariel[2]
[1]DTU Nanolab, Technical University of Denmark; [2]DTU Campus Service, Technical University of Denmark

In Denmark, the pharmaceutical industry is significantly contributing to the growth in GDP and funds many research projects, mainly within life science. An increasing subset of life science research activities at DTU Nanolab has proven incompatible with the main 14,500 sq ft (1,350 sq meters) ISO 4 and 5 semiconductor cleanroom, such as additive manufacturing, polymers, hydrogels and soft lithography using polydimethylsiloxane (PDMS). On the other hand, many life science projects still benefit from the established nanofabrication methods that the main semiconductor cleanroom offers. When a professor at DTU Nanolab received a 1.75 mill USD grant from the Danish Novo Nordisk Foundation for investments in in rapid prototyping tools for life science, a need arose for a polymer fabrication cleanroom that could function hand in hand with the existing cleanroom and bring the benefits of nanofabrication to life science.

DTU Nanolab invested ca. 4 million USD of its own funds in turning the ground floor of an existing office building situated next to the main cleanroom building into a polymer fabrication cleanroom, thus providing all nanofabrication “under one roof”. A small 1,020 sq ft (95 sq m) basement room was used for air handling, process cooling, CDA, vacuum and gas distribution. The lab consists of 1,350 sq ft (126 sq m) “box within a box” ISO 7 cleanroom plus 226 sq ft (21 sq m) gowning area. It is designed for rapid installation and exchange of various tabletop and stand-alone equipment. Additionally, a small 226 sq ft PDMS lab for soft lithography is located next to the cleanroom. An outreach area outside the cleanroom provides a unique look into the cleanroom for visitors through a panorama window.

The space constraints of the office building were quite challenging. The height of the cleanroom ceiling is only 7.9 feet (2.4 m) in order to make space for a FFU plenum above. Hence, the lightning is integrated into the ceiling. In the basement, the makeup handling unit and the exhaust system had to be stacked. The lab is in the final stages of installation and will be handed over to DTU Nanolab mid-2024.

Figure 1: The PolyFabLab ISO 7 cleanroom during the last stages of installation.

Evolving the Workhorse: Sustainable and Flexible Wet Bench Design

Maansi Patel and Kris Payer
MIT.nano

Chemical fume hoods and wet benches play a major role in any laboratory setting, including academic and industrial cleanroom fabrication facilities. Wet chemical processing is used extensively in sample preparation, material etching, and in the lithography steps that we use to pattern at nearly every step of a nanofabrication process. The extensive and unique use of wet benches makes it challenging to anticipate one design for all types of processing. In addition to high utilization, hoods and wet benches are a major factor in any facility's design, layout, and equipment expense budget. We will explore the requirements to take into consideration when planning for the construction or refurbishment of a nanofabrication facility: how to design for hoods and wet benches from a blank slate.

When designing a new facility, at a minimum the utility loads of hoods must be accounted for, specifically the exhaust fan load and the makeup air load. Beyond this, a strong case can be made to include hoods and wet benches as part of the base build installation package. Prescribing intended USES for hoods can be detrimental. However, if the general purpose of each wet bench can be pre-determined and the relevant safety concerns are identified, then the hood design can be optimized, minimizing the need for future modifications. Additionally, understanding how wet benches will be used in a process flow can help determine the optimal facility layout. Gathering ideas for design elements from the fabrication community (Faculty, Staff, Users) is a crucial step to ensuring final setup is practical in use and versatile.

We can also consider methodologies to future-proof individual hoods and wet benches. As the research landscape changes, so can the wet processing requirements. As sample sizes and bath volumes increase, chemical utilization skyrockets: what seems straightforward and inexpensive at the beaker scale for a 1 cm^2 piece becomes a huge cost for a 200mm wafer bath. As volumes increase, safety concerns change and waste management challenges will arise. Alternative process techniques need to be investigated and new process controls need to be implemented. In this talk, we will discuss the various design features that can be incorporated to make wet processing equipment usable for a wide variety of sample sizes.

5.1 - Tue 11:00 am

Using a 3D Digital Twin to Tap into Data Sources

Berit Herstrøm, Anders M. Jorgensen, Flemming Jensen, Jan V. Eriksen, Jörg Hübner
DTU Nanolab, Orsteds Plads 347, Kongens Lyngby, Denmark

Learning from other's past experiences is fundamental for experimentalists. That is part of the reason why published papers and theses are important methods of documentation. For strongly experimental facilities, such as cleanrooms, more detailed documentation is needed to capture relevant information and enable the possibility of successfully repeating a process recipe.

Many facilities use online resources with, for example, standard operating procedures, process libraries and safety information. As data volumes grow, so does the value – in particular for new users. However, with increased data volumes it becomes harder to pick out the important points in the sea of data. In essence it leads to a situation where it can be hard for new users to see the forest for the trees.

DTU Nanolab has created several expansive data sources over the past couple of decades including, an extensive wiki library named *'LabAdviser'* (Fig 1.) *https://labadviser.nanolab.dtu.dk/*, and a library of videos stored on the *'DTU Nanolab'* channel on YouTube https://www.youtube.com/@dtunanolab1398. Labadviser contains more than 600 pages, and the YouTube channel has more than 70 videos with more than 180.000 views in total.

As pointed out, such rich data sources are valuable but can be hard to navigate. To tackle this a digital 3D model (https://www.nanolab.dtu.dk/capabilities/cleanroom-3d-tour) of the physical facility has been meshed with the data sources (Fig 2.). The 3D digital twin is created using the Matterport® environment. Inside the model, points of interest of various nature are highlighted using dots. Most of these dots refer to tools which thereby link to the LabAdviser wiki and relevant YouTube videos.

The main benefit of this approach is to create an environment where a curious person (e.g. a student doing course assignments) can explore the cleanroom and immediately gain access to further information. The model results in a very low threshold for proceeding, as compared to landing on the frontpage of the wiki or the YouTube channel, which can be somewhat overwhelming.

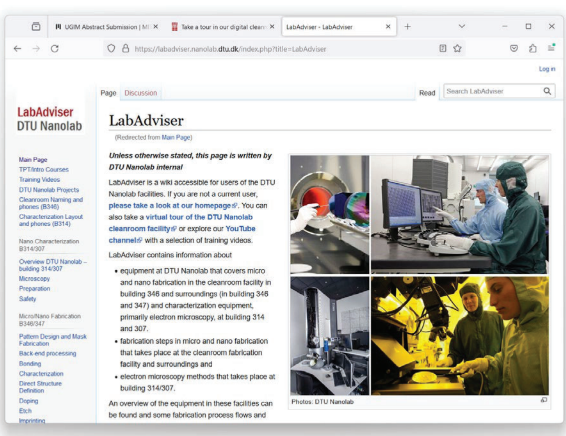


Fig 1. *Labadviser wiki front page. The wiki contains information on processes, materials, and tools. Including comparison pages to allow users to investigate different approaches.*

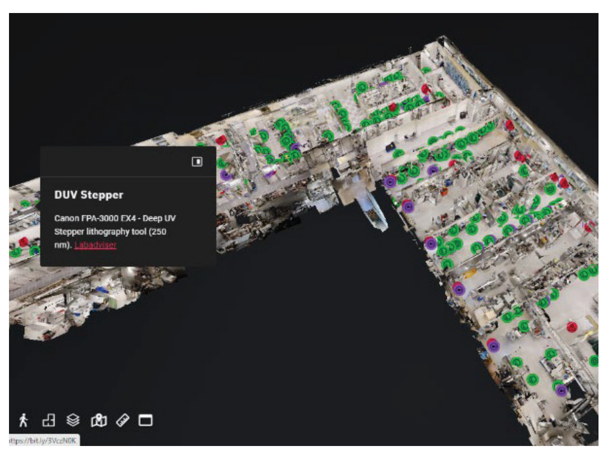


Fig 2. *3D digital twin representation of the main cleanroom facility. Green dots give direct access to process wiki pages, purple dots link to videos and red ones are safety installations.*

Business Tools and Processes to Improve Core Facility Operations

Robert Cornwall
Managing Director Materials Research Institute, Penn State

Take-Away: Improving operational efficiencies of core user facilities using various technologies including Laboratory Equipment Operations LEO – PSU's branching of NIST NEMO reservation and billing systems; a CRM system for internal and external customer tracking, business workflows, and sample case management; a system to pull log files off of equipment sample runs to improve future research; just in time reporting to make good business decisions; and AI opportunities to enhance operations and research. The hope is that others can learn from what we have done.

The Materials Research Institute at Penn State runs three large-scale core facilities, The Materials Characterization Lab, the Nanofabrication Lab and the 2D crystal Consortium, providing characterization, fabrication, and crystal atomic level thin-film growth capabilities to a wide range of PSU faculty and external users. With 45 technical staff and nearly ~$80M worth of up-to-date equipment we provide comprehensive training and services to a broad community. This presentation will discuss our goal to implement systems and workflows to better manage and serve the research community and how we integrate and extend those systems across Penn State's $1.2 billion research enterprise.

Laboratory Equipment Operations (LEO) – a branch from NEMO four years ago with some significant differences including: required transaction confirmation, multiple cores, enhanced timing considerations, Integrated sample data tracking information and others.

Lifetime Sample Tracking (LiST) – real time capture of experimental data on samples created or characterized that can directly pull data from equipment log set up files and output.

Customer Relationship management and sample case management (Power-CRM – Microsoft based) – optimize internal and external customer relationships/award management and sample flow through our cores with a powerful case management solution.

Enhanced reporting to improve value assessment and business decisions.

AI opportunities to improve efficiencies and enhance research.

NEMO Lab Management and Operations Software

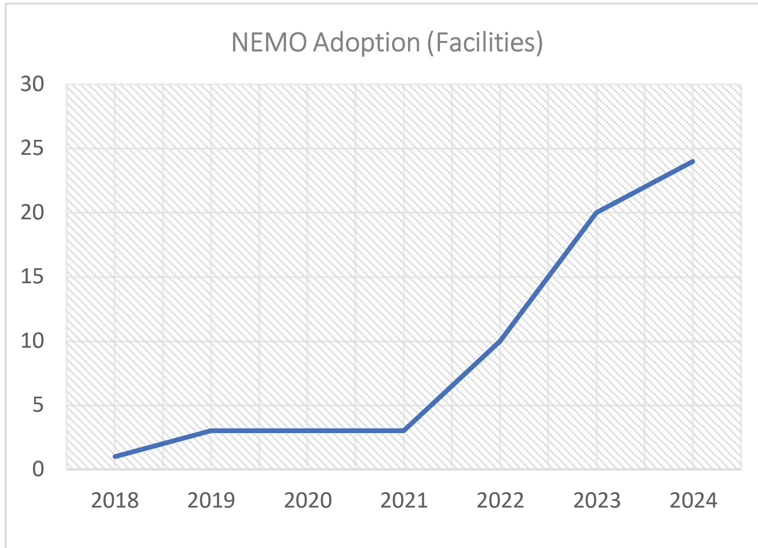
M. Rampant, R. Ilic, J. Zhang
Center for Nanoscale Science and Technology, National Institute of Standards and Technology, Gaithersburg, MD, USA

The NEMO web application allows users to schedule equipment reservations, controls equipment and lab access with interlocks, provides recordkeeping for administrative staff, and more.

NEMO, initially launched in November 2013 at the CNST NanoFab, gained wider accessibility and a significant increase in its user base through its open-sourcing in January 2018[1].

In October 2020, an exhaustive Feature Manual[2] was released and is continuously updated with each new version. It is over 1000 pages today.

In 2023, a Hardware Accessories Manual[3] was also released, containing schematics and configuration for sensor boxes. It was updated in 2024 to include interlock boxes and a USB controller module.



Since UGIM 2022, we added new features and received contributions from many facilities, including:

- support and tracking for Modbus-enabled Sensors (temperature, humidity, particle monitoring, etc.)
- support for safety data sheets
- recurring consumable charges (storage bins, monthly rental/cleaning, CAD subscription, etc.)
- safety hub for organizing safety documentation
- adjustment requests
- service contracts, procurements and contractors trackin0067
- rest API expansion to allow creation, update, and deletion (MIT.nano)
- tool freed time notifications when reservations are moved, cancelled, shortened, or missed (Princeton Micro/Nanofabrication Center)
- multi-tool calendar view (Stanford Nanofabrication Facility)
- color coded configuration settings in calendar (UPenn Singh Center)
- tool status API (Cornell Nanoscale Facility)
- other contributions from USC Nanofab, 4DLabs, UC Irvine, India's National Institute of Immunology, Polytechnique Montreal and JPL Microdevices Laboratory

References:
[1] NEMO code repository. https://github.com/usnistgov/NEMO
[2] NEMO Feature Manual. https://nemo.nist.gov/public/NEMO_Feature_Manual.pdf
[3] NEMO Hardware Accessories Manual. https://nemo.nist.gov/public/NEMO_Hardware_Accessories.pdf

Building an AI Copilot for Nanofabrication Facilities

Samantha Roberts[1], Frederic de Vaulx[2], Aakash N S[3]
[1]ASRC Nanofabrication Facility, City University of New York, NY, USA;
[2]Prometheus Computing LLC, MD, USA; [3]Jovian, Bengaluru, India

Running an academic nanofabrication facility currently relies upon uncurated knowledge scattered across many different repositories and sources that are not easily searchable, shareable or disseminated. Resources like the MIT Labnetwork, an email forum, allow users to interact and share information with some of the most knowledgeable people who run and use nanofabrication facilities. However, specific knowledge contained in the 18 years of data on the forum can be very difficult to find, retrieve or categorize.

We will show a demo app using a Large Language model (LLM) and a method called Retrieval Augmented Generation (RAG) to create a chatbot app that makes the knowledge contained in the Labnetwork forum easily searchable for any user via a web browser and chat interface. In this process (Figure 1) the Labnetwork archive website is scraped, and message information such as name, email, message ID and datetime is extracted. The email text body is vectorized using a LLM that represents semantic meaning in a high dimensional numerical vector, and both the vectors and metadata are stored in a cloud database. Questions asked via the chat interface allow the user to interact in a conversant, accessible manner, finding and retrieving the relevant discussions contained in 18 years of data.

We will then discuss how these capabilities can extend to many other types of documentation and be instrumental to both staff maintaining the tools as well as lab users. Tool manuals, tool maintenance history, usage history, process recipes and fabrication results are examples of data that could all be accessible in this conversant manner, and this information could be presented at various levels depending on user expertise. Streamlining this knowledge retrieval process would minimize costly tool downtime and enhance the efficacy of research by making information readily accessible. Additionally, these methods also serve as a way to preserve institutional and domain knowledge in ways that our community has never attained before. This could help institutions and facilities reach a new level of collaboration across the world.

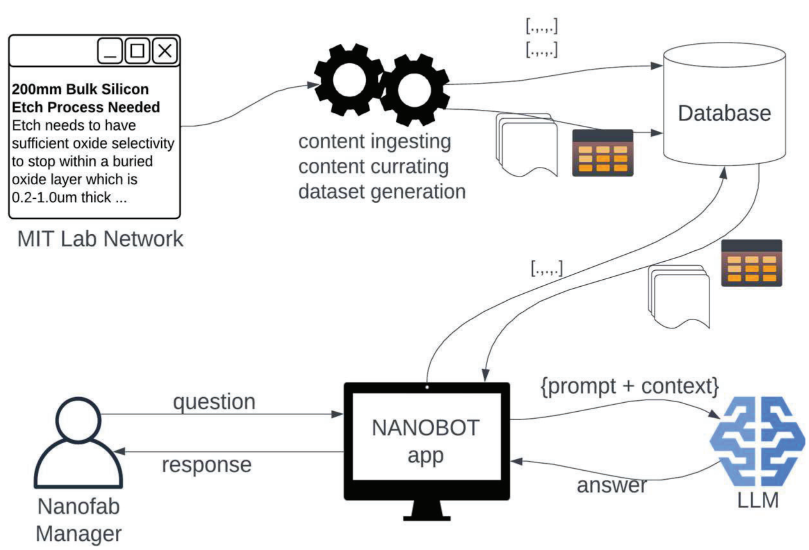


Figure 1. *The making of an AI copilot (Nanobot) for nanofabrication facilities*

A Radical Approach to Manage Access to E-Beam Lithography

Karen Birkelund, Thomas Pedersen, Elena Lopez Aymerich, Peixiong Shi
DTU Nanolab, Technical University of Denmark, Bldg 347, Ørsteds Plads, 2800 Kgs. Lyngby, Denmark

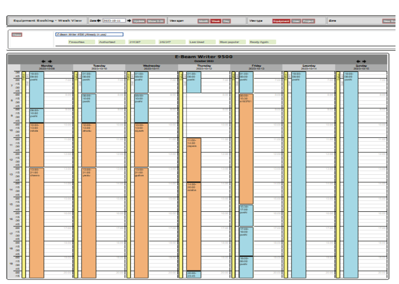
DTU Nanolab runs a JEOL e-beam writer JBX-9500FSZ purchased in 2012. It has recently been upgraded with a 200 MHz sub scanner and features an auto stoker system that can contain 10 sample cassettes at a time. Sample sizes span from 2"-8" wafers and down to small chips. It has a maximum writing field of 1mm x 1mm, an acc. voltage of 100 kV, min. beam size of 4nm and a beam current that ranges from 0.1nA to 100nA. The tool is mainly used for research projects but has also significant commercial usage for R&D as well as production.

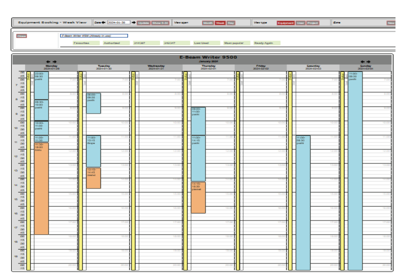
The interest in the tool is very high, so high that last year users had to wait around 2 months to book a slot despite several booking restrictions that were meant to "guide" users into a reasonable booking and usage pattern. This became such a bottleneck that we had to take action. By comparing the bookings with the actual writing time, it turned out that many bookings were booked just to ensure a time in case of need. Overbooking was also quite common even among very experienced users who should know better. And often people used the time for job preparation on the tool, which could as well be done on a different computer. It is often close to impossible to plan 2 months in the future which resulted in many last-minute cancellations due to failed sample or job preparation. Often the users even forgot that they had a booking and simply did not show up or cancelled the booking at the last minute. Last minute cancelations are hard to deal with because very few can jump in and use the time with such short notice.

To prevent these unhealthy patterns, we have over time discussed and implemented a number of booking rules such as a limit of 3 hours booking within normal working hours and 6 hours outside working normal hours, only two future bookings per user, pay per booking instead of paying per usage etc. All measures that should guide user behavior and thereby free up more slots on the tool. But users innovative creativity in circumventing rules has persistently exceeded our innovation power in establishing new rules. They exchange bookings within group networks, they book slots for each other, they even keep departed (and not yet deleted) users accounts for booking the tool.

How can the tool's full capacity be reached with minimal effort from our side and which other benefits could be achieved in the process?

In November 2023 we decided to change the booking rules in a rather dramatic way: It is no longer possible for the users to book the e-beam by themselves. All jobs must be prepared in advance and be approved by Nanolab staff, who then assign the user a writing slot corresponding to the job asked for. It is a comparatively little effort for us, but the impact has been enormous. A slot can now be assigned within two days, there is an educational benefit and less user errors happen, and it has resulted in more free time for other research and development works on the tool.





a) E-beam writer JBX-9500FSZ at DTU b) Booking calendar oct.2023 and c) Booking calendar jan.2024

6.4 - Tue 2:40 pm

FabuBlox: A Visual Design & Data Management Tool for Micro- and Nanofabrication Processes

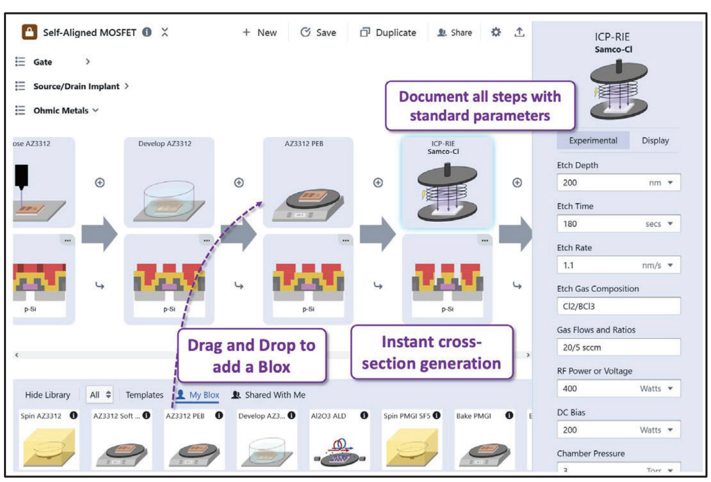
Jan Tiepelt, Jack Muller, Eyal Perry, and Joshua Perozek
FabuBlox, Inc.

The nanofabrication world has a communication problem – across the decentralized R&D ecosystem of hundreds of academic, government and industry fabrication facilities worldwide, there are no standard frameworks for nanofabrication data management, visualization, knowledge transfer, or process discovery. This leads to slow, inefficient, and expensive fabrication process development. Fab knowledge remains scattered, unorganized, incomplete, and searchability of existing databases is highly limited.

To address these challenges, we have developed a solution: FabuBlox. As a highly accessible, cloud-based platform that combines a generative EDA interface with GitHub-like repository-building capabilities, we set a new standard for visual design and data management within micro- and nanofabrication. The purpose-built FabuBlox Process Editor provides users with standardized process blocks and parameter spaces to collaboratively build and easily share processes while algorithmically and automatically generating wafer cross-sections. Combined with the FabuBlox StackSimulator, users have instant, server-free access to an intuitive and accurate process emulation platform for to-scale recreations of their processes.

Further, the FabuBlox data standard with robust documentation in a centralized manner enables process repository building with unprecedented ease of shareability, searchability, and filtering functions for any parameter, material, or tool used. Through the incorporation of process module repositories – short, repeated tool sequences – facility managers can share and constantly update best known practices and recipes to help users streamline process development and avoid redundancy in problem solving.

In the near future, FabuBlox will allow for creation of process version history with automated parameter change tracking in fab runs, similar to the standards set in software development by Git. FabuBlox process repositories will be further enhanced by incorporation of metrology data in our data structures, thereby allowing for tracking of tool calibrations by facility managers, users, and even tool vendors. This will ultimately enable process interoperability by intelligent recipe translation across facilities on FabuBlox. Finally, with the incorporation of automated material and tool compatibility design rule checks, specific to each set of tools, FabuBlox will improve efficiency of facility operations and reduce tool downtimes. This will be realized in part by enabling communication with the NEMO platform, adding real-time tool availability information to FabuBlox and furthermore enabling standardized coordination of fabrication capabilities across nanofabrication facilities.



7.1 - Tue 3:40 pm

Enhancing Research Data Management and Access through an Integrated Booking System

Richard Kolář, Michal Urbánek, Jiří Zita

CEITEC Nano Research Infrastructure, Brno University of Technology, Brno, Czech Republic

In recent times, data management, laboratory notebooks, and raw data have gained prominence in the daily lives of researchers. Grant calls now stipulate terms and conditions that necessitate scientists to describe their data management practices and adhere to the FAIR (Findable, Accessible, Interoperable, Reusable) policy during project submissions. While individual researchers can achieve this using software tools and scientific data repositories like Zenodo or OSF, our team has taken a step further by integrating these practices into our Booking system.

As a research infrastructure, we recognized the importance of securing the raw data generated by our equipment and granting users seamless access. With over 80 diverse pieces of equipment spanning nanofabrication to characterization, creating a unified solution has been challenging.

Our initial focus was on automatically downloading raw data from the equipment control computers. However, this task is more intricate than it appears, considering the variety of operation systems and their version. Once the raw data are uploaded to the cloud, they synchronize with reservations and user accounts. Users can conveniently access their raw data through the Booking system immediately after completing measurements. To facilitate access to and organization of RAW data, we've integrated an electronic laboratory notebook into our Booking system. Users provide essential parameters, experiment plans, and results for each reservation. Additionally, they can enrich the logbook with supplementary information such as samples, images, and documents – all seamlessly connected to the corresponding raw data.

This approach not only benefits our specialists and technicians in monitoring equipment usage but also empowers researchers with efficient data management and retrieval capabilities. By bridging the gap between raw data generation and user access, our integrated system enhances the overall research experience.

During my presentation, I will share our experiences with the electronic laboratory notebook and data management implementation within our Booking system.

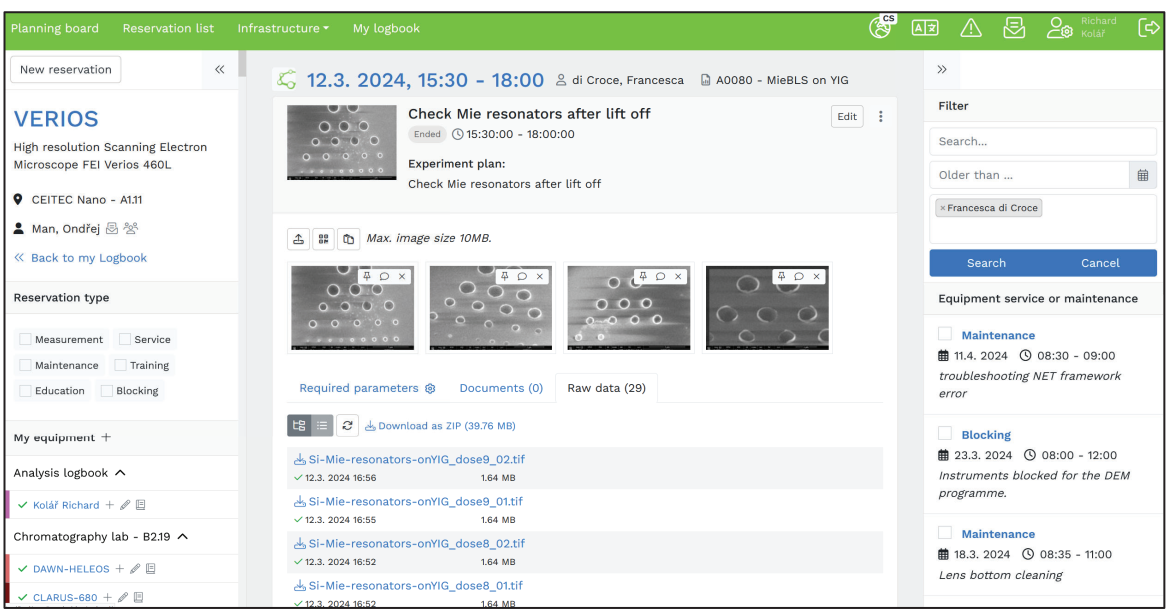


Fig. 1: An example of the electronic logbook with RAW data and images in the reservation.

7.2 - Tue 4:00 pm

Carbon Footprint Reduction for a Prototyping 200mm Wafer Fab*

Dan Pulver, Scott Zarr, Robert Holden, James Gallo, Ian Pahl
MIT Lincoln Laboratory, Lexington, MA, USA

Many research, development, and prototyping wafer fab facilities like ours were built before broad understanding of climate change and the carbon footprint contributions from their operations. Individual organizations, including cleanroom operations, must join local, state, and national efforts to understand and manage energy use and other contributions to mitigate global warming.

We've achieved significant carbon footprint reduction at MIT Lincoln Laboratory's Microelectronics Laboratory, a high energy and energy-dense user at our site, and will cover related risk management strategies for those changes. We've invested in wafer surface surveillance enabling us to modify longstanding setpoints and challenge conventional ISO4 cleanroom operating guidelines.

We have evaluated prospective next steps and will share those options and relative impact.

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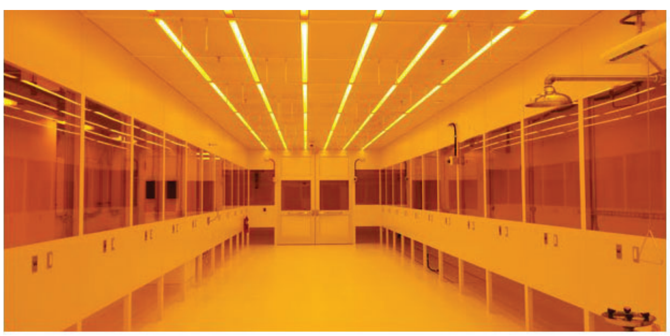
The Journey to Building a New Cleanroom: Preventable Issues and Why They Still Happened

Donghai Zhu

John O'Brien Nanofabrication Laboratory, University of Southern California, Los Angeles, California

USC built its first cleanroom in the early 1990's. It was well designed and consisted of both research and instructional labs. Over the past 30 years, we have gained and accumulated the experience needed to manage and operate these labs, learned lessons, and now know what improvements should be made in terms of utility, equipment operation, and lab layout to make the lab safer, equipment operation more reliable, and lab work easier and more efficient. As the amount of equipment increases and the demands from users grew, we initiated the discussion and planning to build a new nanofabrication cleanroom in 2013. From 2013 to 2020, we went through the new cleanroom planning, design, construction, tool move in and hookup, and acceptance test processes. The brand-new building was completed in 2017. However, it took three years to construct the power and utility drops from just the mezzanine to the cleanroom and to hookup all the tools. Finally, in 2021, the state of the art 12,000 sq. ft. cleanroom was able to start operation. It's been a long journey.

In this talk, we will look back and present what we encountered and experienced~~,~~ and how issues that could have been prevented still occurred when building the new cleanroom. We will present the roadblocks that came up during our work with the project management and environment health and safety departments, the design company, and the general contractors and sub-contractors. We will also discuss the issues we encountered in the project, such as with the gas line leak detection, acid waste neutralization, and process chilled water systems, as well as with the UPS connections to the utility equipment and the LN2 fill station, just to name a few.




Supply of Lab Utility Gases - Planning for a Safer, More Economical, and Decarbonized Future

David Wolff[1], Michael Montesi[2]
[1]Nel Hydrogen, [2]ON Site Gas

Academic user facilities use huge quantities of nitrogen for a wide range of purposes. Hydrogen volumes, typically far smaller than nitrogen use, create special issues because of hydrogen's unique chemical and physical properties.

Nitrogen is used in a many different applications in user facilities, including blanketing, purging, dilution, to prepare equipment for service, and to inert equipment when not in use, and many others. While delivered nitrogen is modest in price, the vast quantities of nitrogen used drive up the cost. Nitrogen uses range from utility to process critical – hence purity requirements span a range.

Hydrogen is required for many deposition and thermal processing steps in academic user facilities. Unlike nitrogen, quantities used are modest, but hydrogen is much more expensive than nitrogen (typically user facilities will be paying 100x nitrogen unit pricing for hydrogen versus nitrogen, on smaller volumes of typically purer gas).

Academic user facilities are compact, densely packed, with a high burden of toxic and hazardous gases & chemicals, and are generally located in a crowded urban-like campus setting – all of which makes gas delivery and storage challenging and expensive. Cylinder gases are uniquely challenging because of the need to handle cylinders frequently and the multiple hazards that result.

Along with many other cost, safety, usability, process-related and other challenges, now user facilities are asked to consider decarbonization among your performance criteria. Eliminating truck deliveries many be a powerful contributor to success in this metric.

Presentation will discuss hydrogen and nitrogen generation options, and where they fit into user facility planning and operational processes.

8.2 - Wed 9:20 am

Silane and Other Pyrophoric Gasses

Greg L. Owen, PE
Principal, GLO Consulting, LLC

Silane and other Pyrophoric gases are commonly used in university cleanrooms and other laboratories for the development of electronic devices. If not handled properly, these gases pose a significant risk to the operation of a university facility as well as to their staff and users. This presentation will provide a clear understanding of the risks associated with the various Pyrophoric gases commonly used in the University research environment an provide guidance for the safe, and code compliant storage and dispense of pyrophoric gases in a Cleanroom research environment. This presentation will detail the requirements of the International Fire Code in Chapter 64, Pyrophoric, mandated Compressed Gas Association Standard CGA-G-13, *"STORAGE AND HANDLING OF SILANE AND SILANE MIXTURES*" for the storage and dispense Silane and how it relates to other pyrophoric gases.

8.3 - Wed 9:40 am

Managing a High Volume of Users in a Characterization Facility

Suresha S J
MNCF, CeNSE, Indian Institute of Science, Bengaluru, India

The Centre for Nano Science and Engineering (CeNSE) was established in 2010 at the Indian Institute of Science, Bengaluru, as a separate academic unit in a new bespoke structure. The Centre has been built around two state-of-the-art central facilities – The National Nano Fabrication Centre (NNFC) and the Micro and Nano Characterization Facility (MNCF), both of which are national facilities meant to serve users from both academia and industry. It has been supported by the Ministry of Electronics and Information Technology (MeitY) and other agencies of the Govt. of India.

The MNCF is housed in a 7000 sq. ft. precision-controlled environment and is comprised of four distinct laboratories for Electrical, Mechanical, Optical and Material Characterization all under one roof, making it quite unique in the academic world. The facility has more than fifty pieces of equipment “handled” by a dedicated staff of scientists and technologists, offering researchers convenient and reasonably priced access to a wide range of state-of-the-art analytical instrumentation and services under one roof. As noted, MNCF is a national user facility, which supports the research activities of students and faculty from IISc and a number of academic institutions across India, in addition to national laboratories plus start-up industries across India and abroad. The MNCF boasts a wide range of high-end equipment spanning multiple disciplines of nano science and engineering, rarely found under a single roof.

Being a unique multiuser national research facility, MNCF is built to deal with a high volume of requests from all over India, throughout the year. Indeed, more than 2000 users are “customers” of the facility in a calendar year. Thus, managing user requests and delivering results for them on time is always a challenging task. In addition to meeting user requests, MNCF also has to “make room” for many training and outreach programs, such as the Indian Nano Electronics Users Program (INUP) and in-house material characterization courses, all of which are held regularly, thereby placing a heavy demand on “tool time” and “engineers’ time.” As such, we have, over the years, developed different strategies to understand and fulfill the various user requirements. We have a team that interacts with the users and have a technical discussion to understand their samples and requirements, and guide them accordingly. We have dedicated time slots for external users, as well as “emergency slots” for immediate requirements. We also train students and make them “independent users,” some of whom become “expert users” who help reduce the load on the dedicated MNCF staff. The expert student users are asked to help train others, especially during the off-office hours, thereby reducing the burden on the MNCF staff and enabling the facility to be used efficiently. Challenges to be addressed regularly include balancing requests from external and internal users and handling difficult user demands.

8.4 - Wed 10:00 am

Sustainability at the Australian National Fabrication Facility: An Update

Dr. Tatiana Pinedo Rivera[1], Michael Imsic[2], Dr. Ash Dyer[3]

[1]Team Lead, Senior Process Engineer and MCN's Sustainability Lead (tatiana.pinedo@nanomelbourne.com), [2]MCN's Facility Manager, [3]MCN's Deputy Facility Manager, Senior Process Engineer and Sustainability team co-founder; MCN (Melbourne Centre for Nanofabrication), ANFF-Vic (Australian National Fabrication Facility – Victorian hub)

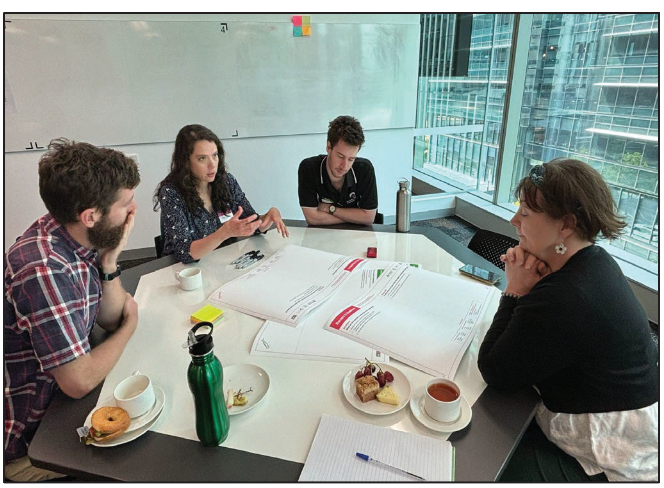
The necessity of embracing sustainability practices in all industries is becoming more urgent, especially for laboratories which inherently are resource-intensive environments. The challenge is even greater for Micro/nanofabrication facilities due to their significant energy and water consumption, as well as the production of large quantities of waste, including materials and chemicals, retired tools, e-waste, and single-use items.

The good news is that highly resource-intensive industries like ours have greater potential for improvement, resulting in significant positive outcomes once changes are made.

At the Melbourne Centre for Nanofabrication (MCN), an Australian National Fabrication Facility (ANFF) hub, we believe in the power of small steps to implement sustainability principles and inspire community change. This presentation will provide an update on the latest sustainability initiatives at MCN since UGIM 2022, including our journey from a small "Green Impact" team to achieving "My Green Labs certification" and expanding our efforts nationwide within ANFF and Australian Universities.

Our newest initiative, Labs Who Care, is a movement and a community promoting sustainability practices in cleanroom operations to make a positive impact in our industry and beyond**.**

LABS WHO CARE



9.1 - Wed 11:00 am

Workflows for Prototyping Cleanroom Management*

Dan Pulver, Craig Hill, John Hunt, Chris Porter
MIT Lincoln Laboratory, Lexington, MA , USA

Research and development cleanrooms have diverse and recurring management challenges. We lack production performance information to optimize capital spending, to guide service contract purchase, and to select where to update procedures and training. We choose resource assignments to balance stakeholder's expectations, manage risks, and address opportunities. These collective decision methods may evolve to operational best practice over time and should become institutional wisdom. Flexible, prescribed workflows help successfully leverage these best practices amongst more contributors and varied processes to document and improve lab activities.

At MIT Lincoln Laboratory's Microelectronics Laboratory, we have management procedures and related web-accessed workflows to guide, prompt, and record our performance within these procedures. Initially written to achieve ISO9001:2015 quality management certification, now they constitute much of our management activity. We also periodically assess the context of our organization, again required by the ISO9001:2015 standard, and in combination with our workflow data decide resource assignment and activity selection.

This talk reviews workflow implementation in our cleanroom operations, enabling continual improvement while balancing our organization's context to assign resources. Sharing these concepts may have value for others in the community.

This material is based upon work supported by the Department of the Air Force under Air Force Contract No. FA8702-15-D-0001. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of the Air Force.

9.2 - Wed 11:20 am

Moodle - A Platform for E-Learning and Instrument Training

Jiří Zita, Michal Urbánek, Richard Kolář
CEITEC Nano Research Infrastructure, Brno University of Technology, Brno, Czech Republic

In the CEITEC Nano Research Infrastructure, we have decided to use the Moodle platform for e-learning and instrument training. The main reason for moving training and documentation to the online environment is to save time for instrument guarantors during training and to test users' knowledge before they are allowed to sign up for the training.

The most significant advantage of Moodle is that it is a free and open system with many possible plugins and add-ons. You can personalize many parameters to meet your university, institution, or company requirements.

Our Moodle is divided into four categories:

General training: This contains courses with minimum general knowledge required for the effective and safe operation of specific types of equipment, like lithography equipment, electron microscopes, etc. These courses conclude with a quiz or exam, and their completion may be required before attending the hands-on training.

Equipment training: Courses there summarize the knowledge needed to operate specific equipment, provide supporting information for hands-on training sessions, and provide additional manuals and other resources relevant to the equipment.

1. **Useful information and resources**: This section provides valuable resources for your day-to-day work in CEITEC Nano laboratories.
2. **User section**: Serves for sharing know-how, tips & tricks and other information between the users.

It is also crucial that in Moodle, we can create a database of questions on individual topics, from which we can take questions for follow-up training. If the user does not achieve the required knowledge grade, the next course will not be opened for them. We can also view specific statistics regarding completed courses and achieved results for each user.

During my presentation, I would like to share our experiences with the Moodle platform and show examples of lessons and courses.

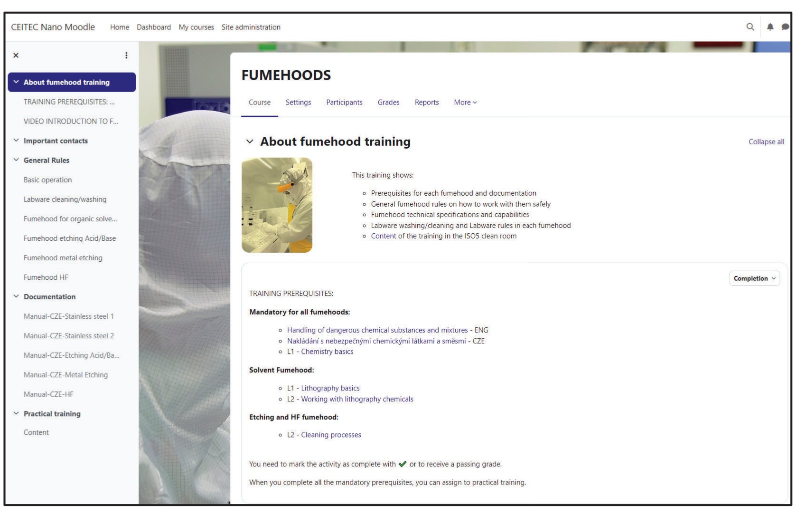
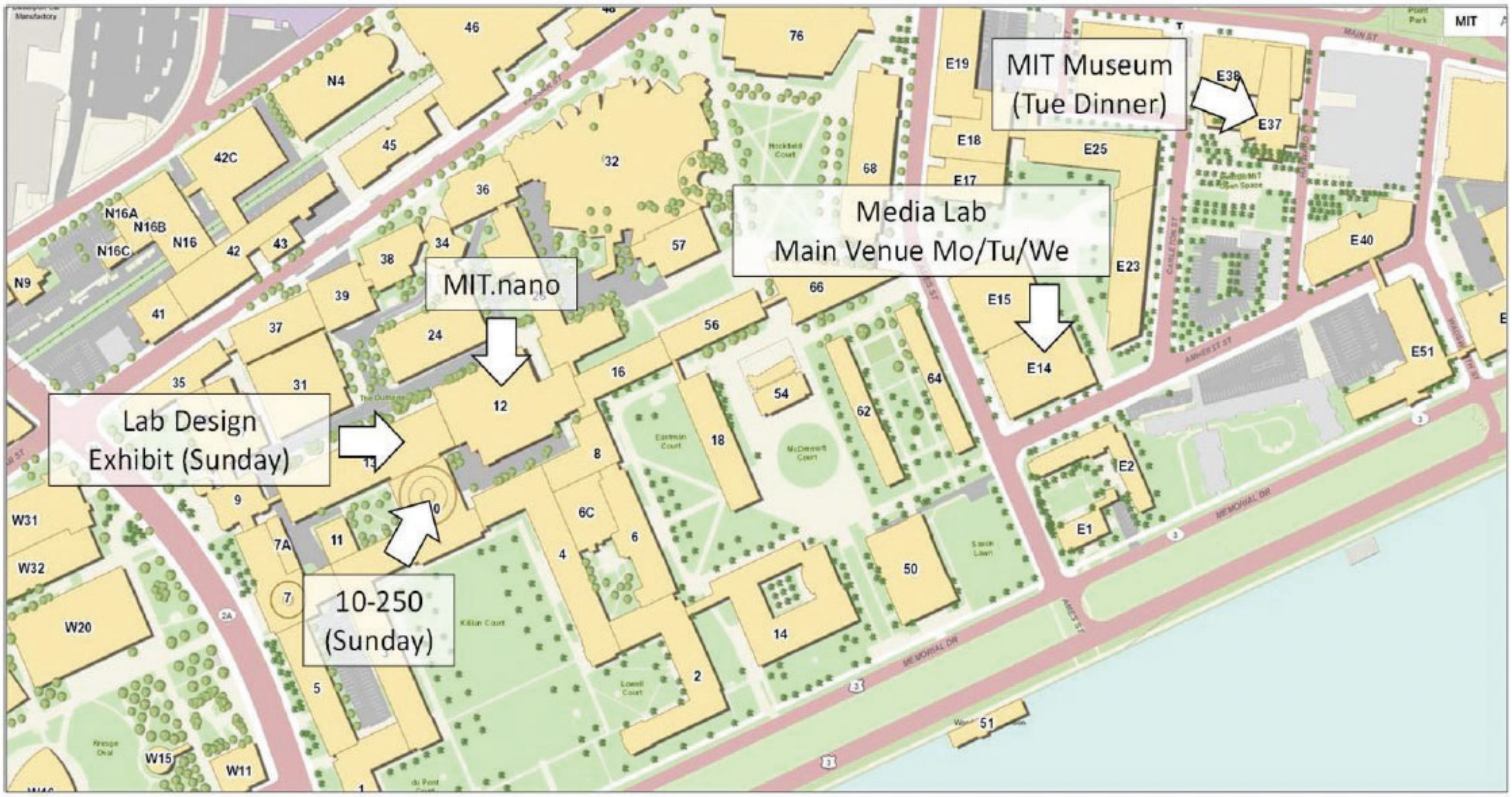


Fig. 1: The page example of CEITEC nano Moodle instrument training

A team of MIT students, faculty, staff, and alumni fabricated a new One.MIT wafer inside MIT.nano's cleanroom. Photo: Ken Richardson

Key Locations for UGIM 2024



Museum of Fine Arts (in Boston) – Monday Dinner

Sunday Program
MIT.nano – Building 12
60 Vassar Street (rear),
Cambridge

Bush Building – Building 13
105 Massachusetts Ave,
Cambridge

Maclaurin Building – Building 10
222 Memorial Drive, Cambridge

Main Conference
MIT Media Lab – Building E14
75 Amherst Street

Museum of Fine Arts
465 Huntington Ave, Boston

MIT Museum
314 Main Street, Cambridge

Sunday Vendor Showcase

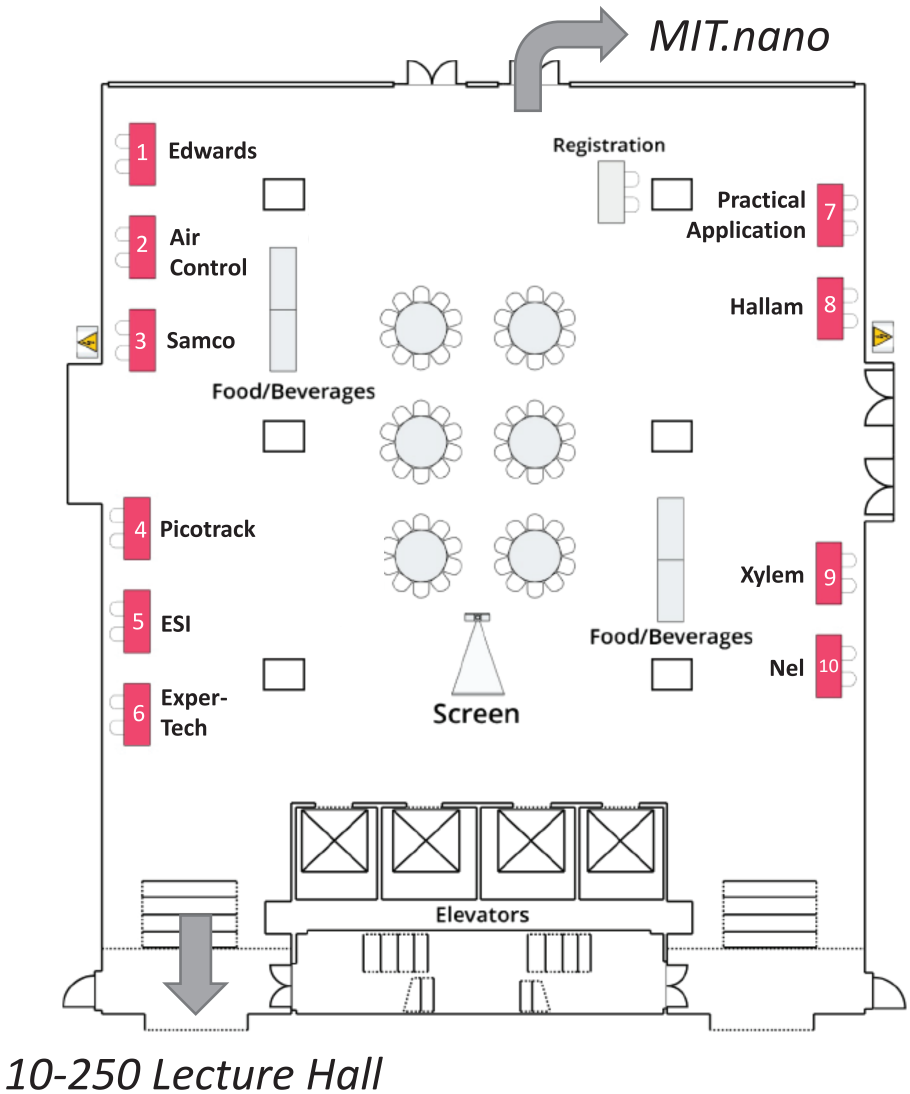


Table #	Vendor
1	Edwards
2	Air Control
3	SAMCO
4	Picotrack
5	ESI
6	Exper-Tech

Table #	Vendor
7	Practical Applications
8	Hallam-ICS
9	Xylem
10	NEL

Monday Vendor Showcase

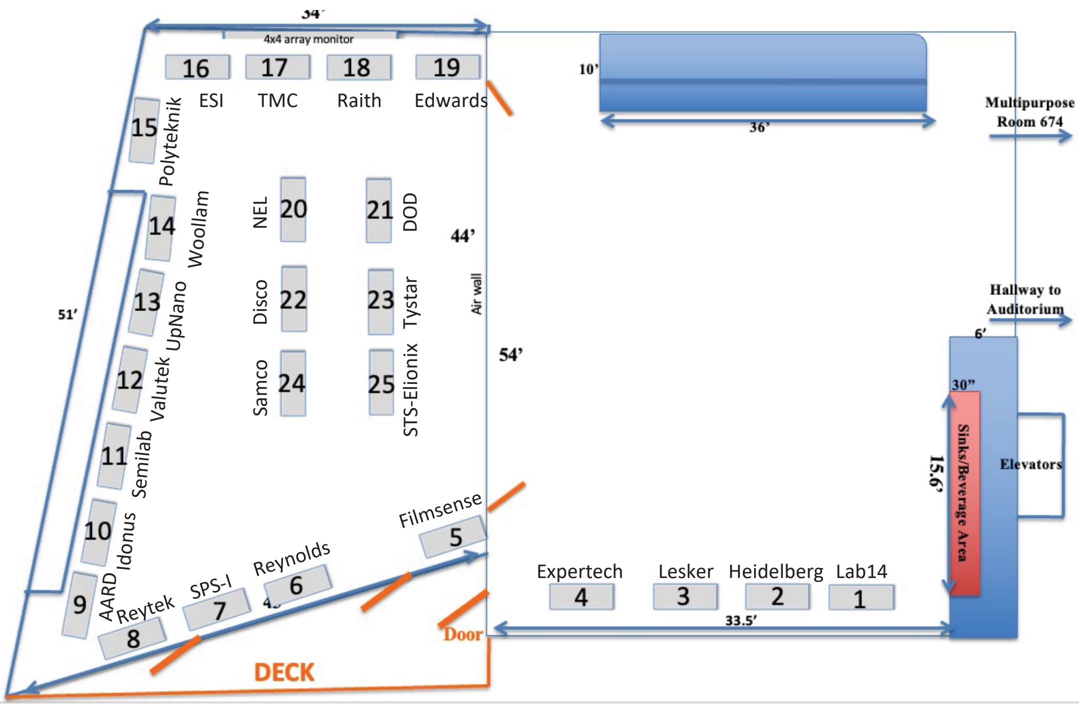


Table #	Vendor
1	Lab14
2	Heidelberg Instruments
3	Kurt J. Lesker
4	Expertech
5	Filmsense
6	ReynoldsTech
7	SPS-International
8	Reytek
9	AARD
10	Idonus
11	Semilab
12	Valutek
13	UpNano

Table #	Vendor
14	J.A. Woollam
15	Polyteknik
16	ESI
17	TMC
18	Raith
19	Edwards
20	Nel
21	DOD Technologies
22	Disco
23	Tystar
24	Samco
25	STS-Elionix

Tuesday Vendor Showcase

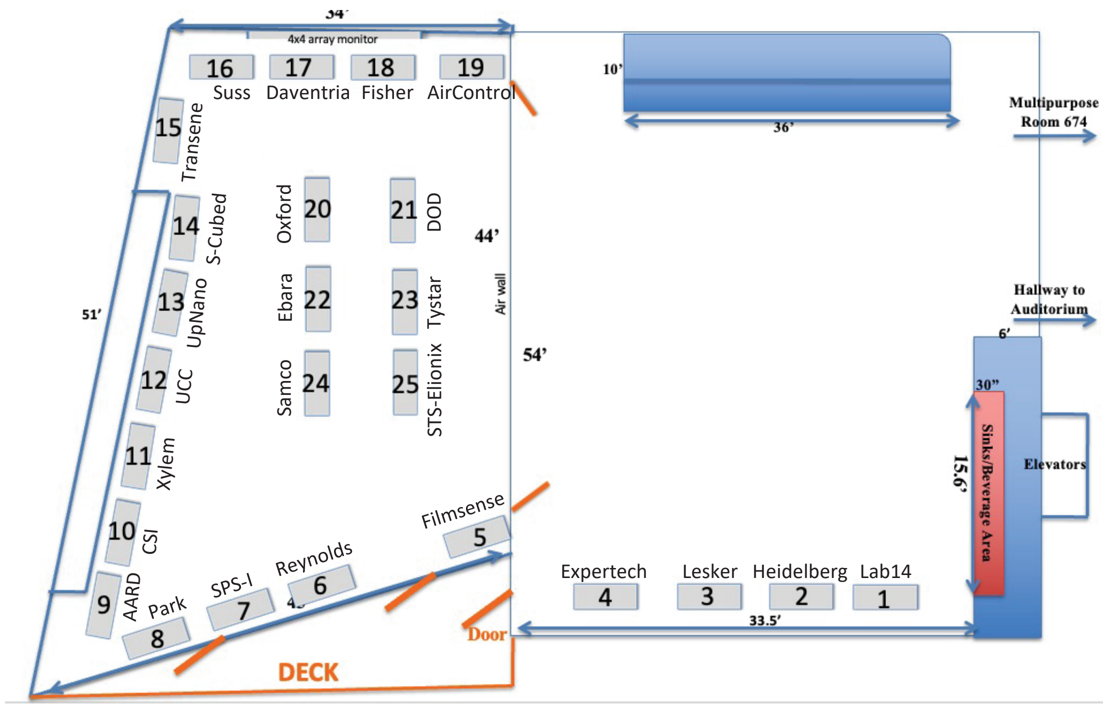


Table #	Vendor
1	Lab14
2	Heidelberg Instruments
3	Kurt J. Lesker
4	Expertech
5	Filmsense
6	ReynoldsTech
7	SPS-International
8	Park Systems
9	AARD Technology
10	Critical Systems, Inc
11	Xylem
12	UC Components
13	UpNano

Table #	Vendor
14	S-Cubed
15	Transene
16	Suss
17	Daventria
18	ThermoFisher
19	Air Control
20	Oxford Instruments
21	DOD Technologies
22	Ebara
23	Tystar
24	Samco
25	STS-Elionix

Wednesday Vendor Showcase

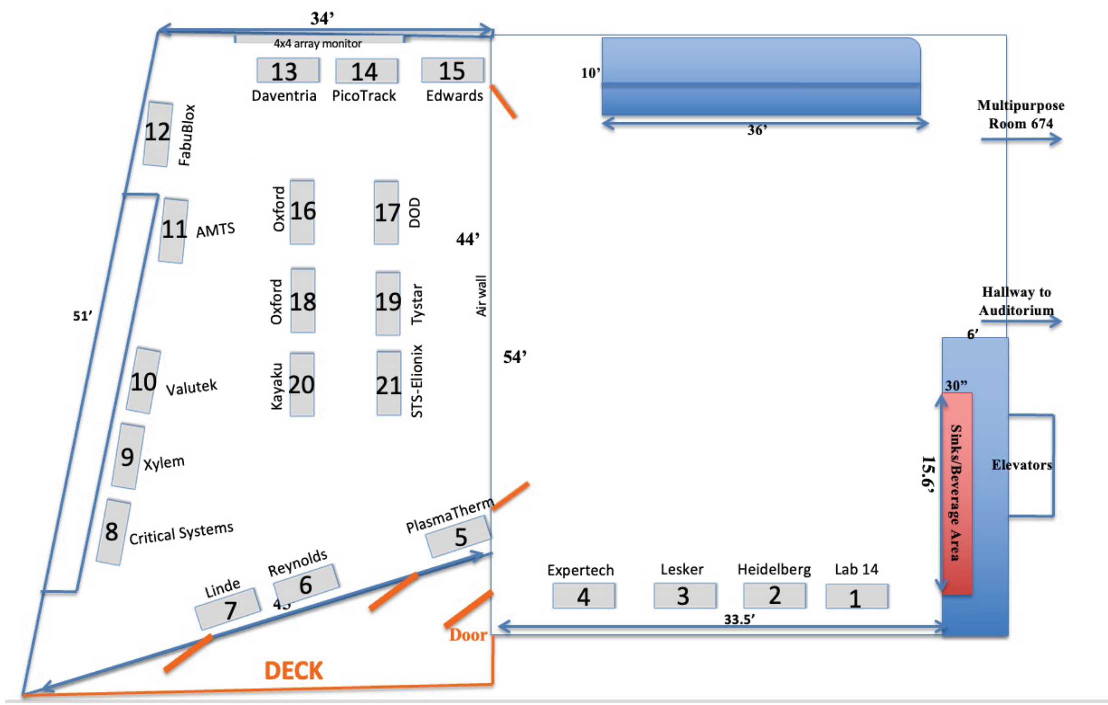


Table #	Vendor
1	Lab14
2	Heidelberg Instruments
3	Kurt J. Lesker
4	Expertech
5	PlasmaTherm
6	ReynoldsTech
7	Linde
8	Critical Systems, Inc
9	Xylem
10	Valutek
11	AMTS

Table #	Vendor
12	Fabublox
13	Daventria
14	PicoTrack
15	Edwards
16	Oxford Instruments
17	DOD Technologies
18	Disco
19	Tystar
20	Kayaku
21	STS-Elionix

Who's Where & When? By Name

Vendor	Sun	Mon	Tue	MITM	Wed
AARD		■	■		
AirControl	■		■		
AMTS					■
CSI			■	■	■
Daventria			■		■
Disco		■		■	■
DOD		■	■	■	■
Ebara			■		
Edwards	■	■		■	■
ESI	■	■			
Expertech	■	■	■	■	■
FabuBlox					■
Filmsense		■	■		
Hallam	■				
Heidelberg		■	■	■	■
Idonus		■			
Woollam		■			
Kayaku					■
Lab14		■	■	■	■
Lesker		■	■	■	■
Linde					■
NEL	■	■			
Oxford			■	■	■

Vendor	Sun	Mon	Tue	MITM	Wed
Park			■		
Picotrack	■				■
Plasmatherm					■
Polyteknik		■			
Practical Appl.	■				
Raith		■			
Reynolds		■	■	■	■
Reytek		■			
Samco	■	■	■		
S-Cubed			■		
Semilab		■			
SPS-Intl.		■	■		
STS Elionix		■	■	■	■
Suss			■		
Thermo Fisher			■		
TMC		■			
Transene			■		
Tystar		■	■	■	■
UC Comp.			■		
UpNano		■	■		
Valutek		■		■	■
Xylem	■		■	■	■

Who's Where & When? By Date

Vendor	Sun	Mon	Tue	MITM	Wed
Hallam	■				
Practical Appl.	■				
NEL	■	■			
ESI	■	■			
Idonus		■			
Woollam		■			
Polyteknik		■			
Raith		■			
Reytek		■			
Semilab		■			
TMC		■			
Samco	■	■	■		
Air Control	■		■		
Ebara			■		
Park Systems			■		
S-Cubed			■		
Suss			■		
Thermo Fisher			■		
Transene			■		
UC Comp.			■		
AARD Tech.		■	■		
Filmsense		■	■		
SPS-Intl.		■	■		

Vendor	Sun	Mon	Tue	MITM	Wed
UpNano		■	■		
Daventria			■		■
AMTS					■
FabuBlox					■
Kayaku					■
Linde					■
PicoTrack	■				■
Plasmatherm					■
CSI			■	■	■
Oxford			■	■	■
Disco		■		■	■
Valutek		■		■	■
DOD Tech.		■	■	■	■
Heidelberg		■	■	■	■
Lab14		■	■	■	■
Lesker		■	■	■	■
Reynolds Tech		■	■	■	■
STS Elionix		■	■	■	■
Tystar		■	■	■	■
Edwards	■	■		■	■
Xylem	■		■	■	■
Expertech	■	■	■	■	■

Undergraduate students in MIT’s 6.2600 lab class

THANK YOU TO ALL OF THE 2024 SPONSORS!

UGIM is made possible through generous sponsorships from leading industries in micro/nanofabrication.

CRITICAL SYSTEMS, INC.

SEMI S2 Certified

CERTIFIED QUALITY MANAGEMENT SYSTEM ISO 9001:2015 STANDARD

Gas Distribution

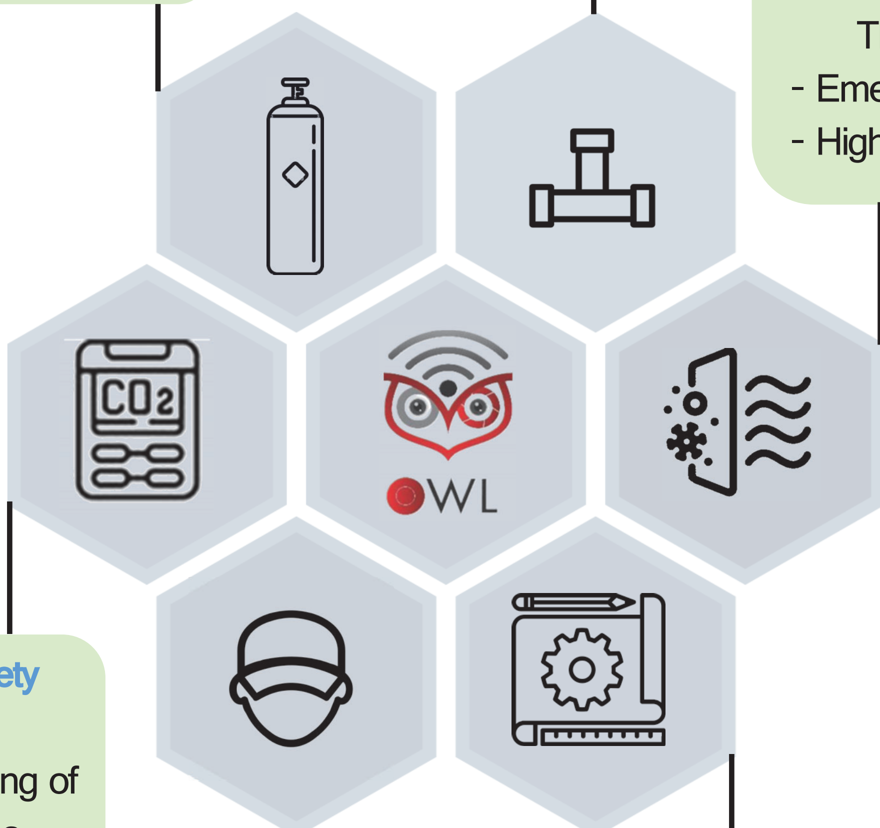
- Valve Manifold Boxes & Panels
- Splitter Boxes

Gas Delivery and Storage

- Gas Cabinets & Panels
- Purifier Panels
- Automated and Manual

Gas Abatement

- Point of Use
  - Dry, Wet, and Thermal Wet
- Emergency Release
- High Flow



Configurable Safety Monitor

- Active monitoring of up to 20 toxic gas monitors at a glance

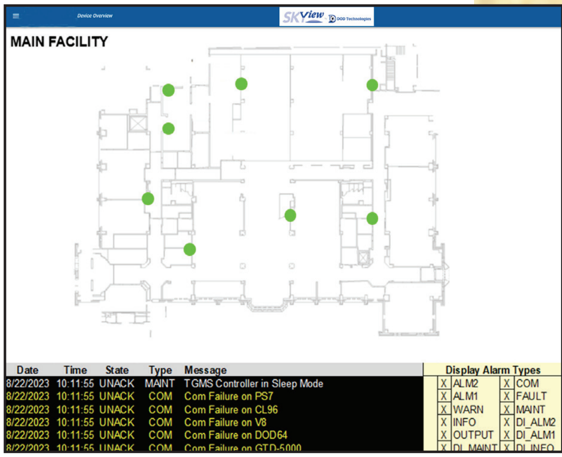
In-House Engineering

- Custom System Designs

On–Site Services

- In-person Startup & Training
- User Specific Service Contracts
- Lifetime Warranty

SKYview by DOD Technologies



Toxic Gas Monitoring System Software

Monitor multiple gas detectors from one control station. System features include:

- Access to Alarm History, Concentration History, Individual Instrument Data, Input/Output Status, Optional Paging System and Security System Setup
- User-Level System Modification Access
- Web Server Capability
- Developed In U.S.A. by DOD Software Engineers

Contact your DOD Technologies representative (815-788-5200) for more information or a quote.

DODtec.com

EDWARDS

ENVIRONMENTS WHERE INNOVATION THRIVES

Edwards is the global leader of vacuum and abatement technology. We take pride in being at the forefront of scientific advancements and delivering innovative products that are essential to our daily lives.

Everywhere you find vacuum requirements, you will find Edwards leading the way. From medicines to mobile phones, from computers to coffee beans, to cars and chemicals, we pride ourselves in making a difference in people's lives. we do it responsibly, ensuring that we innovate sustainably, while helping our customers to maintain their competitive advantage and operational excellence.

With over 100 years of experience, Edwards is the preferred partner for many thousands of customers worldwide who require vacuum solutions for critical applications.

Our partnership with customers and our commitment to setting new standards have made us a trusted name in the industry.

Edwards US manufacturing expansion

Discover the future of dry pump manufacturing with Edwards' latest groundbreaking initiative – the Genesee Dry Pump facility in New York.

Scan the QR code and unveil the innovation, excellence, and sustainability driving this state-of-the-art facility. Join us as we revolutionize the industry and pave the way for a cleaner, more efficient future.

EDWARDS

Commitment to sustainability

We strive to be the environmental leader in the field of vacuum and abatement through sustainable approaches for our technology, products, and services to benefit the environment.

- Throughout the life cycle of our products, we offset more carbon emissions than we produce.
- Our technologies are essential for manufacturing a diverse range of environmentally-friendly products, with vacuum technology playing a critical role in producing solar cells and solid-state lighting.
- We encourage product refurbishment, remanufacturing 35,000 units yearly, and disassemble vacuum products at the end of their life cycle to recycle primary materials, preventing landfill disposal.
- We're actively investing in state-of-the-art facilities that surpass environmental standards and revolutionizing our operational methods, such as our ongoing transition of our European and North American facilities to exclusively using 100% renewable electricity.

Partnerships

Edwards has joined Catalyze, by Schneider Electric. Through the program, we will accelerate access to renewable energy for our own operations and our supply chain partners.

Edwards is a founding member of the Semiconductor Climate Consortium (SCC), confirming our support of the Paris Agreement and associated agreements aimed at achieving the 1.5°C target, and committing to advancing climate action throughout the semiconductor industry supply chain.

Thermal Processing Platforms

Proven Performance Furnace System for Academia & Research

The CTR furnace system provides a fully automated package in an exceptionally small footprint. Providing both atmospheric and LPCVD processes, the CTR is an ideal solution for pilot lines, low volume production sites, R & D, and government and academia institutions. This product has capabilities far beyond the tabletop or laboratory furnace systems of the past.

The fully automated and recipe driven CTR systems rival the process uniformity and film quality of full-size furnace systems.

CTR System Benefits

- Footprint is smallest in class
- Stackable design
  - Up to four (4) CTR 125's
  - Up to four (4) CTR 150's
  - Up to three (3) CTR 200's
  - Up to two (2) CTR-300's
- Process Controller Options
- Low cost of ownership – due to compact design and water-cooled heater element
- Highly reliable & production proven platform
- CTR reactors are available as manual load or with fully automated loading system. Atmospheric and LPCVD applications are supported.

CTR Advantages

- Stackable & Compact
- Range of High-Performance heating elements
- Full suite of Safety interlocks
- Integrated control system with GUI for interfacing with multiple tools
- Full Process Suite (Atmos & LPCVD)

Thermal Processing Platforms

Proven Performance Furnace System for Academia & Research

CTR Dimensions

CTR-125

- 32” (W) x 17.6” (H) x 61.8” (D)

CTR-150

- 34.7” (W) x 21.1” (H) x 80” (D)

CTR-200

- 35” (W) x 24.0” (H) x 83.2” (D)

CTR-300

- 42.8” (W) x 32.1” (H) x 93.2” (D)

Vertical Platform (VTR)

VTR (Vertical Thermal Reactor)

An industry proven reliable vertical furnace solution that is capable of handling 4”, 5”, 6” & 8” wafer substrates.

A full suite of process capabilities. More than 800 units operational in the field. US designed and manufactured.

Expertech Overview

A privately owned and operated supplier of Thermal processing equipment for more than 30 years. Managed by industry veterans, all of whom have > 30 years experience in this product segment.

A core focus on the provision of modern and reliable platforms for use in all research segments, with a low cost of ownership and a value for money ethos.

A team that is customer focused that can adapt and provide proven solutions to meet the specific needs of the end user.

Expert Semiconductor Technology Inc,

10 Victor Square (Suite 100), Scotts Valley,

CA 95066, U.S.A.

Tel - +1 831 439 9300

www.exper-tech.com

Email – websales@exper-tech.com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REYNOLDSTECH

HELPING OTHERS TO MANUFACTURE

Chemical Management Systems

AVAILABLE MATERIALS

- 304 Stainless Steel
- 316L Stainless Steel
- FM 4910 CPVC
- PVDF
- FRPP

SUPPORTED PROCESSES

- Bulk Supply (Local/Remote)
- Bulk Collection (Local and Remote with Dual-Vessel and Autorollover)
- Mixing/Blending
- Dosing
- Mobile Supply/Collection Carts
- Chemical Transport Carts
- Chemical Lift Stations

TURNKEY SOLUTIONS

ReynoldsTech offers innovative, start-to-finish custom solutions for its customers. From initial budget estimates to fabrication through factory acceptance testing and project close-out, ReynoldsTech has been using its 40 years of design/build expertise to help others manufacture.

For more information on any of our products or services please visit us on the Web at:

www.ReynoldsTech.com

Figure 1. Quad 5-gallon solvent chemical distribution system

- ReynoldsTech is proud to have supplied a number of high-level government, university, and production facilities.
- Waste collection systems are available from 10L to up to numerous 55-Gallon drums with autorollover functionality.
- Chemical supply systems can be on-board or remote and can be for bulk distribution or small dosing setups.
- All units come standard withj a wide array of safety interlocks to protect users.

ReynoldsTech has been on the cutting edge of the chemical management industry for over 40 years. We offer a complete complement of innovative equipment for all your chemical management needs. Our family of chemical management systems brings our customers equipment for use in the delivery, collection, and mixing/blending of both small volumes and bulk volume acid, caustic, and solvent chemicals. From 10/20L local collection/distribution to multiple 20L remote collection/distribution setups and dual 55-gallon drum collection/distribution systems, ReynoldsTech has your chemical management needs covered. Here at ReynoldsTech, we bring to each job an understanding of what it means to have a project completed with quality, craftsmanship, and most of all service. We look forward to working with you in the near future.

Figure 2. Dual 55-gallon drum waste collection system

REYNOLDSTECH

HELPING OTHERS TO MANUFACTURE

Chemical Wet Benches

AVAILABLE MATERIALS

- 304 Stainless Steel
- 316L Stainless Steel
- FM 4910 CPVC
- PVDF
- FRPP

SUPPORTED PROCESSES

- Etching
- Cleaning
- Lithography
- Plating
- Stripping
- Liftoff
- Polishing
- Develop
- RCA Clean

TURNKEY SOLUTIONS

ReynoldsTech offers innovative, start-to-finish custom solutions for its customers. From initial budget estimates to fabrication through factory acceptance testing and project close-out, ReynoldsTech has been using its 40 years of design/build expertise to help others manufacture.

For more information on any of our products or services please visit us on the Web at:

- ReynoldsTech is proud to have supplied a number of high-level government, university, and production facilities.
- Systems are available from standard manual units to semi-automatic or fully automatic configurations.
- Systems are developed for single wafer or full batch spray or immersion processing, each with dry-in/dry-out capabilities.
- Units come standard with a wide array of safety interlocks to protect users.

ReynoldsTech has been on the cutting edge of the semiconductor industry for over 40 years. We offer a complete complement of innovative equipment for your wet processing needs. Our expert services allow us to bring to our users not only standard tool configurations but also a full range of custom process equipment. We offer tooling suitable for use in acid, caustic, or solvent environments. Available in manual, semi-automatic, and fully automatic configurations, ReynoldsTech wet process stations are suitable for educational purposes, research and development endeavors, as well as large-scale manufacturing. Here at ReynoldsTech, we bring to each job an understanding of what it means to have a project completed with quality, craftsmanship, and most of all service. We look forward to working with you in the near future.

Process Tooling

- Heated Process Tanks (Electric or Liquid-Liquid)
- Ultrasonic/Megasonic Process Tanks
- Filtered/Recirculatng Process Tanks
- Cascade Rinse Tanks
- Quick Dump Rinse Tanks
- Quartz Tanks
- Utility Sinks
- Glove Wash
- Plating Cells
- Spin-Coaters
- Bake Stations/Hot Plates
- Local Waste Collection Systems
- Drying Stations

TYSTAR CORPORATION

TYSTAR CORPORATION

Tystar is more than a semiconductor equipment supplier. We're about crafting service-driven, innovative solutions. With over four decades of expertise in material processing tools for the semiconductor and MEMS industries, we pride ourselves on our ability to meet your needs with precision and care.

- Small Footprint Designs
- Extensive Process Database
- Large Installed Customer Base
- Dedicated Engineering Support Team
- Ease of Maintenance and Servicing

STANDARD TYTAN FURNACE

The Standard Tytan Furnace Systems are designed for diffusion, oxidation, annealing, and LPCVD applications. The systems require considerably less floor space and electrical power than conventional furnaces of equal capacity.

- Innovative Isothermal Chamber Design
- Small Footprint
- Up-time Performance in Excess of 95%
- Gas and Electric Power (50%) Savings
- Superior Process Uniformity
- Particle and Haze Free Deposition
- Suitable for Production Environments and High Batch Sizes

TYTAN Furnace Comparison Chart

STANDARD SERIES

Furnace Module	2000	8300
Wafer Size	6"	8"
Tubes (Up to)	≤4 TUBES	≤3 TUBES
Wafer Per Tube	200 ATM	200 ATM
	100 LPCVD	100 LPCVD
Flat Zone	34"/864 mm	34"/864 mm
Footprints	L 164"/4166 mm	L 164"/4166 mm
(Length, Height, Depth)	H 82"/2083mm	H 82"/2083mm
	D 30"/762 mm	D 30"/762 mm
Maximum Power	60 KVA	75 KVA

(310) 781-9219 (310) 781-9438 sales@tystar.com 7050 Lampson Avenue, Garden Grove, CA 92841

MINI-TYTAN FURNACE

The Mini-Tytan Furnace Systems are designed for diffusion, oxidation, anneal and LPCVD applications. With an 18” flat zone, the systems require less space than the Standard TYTAN Furnace. Suitable for R&D, Universities, and Production environments.

- Innovative Isothermal Chamber Design
- Small Footprint
- Up-time Performance in Excess of 95%
- Gas and Electric Power (50%) Savings
- Extremely Compact and Space Efficient
- Superior Process Uniformity

TYTAN Furnace Comparison Chart

MINI SERIES

Furnace Module	1600	1800	3600	3800	4600
Wafer Size	6"	8"	6"	8"	6"
Tubes (Up to)	1 TUBE	1 TUBE	≤3 TUBES	≤3 TUBES	≤4 TUBES
Wafer Per Tube	100 ATM 50 LPCVD	100 ATM 50 LPCVD	100 ATM 50 LPCVD	100 ATM 50 LPCVD	100 ATM 50 LPCVD
Flat Zone	18"/457 mm	18"/457 mm	18"/457 mm	18"/457 mm	18"/457 mm
Footprints (Length, Height, Depth)	L 63"/1600 mm H 54"/1372mm D 30"/762 mm	L 63"/1600 mm H 54"/1372mm D 30"/762 mm	L 138"/ 3505mm H 69"/1753mm D 30"/762 mm	L 138"/ 3505mm H 82"/2083mm D 30"/762 mm	L 138"/ 3505mm H 82"/2083mm D 30''/762 mm
Maximum Power	18 KVA	28 KVA	40 KVA	45 KVA	50 KVA

PROCESSES

Atmospheric Processes

- Dry Oxidation
- Pyrogenic Wet Oxidation
- Drip Feed Wet Oxidation
- Diffusion of Solid Source Dopants (Bn, P_2O_5)
- Diffusion of Liquid Source Dopants ($POCl_3$, BBr_3)
- Anneal (Sintering, Alloy, Metal Annealing)
- Nano Materials APCVD

Tystar Unique Processes

- Photo-enhanced CVD
- Modified CVD (Fiber Preform)

LPCVD Processes

- Polysilicon, Doped Polysilicon, Amorphous Silicon LPCVD
- LTO, Doped LTO, BPSG, BSG, and PSG LPCVD
- HTO LPCVD
- TEOS LPCVD
- Silicon Nitride LPCVD (Low Stress, Stoichiometric)
- Silicon Oxynitride LPCVD
- Silicon Germanium (SiGe) LPCVD
- SIPOS LPCVD
- Silicon Carbide LPCVD
- Nano Materials LPCVD

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VALUTEK

Meet Valutek

Our Mission

Our mission is to assist our critical environment customers in achieving their productivity, yield, and compliance goals.

Our Vision

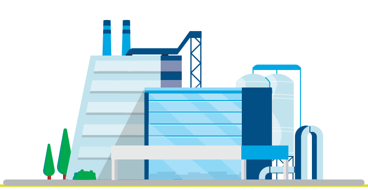
- Product Quality and Consistency
- Innovative and Entrepreneurial
- Industry Knowledge Share
- Customer Education

Valutek is one of the first and few manufacturers to offer a full product portfolio of best-in-class cleanroom products. Since 1988, our controlled environment consumables have been helping leading organizations in Life Sciences, Advanced Materials, and Academia operate their cleanrooms in a consistently stable state.

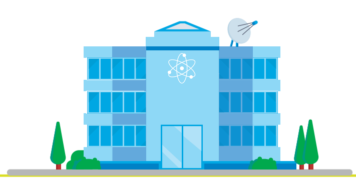
Valutek makes it easy to determine which products are most appropriate by offering three distinct product lines specially engineered to exceed the cleanliness needs of your unique controlled environment. Our innovative business model eliminates the need to coordinate with multiple manufacturers, invoices, and contacts – Valutek does it all.

For over three decades, Valutek has demonstrated its commitment to the advancement and evolution of controlled environments. We generously share our market expertise with our valued customers to help them achieve the best possible outcomes.

Advanced Materials



Life Sciences



Government & Academia

Valutek Cleanliness Classification

NanoTek
ISO 3-4 (Class 1-10)

MicroTek
ISO 5-6 (Class 100 - 1,000)

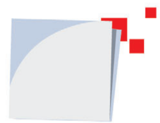
MacroTek
ISO 7 + (Class 10,000 +)

VALUTEK
Products and Services

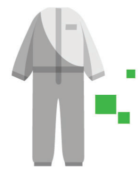
Valutek offers a comprehensive portfolio of cleanroom products designed to meet the stringent requirements of controlled environments. **Our product range includes gloves, wipers, apparel, adhesive mats, documentation, glove liners, cleaning supplies, and ESD consumables.**

Product Categories

Gloves

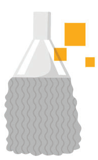


Wipers

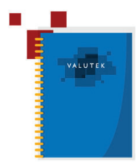


Apparels

Adhesive Mats



Cleaning & Maintenance



Documentation

Glove Liners

ESD

In addition to our extensive product offerings, Valutek provides cleanroom consumable testing services to validate the quality of a vendors' products and ensure that the garments being used meet cleanroom specifications of the facility.

The testing services aim to provide a comparative analysis of the current product and other available options. All testing is conducted according to IEST/ASTM documented test practices.

1-800-763-1250 or 602-256-0540
orderdesk@valutek.com
Valutek Phoenix HQ: 220 S 9th Street Phoenix, AZ 85034
www.valutek.com

INNOVATIVE ULTRAPURE WATER SOLUTIONS

Evoqua Water Technologies, now part of Xylem, is a leading water solutions provider for the microelectronics and nanotechnology market with decades of experience, a world-class service network, and industry-leading innovation. From high-volume manufacturing of integrated devices to the production of high-purity specialty chemicals and wafers, our cutting-edge ultrapure water (UPW), wastewater, and reuse solutions will help you improve product quality, yields, and meet discharge and sustainability goals.

www.xylem.com

INNOVATIVE ULTRAPURE WATER SOLUTIONS

With a global service presence that includes the largest service network in North America, Xylem stands ready to support microelectronics production and innovation with fast response, dependable service, and performance you can trust.

- **Ionpure® VNX Modules**
  Continuous electrodeionization (CEDI) technology provides chemical-free, self-regenerating production of ultrapure water for safer, more consistent operation
- **Vanox® AOP System**
  Reduces and controls difficult to remove total organic carbon (TOC) for optimal performance
- **Wastewater Ion Exchange Services**
  Removes metal contaminants from waste streams to meet discharge requirements or to achieve water quality standards for reuse and recycling
- **Sophis™ Digital Services**
  Combines smart technology, data analytics, engineering expertise, and proactive service to efficiently manage the entire product lifecycle for peak performance
- **Mobile Solutions**
  An ever-expanding fleet of mobile water treatment solutions to meet your temporary and emergency high-purity water needs

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Let's Solve Water


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→ Fume hoods
→ laminar flow equipment
→ Wet process stations
→ Chemical fume hoods
→ Glove boxes
→ Robotics
→ Dry boxes
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→ Carts and racks
→ Custom fabrication in Acrylic, PVC, Lexan, Polypropylene and Stainless Steel.
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Constructing an Intelligent Tomorrow

ABOUT US

AM Technical Solutions (AM), founded in 1994, is a proven and licensed architecture, engineering, construction and commissioning firm. Our company delivers the entire scope of work for high-tech construction projects on schedule, on budget, and at the level of quality required by customers. Our company does not settle for the construction industry standard of "Pick 2" from schedule, budget, and quality.

The AM core foundation was built on quality programs that optimized semiconductor facility operations. As the company developed, AM added core competencies through strategic acquisitions, to create a complete end-to-end solution for high-tech construction project delivery.

CONTACT US

Abbie Gregg

agregg@amts.com

AMTS.COM

HIGH TECH CONSTRUCTION

Global Architecture, Engineering, Construction and Commissioning Firm

SOLUTIONS

- ARCHITECTURAL & ENGINEERING DESIGN
- CONSTRUCTION MANAGEMENT
- QUALITY INSPECTIONS & TESTING
- CLEANROOM BUILD AND INSTALLATON
- COMMISSIONING
- CLEANROOM CERTIFICATIONS

AWARD WINNING PROJECTS

- 2002 | FAB OF THE YEAR – Silterra Fab 1 – semi
- 2006 | LAB OF THE YEAR – Arizona State University Biodesign Institute – R&D
- 2011 | LAB OF THE YEAR – King Abdullah University of Science and Technology – R&D
- 2019 | LAB OF THE YEAR – MIT.nano – R&D

ATLANTIS LABS

Atlantis Labs provides installation, integration, configuration and custom development services for the NEMO laboratory management system. In addition, we provide yearly support and maintenance services to ensure your instance of NEMO is always up to date and running smoothly.

NEMO is an open source system developed at the National Institute of Standards and Technology (NIST) to manage and operate its NanoFab facility. It is being actively maintained and has been forked many times by other labs and universities

Atlantis Labs has extended the original NEMO code base to include support for authentication, billing, user details, access control, reports, training, publications and more. Additional plugins to meet your specific need can be custom developed.

Services Provided

starting prices and included services

Installation – $5,000

NEMO lab management software, Nginx web server, PostgreSQL database, Version-controlled configuration, Remote control server management, Encoded secrets, Server provisioning, Keycloak user management & authentication, HTTPS certificate management, Safety Data Sheets configuration, Server secure configuration.

Server + Maintenance Yearly Support – $6,000

Unlimited customer and technical support, Maintenance and updates of all applications, Server maintenance, Troubleshooting, Priority bug fixes on any NEMO plugin, 5 hrs of custom development.

Custom Development

Priced depending on requirements

Contact us at nemo@atlantislabs.io
www.atlantislabs.io

DAVENTRIA

Advanced Process Technology for Development Labs

CMP — Metrology — Backgrinding — Vacuum Gauges

Service, Sales, Process Development & Spare Parts

G&P TECHNOLOGY

CMP and Post-CMP PVA Clean

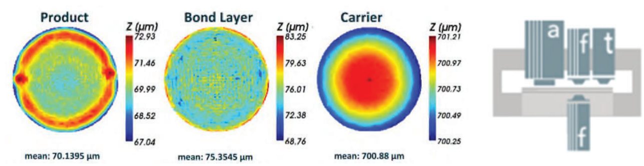
- CMP tools for up to 300mm
- Designed for University Use
- Automated Process Control
- Membrane Wafer Carrier
- In-situ Pad Conditioning
- Unmatched Reliability

- Post CMP PVA Cleaning
- Single Station or Multi
- Automated Clean Process
- Doubleside PVA Brush
- Rinse & Dry
- Megasonic Capable

sentronics METROLOGY

Multi-Sensor Metrology Platforms

- Compact Optical Metrology
- Open Platform, Configurable
- Multilayer Thickness
- Surface Topology & Step Height
- Thin Film Measurement
- Rapid Adaptive Metrology

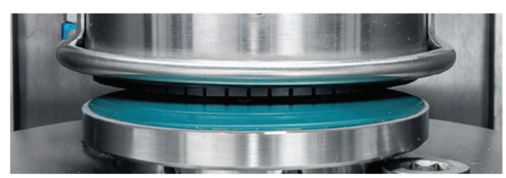


An example of multi-sensor capability combining top and bottom mounted sensors for fast (<2min) high lateral-resolution layer thicknesses for a 200mm bonded wafer assembly. Sensors can be added to SemDex platforms as needed, and for a limited investment.

G&N

Wafer Thinning & Backgrinding

- Compact Grinding Platform
- User Friendly Touchscreen Controls
- High Visibility Process Chamber
- Variable RPM Rotary Table
- Vacuum Chuck with Shape Control
- 75 Years of Grinding Experience



Configurable grinding platforms with work chuck and grinding capability for any wafer size or SiC pucks.

ph instruments srg technology

Spinning Rotor Gauge Vacuum Measurement

- Vacuum Measurements with 1% accuracy
- Calibration Systems for HC/CC Gauges
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* Photoresist Removal, Descum or Oxidation
* Extermely low damage Plasma

e-Series of Ashers:

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e3611 single chamber TCP RF plasma

e3612 dual chamber TCP fast Throughput

Advantages:

- Increase Yield
- Improve Uptime
- Reduce Maintenance Costs
- Lower Cost of Ownership
- Windows 10 based IDX software

ESI has been providing unique innovative upgrades, cost-effective technical solutions, high quality equipment worldwide since 1986. All of our equipment goes through a series of rigorous full process tests which are documented, standardized, and certified by performance and reliability standards to ensure the highest quality. All our systems and sub systems are manufactured in the USA. Our existing customers come back to us because of the high quality and outstanding customer service we provide.

FabuBlox: A Unified Platform for the Future of Digital Twins and AI-Driven R&D in Micro- and Nanofabrication

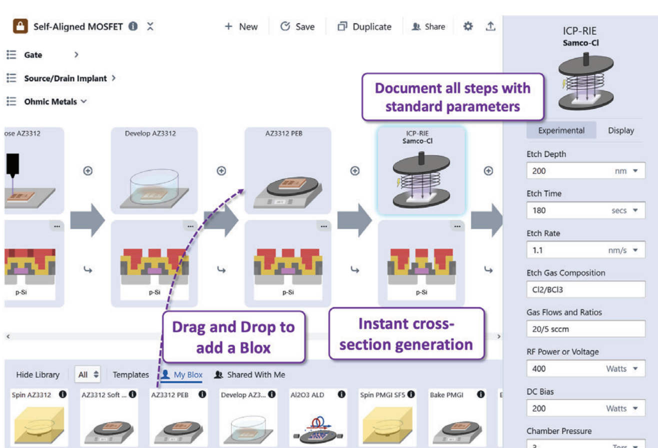
FabuBlox, Inc.
Contact us at founders@fabublox.com

The nanofabrication world has a communication problem – across the decentralized R&D ecosystem of academic, government and industry fabrication facilities worldwide, there are no standard frameworks for nanofabrication data management, visualization, knowledge transfer, or process discovery. This leads to slow, inefficient, and expensive fabrication process development. Fab knowledge remains scattered, unorganized, incomplete, and searchability of existing databases is highly limited.

FabuBlox is a highly accessible, cloud-based platform that combines a generative EDA interface with GitHub-like repository-building capabilities setting a new standard for visual design and data management within micro- and nanofabrication. Similar to the way Git revolutionized data management and collaboration in software development, FabuBlox offers a disruptive cross-fab solution to these challenges in nanofabrication, thereby re-imagining interoperability of nanofabrication processes and enabling the next generation of digital twins as well as AI-driven process development and discovery.

The FabuBlox Process Editor provides users with standardized process blocks and parameter spaces to collaboratively build and easily share processes while algorithmically and automatically generating wafer cross-sections. Process repository building is enabled with unprecedented ease of shareability, searchability, and filtering functions for any parameter, material, or tool used. Through the incorporation of process module repositories – short, repeated tool sequences – facility managers can share and automatically update best known practices and recipes to help users streamline process development and avoid redundancy in problem solving. In the near future, FabuBlox will support tracking of process and module version history with automated parameter change detection.

A fundamental integration of facility infrastructure within the FabuBlox ecosystem is currently being implemented. Automated material and tool compatibility design rule checks, specific to a facility's set of tools, will improve operational efficiency by reducing tool down-times and adding automated contamination control. FabuBlox process repositories will be further enhanced by incorporation of metrology data, thereby allowing for tracking of tool calibrations between facility managers, users, and tool vendors. The creation of digital twins on FabuBlox will ultimately enable process interoperability by intelligent recipe translation across facilities. These feature with closely integrate with the NEMO platform, adding real-time tool information and metrology to FabuBlox.

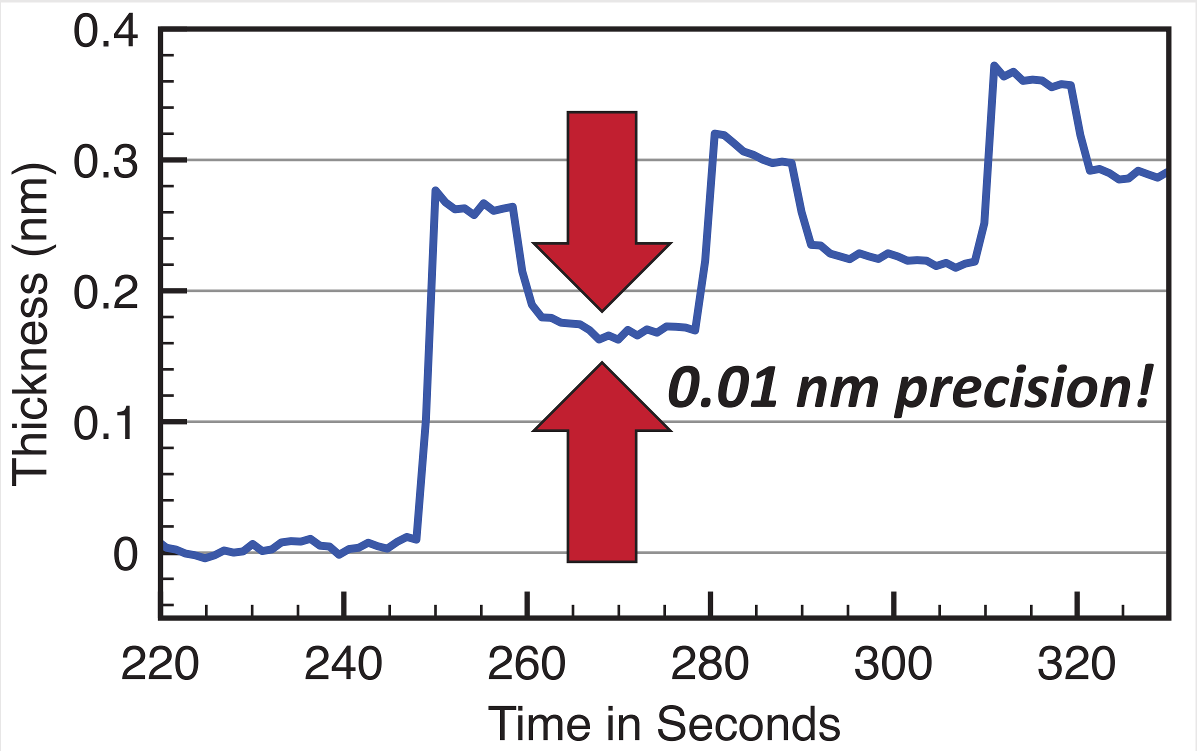


The FabuBlox Process Editor Interface

Film Sense™

- **Accurate Thin Film Measurements at Affordable Price**
  - Patented Multi-Wavelength Ellipsometer Technology
  - Ex Situ, In Situ, and Automated Mapping Systems
  - Fast, Easy-to-use, Reliable Measurements
- **Film Sense Model Builder**
  - Automatically build & test multiple models, ranging from simple models with book value optical constants, to non-ideal models with surface roughness & grading (even parameterized oscillator models for some film types)
  - Great tool for users new or little experience with ellipsometers
- Can determine thickness, optical constants n&k, surface roughness, composition, temperature, multiple layer thicknesses, etc.

In Situ Monitoring



www.film-sense.com

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WHAT WE DO

At Hallam-ICS, we specialize in the design and development of process, electrical and mechanical systems, control and automation solutions, and critical safety and regulatory compliance for complex semiconductor, life sciences, and industrial manufacturing plants and facilities.

What sets us apart is our encompassing approach, understanding both the business goals and the technical engineering and control insight required to create and update modern plants and facilities so they become a competitive advantage for your organization.

We Provide Precision Engineering and Project Management in Every Project

Often called on to solve the most complicated challenges in a facility, Hallam-ICS is known for breaking down the barriers to improvement and success with engineered solutions. We mobilize a team to understand the challenges you're facing, whether in a new or existing facility, and apply our expertise to design and implement the best path forward.

Hallam-ICS teams can work alongside other experts for a single system or lead your engineering and process solutions end-to-end, from initial design through operational lifecycle. Regardless of how an engagement starts, our clients keep us on deck as an ongoing advisor or bring us back for the next obstacle.

Helping Semiconductor Clients Accelerate and Scale Without Impacting Production

The path to opening a new fab quickly or improving operations in existing fabs requires significant domain knowledge of their inherent hazards and processes, and the ability to protect semiconductor production during projects.

Hallam-ICS specializes in control systems and engineering solutions for hazardous materials and clean environments, having partnered with semiconductor companies for the last 35 years, from engineering base builds and tool installations to control solutions for chemical management and toxic gasses. In the last decade, Hallam-ICS has become the industry's go-to for TGMS, and the partner leading semiconductor organizations rely on to solve the most challenging engineering and controls projects in the fab.

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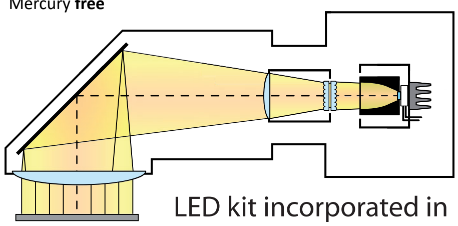
idonus

Equipment for microfabrication, processing, inspection and assembly

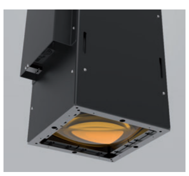
Founded in 2004, idonus is a Swiss company specialized in the development and fabrication of manufacturing equipment for the MEMS and semiconductor industries. Our product portfolio includes UV LED Exposure and Alignment Systems for Photolithography, Vapor Phase chemical Etcher for silicon-based devices, IR inspection and other high-performance equipment.
We customize products according to needs of our clients. The vertical integration of the company enables fast prototyping and shorter lead times for customers.

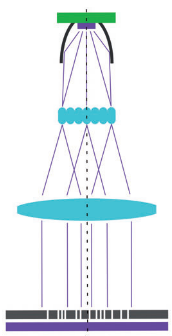
UV-LED Light source

Stand alone or Kit for Retrofit for Mask Aligner



LED kit incorporated in mercury lamphouse





BENEFITS

- Increased process control and stability
- Higher yield
- Longer lifespan
- No hazardous materials and toxic waste
- Low maintenance costs
- Instant ON/OFF, reduced equipment downtime
- Regulatory compliant

FEATURES & PERFORMANCE

- Optical resolution: 0.5 um
- Irradience: 100 mW/cm² and beyond
- Exposure area: up to 600 x 600 mm
- Non-uniformity: 2.5 %
- Collimation angle: 0.9° to 2.5°
- Wavelength: 365/405/435 nm

Mask Aligner

for photolithography exposure

FEATURES & PERFORMANCE

- Modular system architecture
- Manual / Semi-automated / Fully-automated
- Exposure area: up to 600 x 600 mm
- Resolution: below 1 µm
- Alignment precision: 1 µm
- Irradiance: 100 mW/cm² and beyond
- Top side and back side alignment

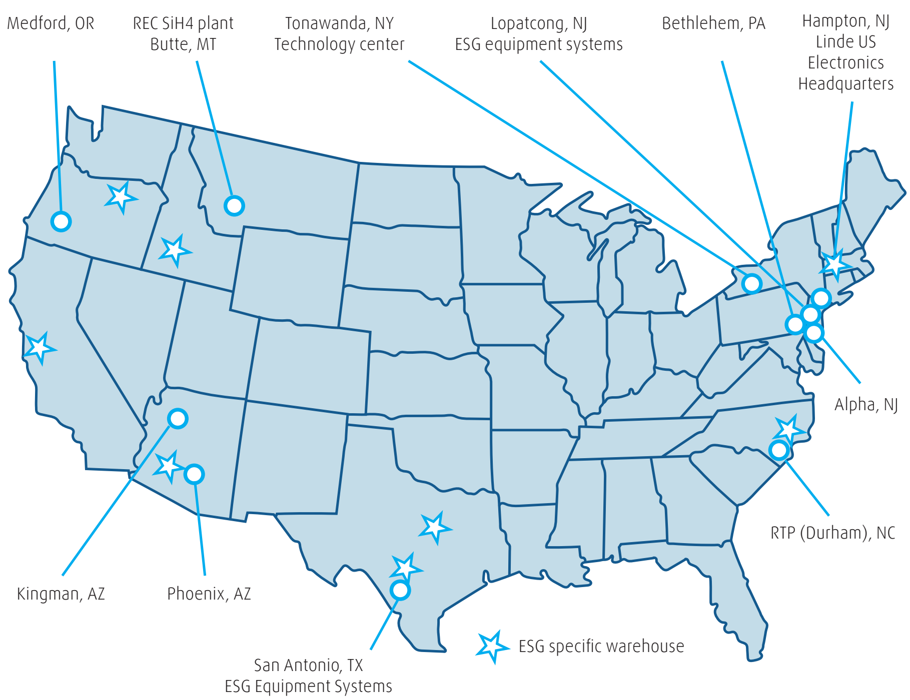

Monitor Deposition in Real Time
Ellipsometry offers solutions that improve your process with live feedback.
+OPTIMIZE DEPOSITION PROCESS
Determine thickness and optical properties of films and multi-layer stacks for metals and dielectrics
+IMPROVE QUALITY CONTROL
Detect variations as they occur with live feedback during the deposition process
+MONITOR GROWTH KINETICS
Sub-angstrom thickness sensitivity provides additional information about film nucleation, surface conditions and other process parameters
J.A. Woollam

Why Choose Linde?

With a global supply network of products and services, Linde provides customer-tailored gas handling solutions to meet their process needs. Our mission to make our world more productive includes the following:

- Our commitment to continuously improve our safety culture and performance world-wide.
- Our commitment to responsive deliveries and accurate lead times.
- Our commitment to provide customer-tailored supply system designs.
- Our commitment to service after the sale:
  - 24/7/365 phone support
  - Field Service – for system training, start-up, and commissioning
- Our commitment to provide customer required HAZOP support for our systems.

Let our experts help you select configurations based on your specific requirements.



Learn More About Linde

We are a leading industrial gas & engineering company.

- 100+ countries with ~65,000 employees
- $33 billion sales in 2023
- $12.6 million global givings in 2023
- 2 million+ customers
- 7,500+ active patent assets worldwide

- At Linde, safety is a core value that keeps us focused on the well being of our people, the environment and communities we operate within.
- At Linde, a leading industrial gas and engineering company, we are committed to supporting the semiconductor and solar industries with five existing plants and plans for a sixth in two years.
- We provide a reliable product supply with 95% of electronic gases sourced from a 100% US supply chain.
- Our expert electronics group includes a team of safety engineers and quality team members in the US, supported by critical quality components like Linde TLIMS and quarterly quality reports.




Ultra-High Purity UHP Gas Equipment Solutions

Linde provides a complete line of UHP gas equipment solutions that are designed and manufactured to provide safe and reliable gas delivery service:

- Manual and semi-automatic valve panels
- PLC controller technology
- Automatic gas cabinets
- Valve manifold boxes (VMBs) and distribution valve boxes (DVBs)
- Bulk specialty gas systems (BSGSs), specifically designed for larger gas packages (tonners, drums, ISO containers, tube trailers)

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Key Products and Services

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Material Science & Chemistry

The versatility of Park AFMs allows them to serve as the optimal nanometrology solutions within the materials science and chemistry fields, wherein nanometrology is employed to characterize the properties and behavior of nanoscale materials and molecules. With the capability to characterize materials' electrical, magnetic, mechanical, and morphological properties, Park AFMs offer specialized operating modes that empower materials researchers to advance their understanding and control of nanoscale behavior. They also enable chemistry scientists to scale up their research on the chemical composition, structure, and reactivity of nanoparticles, nanocomposites, and other nanoscale materials.

- **Research and Surface Analysis**
- **Nano Infrared Spectroscopy**

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Park's Imaging Spectroscopic Ellipsometers combine the benefits of spectroscopic ellipsometry and optical microscopy in a single device. The integration of the two technologies creates a unique metrology tool that redefines the limits of both spectroscopic ellipsometry and polarization-contrast microscopy. The enhanced spatial resolution of Parks Imaging Spectroscopic Ellipsometers expands ellipsometry into new areas of microanalysis, microelectronics, and bio analytics.

- **Imaging Spectroscopic Ellipsometry**

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TECHNOLOGY

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High Quality Coater & Developer Track Systems

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Wide technology portfolio configurable to address Lab-to Fab needs.

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Highest degree of precision, throughput, and process repeatability.

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- RIE
- DSE™
- IBE
- ALE
- HDRF™

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Precise thin film formation of dielectrics, metals and alloys with unique properties.

- PECVD
- HDPCVD
- IBD
- F.A.S.T.®
- Evaporation
- Sputtering

Thermal Processing

Damage-free material removal and coating with maximum yield and flexibility to process multiple wafer sizes.

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- RTA
- RTO

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WHEN THIN FILMS MATTER

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- An **appreciated** and **significant** partner in the thin film industry

CLUSTER PLATFORM HIGHLIGHTS

- Process frame for epitaxial growth of thin films at elevated temperatures up to 1000°C
- Glancing angle deposition (GLAD) on wafers in volume production
- Dynamic in-situ feedback control by PEM or RGA in reactive sputtering
- Market leading process software technology for accurate real-time control of deposition
- Bridge tool for process development to volume production

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- Remote plasma sputtering
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- E-beam evaporation
- Thermal evaporation
- Ion beam assisted deposition (IBAD)
- Pre-clean modules
  - Degas
  - RF pre-clean
  - ICP soft etch

FLEXIBILITY AND RELIABILITY

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- **Equipment Fabrication** - CAD/CAM, Certified Plastic & Metal Welding, UL Industrial Control Panel Shop, CNC, Assembly, and Full-Scale Testing
- **Laboratory Testing** -Massachusetts Department of Environmental Protection Certified Wastewater Testing Laboratory #MA-1080.
- **Field Services** – Maintenance, Calibrations, Repairs, Analytical Testing, Operation, and emergency service

Acid Waste Neutralization System

Practical Applications, Inc.
8 Adele Road
Woburn, MA 01801
617-423-5639
info@paih2o.com

Company Profile

Raith GmbH

SUMMARY

Raith is a leading precision technology solution provider for nanofabrication, electron beam lithography, maskless laser lithography, focused ion beam fabrication, nanoengineering, and reverse engineering applications.

Customers include universities and other organizations involved in various fields of nanotechnology research and materials science, as well as industrial and medium sized enterprises that use nano- and microtechnology for specific product applications or produce compound semiconductors.

Founded in 1980 and headquartered in Dortmund, Germany, Raith employs more than 300 people and plans to grow further. The company works as closely as possible with customers in the most important global markets through subsidiaries in the Netherlands, the USA, Asia, and India and through an extensive partner and service network.

In February 2013 Raith joined forces with Vistec Gaussian Beam Lithography, another leading electron beam lithography equipment manufacturer with more than 45 years of experience. This extension of the product portfolio now enables customers to select from a comprehensive range of nanofabrication systems and services. In July 2021 Raith acquired 4PICO Litho, expanding its nanofabrication portfolio to take in maskless laser lithography.

With its broad range of solutions, Raith operates in all areas where micro- and nanostructures are deployed as indispensable components of products, devices, and technologies. Raith systems are typically utilized in scientific disciplines like quantum physics, nanoelectronics, photonics, materials science, nanobiotechnology, and nanomedicine. Some of the largest application areas focus on semiconductor, information, and data storage technologies. Lithographic processes served by Raith’s solutions are also used for developing new devices and processes in the field of renewable or solar energies and in counterfeit protection.

Fisher Scientific Channel

Premier Scientific Supplies Partner for Research and Production

The Fisher Scientific channel offers convenient access to the most comprehensive offering of products and services to allow customers in the research, production, healthcare, and science education markets increase productivity and efficiency.

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- Consultative representatives with deep technical expertise
- Technical specialists offer life sciences, chemical, safety, and production support
- Dedicated customer service and inventory management teams in North America

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- Industry-leading scientific supplies portfolio
- 2.5M+ products from over 9,000 suppliers globally
- Product categories include reagents and chemicals, instruments and equipment, consumables, and safety

eCommerce Platform

- Efficiently search, order products, and track shipments
- Seamless integration with customer eProcurement systems
- Over 70% of orders worldwide are transacted online

Supply Chain

- Integrated network designed for next-day delivery
- Consolidated and scheduled shipments per customer requirements
- Cold-chain logistics and dangerous goods handling

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Overview

TMC is a leading global supplier of vibration control solutions for Original Equipment Manufacturers and end users. TMC has long been acknowledged to be the technical leader in our industry based on our installed base, number of patents, sales, number of engineers and scientists, and product technological superiority. Yet all our knowledge and experience is of limited practical value if we do not have a mechanism to quickly and efficiently design and manufacture the products required to solve problems with uncompromised quality and specifications.

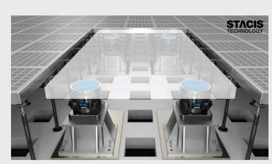
At our core, we are manufacturers. While others pay lip-service to manufacturing while outsourcing much or all their production, TMC stands apart as a true vertically integrated factory. Unparalleled expertise in precision floor vibration control and a commitment to manufacturing. This is what sets TMC apart.

Products and Services

STACIS 4®

SEM-Base®

CleanTop®



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Changelog

This UGIM, we are trying out a couple of new things / changes - some MIT-specific and some general. The list below highlights this set of experiments. Many of these changes were based on, or inspired by, past UGIM and ENRIS conferences. We're always curious to know how they worked out, so tell us after the conference!

Sunday Program: Inspired by past UGIMs, which traditionally focused Sunday afternoon on helping new members of the UGIM community and sharing knowledge, we decided to utilize the Sunday afternoon session to explore current areas of interest to the broader UGIM community. With Chips-Act activities ramping up, we felt exploring the design and building of complex nano facilities (with MIT.nano as a bit of an introductory case study) would be of broad interest. To this end, we invited four MIT staff and faculty to introduce MIT.nano and 12 industry experts to cover the various building systems. But, rather than take a deep-dive, we asked them to tell us the three things everyone should know about their system / area of expertise. We conclude the session in the evening with a panel discussion, aimed at connecting the dots and highlighting the inter-dependencies between the various systems.

Working-Groups: We are prototyping working-groups, as a concept for future UGIMs and way to continue on-going discussions between labs. The structure of a working group is: (1) to pre-discuss a topic of broad interest and therefore (2) pool in-depth data and information from across many different participant organizations. The resulting group-consensus (or lack thereof) will be presented at UGIM in a 40 min talk (ideally a balance of presentation and open discussion). We hope the working group can create a reference point, or even an "industry standard", which lab managers can point towards in their own decision making (or when convincing their administration). Post-UGIM, we hope that the working group discussions will continue (maybe on a quarterly basis).

Facility Quick-Intro: The idea of having 2-minute, 2-slide quick overviews of labs at UGIM arose by combining two concepts that we liked: (1) MIT's Microsystems Technology Laboratories' annual research conference, where students give 60-second intros of their research, and (2) the facilities posters at ENRIS 2023 which included interesting details about different labs. We merged these two ideas, and hope that an introduction and data on 40 different labs will help attendees understand the landscape of different facilities, as well as serve as a way to strike up conversations among labs. We also included "recently added" & "tool wishlist" as categories, which should be an interesting way to spot trends, or create conversations among labs. By publishing the slides, and inviting all other labs to contribute (even if not presenting in this format), we hope to create a valuable snapshot of the shared facility landscape in 2024 – with similar updates possible at future UGIMs.

Sponsor Table Multiplexing: Based on discussions with vendors during UGIM 2022, and because of limited floor space in our main event venue, we structured the sponsorship opportunities to enable single-day and multi-day sponsorship. This means that attendees have to be more aware of who is exhibiting when; but it also allows us to have a broader range of sponsors in spite of space limits. We hope this will also help focus attendee's attention, as long as we advertise which sponsor is present each day (see back of conference book for a map). That said, sponsors can customize through an a-la-carte menu (which could include a presence every single day if they so choose).

Sponsor tables on Sunday, Wednesday & during the Tuesday evening event: With the Sunday focused on building a lab, as well as tours, we realized that some sponsors may prefer to have tables during the Sunday session – especially for those focused on building systems or who have tools present at MIT.nano that people see during the tours. In addition, during our walk-through of the MIT Museum space, we figured that having "discussion tables" during the Tuesday dinner could be a nice way to elevate Platinum sponsors and continue lab-vendor discussions in a more social setting. Finally, additional tables on Wednesday provide additional exhibit opportunities, and additional tables for Platinum sponsors.

Long breaks & Exhibit Space Live-Stream: During UGIM 2022 at the U. of Wisconsin, we really enjoyed the 40-minute-long breaks, which allowed deeper engagement with vendors (beyond rushing out for coffee and restrooms). We kept that pace, to balance talks & interactions. We also added a video feed of the auditorium inside the exhibit space – to make it easier for attendees to alternate between the talks and exhibits (without fear of missing a talk they wanted to hear), and for vendors being able to see the talks without abandoning their sponsor table.

Program Book and Vendor Pages: From our own experience, brochures and marketing materials picked up during a conference often don't make the return trip home, because of the loose collection and varying sizes. To offer a longer lasting solution, we chose to include 1 page for each sponsor (2 pages for Platinum sponsors) in the program book – so that attendees have a single place to reference and learn about capabilities and opportunities for their own labs.

Starting Hours & Distributed Tours: Not everyone likes getting up at 6am in search of a conference breakfast - so we're starting the conference at 9am; with breakfast beginning at 8am. The "late" start allows us to also offer lab tours in the morning at 7:30am, for the early risers. To avoid crowding during lab tours, we decided to distribute tours – with options on Sunday afternoon, Tu/We mornings, and Wednesday afternoon (for those who are leaving Boston late or those attending the full Sunday program). We also split tours into different flavors, so that people can put together the program that they're interested in.

Coffee, Tea, and Raffle: Instead of spending money on catered, overpriced, cold coffee in cardboard jugs, we bought six Nespresso coffee makers and supplies. Attendees thus can make their own coffee throughout the day (we also offer instant coffee for anyone impatient). Coffee capsules will be recycled at Nespresso after the conference to reduce trash. Complementary to the coffee we picked a selection of 32 different teas (16 in sachet form, 16 as loose leaf). On Wednesday, during the conference closing, we will then raffle off the Nespresso machines: to whomever has made it through the conference (presumably thanks to the coffee…) and we'll ship the winners their machines, a week or two after. All academic attendees are eligible for the raffle (no MIT staff, MIT-affiliates, nor industry attendees are eligible). Physical presence and alertness on Wednesday during the closing ceremony is required to be eligible to win. We hope the end-of-conference raffle will be a fun way to end the conference.

Early & Late Paper Submissions: We thought it may be easier to review abstracts by having two deadlines – for early & later submissions. It wasn't quite as easy as we thought, because of the uncertainty in how many total submissions would occur (and so we partially accepted some of the early batch submissions, while delaying the rest). Overall, it still helped us in planning, and seemed worthwhile to do (and hope that it helped authors with their own planning, too).

Food Roadmap

[V] = Vegetarian Lunch Option
GF/Vegan options available, inquire

Sunday Lunch Boxes
(Pressed Cafe)

1. Eggplant Chicken Parm
2. The Zohan (Grilled chicken, Hummus, Avocado, Cheddar)
3. Chipotle Braised Short Rib Grilled Cheese
4. Tel Aviv Tuna Salad with Zaatar Pesto & Labneh
5. Strawberry Goat Cheese Wrap [V]

All pressed on Ciabatta & with a side of potato salad.

Freshly pressed juices: Citrus Energy, California Sun, Ginger-Turmeric Lemonade, Watermelon and Blood Orange Agua Fresca

Afternoon Refreshments
(Colette Bakery)

Chocolate Croissants
Cannelé
Madeleines
Chouquette

Sunday Food-Trucks Dinner

1. Hometown Poke
2. Red Bones BBQ
3. Locos Amigos Tex-Mex
4. The Cookie Monstah (Ice Cream Cookies)

Monday Breakfast
(Tatte)

1. Sweet & Savory Pastries
2. Savory Pita Assortment
3. Mixed Berry Muesli Cups
4. Artichoke & Feta Quiche
5. Ham & Cheddar Quiche

Morning Refreshments
(Blackbird Donuts)

Boston Cream (filled)
Everything Bagel (filled)
Strawberry Rhubarb (filled) [Vegan]
Coffee Oreo
Maple Braid

Monday Lunch
(Tatte)

1. Short Rib Grilled Cheese Sandwich
2. BLT with Avocado and Sriracha Mayo
3. Pita with Roasted Chicken and Chopped Salad
4. Sun-Dried Tomato & Eggplant Sandwich [V]

Self-served salads:
Spiced Shrimp & Avocado Mousse Salad
Fattoush Salad (Baby lettuce, feta, croutons) [V]

Afternoon Refreshments
(LA Burdick Chocolates)

Fruit Candy Assortment
5 Types of Chocolate Bonbons
Luxembourgers

Monday Dinner Reception

Trolley Ride through historic Boston to the Museum of Fine Arts, Boston

Hors d'oeuvres, and pre-dinner drinks, Rotunda & Colonnade, and Gallery

Seated dinner in the Atrium Courtyard

Select galleries open for visiting/roaming

Tuesday Breakfast
(Bakey Babka)

1. Chocolate Babka
2. Peach Babka
3. Potato Burekas
4. Spinach & Cheese Burekas
5. Cheese Sticks

Morning Refreshments
(Blackbird Donuts)

Boston Cream (filled)
Everything Bagel (filled)
Chocolate Mousse (filled)
Salted Toffee
Strawberry Sprinkle [Vegan]

Tuesday Lunch Boxes
(Pressed Cafe)

1. The Middle East (Grilled Chicken and breaded Eggplant, Hummus, Tahini, Cilantro Hot Sauce)
2. Spicy Bbq Chicken with Smoked Bacon
3. The Wellington (Braised Beef Short Rib, Roasted Mushroom)
4. Grilled Salmon BLT with preserved Lemon Mayo
5. The Medusa (Grilled eggplant, Spicy Feta, Hummus), [V]

All pressed on Ciabatta & with a House Greens Salad

Freshly pressed juices: Citrus Energy, California Sun, Ginger-Turmeric Lemonade, Watermelon And Blood Orange Agua Fresca

Afternoon Refreshments
(Eataly Boston)

Assortment of Pasticcini
(small pastries)

Tuesday Dinner “Exploration”

MIT Museum

Hors d’oeuvres
Pre-dinner Drinks
Various Small Plates
Churro Bar & Cookies

Wednesday Breakfast
(Colette Bakery)

1. Cho-Colette
2. Amandine
3. Strawberry Brioche
4. Savory Flammkuchen
5. Quiche Lorraine
6. Quiche Vegetarian

Morning Refreshments
(Colette Bakery)

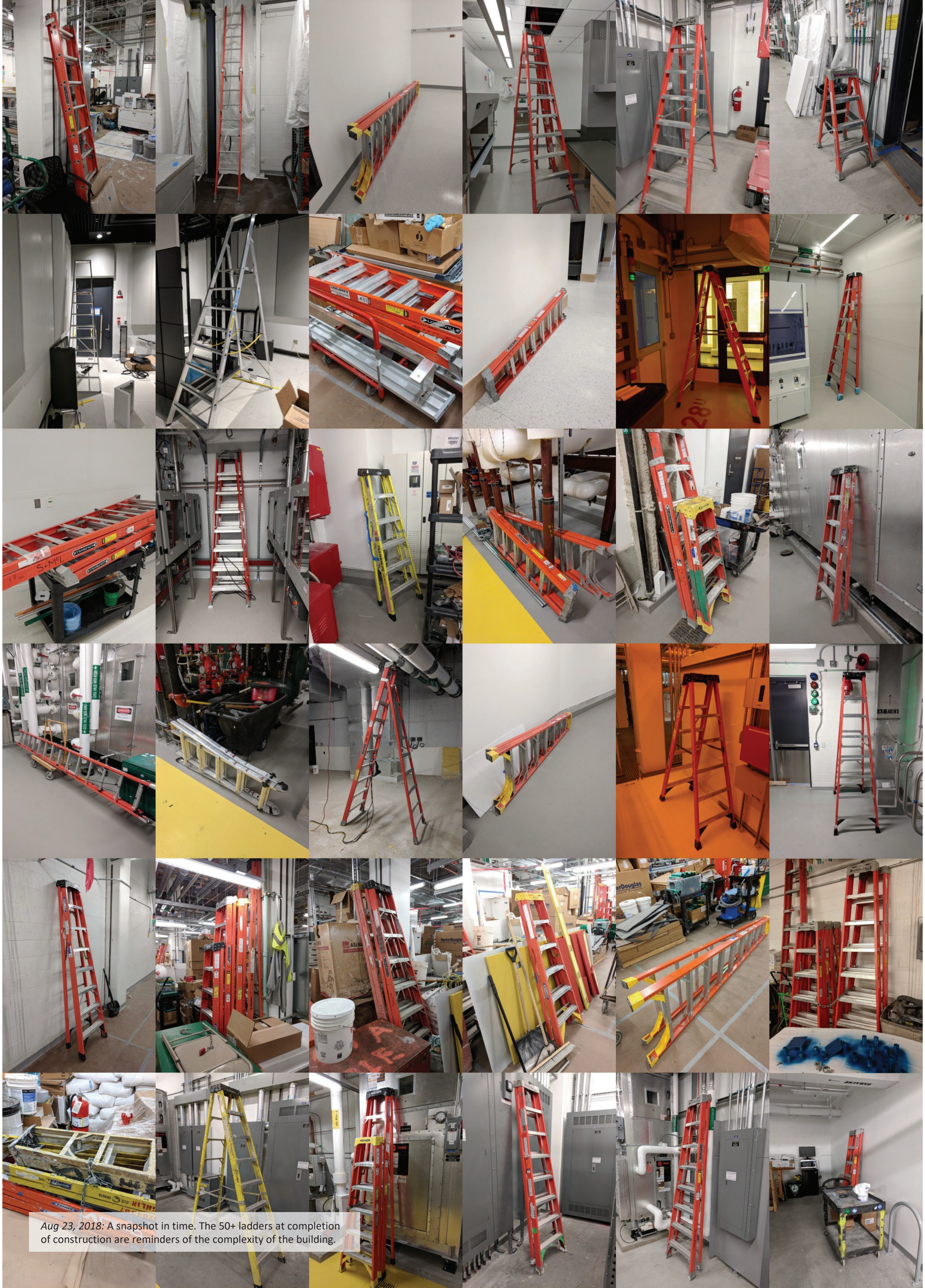
Eclairs
Macarons
Paris-Brest
Chouquettes

Wednesday Lunch
(Tatte)

1. Short Rib Grilled Cheese Sandwich
2. Turkey BLT with Avocado and Sriracha Mayo
3. Chilled Salmon Sandwich
4. Roasted Cauliflower Sandwich [V]

Self-served salads:
Strawberry, Roasted Peach & Chicken Salad
Crunchy Halloumi Salad [V]

Fresh fruits, coffee, tea, and water available throughout.



Aug 23, 2018: A snapshot in time. The 50+ ladders at completion of construction are reminders of the complexity of the building.

From 2019 through 2023, tools from the Microsystems Technology Laboratories cleanroom in MIT Bldg. 39 were moved into MIT.nano Bldg. 12, or decommissioned and sold/donated. A few of these tools were too large for the elevator and hallways, and required a little bit more effort to take out…

Police details, asbestos remediation (window glazing), Cambridge Fire watch, decontamination, disconnecting and rigging all executed and supervised by MIT.nano.

Asbestos remediation prior to taking out the windows

December 2020 - Installation of additional N_2 tank, replacement O_2 tank and upgraded vaporizer capacity

July 2022 - Moving the Endura PVD

November 2022 – Decommissioned EPI deposition system. Polysilicon and Epitaxy contaminated forelines required detailed decon processes

July 2022 - Removal of decommissioned furnaces

Main Conference Sessions

Quick Reference. Additional program details in the booklet

Monday, June 24

9:40 AM | Hardware Locked Wafer Cage: A Behavioral Psychology Experiment
10:00 AM | We Were Robbed: A Heist at the Washington Nanofabrication Facility
11:00 AM | Undergraduate Staffing at an Academic Core Facility
11:20 AM | Starting a Microfabrication Undergrad Course
11:40 AM | Facilities Pitch
1:40 PM | Now Is Our Time To Shine: Capitalizing on the Expertise of the NNCI Network to the Create High-Tech Workforce
2:00 PM | The Joy of Owning a 25-Year-Old DUV Stepper Tool
2:20 PM | Increasing Recruitment and Retention into Semiconductor Manufacturing
2:40 PM | Student Engagement Programs to Assist Core Facility Staff in Research and Outreach Efforts
3:40 PM | Working Group: Staffing

Tuesday, June 25

9:00 AM | Establishing a Pilot Line in a Multiuser, Multi-Technology, Cleanroom
9:20 AM | Selection of Materials of Construction for Nanotech Process Tools
9:40 AM | Renovating and Aged University Building To add a Cleanroom
10:00 AM | PolyFabLab: A New IOS7 Cleanroom for Life Science Polymer Fabrication
11:00 AM | Evolving the Workhorse: Sustainable and Flexible Wet Bench Design
11:20 AM | Using a 3D Digital Twin to Tap Into Data Sources
11:40 AM | Facilities Pitch
1:40 PM | Business Tools and Processes to Improve Core Facility Operations
2:00 PM | NEMO Lab Management and Operations Software
2:20 PM | Building an AI Copilot for Nanofabrication Facilities
2:40 PM | A Radical Approach to Manage Access to E-beam Lithography
3:40 PM | FabuBlox: A Visual Design & Data Management Tool for Micro- and Nanofabrication Processes
4:00 PM | Enhancing Research Data Management and Access through an Integrated Booking System
4:20 PM | Carbon Footprint Reduction for Prototyping 200mm Wafer Fab
5:20 PM | Working Group: Process Control

Wednesday, June 26

9:00 AM | The Journey to Building a New Cleanroom: Preventable Issues and Why They Still Happened
9:20 AM | Supply of Lab Utility Gases: Planning for a Safer, More Economical, and Decarbonized Future
9:40 AM | Silane and other Pyrophoric Gases
10:00 AM | Managing a High-volume of Users in a Characterization Facility
11:00 AM | Sustainability at the Australian National Fabrication Facility: An Update
11:20 AM | Carbon Footprint Reduction for a Prototyping 200mm Wafer Fab
11:40 AM | Workflows for Prototyping Cleanroom Management
12:00 PM | Moodle: A platform for e-learning and instrument training

Vendor Schedule

Vendor	Sun	Mon	Tue	MITM	Wed
Hallam	■				
Practical Appl.	■				
NEL	■	■			
ESI	■	■			
Idonus		■			
Woollam		■			
Polyteknik		■			
Raith		■			
Reytek		■			
Semilab		■			
TMC		■			
Samco	■	■	■		
Air Control	■		■		
Ebara			■		
Park Systems			■		
S-Cubed			■		
Suss			■		
Thermo Fisher			■		
Transene			■		
UC Comp.			■		
AARD Tech.		■	■		
Filmsense		■	■		
SPS-Intl.		■	■		

Vendor	Sun	Mon	Tue	MITM	Wed
UpNano		■	■		
Daventria			■		■
AMTS					■
FabuBlox					■
Kayaku					■
Linde					■
PicoTrack	■				■
Plasmatherm					■
CSI			■	■	■
Oxford			■	■	■
Disco		■		■	■
Valutek		■		■	■
DOD Tech.		■	■	■	■
Heidelberg		■	■	■	■
Lab14		■	■	■	■
Lesker		■	■	■	■
Reynolds Tech		■	■	■	■
STS Elionix		■	■	■	■
Tystar		■	■	■	■
Edwards	■	■		■	■
Xylem	■		■	■	■
Expertech	■	■	■	■	■