MASH

Mid-Atlantic SEMICONDUCTOR HUB

Partnering for a Strong American Semiconductor Future

WHAT IS MASH

MASH is an interdependent coalition of top universities and industries that will combine resources and expertise to meet the needs of the semiconductor industry in the U.S. by strengthening and aligning research, manufacturing, and workforce development.

FOUNDING UNIVERSITIES

CONTENTS

MISSION & SCOPE

MASH Mission & Scope

MASH will support the CHIPS and Science Act to enhance America's strength in semiconductors and microelectronics and promote economic development.

The goal of MASH is to create the world's largest nanofabrication, packaging, and characterization facility by linking and enhancing the facilities in the region. The MASH "distributed" network of facilities will support technology transition to manufacturing and offer redundancy of resources and immediate access to a huge amount of technical expertise in semiconductors.

MASH will focus on helping the semiconductor industry to transition materials into systems, which is a critical industrial need of many emerging applications such as advanced communications, non-volatile memory, More than Moore devices, Industrial Internet of Things, artificial intelligence, edge computing, wireless communications, quantum devices, environmental sustainability, and materials and substrates.

MASH activities will center around three cross-cutting areas: Si-adjacent technologies, advanced packaging, and virtualization of semiconductor processes.

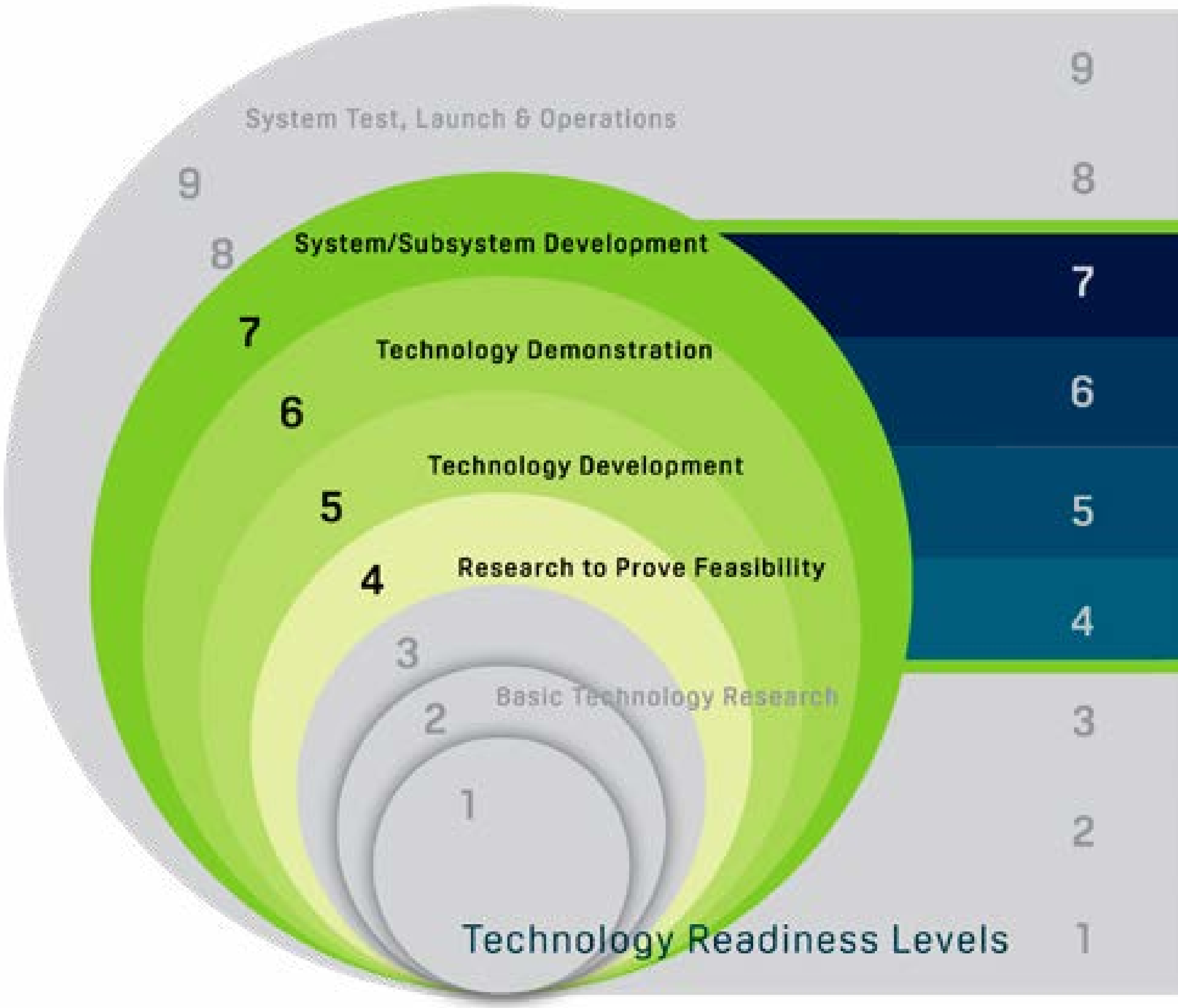
MASH will develop skills-based educational and workforce development plans to provide companies with an agile system to meet staffing requirements, and at the same time, enhance racial and socioeconomic diversity.

MASH will be a hub for regional and national activities to promote professional education and training, educate the public on semiconductors and microelectronics, share and coordinate materials standards, identify funding opportunities, and build networks and technology road maps.

MASH Mid-Atlantic SEMICONDUCTOR HUB

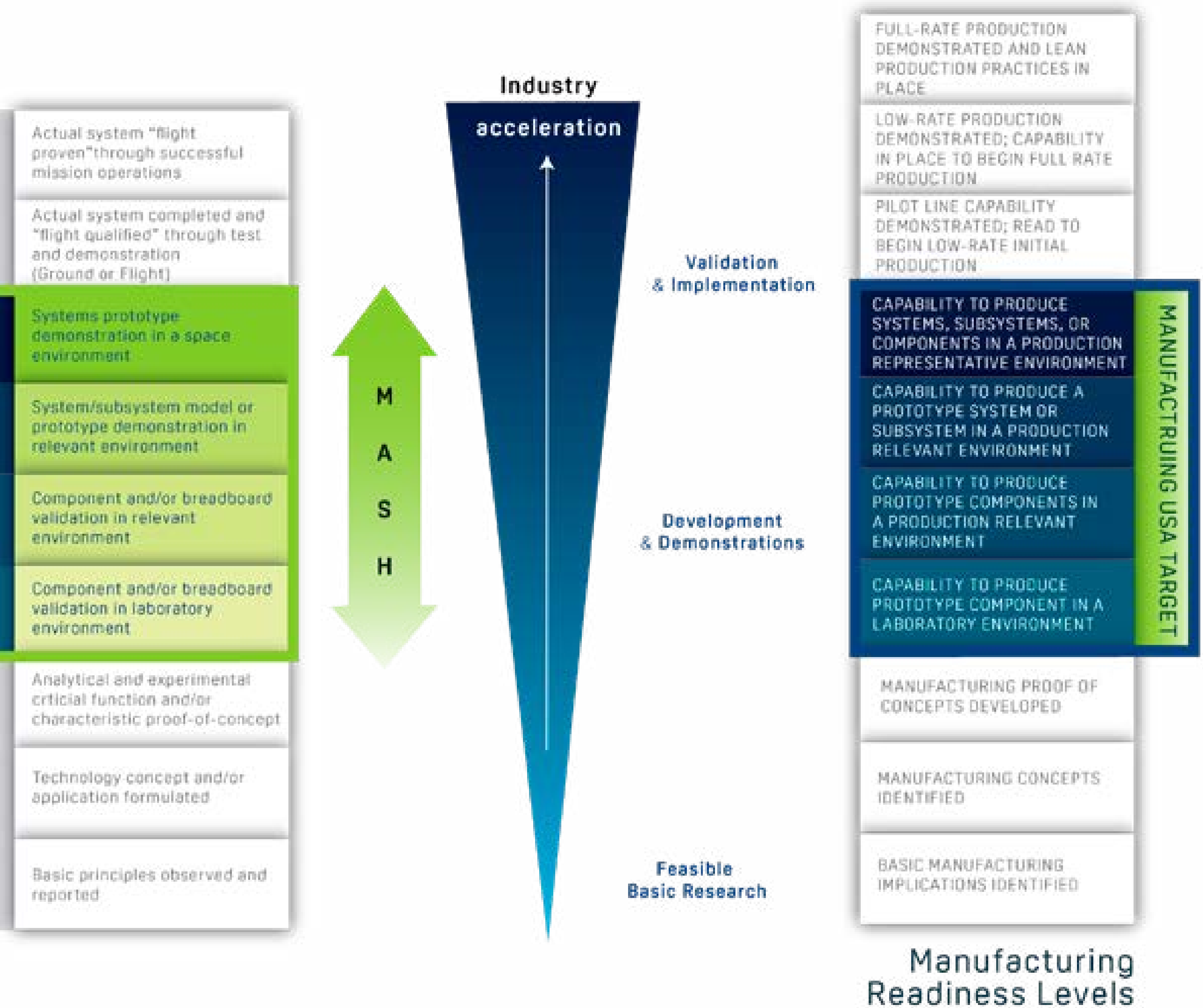
MASH WILL HELP TO ACCELERATE RESEARCH FROM PROTOTYPE TO PRODUCT BY:

- providing state-of-the-art workforce training and education to revitalize and modernize the microelectronics and semiconductor-related US workforce
- increasing domestic investment in semiconductor manufacturing equipment and education
- offering access to small and medium enterprises to the advanced resources and expertise needed to develop novel products



TECHNOLOGY

READINESS LEVELS



PennState

The success of Penn State as a leader in the researching and engineering of materials and devices has enabled the establishment of a robust research infrastructure through shared facilities. Most of these facilities are centrally housed in the 275,600 square-foot Millennium Science Complex at University Park where an entire wing of the building is dedicated to materials research.

2DCC: synthesis

NSF 2D CRYSTAL CONSORTIUM MATERIALS INNOVATION PLATFORM

The 2DCC operates as a national resource providing access and expertise in 2D chalcogenide layered materials in the form of bulk crystal, multilayers, and one-atom thick films. It enables cutting-edge research into next-generation 2D electronics and collaborates with microelectronics manufacturing companies.

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The 2DCC-MIP is funded by NSF cooperative agreement DMR-2039351.

NANOFAB: fabrication

NANOFABRICATION LABORATORY

The Materials Research Institute Nanofab provides access to state-of-the-art nanofabrication capabilities and expertise to researchers from academia, industry, and federal research labs. The Nanofab is a 15,000 sq.ft. cleanroom (Class 1000/100) and high-quality support space and is unique in its ability to handle small parts up to 200mm wafers on most tools. The Nanofab staff, in addition to its nanofabrication expertise, has broad experience in condensed-matter physics, chemistry, X-ray physics, optics, and magnetism, offering a broad knowledge base to support the user community. The Nanofab has decades of experience in developing piezoelectric and ferroelectric materials, MEMS devices, heterogeneous integration, and glass packaging. The facility has a long tradition of teaching semiconductor processes to undergraduate and graduate students, and it works closely with industry in developing processes compatible with technology transfer. We are currently working with many semiconductor companies and start-ups that take advantage of our expertise in materials synthesis, integration, and nanofabrication.

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MCL: characterization

MATERIALS CHARACTERIZATION LABORATORY

The MCL is a core facility of the Materials Research Institute and is a fully staffed, open access facility providing access to characterization equipment for materials and devices to enable advanced research while educating the next generation of highly qualified scientists and researchers. The MCL laboratories occupy more than 15,000 square feet within the Millennium Science Complex (MSC) at Penn State and are staffed by interdisciplinary scientists and engineers. Current MCL state of the art capabilities include transmission electron microscopy, scanning electron and ion microscopy, surface characterization, X-ray scattering, molecular spectroscopy, thermal analysis, particle characterization, electrical characterization, and mechanical testing.

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AIMI: AI, machine learning

CENTER FOR APPLICATIONS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING TO INDUSTRY

Penn State's Center for Applications of Artificial Intelligence and Machine Learning to Industry (AIMI) connects industry members with Penn State's vast research community of artificial intelligence (AI) and machine learning (ML) researchers and their students to solve real-world problems and seize market opportunities.

AIMI can help your business or organization partner with world experts to explore innovative ways to leveraging AI that addresses your organizational needs, engage directly with faculty and students on short-term, low-risk, high-reward, shared intellectual property development. We develop a comprehensive and diverse workforce pipeline through substantive involvement in shared projects and deliverables.

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FACILITIES

STRONG #1 REPUTATION

NSF Expenditures rankings by U.S. Universities – **#1 in Material Science** & **#2 in Materials Engineering**

#2

DIGITAL TWINS:
materials growth & immersive interaction

MATERIALS GROWTH SIMULATIONS

Penn State has extensive expertise in simulating materials growth and calculating material properties – covering size ranges all the way from atomistic-scale to the continuum. This involves computational methods including quantum mechanics – in particular: density functional theory, physics-based and machine learning-based, reactive and non-reactive empirical force fields, phase field- and phase diagram-based methods, and computational fluid dynamics methods. In each of these methods, Penn State provides world-leading method development and application expertise – which established connectivity to experimental efforts in 2DCC and Nanofab.

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IMMERSIVE INTERACTION WITH DIGITAL TWINS

By creating a high-fidelity digital twin of physical processes, Penn State can provide a state-of-the-art immersive networking and computing platform to support interactive training, real-time immersive monitoring, and precise control through virtual/mixed reality (VR/MR) headsets. Customizable to suit a diverse range of digital twin applications, we can offer comprehensive guarantees on human performance, ensuring seamless integration and operational excellence from start to finish.

These digital twin activities are supported by the Materials Research Institute (MRI), the Institute of Computational and Data Science (ICDS), and the Center for Immersive Experiences (CIE). In support of semiconductor research, ICDS has a number of strategic efforts under its artificial intelligence (AI) Hub. The high performance computing infrastructure maintained by ICDS and its highly qualified staff also enable the handling of large data sets arising from detailed synthesis monitoring, and complex device designs that increasingly need hierarchical spatial and time analytics in their simulations. CIE is driven to catalyze fundamental scientific research efforts through immersive technologies. Using high fidelity and hyper realistic virtual, augmented, and mixed reality experiences, paired with a deep expertise in human factors, advanced simulations, and computer visualizations, our work is easily integrated into research, education, and outreach efforts. Projects in the center range from fully interactive digital twins of complex manufacturing systems to hands-on training to upskill the current and future workforce. Because the scope and potential reach of xR is not limited to any one discipline, CIE's work is rooted in empirical research and a pedagogical approach to its implementation.

CONTACTS:

Bin Li, binli@psu.edu *(immersive interaction with digital twinning)*

Jessica Menold, jdm5407@psu.edu *(CIE)*

250 WIDE-RANGE OUTREACH

Since 2017, MRI has worked with **100+** companies in Pennsylvania alone and **250** independent organizations

Comprising four major facilities, the Singh Center for Nanotechnology is vital to the research and educational programs at the University of Pennsylvania and are leveraged by partner institutions and local industry within the Mid-Atlantic region.

Unifying these central resources fosters the exchange of scientific ideas and the development of nanoscale science and technology, brings together crosscutting capabilities and the staffing to support these tools, and provides the modern infrastructure necessary to establish a regional center for nanotechnology.

QNF: fabrication

QUATTRONE NANOFABRICATION FACILITY

The Quattrone Nanofabrication Facility (QNF) operates a ~11,000 sq.ft. cleanroom with cutting-edge equipment, including electron-beam and optical lithography, deposition techniques, processing tools, metrology, and device characterization. Additionally, QNF offers a complementary facility for soft lithography for soft materials and laser micromachining, catering to diverse materials processing, microfluidics, and lab-on-chip activities. To complete the cycle, QNF provides backend equipment for device packaging and hybridization, encompassing wire bonding, wafer bonding, electrical testing, and wafer dicing.

CONTACT: QNF Director, Eric Johnston, ericdj@seas.upenn.edu

SOFT LITHO: fabrication

SOFT LITHOGRAPHY LAB

The QNF Soft Lithography Lab facilitates PDMS device fabrication for microfluidics and microcontact printing. Equipped with essential tools like an ABM mask aligner and Anatech barrel asher, the lab provides photoresist, PDMS, and necessary supplies. The lab addresses the growing demand for miniaturized liquid-based assays in research, diagnostics, and sample analysis. Soft lithography enables diverse applications, including particle separation, cell culture, chemical mixing, and organ mimetics. It is also instrumental in non-fluidic devices like micro-contact printing and cellular force measurement, exemplified by microfabricated culture devices for long-term neuronal studies.

CONTACT: QNF Director, Eric Johnston, ericdj@seas.upenn.edu

NCF: characterization and measurement

NANOSCALE CHARACTERIZATION FACILITY

The Nanoscale Characterization Facility (NCF) at the Singh Center offers cutting-edge electron- and ion-beam analysis tools. The facility includes an integrated sample preparation laboratory with complete sample coating and plasma cleaning capabilities and cryogenic TEM sample preparation equipment. A computer suite for offline image and data analysis and office and meeting space for staff and industrial users round out the facility in the Singh Center.

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SLPF: microscopy

SCANNING AND LOCAL PROBE FACILITY

The Scanning and Local Probe Facility (SLPF) is a comprehensive user facility of scanning probe microscopes and confocal Raman microscopes allowing characterization of morphology, mechanical properties (friction, stiffness, adhesion), electrical properties (surface potential, conductivity, piezoelectric force), and chemical structure in over a range of environment. Some instruments combine techniques, such as fluid cell AFM + fluorescence microscopy for in situ measurements and AFM + Raman for tip-enhanced spectroscopy.

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FACILITIES

NYU

NANOFAB: cleanroom

NANOFAB CLEANROOM
The Nanofab Cleanroom comprises over 2,500-square feet of class 100 and 1,000 cleanroom space, with a host of advanced micro/nano fabrication tools, spanning the areas of lithography, etch, deposition, and metrology with capabilities to support processing from pieces to 8" wafers. The Nanofab has state-of-the-art capabilities that are unique in NYC area—such as atomic layer etch (ALE) of compound semiconductors; ion beam etch of magnetic materials with SIMS endpoint; and plasma-enhanced atomic layer deposition (PE-ALD)—enabling faculty to conduct cutting edge research in the area of AI and quantum hardware technologies..

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CENTER: cybersecurity

THE NYU CENTER FOR CYBERSECURITY
The NYU Center for Cybersecurity is an interdisciplinary academic and research institute dedicated to training the current and future generations of professionals while also shaping public discourse and policy decisions with both its leading-edge research and scholarship. The Center focuses on both meaningful real-world technology and conducts cutting-edge research into this all-important sector that impacts all of us. Since its founding, the Center has pioneered many secure AI hardware devices and monitors.

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MAKERSPACE: prototyping

THE NYU TANDON MAKERSPACE
The NYU Tandon MakerSpace is a cutting-edge lab created to foster collaborative design projects. It features rapid prototyping and PCB production equipment, as well as advanced machining and testing capabilities. The MakerSpace is designed to support and encourage project-based learning at all levels and provides training and workshops on machine usage, prototyping skills, and design.

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WIRELESS: research portfolio

THE NYU WIRELESS
The NYU Wireless research portfolio involves nearly 100 faculty and graduate students, and is continually working on a wide range of fundamental problems in the development of next generation wireless technologies — from basic devices, to fundamental knowledge of channels and systems, to the key issues facing networks, security, and applications. Key areas of research include terahertz communications and sensing; mobile edge networking and computing; millimeter wave (mmWave); terahertz (THz); and quantum nanodevices and circuits; 5G and 6G applications (such as robotics, UAVs, autonomous vehicles); machine learning; communication foundations; and 6G testbeds. NYU WIRELESS has a large industrial affiliate program with connections to many companies and start-ups that can use semiconductor manufacturing capabilities.

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The University of Delaware has been a pioneer in materials research and development since the founding of its renowned Center for Composite Materials in 1974. Complementing this legacy, UD has established premier infrastructure and expertise for the innovation of semiconductor materials and devices, including facilities for nanofabrication, epitaxial materials growth, characterization, and electron microscopy.

UDNF: nanofabrication facility

UNIVERSITY OF DELAWARE NANOFABRICATION FACILITY (UDNF)

The University of Delaware Nanofabrication Facility enables faculty, academic and corporate partners to create devices smaller than a human hair, supporting scientific advances in fields ranging from medical diagnostics to solar energy harvesting. Located in the 194,000-square-foot Harker Interdisciplinary Science and Engineering (ISE) Laboratory, UDNF has expert staff, state-of-the-art technology and world-class capabilities in lithography, deposition, dry etching, thermal processing, characterization, and device packaging. Areas of excellence include photonic devices and nanostructured solid-state materials with unique optoelectronic and magnetic functionality.

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The 8,500-square-foot clean room in the UD Nanofabrication Facility is divided into Class 100 and Class 1000 spaces.

AMCL: characterization lab

ADVANCED MATERIALS CHARACTERIZATION LABORATORY (AMCL)

Housed in the research wing of Harker Interdisciplinary Science and Engineering (ISE) Laboratory, UD's Advanced Materials Characterization Laboratory offers an array of sophisticated instrumentation, including an elite X-ray absorption spectroscopy (XAS) system offering synchrotron-like performance and 3D X-ray imaging microscopes that perform nondestructive, nano-computed tomography, similar to a hospital CT scan, with applications in areas ranging from additive manufacturing to pharmaceutical packaging. The AMCL is operated as a user facility and is staffed by expert personnel who train users through a robust series of short courses.

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MGF: materials growth

MATERIALS GROWTH FACILITY (MGF)

UD's Materials Growth Facility unlocks new functionalities in semiconductor materials. The MGF provides the infrastructure and staff support necessary for faculty, academic, and corporate partners to undertake competitive research, offering III-V and topological insulator growth of epitaxial semiconductor films, magnetic and precious metal sputtering, and electron beam evaporation of high temperature metals — all interconnected under ultra-high vacuum. MGF researchers study a diverse range of materials including metal/semiconductor nanocomposites, topological insulators, dilute bismuthides, hyperbolic metamaterials, magnetic tunnel junction heterostructures, heavy metal/ferromagnetic metal ultrafast spintronics, and quantum dot arrays.

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FACILITIES

UD-CCM: composite materials

CENTER FOR COMPOSITE MATERIALS (UD-CCM)
Since its founding in 1974, the University of Delaware's Center for Composite Materials has been nationally recognized as a center of excellence by the National Science Foundation and the U.S. Department of Defense for interdisciplinary research, education and technology transfer in the areas of materials and synthesis, multifunctional materials, processing science, mechanics and design, sensing and control, and software. Utilizing 52,000 square feet of state-of-the-art facilities, UD-CCM develops models and simulations in a "virtual manufacturing" environment for process optimization and tool design, leading to improved quality, affordability, and innovative new composite manufacturing processes. The center also develops online sensors and devices for monitoring composites manufacturing to end-of-life and validates control schemes using simulations and manufacturing work cells.

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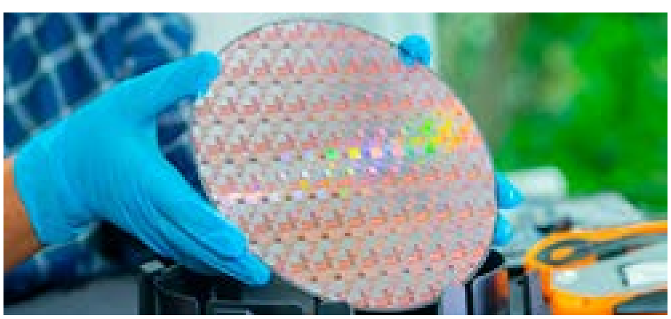

Silicon wafers like the one shown can be used to create computer chips, circuits and other devices.

KeckCAMM: microscopy

W. M. KECK CENTER FOR ADVANCED MICROSCOPY AND MICROANALYSIS CORE (KECKCAMM)
KeckCAMM is a user facility for the structural and chemical characterization of materials at scales ranging from micron to angstrom. Located in the research wing of UD's Harker Interdisciplinary Science and Engineering (ISE) Laboratory, it provides researchers with access to field emission transmission electron microscopes, scanning electron microscopes, and scanning probe microscopes — some with remote access and control to facilitate research collaborations or classroom teaching. Expert laboratory staff provide extensive training opportunities.

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DiCoS: computation

CENTER FOR DATA INTENSIVE AND COMPUTATIONAL SCIENCE (DICOS)
High performance computing capabilities are available at UD through the Center for Data Intensive and Computational Science, including the Delaware Advanced Research Workforce and Innovation Network (DARWIN), which has 105 compute nodes with a total of 6,672 cores, 22 GPUs, 100 terabytes of memory, and 1.2 petabytes of disk storage. DARWIN is part of the ACCESS advanced computing and data resource supported by the National Science Foundation.

CONTACT: Rudi Eigenmann, eigenman@udel.edu

Princeton University offers top-of-the-line scientific research facilities that welcome both external and internal users. Three of the largest core facilities are housed within the School of Engineering and Applied Sciences (SEAS). A central mission of the SEAS core facilities is the education, research, and training of students. These core facilities are part of Princeton Materials Institute, a premier center for materials science and education due to its unique integration of long-term, curiosity-driven research, high-impact innovation, and long standing engagement with industry. At these core facilities the user can fabricate, integrate, and characterize a range of materials.

MNFC: fabrication

MICRO/NANOFABRICATION CENTER

The MNFC is a ~ 18,000 sqft clean room with ISO 5, 6 and 7 space. The MNFC has over 70 processing and metrology tools and had over 200 users from internal and external academics, government, and industry. Our partnership with the state of New Jersey has provided a low entry barrier for start-up companies eligible for state funding to use these facilities. In 2022-2023, seven new start-up companies in the area accessed the MNFC and Packaging lab through this mechanism.

The MNFC provides 2,600 sqft clean space for a dedicated undergraduate teaching lab: students learn what is inside a microchip, how they work, and how they are made, providing hands-on integrated circuit microfabrication for diodes and MOSFETs.

ISO 5 space houses E-beam lithography (patterning to < 10 nm, up to 6 inch samples, e.g., superconducting quantum devices), direct laser writing and a dedicated SEM metrology tool.

ISO 6 space contains various plasma etching tools (Si, III-V, diamond, metals) and deposition tools (ALD, CVD, PVD), a range of thermal processing equipment, various characterization tools (for metrology with rapid processing inspection in mind), and a number of fume hoods and wet benches.

ISO 7 space is dedicated to the soft materials processing space, e.g., PDMS microfluidic device processing. This lab houses a tabletop direct laser write system, degassing ovens, curing ovens, plasma cleaners, and parylene coater. There are also a variety of 3D printers, including system that can produce 3D polymer structures with feature sizes from sub-micron to the millimeter scale for applications such as cell scaffolding and custom nano-needle processing.

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FACILITIES

PACKAGING LAB: back-end integration

MNFC PACKAGING LAB

The Packaging Lab is the largest growing core facility, with a suite of upgrades underway and the fastest growing user base of our cores. Tools include: dicing, scribing, cleaving, wire bonding (wedge, ball), flip-chip bonding, lapping and polishing. Examples of current work include (i) detector build technology at CERN (ATLAS, CMS), (ii) build of the giant six meter $100M CMB telescope at the Simons Observatory, and (iii) photonic sensing capabilities (interfacing with neural-networks).

This facility not only provides these back-end processing tools for users but handles bespoke work for academia, government and industry. Current upgrade projects are (i) installing an Indium evaporator for low temperature fine pitch 3D chip on chiplet integration, (ii) installing an automatic fluid dispensing robot and fine wire wedge/ball bonders.

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IAC: characterization

IMAGING AND ANALYSIS

The IAC has over 300 users per year (including 65 external organizations) and is the largest core facility in New Jersey for advanced characterization. The 7,500 ft^2 labs meet NIST's highest standards for environmental control (EMI, vibration and isolation). The IAC contains three SPMs (including a low temperature q-Plus AFM/STM capable of imaging molecular orbitals and measuring the force required to break a single chemical bond), two FIBs, two SEMs, Micro-CT, XRD, SAXS, TGA/GC/MS, Rheometers, DSC, UV-Vis, Raman, XPS, Ellipsometer, Optical microscopy with IR spectral mapping. A world-leading center for microscopy, it boasts five TEMs, some capable of imaging to <1 Å, and two cryo-EM machines.

CONTACT: Nan Yao, nyao@princeton.edu

Boston University does research that matters, including materials science and engineering work that crosses disciplines and has a direct impact on the industries of the future. From its Engineering Product Innovation Center, a 15,000-square-foot, multi-million dollar engineering and manufacturing facility, to the Fraunhofer Center for Manufacturing Innovation, which transforms emerging research into viable technology solutions for domestic and global clients—BU centers, labs, and equipment are driving cutting-edge research and technologies to address the biggest challenges of the 21st century.

The facilities described below are all housed in the Boston University Photonics Center, a nine-story building housing world-class research laboratories that sustain the work of over 170 faculty, staff, and students.

LAB: cleanroom

OPTOELECTRONIC PROCESSING FACILITY

This multi-user cleanroom is outfitted with advanced equipment for fabricating semiconductor and optoelectronic devices on a wafer-to-die level. The 2,500-square-foot facility includes both a Class 100 photolithography room and a Class 1000 cleanroom. In the Class 1000 cleanroom, capabilities include wet chemical processing, dry etching, thin film physical vapor deposition (including thermal oxidation and annealing), metrology, dicing saw, and wire bonding.

LAB: microscopy

FOCUS ION BEAM/TRANSMISSION MICROSCOPY FACILITY

This multi-user facility provides equipment for materials characterization and high-resolution imaging and analysis of a variety of solid, non-biological materials on nanoscale. The facility is supplemented by an adjacent materials preparation laboratory with equipment for cutting, polishing, dimpling, and ion milling for preparation of surfaces and cross-sections from bulk specimens for examination. These capabilities will be key as semiconductor devices shrink into the nanometer range and new materials are required.

LAB: characterization

PRECISION MEASUREMENT LABORATORY

This lab is a shared-use, core facility dedicated to the characterization of materials using scanning and surface probe microscopies. It also provides capabilities for examination of topographical features using optical laser interferometry profiling.

LAB: materials science

MATERIALS SCIENCE CORE FACILITY

This multi-user facility for materials science characterization houses a variety of equipment including processing hoods for materials preparation and Bruker X-ray equipment for analyzing crystallinity of thin solid-state films.

COLUMBIA UNIVERSITY

FACILITIES

The Columbia Nano Initiative Shared Lab Facilities are open to student and faculty researchers, as well as those from government, start-ups, and industry. The Clean Room offers a comprehensive set of tools for microfabrication and nano-fabrication. The Materials Characterization Laboratory and the Electron Microscopy Laboratory offer state-of-the-art instruments for chemical and structural characterization of materials. The shared facilities stimulates the development of new major research centers.

CNI: nanofabrication

CNI NANOFABRICATION CLEAN ROOM

A ,5000 sqft facility with class 10,000 to 1,000 labs. It is dedicated to providing the processing tools, instrumentation, technical expertise, and team-teaching environment to support and stimulate collaborative research in nanoscale science and engineering. The facility supports the creation and evaluation of devices and materials with state-of-the-art fabrication and characterization equipment. Applications include nanoelectronic and nanophotonic devices, micro and nano-electromechanical systems (MEMS/NEMS), flexible electronics, bio-electronics, nano-bio interfaces, and more. This laboratory supports multidisciplinary research across many academic departments and disciplines within Columbia University and welcomes researchers from other academic institutions, government laboratories, and industrial organizations ranging from start-ups to large companies. The research bridges the physical, chemical, biological, and medical sciences.

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SMCL: characterization

SHARED MATERIALS CHARACTERIZATION LAB

The SMCL provides materials researchers with access to state-of-the-art microscopy, spectroscopy, and diffractometry instrumentation. It supports research across many different departments within Columbia University and welcomes researchers from other academic institutions, government laboratories, and industrial users.

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EM: microscopy

ELECTRON MICROSCOPY

The advanced CNI Electron Microscopy facility includes a Transmission Electron Microscope, two Scanning Electron Microscopes (both located in CEPSR building, one inside the clean room), and a suite of sample preparation instruments. The mission of the facility is to train students and researchers in theory and practice of scanning and transmission electron microscopy and to provide research and education services to the Columbia and greater New York communities. This laboratory supports research across many different departments within Columbia University and welcomes researchers from other academic institutions, government laboratories, and industrial users ranging from start-ups to large companies.

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MASH Mid-Atlantic SEMICONDUCTOR HUB

UNIVERSITY OF MARYLAND

The University of Maryland's researchers and modern facilities are well known for experience and innovations in semiconductor chip design and architecture, nanofabrication, hardware security and cybersecurity, neuromorphic chips with capabilities inspired by biology, micro devices, including medical devices, sensors and sensor components, advanced materials for microelectronics, improving the reliability of microelectronics, and microelectronic components in larger systems for energy efficiency and a more electric future.

CALCE: microelectronics packaging

CENTER FOR ADVANCED LIFE CYCLE ENGINEERING

CALCE has been serving the electronics industry for more than 35 years as a resource and knowledge base for the development of reliable, safe, and cost effective products. It is supported by more than 300 of the world's leading companies. CALCE provides test and failure analysis services and conducts fundamental reliability science research. Research areas include: reliability assessment of components, packaging materials, interconnections, and assemblies; testing and simulation-based failure analysis; electronic product development; life cycle cost; technology tradeoff analysis; thermal management; power electronics; accelerated testing; soft capillarity and wetting; micro-nanoscale transport; parts selection and management; uprating; polymers; prognostics and health management; electrical contacts; passive components; counterfeit detection and mitigation; intersections among thermal-fluid sciences, interfacial transport phenomena, and renewable energy; and supply chain policies.

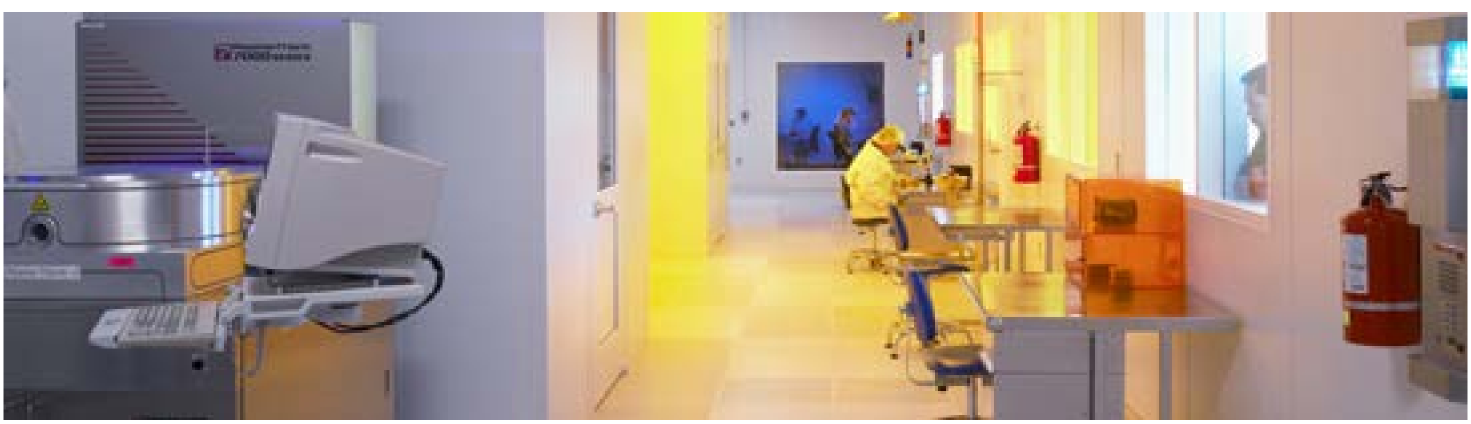
NanoCenter: chip design & manufacturing

The Maryland NanoCenter includes the FabLab (a class 1000 clean room) and the AIM Lab (dedicated to the characterization of structure and composition for a broad spectrum of hard and soft materials and biological systems with nanometer resolution). Additional shared equipment is located in partner labs across campus, covering the gamut of research necessities. NanoCenter facilities are available for use by faculty, students, industry, and government researchers.

LAB: advanced chip manufacturing

SEMICONDUCTOR TECHNOLOGY

UMD research is advancing semiconductor chip technology in chip design, building chips with new sensing capabilities and addressing challenges in chip manufacturing. Projects take advantage of expertise in hardware architecture, advanced integrated circuits, and biochips. Maryland is active in projects sponsored by the Department of Defense, DARPA (including JUMP 2.0), Intel, Northrop Grumman, SRC, NSF, NIST, AFOSR and ONR (including MURIs), and the Army Research Lab (ArtIAMAS).



FACILITIES

MEII: energy storage & materials

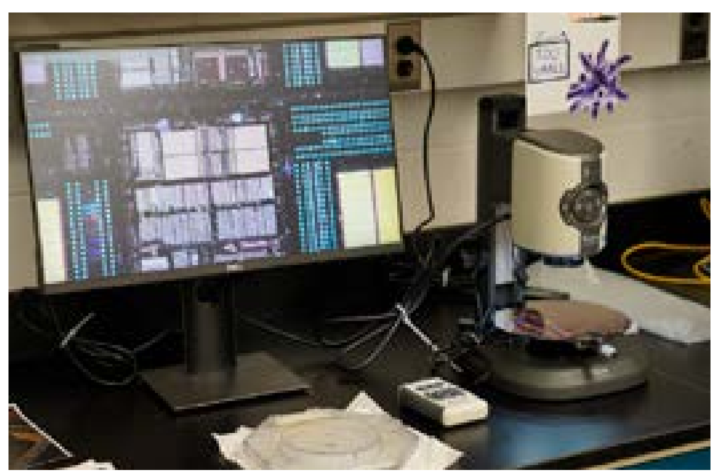
MARYLAND ENERGY INNOVATION INSTITUTE

The scientists of the Maryland Energy Innovation Institute are actively pursuing materials science advances. Special areas of interest include: chemical energy conversion, electrochemical energy, energy efficiency, power systems, renewables, and energy systems safety and reliability. Research areas include atomic layer deposition and thin films, materials for batteries and energy storage devices, power electronics and microinverters, and renewable and efficient energy.

MEMS: sensors & actuators

MICROELECTROMECHANICAL SYSTEMS

Sensors are an important part of many microelectronic devices. UMD researchers have decades of expertise developing sensors for many different purposes, from detecting bio materials and explosives in public spaces, to finding pathogens inside the human body. They also are developing new kinds of sensors with enhanced capabilities based on neuromorphic and biological ideas. Projects include general sensors, medical sensors, and neuromorphic sensors. The MEMS Sensors and Actuators Laboratory was established in January 2000 and focuses on application-driven technology development using micro-nano-bio engineering approaches. Its "systems integration" approach provides holistic solutions for real-world use. This lab specializes in in-situ biomedical and clinical applications, specifically toward gastrointestinal diagnostics, biofilm monitoring and inhibition, and platforms for investigating gut-brain interactions. This research is complemented by efforts in energy storage, harvesting, and conversion to provide power for the desired embedded, self-sustaining MEMS sensors and actuators. Devices incorporate system-oriented design elements relying on MEMS materials and fabrication technology, novel biosensing and biofabrication processes, microelectronics integration, and 3D-printed packaging techniques.



MASH Mid-Atlantic SEMICONDUCTOR HUB

UNIVERSITY OF THE DISTRICT OF COLUMBIA 1851

UNIVERSITY OF THE DISTRICT OF COLUMBIA (UDC) FACILITIES RELATED WORKFORCE DEVELOPMENT PROGRAMS

UDC is the nation's only urban land grant university located in the former National Bureau of Standards (present National Institute of Standards and Technology, NIST) in the Washington DC area within a five-mile radius from Capitol Hill. UDC is an HBCU that comprises a community college (UDC-CC) and main campus jointly offering two-year associate degrees to PhD-level STEM workforce training focusing on underrepresented communities.

MSDL: molecular spintronics

MOLECULAR SPINTRONICS DEVICE LABORATORY (MSDL)

This laboratory focuses on solving technological challenges in developing commercially viable molecular spintronics devices harnessing molecular quantum properties and spin properties of electrons. MSDL houses semiconductor device technology-related resources, including a class 1000 clean room, maskless aligners like lithography tools, several sputtering machines, and dry and wet etching. MSDL supports several doctoral research, ~50 UDC-CC, and ~40 undergraduate students attending Nanotechnology training courses. MSDL is leading the mass-producible magnetic tunnel junction-based molecular spintronics (MTJMSD) field, resulting in five non-provisional patent applications and national and international collaborations. MSDL is reputed to run clean room and nanotechnology resources with negligible operating costs for long-term sustainability.

CONTACT: Dr. Pawan Tyagi, ptyagi@udc.edu

MNL: microscopy

MICROSCOPY AND NANOFLUIDIC LABORATORY

This laboratory houses high a Scanning Electron Microscope with a Focused Ion Beam and an Industry grade Keyence Microscope for quantitative material analysis. This laboratory is also actively researching nanoscale microfluidic channels for diverse applications. This laboratory offers dedicated training for UDC graduate and undergraduate students in the field of microscopy-based material characterization.

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NML: nanoscale measurement

NANOSCALE MEASUREMENT LABORATORY (NML)

NML houses a wide range of nanoscale property and device testing resources, including a remote console to enable real-time access to Penn State material testing capabilities such as TEM. NML is equipped with AFM, Magnetometer, Ferromagnetic Resonance, Cryogenic transport testing, and semiconductor device parameter analyzer. NML has been a major support to UDC STEM faculty starting their research and pursuing grants. NML is the tentative site for UDC's Museum of Nanotechnology in the Washington DC area for engaging the K-PhD audience in outreach related to semiconductor devices and nanotechnology. NML supports ABET-accredited electrical and mechanical engineering undergraduate students' research training, producing a diverse workforce. .

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MTML: thermal management

MULTISCALE THERMAL MANAGEMENT LABORATORY

This laboratory innovates novel solutions for heat management in diverse areas, from computers to large-scale space vehicles. Several additive manufacturing (AM) technologies, such as EOS M280 Laser metal sintering machine and 3D printing of electronic circuits, are employed for research and workforce training in materials and system development for electronic packaging and thermal management. This laboratory also possesses atomic layer deposition and state of thermal property testing resources and actively researches with several NASA and NAVY-related federal organizations.

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