

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.

MISSION & SCOPE



MASH Mid-Atlantic SEMICONDUCTOR HUB



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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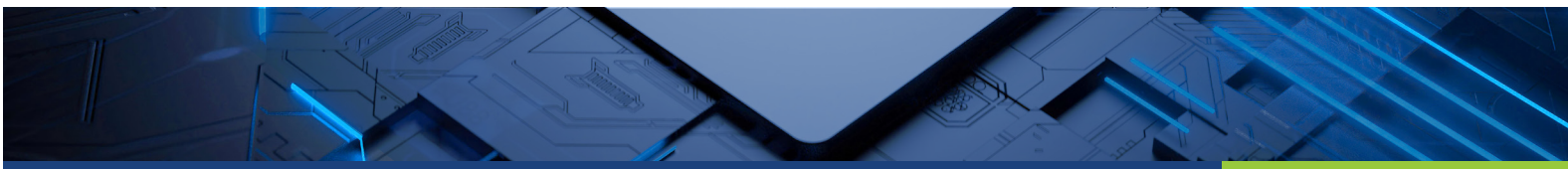
AIMI: AI, machine learning

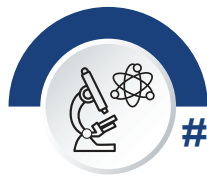
CENTER FOR APPLICATIONS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING TO INDUSTRY

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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STRONG #1 REPUTATION

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

#2

FACILITIES



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.

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250 WIDE-RANGE OUTREACH

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

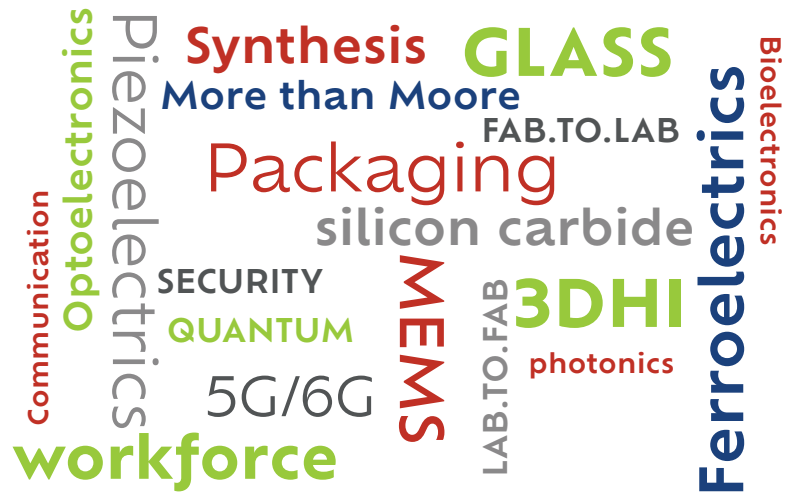


Communication
 Optoelectronics
 Piezoelectrics
workforce
Synthesis
 More than Moore
GLASS
 FAB.TO.LAB
Packaging
 silicon carbide
 SECURITY
 QUANTUM
 5G/6G
MEMS
 LAB.TO.FAB
3DHI
 photonics
Ferroelectrics
 Bioelectronics

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The logo for MASH HUB is centered in a dark blue circle. The word "MASH" is written in a bold, sans-serif font, with the "M" and "H" in white and the "A" and "S" in a vibrant green. Below "MASH" is the text "Mid-Atlantic SEMICONDUCTOR" in a smaller, white, sans-serif font. Below that, the word "HUB" is written in a large, white, sans-serif font. The background of the entire page features a dark blue, high-tech circuit board pattern with glowing blue lines, and a large green triangle on the left side.

MASH

Mid-Atlantic SEMICONDUCTOR

HUB

WANT TO LEARN MORE?



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KEEP INFORMED
GET INVOLVED

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MASH

Mid-Atlantic SEMICONDUCTOR

HUB

Partnering for a Strong American Semiconductor Future