INSTITUTE FOR MATERIALS AND MANUFACTURING RESEARCH

FISCAL YEAR 2025

THE OHIO STATE UNIVERSITY
INSTITUTE FOR MATERIALS AND MANUFACTURING RESEARCH

Letter from Executive Director Steven A. Ringel

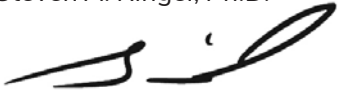
Dear Colleagues,

I am delighted to share with you the FY25 annual report of Ohio State's Institute for Materials and Manufacturing Research (IMR). As is the case every year, it's hard to capture the many accomplishments and innovations of the students, staff and faculty within the IMR community. Attempting a succinct summary of this past year proved no less a challenge, and here are a few highlights you will read about in this year's issue. The IMR-led 22,000-square-foot Battery Cell R&D Center received and installed leading edge equipment to support translational and basic research on next-generation batteries as it races toward an early 2026 grand opening of this unique $30M facility. Simultaneously, IMR is also bringing online its $20M Microelectronics Technology Innovation Cluster (MITEC) that is the primary Hub for the Midwest Microelectronics Consortium, funded by the Department of Defense Microelectronics Commons through the U.S. CHIPS and Science Act. MITEC will support lab-to-fab translation of commercial leap ahead and electronic warfare technologies for the defense community.

Several significant new projects began in the past year. Highlights include a $26 million NSF engineering research center (ERC) to advance domestic natural rubber, Ohio State's second concurrent ERC program, an NSF-supported veterans-focused cleanroom internship at Nanotech West Lab, and a new Air Force Center of Excellence that integrates multiple universities to study the complex and intersecting behaviors of materials from metals to polymers and semiconductors used in space vehicles that operate in low-Earth orbit. Further, early-stage seed grants are yielding team-science research results and recognition for researchers in a myriad of areas. Our growing international partnerships with India and Ireland continue to position IMR and Ohio State as a global center for innovation, training and research.

With all of this, our goal has never wavered. It is to position IMR, and Ohio State, as the nation's leader in providing a sustained, interdisciplinary ecosystem where students, staff and faculty are engaged in a flourishing, impactful and iterative innovation process spanning basic materials research to translation via advanced manufacturing, impacting key areas of science and technology for our world. With that, I hope you enjoy reading highlights from the past year, and please visit imr.osu.edu for more up-to-date information.

Sincerely, Steven A. Ringel, Ph.D.



Executive Director, Institute for Materials and Manufacturing Research
Distinguished University Professor
Neal A. Smith Chair Professor, Electrical and Computer Engineering
Associate Vice President for Research

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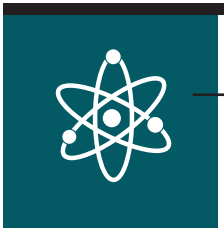

OPERATIONS

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A Closer Look

IMR was established at The Ohio State University in 2006 with a central goal: to guide Ohio State's materials-allied research enterprise to be among the very best in the nation. Now, the Institute for Materials and Manufacturing Research steers this enterprise to continually impact the forefront of materials and manufacturing research; win the most competitive, prestigious research programs and centers; and enable the attraction of top talent in areas that exploit the multi-college breadth of the university. IMR brings together a large and interdisciplinary community consisting of 255 faculty members from 46 departments and 12 colleges, all of whom are actively engaged in research and innovation across the materials and manufacturing continuum.

About IMR

The Ohio State University's Institute for Materials and Manufacturing Research (IMR) is a multi-college, university-level institute that leads materials and manufacturing-related research and innovation through interdisciplinary collaboration. With research teams and centers that cross department and college boundaries, IMR provides a dimension to Ohio State's materials and manufacturing research community that transcends traditional academic structures. This has led to the creation of a research and innovation ecosystem that spans fundamental science to engineering to translational interfacing with industry. As a result, IMR provides an array of support mechanisms, shown on the right, sustaining the community's growth and impact.

IMR's culture of interdisciplinary collaboration and drive for excellence has significantly enabled many centers of excellence, including Ohio State's two NSF Engineering Research Centers, Ohio State's longstanding NSF MRSEC, and others. This approach has also enabled partnerships with colleges and departments to co-lead three faculty hiring programs, including our Materials & Manufacturing for Sustainability Discovery Theme program.

IMR's impact includes the creation of numerous types of high impact partnerships. These include the IMR Battery Cell R&D Center, with a wide range of large and small industry partners, the Intel-supported Center for Advanced Semiconductor Education and Fabrication, and the Materials Innovation and Technology Cluster that serves as a DoD Microelectronics Hub for the Midwest Microelectronics Consortium. In the past few years, IMR's partnerships have extended globally, including its founding of the Ohio State-IIT Bombay Frontier Center.

IMR supports Ohio State's materials and manufacturing community through:

- Strategic leadership
- Intercollege coordination
- Research infrastructure support, development and operations
- Development and administration of major research proposals, programs and centers
- Development and management of strategic industry partnerships
- Support of innovation ecosystems
- Multi-tiered seed funding program
- Global research partnerships
- Outreach and engagement
- Faculty recruitment

Signature Areas & Strategic Themes

IMR derives its strengths from its interdisciplinary nature. This is true whether at the level of established centers of excellence or at the level of small teams. IMR's Signature Areas, and the more focused Strategic Themes within them, represent areas of IMR's existing national and international prominence, unique capabilities and emerging strategic directions.

As such, the Signature Areas help guide IMR's primary directions of activities and allocating resources in research and innovation. The list is dynamic and is reviewed periodically to ensure we are sustaining and growing existing strengths, while being responsive to emerging topics of national and global impact that intersect with our capabilities and that of Ohio State.

Characterization, Computational Materials and Modeling

- Ultra-resolution electron microscopy and imaging: structural, biological, energy and electronic materials;
- Electronic, optical and ultrafast spectroscopies;
- Experimentally informed, physics-based predictive modeling;
- Data-driven modeling and AI architectures for materials discovery;
- Multiscale modeling, cyber-physical integration, and adaptive simulation for complex systems

Electronic and Photonic Materials & Devices

- Compound and wide bandgap semiconductors;
- Epitaxy, novel materials and heterostructures, heterogeneous integration;
- Defects and reliability;
- Advanced electronic and optoelectronic devices;
- Semiconductors in extreme environments

Emergent Materials

- 2D materials synthesis, phenomena and electronic applications;
- Novel magnetic systems and spintronics;
- Topological materials and complex interfaces;
- Quantum materials, phenomena and systems;
- Materials-health science interface and systems

Materials for Next-gen Energy Science and Technologies

- Solid-state and advanced electrochemical energy storage;
- Battery prototyping processing and modeling;
- Photovoltaic and thermoelectric energy conversion;
- Power electronics and low-energy electronic systems

Processing and Prototyping

- Additive manufacturing and data science integration;
- Advanced & high-entropy alloys and lightweight structures;
- Corrosion science, environmental effects and predictive modeling;
- Digital twins and virtual prototyping for strategic tech sectors

IMR Strategy

The Institute for Materials and Manufacturing Research's strategic plan is driven by the goal to support and grow research excellence and impact by our students, staff and faculty to position The Ohio State University as a world leader in materials and manufacturing research and innovation.

VISION

To be the exemplar, interdisciplinary, academic research institute, which by building across colleges, creates a global reputation of excellence and impact at Ohio State through world-class basic and applied materials and manufacturing research, technology advancement, and innovation.

MISSION

- Lead an interconnected, interdisciplinary materials and manufacturing research **community** across Ohio State's colleges and centers;
- Nurture, grow, and support **excellence** in materials research through team development, establishing centers of excellence, and ensuring world-class research infrastructure;
- Drive an **innovation** ecosystem to connect, create and deliver value for our students, staff, faculty and external partners.

To realize success for the IMR vision, we have developed four goals:

1. Lead the Ohio State materials research community to deliver scholarly impact on a national and global scale.

2. Grow global reputation of excellence in materials research by establishing and maintaining centers of excellence in signature areas and ensuring world-class research infrastructure is sustained.

3. Establish IMR translational Centers as national leaders in technical innovation by building an end-to-end pipeline that transforms research into real-world impact through technology development, talent cultivation, and industry collaboration.

4. Develop and implement a financially sustainable business model that mitigates risk due to unexpected situations.

By the Numbers

ANNUAL EXPENDITURES ON PROJECTS*

$124M

NEW AWARDS*

$109M

255 FACULTY MEMBERS

46 DEPARTMENTS

12 COLLEGES

8 PUBLICATIONS PER MEMBER [1]

591 CITATIONS PER MEMBER [1]

193 PATENTS FILED [2]

58 PATENTS ISSUED [2]

93 INVENTION DISCLOSURES [2]

* Sponsored projects only

[1] Average of researchers found on Google Scholar in CY24

[2] Office of Innovation and Economic Development, FY25

Research & Innovation

IMR strives to identify, nurture and establish high-impact research and innovation programs that build from the broad interdisciplinary strengths at Ohio State. From exploratory research by individual faculty members, to research teams, research centers, strategic partnerships and innovation engagements, and even to Ohio State's first global research center, IMR's community of faculty, staff and student researchers have excelled in this mission. This section provides a glimpse of the many highlights in research and innovation that occurred this past fiscal year, lists projects that received seed grant awards from IMR, and showcases programs that provided experiential learning for students in FY25.

Highlights

Each year, IMR highlights a range of research and innovation accomplishments and activities that demonstrate the depth, breadth and impact of Ohio State's materials-allied research and manufacturing community. Here, we provide a summary of some of those spotlights on IMR staff, faculty members and students from the past year.

Highlights

IMR'S NEW BATTERY CELL R&D CENTER ADVANCING NEXT-GENERATION MATERIALS AND TECHNOLOGIES, DEVELOPING FUTURE WORKFORCE FOR CLEAN-TECH MANUFACTURING

Researchers in the large dry room at the Battery Cell R&D Center.

Ahead of its grand opening in January 2026, the Battery Cell R&D Center was already providing an experiential learning setting for advanced battery technology workforce development while bringing its full equipment suite online to accelerate the domestic development of battery cell materials and manufacturing technologies. With more than $29 million in commitments, the project began in 2023 with design work for the 22,000 square feet of facility space dedicated to battery

cell research, prototyping and education. Managed and operated by IMR, the center is located in Ohio State's Innovation District on West Campus, with a satellite site at Nanotech West Lab that focuses on the translation of electrochemical energy storage and conversion basic research to proof of concept to meet market needs.

The facility will accelerate the development and translation of lithium and solid-state batteries from research to practical manufacturing by enabling comprehensive studies of the process in a dedicated assembly environment. Spaces there are dedicated to an array of capabilities for battery cell manufacturing and demonstration, including mixing, coating, calendering, slitting, pouch cell assembly, formation and aging.

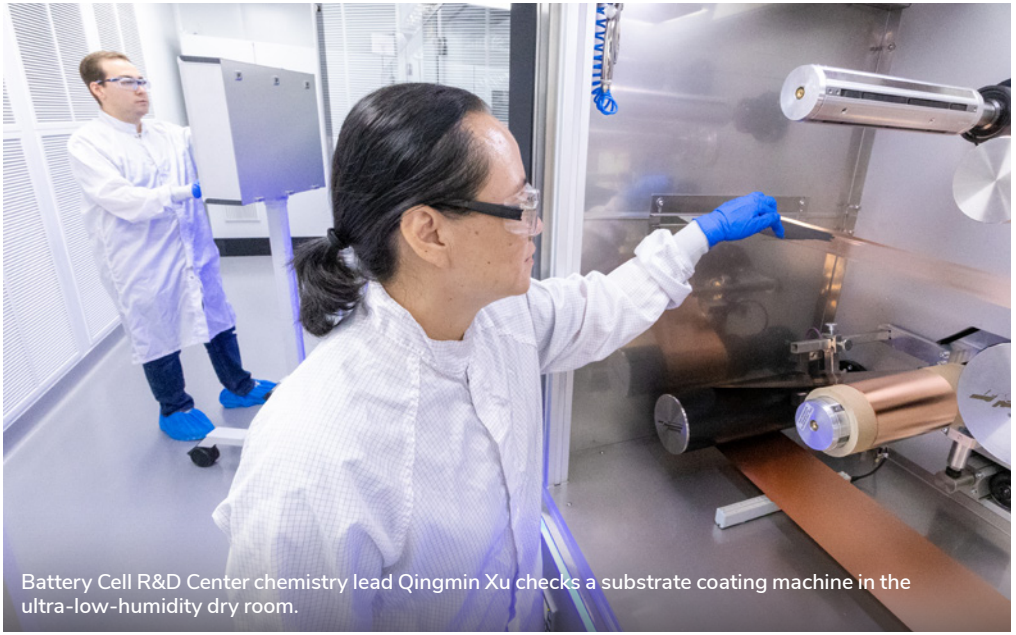
"The launch of the Battery Center marks a pivotal moment in how we define innovation at Ohio State," said Battery Center Director Jay Sayre, who is also IMR director of innovation and a research associate professor in Materials Science and Engineering. "This is not just about advancing battery technologies. It's about evolving our institutional capabilities and aligning our academic strengths with industry needs, government priorities, and regional aspirations. We are building an ecosystem where innovation is a strategic, co-created process that listens, invests, and scales impact across disciplines and sectors."

Through summer 2025 and into fall, truck after truck carrying new equipment arrived at the center.

The first major tool to arrive was a high-precision coating system that bridges the gap between fundamental research and pilot-scale production of advanced lithium battery cells. The acquisition of the Click&Coat system was sponsored by Battery Center foundational partner and manufacturer of the tool Coatema Coating Machinery GmbH and their U.S. distributor next Machinery Group, Inc. The large roll-to-roll substrate processing platform enables the precise, uniform application of battery materials, providing university researchers, students, and industry professionals with a highly customizable

Researchers working at the pouch cell assembly line at the Battery Cell R&D Center.

Highlights



Battery Cell R&D Center chemistry lead Qingmin Xu checks a substrate coating machine in the ultra-low-humidity dry room.

platform for scaling their work.

The arrival and installation of a pouch cell assembly line soon followed. The row of integrated Digatron Systems units improves the consistency and rate of production of lithium pouch cells while reducing product handling throughout the cell stacking process.

Both capabilities are housed in the Battery Center's 4,000-square-foot dry room, a low-humidity (–40 °C dew point) environment essential for assembling moisture-sensitive cell components. The construction of this space was made possible by federal funding and Congressional champions who included then-U.S. Sen. Sherrod Brown and U.S. Reps. Joyce Beatty and Mike Carey, all of whom participated in the November 2023 announcement event. Their work led to $4.5 million in funding through the National Institute of Standards and Technology's (NIST) Extramural Construction program.

Next door to the dry room for lithium battery cells is the center's ultra-low-humidity dry room for solid-state cell manufacturing. This –60 °C dew point environment houses another roll-to-roll coater, the Coatema Smartcoater. This platform offers a compact layout for pilot-scale manufacturing of up to 300-mm-wide substrates.

Beyond coating and assembly, the center also completed installation of new mixing capabilities for both lithium and solid-state manufacturing. For lithium electrodes, the facility added mixers in various sizes to prepare electrode slurries. For solid-state work, a dedicated mixing line is configured for sulfide-based solid electrolytes. Together, these additions expand the center's capacity for materials development and manufacturing processes.

Mark Stasik, facility and operations lead at the Battery Center, will continue managing the complex logistics involved in setting up the Battery Center during its construction phase, ensuring the completion of calendering, slitting, formation and aging capabilities by 2026. Stasik will also

oversee servicing and maintenance of the center's equipment going forward, as well as budgeting and safety.

As critical systems came online, the center welcomed its first users, foundational partners Honda and Schaeffler Americas, for sponsored projects. Honda, the lead foundational partner, committed $15 million to the Battery Center.

The center will also be a hub for academic and industry connections across chemical and physical sciences, engineering, business and policy. Once completed, it will create a pipeline of industry talent while attracting electric vehicle battery manufacturing and supply chain businesses to help support the evolving vision for the industry. Along with accelerating the domestic development of battery cell materials and manufacturing technologies for electrified mobility, the Battery Center is an experiential learning setting for advanced battery technology workforce development.

In summer 2025, the first cohort of interns from the NSF-funded Bridging Academic Training Through Experiential Research and Innovation (BATTERI) program had the unique opportunity to gain hands-on experience in a research center as new systems were installed and tested. Focusing on clean-tech battery manufacturing for the automotive industry, BATTERI was center's first funded program.

Battery Cell R&D Center chemistry lead Qingmin Xu and computational lead Navni Verma set the roll-to-roll coater in the large dry room for operation.

Joining the Battery Center technical team are Nanotech West Lab senior research scientist Qingmin Xu as chemistry lead, Nanotech West Lab research associate Navni Verma as computational lead, Center for Automotive Research research specialist Faissal El Idrissi as testing lead, Nanotech West Lab laboratory manager Paul D. Steffen as environmental health safety lead, and research scientist Jose L Lorie Lopez. Also on the team, Laurie Coyne as administrativea assistant and workforce coordinator, Kari Roth as program manager, Joanna Gardner as project manager, Greg Godic as business manager, and IMR Communications and Public Relations Manager Mike Huson.

Highlights

BATTERI OFFERS ITS FIRST COHORT OF INTERNS CLEAN TECH INDUSTRY INSIGHT AND HANDS-ON LAB EXPERIENCE

BATTERI interns learning about the installation of a coating system at the Battery Cell R&D Center.

The inaugural cohort of interns in IMR's newest experiential learning program, Bridging Academic Training Through Experiential Research and Innovation (BATTERI), gained hands-on experience and built technical skills while working in multiple IMR-operated labs, including the recently renovated Battery Cell R&D Center, and developed industry insight vital to the fast-growing battery sector. Through an intensive 10-week program, seven students from Ohio State, Columbus State Community College and Wilberforce University developed skills and insights to launch careers in advanced battery manufacturing through access to state-of-the-art facilities, experience operating cutting-edge systems, and guidance from expert mentors in both industry and academia. BATTERI was established

with funding from the U.S. National Science Foundation (NSF) through its Experiential Learning for Emerging and Novel Technologies (ExLENT) program.

"This program is more than a vehicle to explore new technologies; it will serve as a catalyst that will shape advanced manufacturing by lighting pathways for a diverse STEM workforce," said IMR Director of Innovation Jay Sayre, BATTERI lead principal investigator and research associate professor in Materials Science and Engineering.

Interns learned lab safety and scientific communication, and received hands-on training while working on real-world projects in multiple labs through the technical training curriculum portion of the program. In the entrepreneurial mindset portion, interns learned from mentors how to uncover and bring new discoveries to the market.

"As an electrical engineering and economics student, I was particularly drawn to how the program seamlessly wove together engineering innovation and entrepreneurial strategy," said Achraf Elinani, who studies at Columbus State Community College. "The training offered me meaningful exposure to market analysis, value proposition development, and practical insights into what it takes to succeed as an entrepreneur down the road."

BATTERI interns at Nanotech West Lab.

For intern Bennett Kolda, an undergraduate student in Mechanical and Aerospace Engineering at Ohio State, the off-site facility tours of industry labs and manufacturing centers were particularly impactful. He then stayed on as an IMR intern, along with Elinani and Ohio State undergraduate student Austin Porter, at the Battery Center through Autumn 2025.

"Through the BATTERI internship, I was able to return to the Battery Center this fall and continue working as a student employee. I am excited for the opportunity to continue the work we started this summer and contribute to the operations and research of the Battery Center!"

Highlights

NEW FACILITY NETWORK THROUGH IMR-LED MICROELECTRONICS INNOVATION AND TECHNOLOGY CLUSTER TO ENHANCE DOMESTIC MANUFACTURING IN ADVANCED SEMICONDUCTOR TECHNOLOGIES

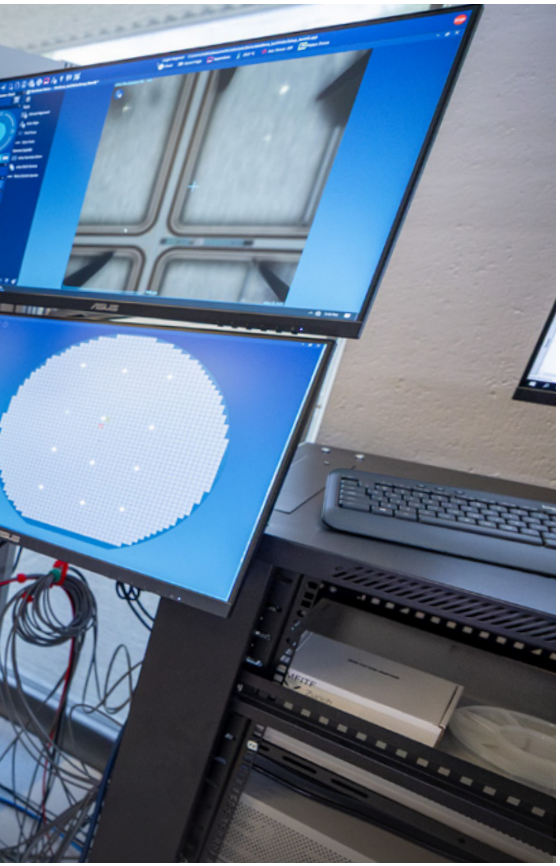
IMR is leading a significant new project that has nearly completed the establishment of a cluster of state-of-the-art user facilities at Ohio State to enhance the transition from research to commercial manufacturing of advanced semiconductor technologies. The new Microelectronics Innovation and Technology Cluster (MITEC), which is a core part of the Midwest Microelectronics Consortium (MMEC), a Department of Defense-designated regional hub funded through the Microelectronics Commons Initiative, will boost the Midwest region's position as a major innovation hub for microelectronics.

In FY25, MITEC integrated new capabilities funded by a the Department of Defense Microelectronics Commons program into Ohio State's existing facilities, as major renovations to accomodate new equipment to enhance materials growth capabilities were

IMR research scientist Joe McGlone works at a testbench in the MITEC Characterization Lab.

made at the Semiconductor Epitaxy and Analysis Laboratory and multiple labs within Nanotech West Lab.

With the shared-user characterization facility complete, the site now includes four electrical-testing testbeds: direct-current, high-voltage, radio-frequency, and cryogenic-temperature.



Additionally through MITEC, Ohio State has enhanced its device fabrication platform with a plasma/thermal atomic layer deposition system and a direct-write photolithography tool to ensure access to these high-demand processes and accelerate device prototyping for Defense applications.

Enhancements to compound semiconductor epitaxy will be operational by year-end 2025, including 100mm wafer-process-compatible metal-organic chemical vapor deposition and hydride vapor-phase epitaxy systems, for AlGaN and Ga_2O_3 technologies, respectively. Additionally, a new, 100mm wafer compatible molecular beam epitaxy system will be installed to support infrared compound semiconductor technologies. These upgrades will expand Ohio State's capacity for cutting-edge research and enable state of the art prototype fabrication.

The MITEC project is led by IMR Executive Director Steven Ringel, a Distinguished University Professor in Electrical and Computer Engineering and Associate Vice President for Research.

"The new MITEC capabilities will have a significant impact on Ohio State's semiconductor ecosystem and infrastructure, with the goal to support device development and prototyping for Department of Defense technology transitions working with the consortium," he said. "We are excited about our partnership with the MMEC as the midwest's leading innovation hub for compound semiconductor technologies."

The project's impact will be transformative, supporting the MMEC in advancing "lab to fab" transition projects in key technology areas of microelectronics, as identified by the Department of Defense.

The MITEC team includes co-PIs Siddharth Rajan, a Distinguished Professor of Engineering, Nanotech West Lab director John Carlin, and IMR research scientist Joe McGlone. In addition to supporting research, MITEC will

Highlights

enable workforce training in semiconductor device testing and fabrication, helping to build the next generation of experts in this field. Projects utilizing MITEC will also have access to the network of existing IMR and Ohio State facilities, including the Center for Electron Microscopy and Analysis and the NanoSystems Laboratory.

OHIO STATE LEADS FEDERAL PROJECT TO ADVANCE THE U.S. DOMESTIC MICROELECTRONICS SUPPLY CHAIN

Ohio State is utilizing the new Microelectronics Innovation and Technology Cluster (MITEC) to play a key role in strengthening the U.S. microelectronics supply chain by advancing domestic chip development and production. The university will lead a collaboration with industry and government partners to support one of five prototype projects across six technical areas critical to the U.S. Department of Defense as part of the Microeletronics Commons initiative. MITEC is a core part of the Midwest Microelectronics Consortium (MMEC) hub infrastructure, operated by IMR.

The Center for Technology Transition and Rapid Prototyping of Infrared Detectors (CENTROID), focuses on electromagnetic warfare and will be led by Sanjay Krishna, professor in Electrical and Computer Engineering and George R. Smith Chair in Engineering. He leads the Krishna Infrared Detector (KIND) lab that researches infrared semiconductor materials and detectors to educate, train and develop the next generation of scientists, engineers and thought leaders.

"Development of the infrared focal plane arrays led by the CENTROID team represents a very critical technology for the Department of Defense," he said. "Our team will undertake critical research to explore novel heterogenous integration approaches for antimonide based semiconductors with silicon."

Supported by the CHIPS and Science Act, the Microelectronics Commons program is a network of regional technology hubs aimed at strengthening the U.S.'s global leadership in microelectronics. MMEC leads the acceleration of microelectronic technologies and delivers solutions to establish a trusted and resilient domestic supply chain.

"Under Dr. Krishna's leadership, The Ohio State University has become a recognized leader in Electro-Optical/InfraRed (EO/IR) research and technology development," said Peter Mohler, executive vice president for the Enterprise for Research, Innovation, and Knowledge at Ohio State. "We are pleased to co-lead one of the first round of projects supported through DOD's new Microelectronics Commons initiative in partnership with the MMEC hub and in concert with our small business partners."

Through CENTROID, the university is collaborating with industry partners Attollo Engineering, IQE USA, SK Infrared and Senseeker Engineering, as well as the U.S. Navy Naval Surface Warfare Center, Crane Division.

VETERANS COME TO NANOTECH WEST LAB TO COMPLETE MICROELECTRONICS AND NANOMANUFACTURING INTERNSHIPS

The first group of interns through the Microelectronics and Nanomanufacturing Veterans Partnership (MNVP) completed their hands-on training in the cleanrooms of Ohio State's Nanotech West Lab in the summer of 2025.

The free program is designed specifically for veterans and combines live-streamed lectures with intensive, hands-on site training in a cleanroom environment. Led by Penn State, it aims to integrate military veterans into the growing nanotechnology workforce.

MNVP intern Daylon Scott, a second-year student in atmospheric science at Columbus State Community College, said he enjoyed the blended learning style with online lectures from Penn State, adding that soon "the curiosity began to take over."

"I honestly enjoyed it, from the instructors at Penn State, to the staff here at Nanotech West Lab," he said. "One of the best learning experiences I've been a part of."

MNVP interns on their final day at the Nanotech West Lab cleanrooms. From left to right: Hemant Ghadi, research scientist in Electrical and Computer Engineering; MNVP intern William Wordsworth; MNVP intern Daylon Scott; Keith Ramsey, Nanotech West Lab research associate; and Nanotech West Lab director John Carlin.

After the program concluded, Scott joined Nanotech West Lab as in intern.

NSF funds the initiative to provide veterans with the skills needed for semiconductor fabrication and nanotech-related careers. Other universities involved in MNVP include Arizona State University, the University of California San Diego, Georgia Institute of Technology, Cornell University, and the University of Texas at Arlington. The program's expansion to Ohio reflects the state's growing investment in semiconductor manufacturing, positioning veterans to take advantage of emerging job opportunities in the region.

Highlights

NSF-FUNDED ERC TO DRIVE DEVELOPMENT OF US NATURAL RUBBER INDUSTRY

TARDISS principal investigator Judit Puskas, professor of food, agricultural and biological engineering and a Distinguished University Professor at Ohio State (right).

Ohio State was awarded $26 million by the U.S. National Science Foundation to establish a new Engineering Research Center (ERC), with proposal development support provided by IMR. The new center, Transformation of American Rubber through Domestic Innovation for Supply Security (TARDISS), will jump-start natural rubber production in the United States and enhance workforce development to fuel the new domestic industry.

"Our ongoing priority is to support the people, communities and businesses in Ohio by leveraging the expertise and research of our outstanding faculty and students through these partnerships," Ohio State President Walter "Ted" Carter Jr. said. "Ohio State is proud to lead this work advancing domestic natural rubber production in our state and region."

IMR staff worked closely with TARDISS investigators throughout the proposal development process and actively supported the extensive NSF review and site-visit process leading to the award. The first round of funding will last for five years, with the ability to renew for another $26 million for five additional years. TARDISS marks Ohio State's second current NSF ERC, with the other focusing on next-generation manufacturing through HAMMER: Hybrid Autonomous Manufacturing, Moving from Evolution to Revolution, which was awarded funding in 2022.

Composed of academic partners and supported by industry stakeholders, TARDISS will lead fundamental research supporting the creation of a "Silicon Valley of Domestic Natural Rubber Production," said Judit Puskas, professor in Food, Agricultural and Bi-

ological Engineering (FABE) and a Distinguished University Professor at Ohio State. As principal investigator on the grant, Puskas will lead the center along with its director, FABE Prof. Ajay Shah. Katrina Cornish, Ohio State professor emeritus and current director of the U.S. Department of Agriculture's Agricultural Research Service and Arid Land Agricultural Research Center, will serve as an external adviser to the center.

TARDISS bridges engineering, biology and agriculture to revolutionize alternative natural rubber production from domestic crops: guayule, the rubber dandelion and mountain gum. The initiative will also help create jobs, train a new engineering and agricultural workforce, and ease supply chain issues by building a domestic rubber supply.

"Ohio State is prepared to make the most of this opportunity to get domestic natural rubber production up and running," said Puskas, a longtime scholar in rubber technology who joined the Ohio State faculty in 2019. "This significant federal support coupled with the large network of expertise under the ERC umbrella positions us well to meet the critical need for a biotechnology-driven solution that boosts domestic manufacturing and reduces reliance on imports."

Disease and high demand threaten the tropical rubber tree Hevea brasiliensis, the world's primary natural rubber source. In 2019, 10 percent of the natural rubber supply was lost to disease – and the risk of transmission of South American leaf blight to Southeast Asia has increased with the expansion of direct airline travel between Brazil and China. Collapse of the global supply would disrupt entire economies around the world, researchers predict.

Through TARDISS, Ohio State is partnering with the California Institute of Technology; North Carolina State University; Texas Tech University; the University of California, Merced; Rensselaer Polytechnic Institute; and Case Western Reserve University as well as industry, educational and technical organizations including The Goodyear Tire & Rubber Co., the Rubber Division of the American Chemical Society and the Waters Corp. The new center is headquartered at the College of Food, Agricultural, and Environmental Sciences (CFAES) Wooster campus.

A greenhouse full of the desert shrub guayule on the university's Wooster campus. Photo courtesy of Katrina Cornish, Ohio State professor emeritus.

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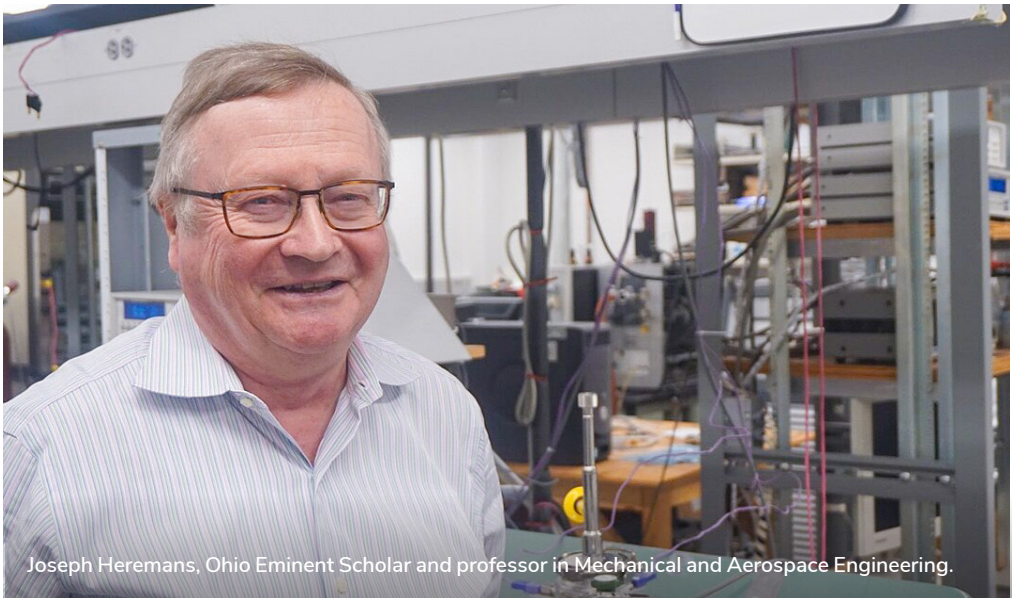
JOSEPH HEREMANS SELECTED FOR DOD'S VANNEVAR BUSH FACULTY FELLOWSHIP FOR HIGH-RISK BASIC RESEARCH FELLOWSHIP


Joseph Heremans, Ohio Eminent Scholar and professor in Mechanical and Aerospace Engineering.

Ohio Eminent Scholar Joseph Heremans has become Ohio State's first faculty member to earn the Department of Defense's prestigious Vannevar Bush Faculty Fellowship, providing about $3 million for high-risk basic research.

Heremans, a professor in Mechanical and Aerospace Engineering, was one of only 11 U.S. researchers recommended for the 2024 fellowship from a pool of 170 initial white papers and 27 finalists.

"I'm thrilled Professor Heremans is leading this ambitious work at Ohio State," said Ohio State President Walter "Ted" Carter Jr. "Buckeyes are on the front lines of research and innovation that create meaningful impact in the world, and this Department of Defense fellowship presents an exciting opportunity to contribute to the United States' global leadership in security technology."

With about $3 million in funding over five years, Heremans will primarily focus on the topic of polarization caloritronics, substituting ferroelectric materials for ferromagnets in potential spintronic-like applications.

"It's like starting anew," said Heremans, also a professor in Materials Science and Engineering and Physics. "It's fantastic to have an established career in research, and then suddenly be given the opportunity to start a completely new direction. It is rejuvenating."

"Bindu Nair, director of the Basic Research Office for the U.S. Department of Defense, explicitly told me to take big risks in the research funded by this program."

In early 2023, Heremans and a graduate student in his lab, Brandi Wooten,

led the work behind a paper in which they predicted and confirmed theoretical properties of solid materials known as ferroelectrics – which hinted at the possibilities Heremans will pursue during the fellowship. He will explore the theory that the flow of electric polarization can be demonstrated experimentally and can be used for engineering functions similar to spin currents: controlling the flow of heat, generating electricity from heat, and transporting information about a thousand times faster than magnetic spins can.

Applications could include heat engines based on polarization currents; electric-field control of heat flow – the thermal equivalent of a transistor; low-power, cooler logical memory using polarization currents rather than spin waves (reducing data-center power needs); and, for the military, minimizing electromagnetic interference, including attempts to jam communication signals.

CENTER FOR EMERGENT MATERIALS RECEIVES NSF FUNDING FOR RESEARCH AND EDUCATION PARTNERSHIP

The Center for Emergent Materials (CEM), Ohio State's NSF MRSEC (materials research science and engineering center) is partnering with California State University, Long Beach (CSULB) to expand participation and access to materials science facilities, education, training, and future careers. IMR helped drive the establishment of CEM in 2008, Ohio State's first NSF Materials Research Science and Engineering Center. Through the years, IMR has continued to share in a myriad of strategic programs and activities dedicated to fostering the next generation of materials discoveries and researchers.

The new funding award through the U.S. National Science Foundation (NSF) Partnerships for Research and Education in Materials (PREM) program supports strategic collaborations between NSF-funded research centers at universities and partner institutions focused on expanding access to education, training and research opportunities. PREM expands CEM's collaborative approach by combining complementary expertise from CSULB in projects ranging from ultrafast and energy-efficient computing to next-generation electronic devices. Collaborations focus on exploring applications in magnetic storage, energy-efficient devices and bio-inspired materials.

"The PREM seed award helped us grow a new class of topological magnetic materials, and with CSULB collaborator Prof. Claudia Ojeda-Aristizabal, probe their electronic band structure through photoemission measurements at Lawrence Berkeley National Laboratory," said co-principal investigator Joshua Goldberger, CEM director and Charles H. Kimberly Professor in the Department of Chemistry and Biochemistry. "This wouldn't have been possible without the seed award."

Jay Gupta, an Ohio State professor in Physics, is also a co-PI of PREM.

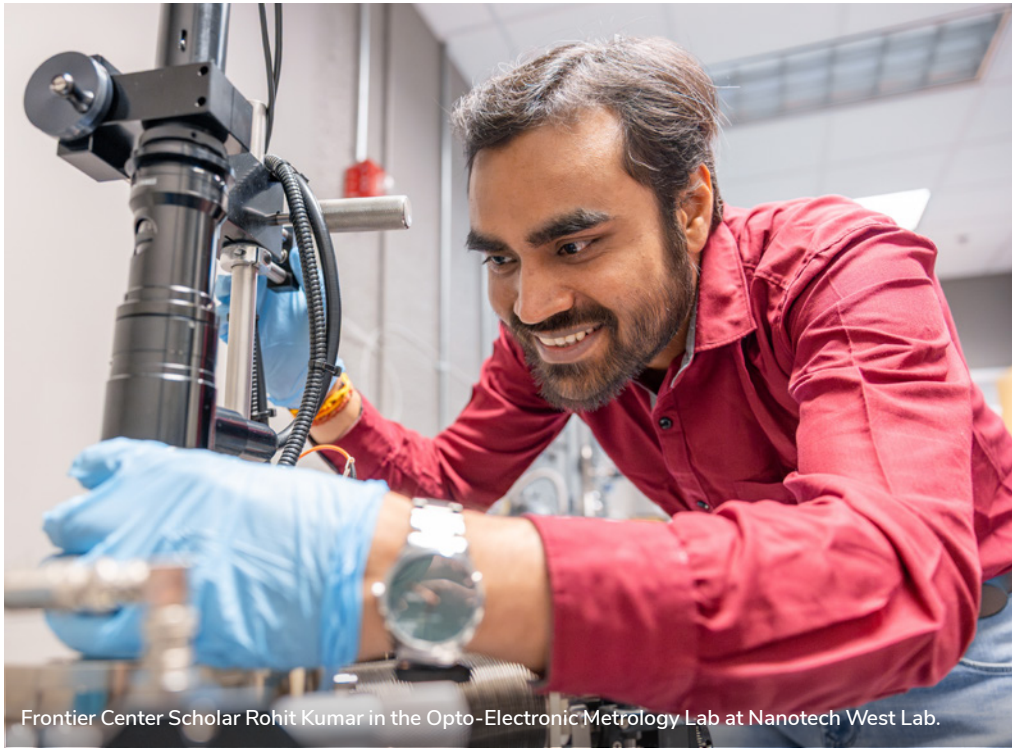
Highlights

FRONTIER CENTER RESEARCH TEAM ADVANCING NEXT-GENERATION SILICON-BASED INFRARED DETECTORS

An international research team from the IIT Bombay–Ohio State Frontier Science and Engineering Research Center is developing a novel extended short-wave infrared detector (e-SWIR) that could reduce costs and enable broader adoption across sensing, healthcare, and space technology.

The team is led by principal investigators Sanjay Krishna, professor in Electrical and Computer Engineering and George R. Smith Chair in Engineering at Ohio State, and Bhaskaran Muralidharan, a professor of Electrical Engineering at IIT Bombay. Also in the group, IIT Bombay doctoral student Rohit Kumar, who spent one semester in Columbus, Ohio, as a Frontier Center Scholar working closely with Krishna on modeling and in the Opto-Electronic Metrology Lab at Ohio State's Nanotech West Lab.

Kumar's dissertation, to be defended in the fall of 2025, centers on this e-SWIR detector work and drew on complementary strengths at both institutions: experimental infrared-photodetector expertise in Krishna's K.I.N.D. Laboratory at Ohio State and nanoscale device modeling and simulation in IIT Bombay's CNQT Group, led by his faculty mentor Muralidharan.



Frontier Center Scholar Rohit Kumar in the Opto-Electronic Metrology Lab at Nanotech West Lab.

"This collaboration brought to-

gether experimental and theoretical strengths, forming a well-rounded team to tackle complex challenges in the field of infrared photodetectors," he said. "Such synergy is crucial for delivering high-impact results to both academia and industry."

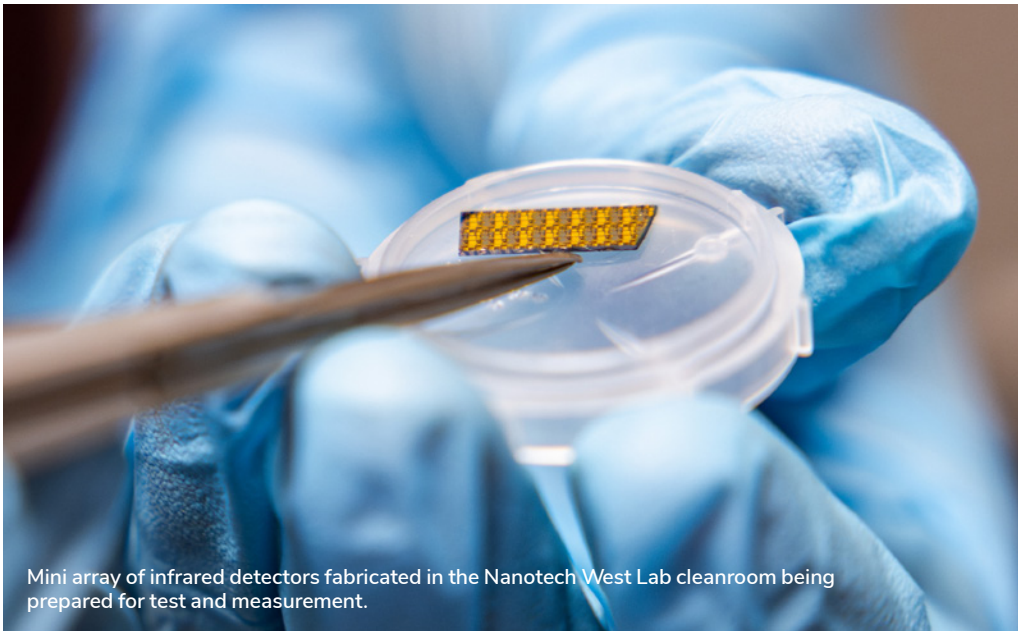
Today's high-bandwidth e-SWIR detectors predominantly use III–V compound semiconductors. These devices can be expensive, harder to integrate with standard silicon chips, and produce a weaker signal beyond about 2.3 micrometers (μm). Germanium-tin (GeSn)-based detectors could provide a path to silicon-integrated e-SWIR detectors.

The team is building a new kind of photodetector, one with a GeSn absorber paired with a SiGeSn barrier. This all-group-IV, silicon-compatible design is engineered to reduce dark-current electron leakage while having a large photocurrent.

To achieve that, the team chose a GeSn/SiGeSn stack. GeSn becomes a direct-bandgap material at about 6% to 7% Sn, depending on strain. Its tunable bandgap spans e-SWIR to mid-infrared, while SiGeSn serves as a silicon-compatible barrier layer. To that end, the team is modeling GeSn/SiGeSn unipolar barrier (nBn) devices to quantify dark-current mechanisms and optimize for high-sensitivity detectors.

With his dissertation defense ahead and the development of GeSn e-SWIR detectors still in the early stages of development, Kumar reflected on his time at Ohio State and how the Frontier Center shaped his path and research.

"Spending nearly a semester at The Ohio State University has been a rewarding experience. I am deeply grateful to the Ohio State–IIT Bombay Frontier Center for this opportunity, which has greatly contributed to my growth as a researcher," Kumar said. "This collaboration has not only broadened my technical skills but also strengthened the foundation for future contributions to research and innovation."



Mini array of infrared detectors fabricated in the Nanotech West Lab cleanroom being prepared for test and measurement.

Highlights

SPACE-MAT LAUNCHES AS NEW AIR FORCE-FUNDED CENTER OF EXCELLENCE TO ADVANCE SPACECRAFT MATERIALS

Professors Enam Chowdhury, Wolfgang Windl and Lisa Hall inspect the "Death Star" vacuum chamber in Chowdhury's Femtosecond Dynamics Lab. Photo courtesy of the College of Engineering.

A new center led by Ohio State aims to predict and extend the use of spacecraft materials through physical and data-driven modeling and to train a new generation of materials engineers. The Science, Performance and Critical Evaluation of Materials in Low Earth Orbit (SPACE-Mat) Center of Excellence is set to receive $5.5 million in funding from the Air Force Research Laboratory (AFRL) and Air Force Office of Scientific Research (AFOSR) to focuse on the advancement of spacecraft materials design. The center will establish protocols for reliably identifying the lifetime-limiting environmental effects in low Earth orbit, setting up ground-based test facilities that replicate those environmental effects, and developing experiments to assess radiation damage and resulting performance changes. The multidisciplinary team includes experts from Georgia Institute of Technology, Michigan State University and the University of Alabama in Huntsville.

"No existing academic discipline covers the necessary education and research training of graduate students in the combination of space environment science, radiation effects on materials and properties, multiscale and data-driven modeling, and uncertainty in combined experimental, modeling and simulation protocols," said SPACE-Mat lead PI Wolfgang Windl, professor in Materials Science and Engineering. "Our team has the expertise to develop a spacecraft materials design workforce for AFRL who are trained in the interdisciplinary space between materials science, space physics and computational modeling."

TYNDALL-OHIO STATE TEAM DEMONSTRATES HETEROGENEOUS INTEGRATION FOR OPTICAL COMMUNICATION SYSTEMS

A research team funded through the Tyndall National Institute of Ireland–Ohio State IMR Research Partnership Program took a major step forward in the advancement of visible light communication (VLC) in FY25 after successfully integrating gallium nitride (GaN) microLEDs and GaN high electron mobility transistors (HEMTs) onto a single-chip platform.

Led by Tyndall researcher Muhammet Genc and Siddharth Rajan, a Distinguished Professor of Engineering in Electrical and Computer Engineering at Ohio State, the team's integration holds the potential to enable considerable reductions in the size and energy consumption of high-speed systems transmitting data using visible light by eliminating power-consuming external drivers required in traditional designs.

"This makes VLC a more viable option for portable devices, such as smartphones, wearable technologies, and IoT gadgets, where space and energy efficiency are critical," the team wrote in Compound Semiconductor magazine. "Additionally, our VLC technology can directly benefit advanced applications in AI data centres, where fast and reliable optical interconnects are crucial for massive data processing."

Distinguished Professor of Engineering Siddharth Rajan in the Semiconductor Epitaxy and Analysis Laboratory. Photo courtesy of the College of Engineering.

Tyndall and Ohio State divided responsibilities at their respective state-of-the-art facilities. This first-generation microLED–HEMT integration achieved a 3 dB modulation bandwidth of 100 MHz, demonstrating high-frequency operation and establishing a solid basis for future improvements in modulation speed and overall performance.

Highlights

IMR ASSOCIATE DIRECTOR MICHAEL GROEBER STEPS INTO NEW ROLE AS SIMCENTER DIRECTOR

Integrated Systems Engineering Professor Michael Groeber is the new director of Ohio State's Simulation Innovation and Modeling Center (SIMCenter). Groeber also is IMR's director of manufacturing, a professor in the Mechanical and Aerospace Engineering Department, and faculty director of the Artificially Intelligent Manufacturing Systems Lab.

SIMCenter's multidisciplinary teams research and apply methods for virtual product development and virtual manufacturing while advancing innovative engineering solutions that rely primarily on physics-based modeling. The center was established in 2013 with a $5 million gift from Honda R&D Americas.

Groeber, who joined Ohio State in 2018 through the IMR-operated Materials and Manufacturing for Sustainability Discovery Theme, leads a research group developing autonomous robotic systems that integrate physics-based modeling, real-time data collection and analysis and AI for manufacturing, handling and inspecting engineering components. He also co-developed SIMPL and DREAM.3D, a software library and application package with hierarchical data and digital microstructure, image processing and analytics for integrated computational materials engineering.

Prof. Michael Groeber at the Center for Design and Manufacturing Excellence (CDME).

"My passion and vision are in the integration of simulation, data analytics and process optimization to advance manufacturing and design," he said. "SIMCenter, in collaboration with myriad research centers at Ohio State, is uniquely positioned to be a major force in manufacturing's resurgence in the U.S."

SANJAY KRISHNA NAMED OHIO STATE'S 2025 INNOVATOR OF THE YEAR

Prof. Sanjay Krishna at the 2025 Research and Innovation Showcase. Photo courtesy of ERIK.

At the Enterprise for Research, Innovation and Knowledge's annual Research and Innovation Showcase, IMR faculty member Sanjay Krishna, professor of Electrical and Computer Engineering (ECE), was named as The Ohio State University 2025 Innovator of the Year.

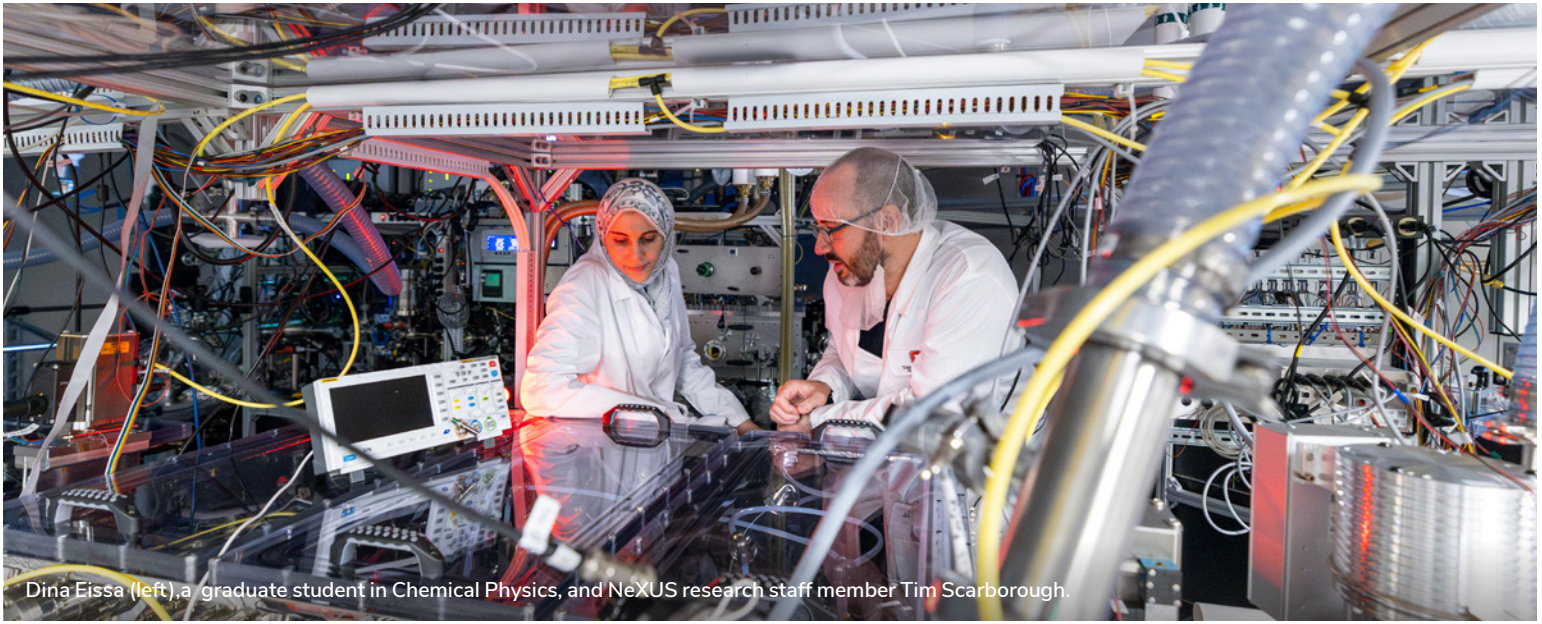
The award recognizes established Ohio State researchers who are actively working to promote the commercialization of university intellectual property, through invention disclosures filed, patents applied for and/or received, technologies licensed or spin-off companies formed. Krishna, the George R. Smith Chair in the College of Engineering, is co-founder and chief technical officer of SK Infrared, a startup focused on defense, aerospace and commercial applications of infrared imaging.

Accepting the award, Krishna said the honor is only the visible result of a long journey shaped by years of trial and error and lessons learned. He credited colleagues and students at the university and his company, people from his schooling and his family, saying many people contributed over decades and that he is simply the recipient.

"It's really humbling to be named Ohio State Innovator of the Year. It really captures the sense of what I'm trying to do," he said. "It's innovation as a professor — to use the science to train the next generation of students and thought leaders and as an entrepreneur — to be able to take that innovation into the marketplace. This is the best job to have."

Highlights

NEXUS AWARDS FIRST YEAR'S COHORT OF FACILITY USERS



Dina Eissa (left),a graduate student in Chemical Physics, and NeXUS research staff member Tim Scarborough.

In its first year of requesting proposals, the NeXUS (National eXtreme Ultrafast Science) facility at Ohio State awarded time for 13 user experiments that utilized ultrafast measurements in applied and fundamental studies of matter at the electron and atomic scales.

Drawing users nationwide from materials science, chemistry and physics, NeXUS supported research using ultrafast X-ray spectroscopy, angle-resolved photoelectron spectroscopy of material surfaces, and scanning tunneling microscopy of material surfaces. The cohort included staff from two national labs and eight early-career researchers.

NeXUS was established in 2019 with support from the National Science Foundation (NSF) and Ohio State. In 2019, IMR launched a proposal-building campaign to promote Ohio State's responses to NSF's new Mid-scale Research Infrastructure program, and Ohio State secured funding for two facilities, including NeXUS.

NeXUS is an open-access user facility that makes biannual calls for us-

er proposals. Research is proposed and evaluated for scientific merit, and teams are granted facility time at no charge, with the cost covered by NSF.

The facility's first scanning tunnelling microscopy user, Joseph “Perry” Corbett, an assistant professor of physics at Miami University, already published results from NeXUS measurements on topological electronic material his group grows.

NeXUS is open to collaborations with companies interested in commercial research studies. It enables ongoing collaborations with IMR, the Center for Emergent Materials, the Institute for Optical Science, and other university researchers interested in its capabilities.

FRONTIER CENTER’S TJ RONNINGEN NAMED FACILITY MANAGER AT NEXUS

In FY25, TJ Ronningen brought his IIT Bombay-Ohio State Frontier Center project-management experience to his new role as facility manager for NSF NeXUS. During his five years with the IMR-operated Frontier Center, Ronningen helped enable the funding and development of 24 new projects bringing together international collaborators.

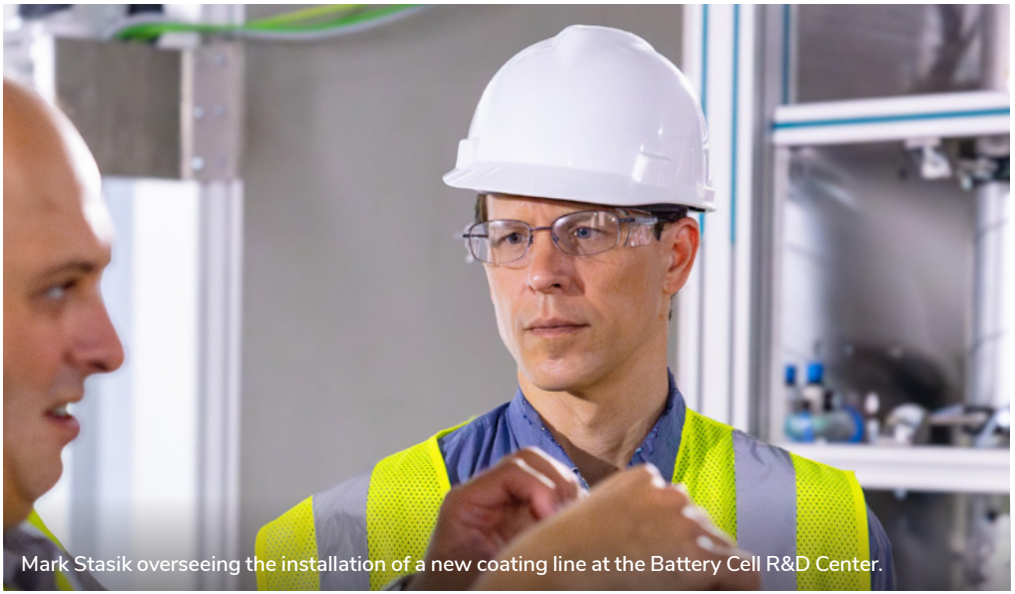
"Frontier Center was my first opportunity to gather and award research proposals," he said. "I’ve used everything I learned from the IMR staff to set up and execute the NeXUS calls."

TJ Ronningen, NeXUS (National eXtreme Ultrafast Science) facility manager.

Ohio State's breadth of expertise and resources has been integral in both roles, he said, adding, "The collaborative research at the heart of Frontier Center is also at the heart of NeXUS, and I’m happy that my job allows me to keep supporting researchers to reach beyond what they can achieve on their own."

Highlights

IMR'S NEW FACILITY AND OPERATIONS LEAD MARK STASIK DRIVES BATTERY CELL R&D CENTER TOWARD OPENING



Mark Stasik overseeing the installation of a new coating line at the Battery Cell R&D Center.

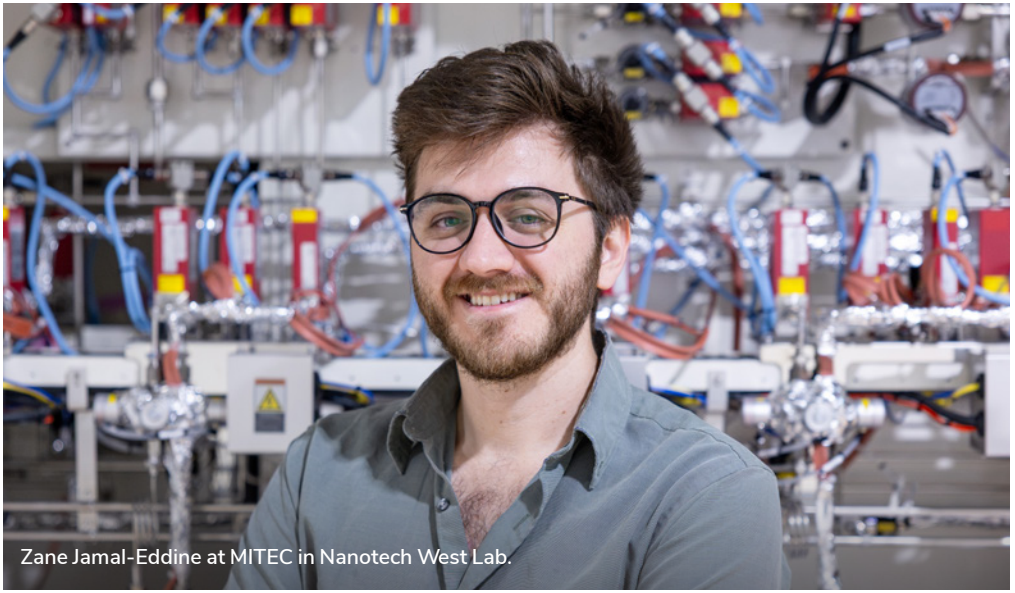
Mark Stasik joined IMR in FY25 as facility and operations lead at the Battery Cell R&D Center in Ohio State's Innovation District on West Campus. There, he is responsible for leading facility operations, including the installation, servicing, and maintenance of the center's equipment. Additionally, he will develop not only the center's safety protocols but also its budget for operations. His role ensures the center's facility and equipment run smoothly, so researchers can focus on their work in an advanced and fast-moving field.

Stasik hit the ground running, managing the complex logistics involved in setting up the Battery Center during its construction phase. He coordinated and navigated the logistics and challenges of equipment delivery, handling and placement. The first major piece of equipment under his care, a large roll-to-roll electrode coating system, arrived in May in multiple crates weighing several thousand pounds each. Since then, the center has received and installed more than a dozen additional systems, each with unique handling and installation needs.

Stasik joined the university from Worthington Steel, in Columbus, Ohio, where he was a materials scientist. There, he investigated technical requests submitted by businesses through mechanical testing, metallography, microscopy, photography and chemical analysis. Prior to Worthington, Stasik was a research scientist working with advanced materials applications, including battery and fuel cell technologies, at Battelle Memorial Institute. Before that, he worked in General Motors' Metal Fabricating.

NEW IMR RESEARCH SCIENTIST ZANE JAMAL-EDDINE FOCUSES ON ADVANCED SEMICONDUCTOR TECHNOLOGIES WITHIN MITEC

Zane Jamal-Eddine, Ph.D., is IMR's newest research scientist specializing in epitaxial growth, design and fabrication of advanced semiconductor technologies. Working in IMR's Microelectronics Innovation and Technology Cluster (MITEC), located at Nanotech West Lab, he guides and enables collaborative research and training in semiconductor growth and processing for strategic defense and commercial areas of next-generation devices based on wide and ultrawide bandgap semiconductors.



Zane Jamal-Eddine at MITEC in Nanotech West Lab.

In his role at IMR, Jamal-Eddine leads and supports research on the epitaxial growth of wide and ultrawide bandgap compound semiconductors using MOCVD and hydride vapor-phase epitaxy, focusing on aluminum gallium nitride, gallium oxide and related advanced semiconductors of interest for applications in power electronics, high-frequency RF electronics, and optoelectronics. He will also support collaborative research efforts in device fabrication, characterization, testing and analysis.

As IMR's lead epitaxy research scientist, Jamal-Eddine is looking forward to engaging in high-impact collaborations across the faculty, students and staff involved in compound semiconductor materials and devices research.

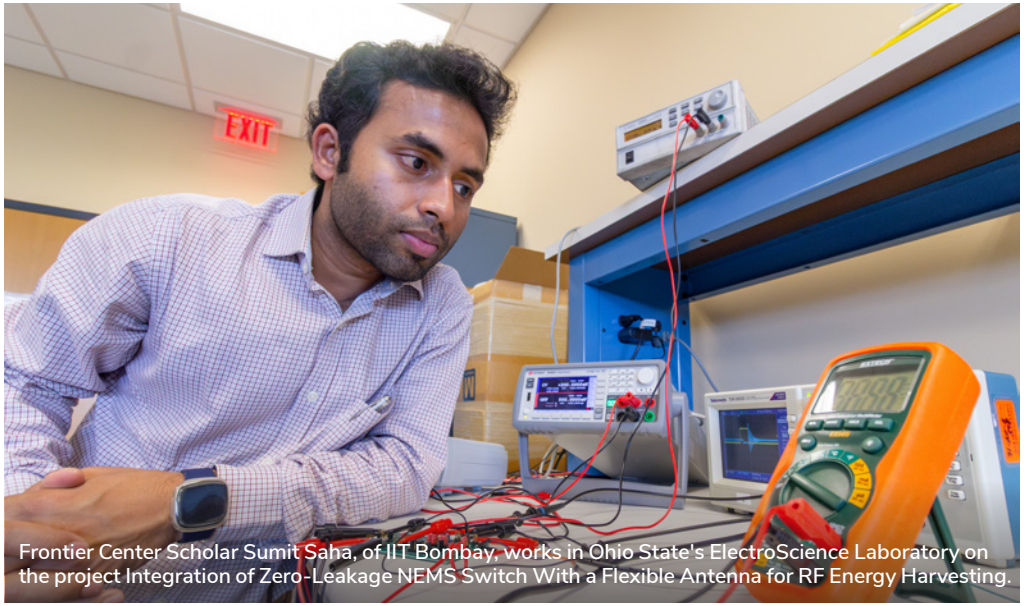
Along with IMR research scientist Joe McGlone, Ph.D., he will serve as a key partner with industry and government collaborators in support of IMR's key role as the primary infrastructure hub for the Midwest Microelectronics Consortium.

Jamal-Eddine has gained significant experience in the semiconductor industry in positions at Lumileds and Intel.

Global Partnerships

OHIO STATE LAUNCHES UNIVERSITY'S FIRST INTERNATIONAL DUAL DOCTORAL DEGREE PROGRAM WITH IIT BOMBAY

Ohio State and the Indian Institute of Technology Bombay (IIT Bombay) have launched a dual doctoral degree program to further strengthen the research and academic relationship between the two universities and provide global educational and professional experience for exceptional graduate students. The new dual degree program cements an existing relationship while expanding access to industrial partners and research areas of interest. The new program is also expected to grow talent in both countries and aid in global workforce development. A special advantage of the new dual doctoral degree program is its association with the previously established IIT Bombay-Ohio State Frontier Science and Engineering Research Center, initiated and managed by IMR for the Ohio State community. The Frontier Center will provide additional opportunities to accelerate students' research in the dual degree program, similar to its continued funding of doctoral student projects that are jointly developed by faculty through the center. IMR Executive Director Steven Ringel and Balasubramaniam Shanker, professor and chair of the Department of Electrical and Computer Engineering, spearheaded the development of the program.



Frontier Center Scholar Sumit Saha, of IIT Bombay, works in Ohio State's ElectroScience Laboratory on the project Integration of Zero-Leakage NEMS Switch With a Flexible Antenna for RF Energy Harvesting.

The initial focus of the degree program will be on microelectronics and artificial intelligence. The program will enable graduate students to pursue their graduate course requirements and research work at both institutions. Students will satisfy the requirements of both institutions within the time typically required for a single degree.

ABHISHEK GUPTA BRINGS NEW ENTREPRENEURIAL EXPERIENCE TO THE FRONTIER CENTER LEADERSHIP TEAM

Abhishek Gupta, associate professor in the Department of Electrical and Computer Engineering at Ohio State, has joined Anant Agarwal, a professor in Electrical and Computer Engineering, and Ardeshir Contractor, a visiting fellow at IMR, as Frontier Center leaders. Their counterparts at IIT Bombay are Physics Prof. Dinesh Kabra and Electrical Engineering Prof. Saurabh Lodha.

Gupta's research focuses on the intersection of applied probability theory, reinforcement learning, and optimization. His research has contributed to improved efficiency of transportation markets, cyberattack detection and mitigation in control systems, and new convergence proofs for reinforcement learning algorithms.

As an alumnus of IIT Bombay, having earned his Bachelor of Technology in aerospace engineering there in 2009, he said he is excited to continue the Frontier Center's work on fostering collaborative efforts among researchers in the two universities. He will support the student researchers in two countries, build bridges with the industry experts, and support junior faculty in building international collaborative research programs. He will also contribute to the data science research in the Frontier Center.


ECE associate professor Abhishek Gupta.

Outside of Ohio State, Prof. Gupta is also a founder of Rewardwise, a customer engagement app, and runs a consulting business, Ensemble Control Inc., where he advises industry leaders on data science algorithms for solving important industrial problems.

He completed his Master of Science in Aerospace Engineering in 2011, Master of Science in applied mathematics in 2012, and earned his doctoral degree in aerospace engineering from University of Illinois at Urbana-Champaign in 2014.

Since joining Ohio State in 2015, Gupta has received the Lumley Research Award from Ohio State's College of Engineering, as well as the Kenneth Lee Herrick Memorial Award for Research Excellence from the Department of Aerospace Engineering at the University of Illinois Urbana-Champaign and the Mavis Future Faculty Fellowship from its College of Engineering.

Global Partnerships

IMR-IRELAND CATALYST PROGRAM CONTINUES EXPANDING GLOBAL COLLABORATION WITH 3 NEW RESEARCH PROJECTS

Ohio State ECE associate professor Shamsul Arafin in the Optics & Photonics Research Lab. He leads VIBRANT in the U.S. with Ireland lead Brian Corbett.

The Tyndall National Institute of Ireland–Ohio State Institute for Materials and Manufacturing Research Partnership Program awarded funding to three new research projects in FY25 through its Catalyst Program. The seed grant program aims to accelerate high-impact research conducted by principal investigators (PIs) from Tyndall and Ohio State by enabling collaborations and access to state-of-the-art research facilities in both countries. By support-

ing collaborative projects leveraging the strengths of both institutions, Tyndall and Ohio State aim to help generate joint publications and proposals for impactful research. The initiative is part of IMR's broader effort to foster international research and expand global collaborations. The Tyndall-IMR program seeded two projects in 2020 and another pair in 2023. Last year, one of those projects grew into the U.S.-Ireland partnership VIBRANT (Visible Light-wave Generation and Manipulation through Non-Linear Waveguide Technology), with support from an NSF grant. In summer 2025, IMR and Tyndall awarded funding to three projects:

Heterogeneous Integration of Antimonide-Based Semiconductors with Silicon: Principal investigators (PIs) Sanjay Krishna of Ohio State and Tyndall's Brian Corbett are teaming up to address a critical technology gap in high-performance short-wavelength infrared detectors that can be heterogeneously integrated with silicon. They aim to develop a selective AlGaAsSb-to-GaSb etch and transfer-to-carrier process to enable transfer printing. This work combines Ohio State's expertise in epitaxial growth and detector design with Tyndall's fabrication and heterogeneous integration capability.

Photonic-electronic integration for mm-wave generation and amplification: Ohio State's Siddharth Rajan and Tyndall's Fatih Bilge Atar are serving as PIs on a new project aiming on-chip integration of high-performance photonic and electronic components for mm-wave applications. Achieving this targeted level of integration will allow the combination of the high-speed, low-noise and tunable capabilities of III-V photonic components with the superior amplification properties of III-V electronics. Researchers will combine Tyndall's microwave photonic chip technology with Ohio State's high performance electronic components for future development of application-specific photonic integrated circuits.


Tyndall National Institute, in Ireland.

Self-Reconfigurable integrated novel optical beamforming circuit for 5G and Beyond Communication: PIs Tawfiq Musah of Ohio State and Abi Waqas of Tyndall are partnering to introduce an integrated wide-bandwidth (up to 50 GHz) beamforming circuit with continuous beam steering, overcoming the limits of conventional switched delay line-based systems and achieving sub-picosecond resolution. This approach would enhance system reliability and performance for high-speed, high-capacity wireless communication. Collaborators expect to deliver novel results by bringing together Tyndall's expertise in designing and fabricating complex photonic circuits with Ohio State's focus on control electronics.

Experiental Learning

IMR EXPERIENTIAL LEARNING PROGRAMS OFFER REAL-WORLD, HANDS-ON EDUCATIONAL OPPORTUNITIES TO STUDENTS

In FY25, 27 students from several institutions of higher education were welcomed to take advantage of experiential learning opportunities through multiple IMR internship programs.

These programs offer paid learning-by-doing positions at Ohio State's Nanotech West Lab and the Battery Cell R&D Center. The programs create new avenues of experiential learning for students, including research experience for undergraduate students, graduate research associateships and externships.

IMR hired nine students from Ohio State, the University of Ohio and University of Cincinnati to train in semiconductor fabrication through the Intel-funded Center for Advanced Semiconductor Fabrication Research and Education (CAFE). IMR hired an additional 10 undergraduate students from a range of studies spanning engineering, business and the arts for positions at Nanotech West Lab. In FY25,

IMR intern Arianna Mena (center) receives the Dr. Robert J. Davis IMR Internship Award from IMR Executive Director Steven Kingel (left) and IMR Director of Innovation Jay Sayre.

IMR also launched its first cohort of seven interns through the NSF-funded program BATTERI (Bridging Academic Training Through Experiential Research and Innovation), in which they developed technical skills and industry insights into the growing battery sector.

Also in FY25, IMR introduced a new award for its undergraduate interns. The first Dr. Robert J. Davis IMR Internship Award recognized Arianna Mena, whose dedication and contributions as a multiyear intern exemplify the ideals and vision for experiential learning that Davis helped establish within IMR and Nanotech West Lab.

IMR'S JOANNA GARDNER BRIDGES EDUCATION PROGRAMS FROM PRE-PROPOSAL TO MANAGEMENT

With a strong track record in proposal development, IMR Research Development Manager Joanna Gardner stayed on after an award for the first time in fiscal 2025 to build on that success and see a winning project through.

Last year, Gardner leveraged years of experience in the pre-proposal process to help IMR establish the NSF-funded program BATTERI: Bridging Academic Training Through Experiential Research and Innovation. She then took the reins, steering the internship program.

"I used to hand off proposals at the moment of submission. Now, I get to see what happens when they win," she said. "BATTERI is proof that a big idea on paper can become a place where students test-drive their futures."


IMR Research Development Manager Joanna Gardner (left) with Frontier Center Scholar Rohit Kumar.

BATTERI interns were trained in advanced battery manufacturing through hands-on projects, constellation mentorship, and entrepreneurial thinking. They also had the unique experience of working in the Battery Cell R&D Center as it was being renovated and new systems were installed and tested.

"We invited our Year 1 cohort into our world six months out from opening, threw the students into that start-up atmosphere, and said, 'let's learn together,'" Gardner said, adding that the success of the interns, whether in labs, plant tours, or collabing with industry leaders, shows how carefully designed experiential learning can shape career trajectories.

She also connects Ohio State and IIT Bombay faculty and students, advancing international collaboration while building pipelines of talent for industry.

Seed Grant Awards

IMR PROVIDES SEED FUNDING FOR 33 RESEARCH PROJECTS IN FY25

Thirty-three new projects led or co-led by researchers at Ohio State received seed funding support in FY25 through various IMR grant programs, as well as the OSU Materials Research Seed Grant Program (MRSGP), which is co-funded and co-managed by the institute. IMR's Global Partnership Grants supported three international research teams through the Tyndall-OSU/IMR Catalyst Program. Additionally, IMR awarded Kickstart Facility Grants to 26 teams led by non-tenured faculty staff and postdoctoral researchers. Lastly, four MRSGP awards were supported by IMR, the Center for Emergent Materials, and the Center for Exploration of Novel Complex Materials.

GLOBAL PARTNERSHIP GRANTS

Global Partnership Grants (GPGs) establish global impact in research and development, technology innovation and shared multinational education. Three Global Partnership Grants were awarded in FY25.

Tyndall-OSU/IMR Catalyst Program

Heterogeneous Integration of Antimonide-Based Semiconductors with Silicon
PIs: Sanjay Krishna, Ohio State, Electrical and Computer Engineering; Brian Corbett, Tyndall National Institute

Photonic-electronic integration for mm-wave generation and amplification
PIs: Siddharth Rajan, Ohio State, Electrical and Computer Engineering; Fatih Bilge Atar, Tyndall National Institute

Self-Reconfigurable integrated novel optical beamforming circuit for 5G and Beyond Communication
PIs: Tawfiq Musah, Ohio State, Electrical and Computer Engineering; Abi Waqas

KICKSTART FACILITY GRANTS

Kickstart Facility Grants strengthen near-term research proposals for external support by helping offset costs associated with research facilities and making shared campus research facilities more accessible. Twenty-six Kickstart Facility Grants were awarded in FY25.

Autumn 2024

A monolithic photoelectrode for modulation of local environments through optoelectronic effects
PI: Jinghua Li, Materials Science and Engineering

Alloy Design for Additive Manufacturing of Functionally Graded Materials Using Computational Modeling
PI: Boian Alexandrov Materials

Science and Engineering, Welding Engineering Program

Characterization and visualization of senescent cells derived EVs
PI: Paula Agudelo Garcia, Biomedical Engineering

Chemical heterogeneities on the sublattice of ordered intermetallics
PI: Andreas Bezold, Materials Science and Engineering

Cryo-EM Characterization of Apolipoprotein L1
PI: Sethu Madhavan, Internal Medicine

Engineered Extracellular Vesicles to mediate motor-like neuron conversion to support temporary muscle reinnervation after peripheral nerve injury
PI: Ana Isabel Salazar-Puerta, Biomedical Engineering

High Strength and Fully-Recyclable Fiber Reinforced Plastics
PI: Lauren Taylor, Chemical and Biomolecular Engineering

Hybrid Molecular Beam Epitaxy with Novel Precursors
PI: Kaveh Ahadi, Materials Science and Engineering, Electrical and Computer Engineering

Interface and Atomic-Scale Defect Characterization of GeSn0.9/Si PIN Photodetectors Using Electron Charge Contrast Imaging and Transmission Electron Microscopy
PI: Punam Murkute, Electrical and Computer Engineering

Mechanical characterization of glomerulus in diabetic kidney disease
PI: Dan Wang, Internal Medicine, Nephrology

Microscopic Investigation of Biodegradation Mechanisms in Coffee Oil Epoxide-Modified PHBV/Natural Rubber Blends
PI: Yael Vodovotz, Food Science and Technology

Seed Grant Awards

Mimicry of Metamaterials Through Liquid Crystals
PI: Xiaoguang Wang, Chemical and Biomolecular Engineering

Optical Characterization of Neutron-Irradiated Point Defects in h-BN for Quantum Applications
PI: Shamsul Arafin, Electrical and Computer Engineering

Solid-state nanopore single-particle level sensor: fabrication and characterization for biomedical diagnostic applications
PI: Buddini Karawdeniya, Biomedical Engineering, Chemistry and Biochemistry

Spring 2025

Hot Crack Susceptibility in Metal Additive Manufacturing of Heavy Section Steel Components
PI: Boian Alexandrov, Materials Science and Engineering, Welding Engineering

Deciphering the Oligomeric Architecture of Membrane-CLIC1
PI: Harpreet Singh, Physiology and Cell Biology

Role of Fe-containing phases on Casting and Rolling of Recycled 6061 Aluminum alloys
PI: Jianyue Zhang, Materials Science and Engineering

Implantable Wireless Optoelectronics for Programmable Neuromodulation in Harsh Biological Environments
PI: Lin Du, Neurology Surgery and Biomedical Engineering

Real-Time Monitoring of Enzyme-Triggered Drug Release from Protein-Coated Silica Nanoparticles Using Microfluidic Nanopipette Sensing
PI: Nisitha Wijewantha, Biomedical Engineering

Stimuli-Responsive Magnetic Interfaces from Fe(II) Spin Crossover Complexes on Ferromagnetic Surfaces
PI: Okten Ungor, Chemistry and Biochemistry

Ex Situ Lift-Off for Quantum and Electronic Applications
PI: Salva Salmani-Rezaie, Materials Science and Engineering

Micro-scale Mechanics of Radiopaque Post-mortem Vascular Contrast Agent in Vascular Mimetics
PI: Sara McBride-Gagyi, Biomedical Engineering

Spectroscopic and Microscopic Characterizations of CVD-grown Hexagonal Boron Nitride with B-10 Isotopes
PI: Shamsul Arafin, Electrical and Computer Engineering

Mechanisms to Enhance Kinetics, Capacity, and Durability of CO_2 Mineralization
PI: Shang Zhai, Mechanical and Aerospace Engineering, Earth Sciences

Visualization and Characterization of Drug Loaded Extracellular Vesicles for Targeted Pulmonary Delivery in LAM
PI: Tatiana Cuellar-Gaviria, Biomedical Engineering

Beneficial Microbes Enhancing Salt Tolerance in Tomato Plants Through Leaf and Root Surface Modifications
PI: Wenshan Liu, Plant Pathology

OSU MATERIALS RESEARCH SEED GRANT PROGRAM

Exploratory Materials Research Grants

Exploratory Materials Research Grants enable nascent and innovative materials research to advance to the point of being competitive for external funding. Two Exploratory Materials Research Grants were awarded in FY25.

Advancing Magnesium Alloys for Infection Resistance in Biodegradable Medical Implants Through Additions of Cerium
PI: Landon Locke, Biomedical Engineering
Co-PIs: Jenifer Locke, Aeriel Leonard, Materials Science and Engineering

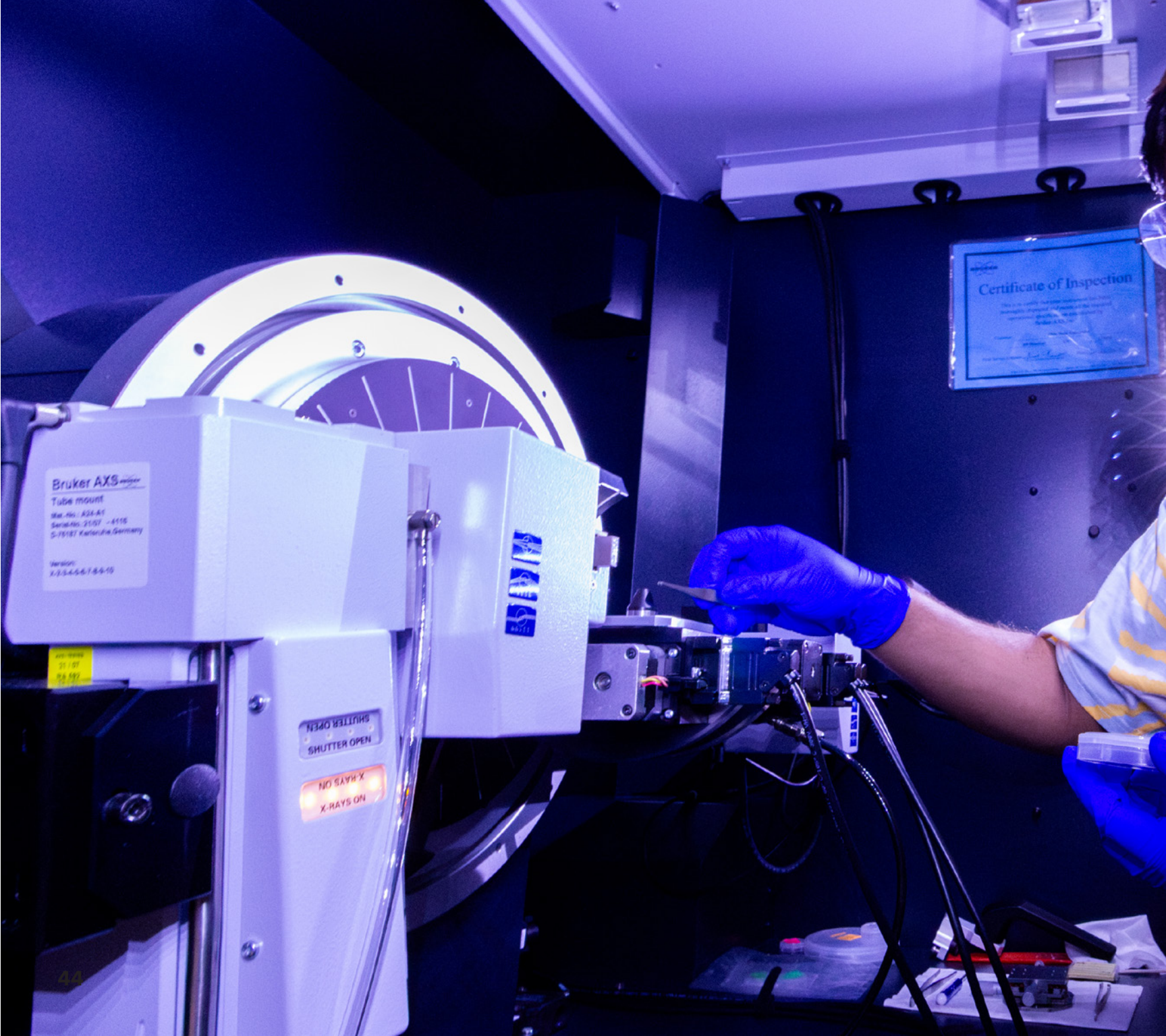
Polymerization of Polyelectrolytes in Anisotropic Solvents
PI: Xiaoguang Wang, Chemical and Biomolecular Engineering
Co-PI: Joshua Sangoro, Chemical and Biomolecular Engineering

Multidisciplinary Team Building Grants

Exploratory Materials Research Grants fund multidisciplinary materials research teams that can later compete effectively for federal block-funding opportunities. Two Multidisciplinary Team Building Grants were awarded in FY25.

Heusler Alloys as a New Materials Platform for Spin Selective Electrochemistry
PI: Robert Baker, Chemical and Biomolecular Engineering
Co-PI: Joshua Goldberger, Chemistry and Biochemistry

Optimizing Metals 3D-Printing with AI-Enhanced Wire-Arc DED
PI: Antonio Ramirez, Materials Science and Engineering
Co-PIs: Rajiv Ramnath, Computer Science and Engineering; Theodore Allen, Integrated Systems Engineering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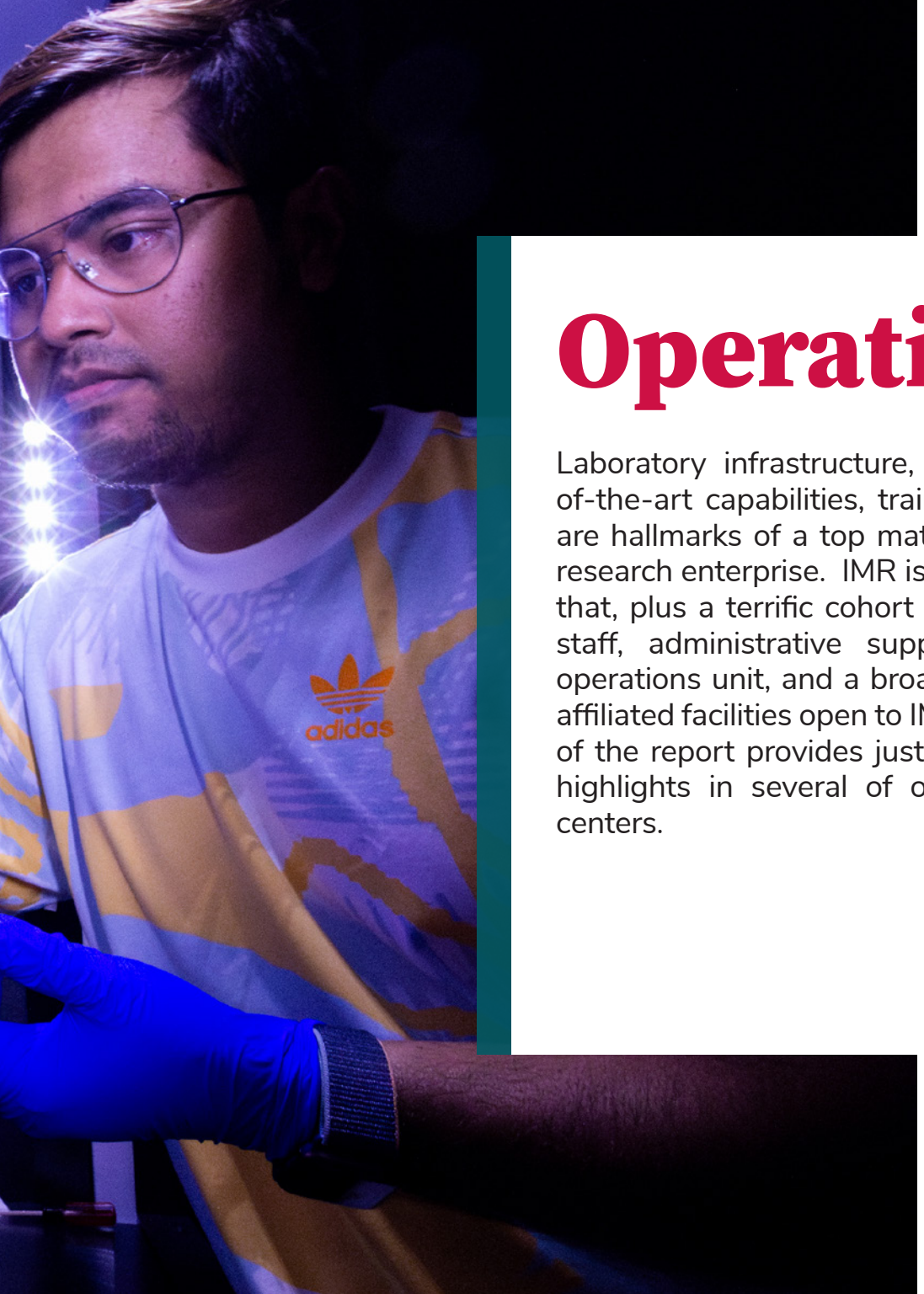


Operations

Laboratory infrastructure, user accessibility, state-of-the-art capabilities, training and safety — these are hallmarks of a top materials and manufacturing research enterprise. IMR is fortunate to include all of that, plus a terrific cohort of highly skilled technical staff, administrative support, a sound business operations unit, and a broad network of shared and affiliated facilities open to IMR members. This section of the report provides just a selection of this year's highlights in several of our primary facilities and centers.

Nanotech West Laboratory

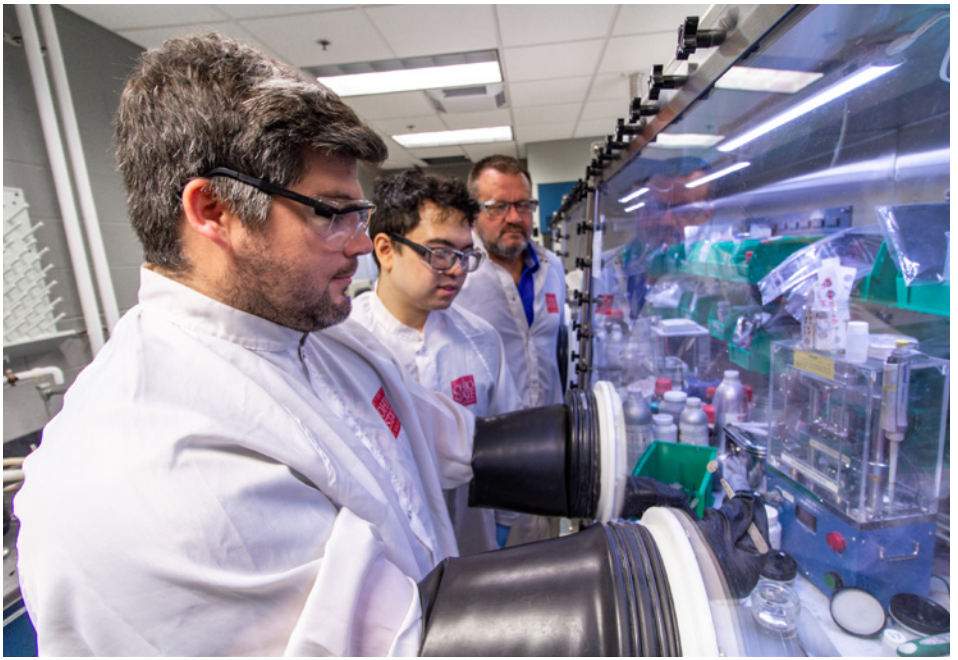
Nanotech West Laboratory (NTW) is a 36,000-square-foot shared user facility supporting state of the art IMR research and innovation in nanotechnology, next-gen semiconductors, photonics, advanced energy storage R&D as well as public-private partnerships for innovation. Managed by IMR, NTW is an extensively equipped and fully staffed facility where researchers can access laboratories and equipment, as well as take advantage of in-house training, process and project support. NTW's user-accessible resources include a 8,000- square-foot full-process flow Class 100 cleanroom that houses cutting edge nanolithography and unique micro-transfer print capabilities, a state of the art lab for epitaxial growth of compound, wide and ultra-wide bandgap semiconductors, comprehensive materials and device characterization capabilities, and a major shared facility for next-gen energy storage and battery R&D. With nearly 300 active users and more than 75 new users trained in FY25, research activities at NTW are broad, and includes current projects on GaN/AlGaN and Ga_2O_3 semiconductors, space solar cells, infrared focal plane arrays and packaging, microfluidics, biotechnology, novel battery materials and more. NTW is located in Ohio State's Innovation District and, as such, also serves as a nexus for university-industry-government partnerships across the IMR community. FY25 brought a massive investment into our infrastructure with the development of IMR's $16M Microelectronics Innovation and Technology Cluster (MITEC), the central part of the Midwest Microelectronics Consortium (MMEC) hub of the DoD Microelectronics Commons program that is supported by the CHIPS and Sciences Act. New capabilities include 4 inch MOCVD and HVPE facilities designed for translational R&D of wide and ultrawide bandgap semiconductor devices, a state of the art RF and high-voltage device measurement lab, and additional cleanroom tools to expand process flow capacity. Learn more at nanotech.osu.edu.

IMR Innovation Lab

The IMR Innovation Lab is a 2,500-square-foot, open-area space that encourages collaboration. The lab's vision is for innovation to inform research opportunities while serving as a hub for a vibrant, interdisciplinary innovation community. It is a place where partners have access to the university and engage with students, faculty, and staff. It is focused on convergence and the translation of IMR's knowledge and assets to solve real-world problems. It is the interface that connects, creates, and delivers impactful value derived from interdisciplinary research to meet the market needs through collaboration and strategic partnerships. Since its inception in late 2016, the impact of the lab is leading to an interdisciplinary, innovation culture that has connected more than 80 faculty, research staff and grad students, and 380 undergraduates, from 43 departments and six colleges, to companies that range from start-ups to Fortune 500s. This has led to the creation of 300 externships and internships, and more than 65 sponsored projects. The lab is also enabling the transition of technologies to commercialization with our faculty, staff and students. Thanks to the Innovation Lab, there has been engagement with more than 90 companies in multiple ways that enable long-term, mutually beneficial relationships with students, faculty and external partners. IMR operates the Innovation Lab as the place where Ohio State guests and industry visitors can engage each other, as well as students and faculty. It is home to a number of IMR events, including INNOVATE-O-thon and other collaborative programs and projects involving faculty, staff and industry partners. It is where students wanting real-world, experiential learning connect with companies wanting better access to the university and undergraduates through externship and internship opportunities. Learn more at imr.osu.edu/innovation-lab.

Energy Innovation Lab

The Energy Innovation Lab (EIL) is focused on translating electrochemical energy storage and conversion research to meet the needs in the market through strategic, industrial partnerships. The extent of the lab's technology development spans from materials to systems and advanced manufacturing. Innovations in energy storage and conversion systems require integrating diverse knowledge from multidisciplinary teams. Through EIL, faculty, staff and students who share this vision are dedicated to defining current issues on electrochemical energy storage and conversion devices, as well as innovating the materials and systems to develop future energy technologies. In electrochemical energy storage and conversion, we synthesize and characterize materials for batteries and fuel cells, study interfaces, conduct postmortem analysis, develop advanced processing and manufacturing techniques, and create new structures. This laboratory ecosystem serves as IMR's core energy multi-user facility and R&D center that are open to internal and external users on a fee basis to support research, development, and education. It is also supported by the IMR Innovation Lab, which manages strategic, industrial relationships to advance technology development, demonstration and deployment. EIL is equipped with multiple systems enabling battery testing and analysis, as well as mixers for electrode materials preparation and a lab scale roll-to-roll coater for electrode fabrication. EIL is enabling multiple projects that resulted from a jointly held research strategy recently established by IMR and Honda. The space is also home to faculty member Jung-Hyun Kim, an associate professor in Mechanical and Aerospace Engineering who was hired through the IMR-operated Materials and Manufacturing for Sustainability Discovery Theme. EIL also hosted multiple workforce training activities for industry users, as well as project-based learning for interns through the NSF-funded BATTERI program.



Metal-Organic Chemical Vapor Deposition (MOCVD) Lab

The Metal-Organic Chemical Vapor Deposition (MOCVD) Lab houses three MOCVD tools for epitaxial growth of compound semiconductors, one for III-V materials like GaAs, one for nitride-based materials like GaN, and another for oxide-based materials like Ga_2O_3. Novel materials, structures and devices developed from the state-of-the-art MOCVD growth techniques cover a wide range of key applications in photovoltaics, photodetectors, light emitters and high power/ high frequency electronics. The unique dual chamber nitride MOCVD system is featured with two chambers that allow the growth of (i) III-nitrides (Al-, Ga-, In-, N), their alloys and heterostructures; and (ii) novel materials/structures based on II-IV-nitrides [e.g., Zn(Mg)Ge(Si, Sn)N_2]. The system is also coupled with a high-power CO_2 laser source. Funded by DOE ARPA-E, and ONR projects, Prof. Hongping Zhao has successfully developed high-power GaN PN diodes with record breakdown voltage of >11 kV. Funded by a Department of Defense Multidisciplinary University Research Initiative (MURI) project, Prof. Zhao develops the next generation ferroelectric nitrides using the nitride MOCVD reactor. The oxide MOCVD tool has successfully developed the state-of-the-art Ga_2O_3, an emerging ultrawide bandgap semiconductor for next-generation power electronics. This tool supports research projects funded by the MURI program, DOE ARPA-E, National Science Foundation, Semiconductor Research Corporation, among others.

Nanofabrication Lab

The Nanofabrication Lab (Nanofab) within Nanotech West is Ohio's premier, and largest state-of-the-art and openly accessible class 100 cleanroom, which houses full process flow capabilities supporting micro-and nano-fabrication of semiconductor devices. With 10 affiliated staff members, plus graduate student super-users and undergraduates, the Nanofab supports researchers from Ohio State and many external organizations. Numerous investments in processing equipment capabilities were realized in 2025, including numerous capabilities to support IMR's Microelectronics Innovation and Technology Cluster (MITEC), a core infrastructure investment for the Midwest Microelectronic Consortium (MMEC) hub. NTW added a second Heidelberg MLA150 direct write laser lithography tool to increase photolithography capacity and enhance throughput. For dielectric deposition, a Veeco Fiji plasma enhanced atomic layer deposition (PE-ALD) was installed in summer 2025 and will be available to users in Q1 FY26. This new PE-ALD expands the breadth of ALD films at NTW to include nitrides and SiO2 which had not been possible previously. As a critical and frequent step in most process flows, metal deposition for high quality Ohmic and Schottky contacts on semiconductors has been a bottleneck for Nanofab researchers. A third evaporator, Angstrom AMOD electron beam evaporator, will increase capacity, capability, and flexibility. It has tooling to optimize metal utilization for either 8 x 100 mm wafers or small, less than 1 cm square, samples resulting in cost savings for researchers depositing precious metals. In addition, the Angstrom AMOD adds significant new capabilities including an optional cooled stage for nanostructure fabrication and an ion beam source for ion beam deposition and in-situ ion beam cleaning to remove surface oxides or contaminants prior to deposition. It will be installed in Autumn 2025 and available to users by the end of the calendar year. Additionally, new optional tooling was added to the existing CHA electron beam evaporator to optimize metal step coverage on device sidewalls. These improvements in etching and deposition necessitated expanded step height, roughness, and optical inspection techniques. In FY'25, NTW add both stylus and optical 3-D profilometers to the metrology suite to give researchers the option to make a physical or optical (non-contact) measurement, with either a Bruker DektakXT Advanced stylus or an RTEC UP-3000 optical profilometer respectively.

Opto-Electronic Metrology (OEM) Lab

The Opto-Electronic Metrology (OEM) Lab at Nanotech West Laboratory (NTW) continues to provide essential testing and packaging capabilities that support the full semiconductor device fabrication and characterization cycle.

For materials analysis, researchers in both semiconductor epitaxy and battery development utilize advanced instrumentation including the Bruker D8 X-ray Diffractometer (XRD), Bruker Icon 3 Atomic Force Microscope (AFM), and Hitachi S-3000H Scanning Electron Microscope (SEM). These tools enable high-resolution analysis of crystallinity, surface morphology, and microstructural properties. The lab also provides contactless minority carrier lifetime measurements using both Transient Microwave Reflectance (TMR) and 8D Photoluminescence systems. The TMR system measures changes in microwave reflectivity after pulsed optical excitation to evaluate recombination dynamics and surface passivation quality. The 8D system offers spatially resolved lifetime and photoluminescence mapping across the infrared spectrum with sub-millimeter resolution. Together, these tools enable non-destructive, wafer-scale assessment of material uniformity and carrier dynamics. This integrated approach supports the development and optimization of high-performance optoelectronic and photovoltaic devices.

In addition, the lab's infrared (IR) testing capabilities were recently expanded by students from Professor Sanjay Krishna's group who developed advanced setups for measuring quantum efficiency (QE), noise, and other key performance metrics of high-voltage IR avalanche photodiodes. NTW now supports comprehensive IR detector characterization, including QE and spectral response measurements, using FTIR systems, calibrated blackbody sources, and monochromators, providing critical insight into the optical sensitivity, responsivity, and noise behavior of next-generation IR detectors, supporting the development of high-performance imaging and sensing technologies.

Finally, new tool additions to the lab in FY25 have provided significant on-wafer electrical test capabilities including semi-automated probe stations for high voltage and high frequency measurements on up to 200mm wafers. With this broad and evolving infrastructure, the OEM Lab continues to serve IMR as a versatile hub for advanced metrology of optoelectronic materials and devices.

Semiconductor Epitaxy and Analysis Laboratory

The Semiconductor Epitaxy and Analysis Laboratory (SEAL) is Ohio State's primary facility for molecular beam epitaxy (MBE). As one of the largest MBE facilities in the U.S., this world-class, shared user facility supports interdisciplinary research and development on epitaxial growth of electronic and photonic materials and devices. SEAL is fully staffed and open to university and industry researchers. SEAL houses seven state-of-the-art MBE chambers, each dedicated to different, complementary material systems to provide epitaxial growth of crystalline layers, heterostructures, nanostructures, and device structures in a variety of material domains. Research focuses on a range of semiconductor materials, including III-V materials based on arsenides, phosphides, antimonides, and nitrides, advanced oxides, as well as perovskite oxides and 2D materials. During the past year, SEAL has repurposed one of its MBE chambers (in conjunction with donated equipment from AFRL) to accommodate unique oxide materials investigations. This work is in support of Prof. Tyler Grassman and Prof. Roberto Myers research within a large AFOSR-funded MURI program (PI: M. Ghazisaeidi). SEAL capabilities also include a wide range of advanced materials characterization tools, including high resolution X-ray diffraction, photoluminescence and Hall effect, to support epitaxial materials research. SEAL is managed by IMR and operates under the guidance of the Department of Electrical and Computer Engineering and the College of Engineering.
Learn more at seal.osu.edu.

RESEARCH REVIEW: BREAKTHROUGHS IN UV OPTOELECTRONICS USING MBE GROWTH

Researchers at Ohio State have achieved major advances in ultraviolet (UV) optoelectronics using AlGaN-based tunnel junctions in the last year. Enabled by precision molecular beam epitaxy (MBE) systems at SEAL, managed by IMR's Mark Brenner, the team demonstrated transparent tunnel junctions with record-low voltage and resistance, multi-active region LEDs, the widest bandgap interband tunnel junctions, and the first AlGaN TJ laser. This work has been presented at several prestigious conferences, including at an Invited Presentation at this year's International Conference for Nitride Semiconductors in Malmo Sweden. These innovations overcome several fundamental limitations in wide bandgap materials, enhancing efficiency and enabling far-UV emission for disinfection and sensing. Graduate students Arnab Ghosh and Agnes Xavier led this research and are now entering industry. The work, led by Professors Shamsul Arafin and Siddharth Rajan, builds on over a decade of research in this area, and is pushing the frontiers of ultra-wide bandgap semiconductor research.

Nanosystems Laboratory

NanoSystems Laboratory (NSL) provides a broad base of academic and industrial users with access to advanced material characterization and fabrication tools for research and development applications. NSL operates a diverse set of research instrumentation, such as (1) fabrication tools: SEM/e-beam lithography, Physical Vapor Deposition, Ar ion milling and ICP/RIE etching, maskless photolithography, and diamond CVD growth; and (2) characterization tools: SEM/EDS, X-ray diffractometry, SQUID magnetometry, electrical measurements (PPMS), AFM/MFM, EPR/FMR spectroscopy, C-Trap Optical Tweezers microscopy and Kerr microscopy. NSL operates two 1,100-square-foot clean rooms, housing deposition, lithography, etching, and gloveboxes.
Learn more at nsl.osu.edu

RESEARCH REVIEW: QUANTUM SENSING OF BROADBAND SPIN DYNAMICS AND MAGNON TRANSPORT IN ANTIFERROMAGNETS

The research groups of P. Chris Hammel (Physics, Ohio State University), Simranjeet Singh (Physics, Carnegie Mellon University) and Joshua Goldberger (Chemistry and Biochemistry, Ohio State University) from the OSU Center for the Emergent Materials (CEM) in collaboration with Shubhayu Chatterjee (Physics, Carnegie Mellon University) and the group of Bing Lv (Physics, The University of Texas at Dallas) conducted experiments on quantum sensing of broadband spin dynamics and magnon transport in van der Waals antiferromagnets (AFM) $CrCl_3$ and $CrSBr$ using NV^- centers in diamond. The authors characterized the intrinsic exchange fields and magnetic anisotropies of the AFM. They also demonstrated magnon transport over tens of micrometers and observed that optical detection efficiency increases with increasing frequency. The measurements leveraged NV^- spin relaxation due to low-frequency magnetic field fluctuations arising from the excited collective dynamics of magnons in AFM.

The research at Ohio State was primarily supported by the Center for Emergent Materials, a National Science Foundation (NSF) MRSEC, under award number DMR-2011876 which also provided partial funding for the NanoSystems Laboratory shared facility used in the research.

The results and discussions are presented in the publication: Alex L. Melendez, Shekhar Das, Francisco Ayala Rodriguez, I-Hsuan Kao, Wenhao Liu, Archibald J. Williams, Bing Lv, Joshua Goldberger, Shubhayu Chatterjee, Simranjeet Singh and P. Chris Hammel “Quantum sensing of broadband spin dynamics and magnon transport in antiferromagnets” Science Advances 2025 11(26) eadu9381.

Supported Centers

CENTER FOR DESIGN AND MANUFACTURING EXCELLENCE

The Ohio State University's Center for Design and Manufacturing Excellence (CDME) prepares undergraduate students to be the nation's manufacturing leaders through hands-on experience working on industry-funded projects. More than 430 undergraduate students across academic disciplines have been impacted by CDME to date, with over 100 students employed by the center in FY25.

Every project at CDME involves undergraduate students in every aspect from beginning to end. Students work as part of multidisciplinary project teams that are timeline and deliverable-driven, all while receiving apprentice-style mentorship from experienced engineers.

CDME's areas of emphasis cover many manufacturing sectors, including robotics, machine learning, additive manufacturing, metal casting, biomedical devices, medical modeling, machining and cybersecurity. The center boasts partnerships with more than 150 companies, has completed over 700 projects and has been awarded over $140 million in applied research.

CDME operates manufacturing research facilities in five buildings across Ohio State's campus, home to more than $15 million in industrial-scale equipment. The center employs over two dozen full-time technical staff members and supports over 120 affiliated faculty members.

Learn more at cdme.osu.edu

RESEARCH REVIEW: CDME LAUNCHES METAL HUB TO STRENGTHEN U.S. METAL MANUFACTURING WORKFORCE

CDME received $1 million for a metal casting workforce development and upskilling program from the Institute for Advanced Composites Manufacturing Innovation (IACMI). The award established a Metallurgical Engineering Trades Apprenticeship and Learning (METAL) Hub to address a shortage of skilled labor in the manufacturing sector through hands-on training for students and professionals in CDME's metal foundry. CDME hosts weeklong boot camps open to students and professionals and taught by industry and faculty experts. These camps provide hands-on experience in metalworking, heat treatment, and machining, while also exploring specialized topics like automation in the casting and forging industries. IACMI and CDME are also working together to create pathways for academic credit, industry certifications, apprenticeships and degree opportunities, allowing students to build practical skills and gain credentials.

CENTER FOR ELECTRON MICROSCOPY AND ANALYSIS

The Center for Electron Microscopy and Analysis (CEMAS) is the preeminent materials characterization hub for business and academia. The center provides a world-class environment for the teaching and practice of advanced microscopy across all scientific disciplines, from biomaterials to nanoelectronics, energy materials, advanced structural materials and medicine. With one of the largest concentrations of electron and ion beam analytical microscopy instruments in any North American institution, CEMAS brings together multidisciplinary expertise to drive synergy, amplify characterization capabilities and challenge what is possible in analytical electron microscopy. The facility offers a full-service, expertly designed environment for researchers executing entire microscopy and analysis programs.

Capabilities include scanning electron microscopy (SEM), focused ion beam microscopy, transmission electron microscopy (TEM), X-ray diffraction, micro-computed tomography and cryo-electron microscopy (cryo-EM). Highlights of CEMAS' $40M equipment portfolio include the Thermo Scientific Themis Z S/ TEM and Thermo Scientific Glacios Cryo-TEM. During FY25, CEMAS was leveraged to help win more than $305mil in awards enabling research across 54 departments. The center supported 938 users, including 219 principal investigators and 137 external partners.

Learn more at cemas.osu.edu.

RESEARCH REVIEW: MICROCT FOR BONE DENSITY DISCOVERIES

Anthropology Assistant Professor Habiba Chirchir studies gracile morphology and, to understand human bone density, she studies primates and other mammals with whom humans share certain behavioral traits. She used the Heliscan to get 3D images of bones from domestic dogs and colobus monkeys from Kenya. The 3D images from the scans reveal the internal bone structure, providing a detailed view of bone density. Visualizing the bone structure helps identify patterns linking activity levels to bone density and other bone architectural changes.

X-ray microCT at CEMAS provides a non-destructive method to produce 3D visualizations of the internal structure of an object. The Heliscan™ x-ray microCT provides this capability as a service to internal and external users. Learn more at cemas.osu.edu.

Community

The breadth of the Ohio State materials-allied research community reaches across colleges. To promote this breadth of disciplines, and to identify and establish critical areas of research at their intersections, IMR hosts and supports several outreach and engagement events each year that promote Ohio State's presence in strategic areas of interest. In FY25 IMR hosted the Materials and Manufacturing Conference and supported several other events, including the first annual Ohio Hydrogen Technology Forum. In this section, you will also find the IMR team, a rundown of affiliated centers and core laboratories, and a roster of IMR's 255 faculty members.

Events

2025 OHIO STATE MATERIALS & MANUFACTURING CONFERENCE

Hundreds of researchers from academia, industry and government labs from around the world came together to discuss the latest advances in materials-allied research and innovation at the 2025 Ohio State Materials & Manufacturing Conference (MMC). In FY25, IMR welcomed 33 external speakers and researchers from the Ohio State materials and manufacturing community for two days of technical talks, as well as IMR's keynote address and MMC '25 poster session.

This is the 14th MMC event held by IMR as an opportunity to connect Ohio State's materials and manufacturing community, celebrate their accomplishments, and explore innovative research. The event was held April 30 to May 1 at Ohio State's Scott Lab.

"The Materials and Manufacturing Conference was a lot of fun this year," said Brian Skinner, an associate professor of Physics hired through the university's Materials and Manufacturing for Sustainability Discovery Theme, which is operated by IMR. "I particularly enjoyed that it brought seemingly different topics (like space science and quantum computing) to the same audience so that we could see the surprising similarities of approach and scientific core ideas. It gave a lot of us a chance to learn new things and to explain our science to both colleagues within our field and to people who we normally wouldn't have a chance to talk to."

MMC '25 opened with a keynote from Dr. Richard A. Vaia, chief scientist in the Air Force Research Laboratory's Materials and Manufacturing Directorate in Dayton, Ohio. His talk guided attendees through the history of aerospace materials and manufacturing, from the Wright Flyer to the

F-47 fighter jet and Starship spacecraft. He also emphasized the urgent need to embrace digital tools to accelerate future discoveries.

“Everything is made of something, and thus impactful materials research is a multi-disciplinary endeavor. IMR has fostered this engaged and energized community at Ohio State,” Vaia said. “They are developing the future leaders we need by tackling some of the hardest materials and manufacturing process challenges that are limiting tech solutions for many social issues.”

Fifty graduate students shared their research projects during the event’s poster session. Presenters represented not only the College of Engineering but a wide range of other departments from across Ohio State, including Astronomy, Chemistry and Biochemistry, Food Science and Technology, and Physics. "The MMC student poster session provided me with an exciting opportunity to present my research to a wide-ranging audience encompassing various dimensions of the materials research field,” said Anant Sohale, a top poster session awardee and graduate student in Chemical and Biomolecular Engineering. Sohale, who is advised by professor Umit S. Ozkan, presented “Synthesis and characterization of boron-doped CNx materials for oxygen reduction reaction in fuel cells.” He added, “All the posters were very informative, and it was a great learning experience — both as an attendee and a poster presenter."

Sohale and the other top ten presenters were recognized the following day, during the MMC award ceremony. The awards were presented by Thomas Kolbusch, Vice President and Director of Sales, Marketing and Technology at Coatema Coating Machinery GmbH.

Along with Coatema, the 2025 event was sponsored by their U.S. distributor next Machinery Group, as well as Taiyo Nippon Sanso.

Events

INAUGURAL OHIO HYDROGEN TECHNOLOGY FORUM

Researchers, students, experts and innovators gathered at Ohio State's Energy Advancement and Innovation Center in June for the first annual Ohio Hydrogen Technology Forum to network and discuss advancements, challenges and opportunities related to fuel cell and hydrogen technology across the state. IMR co-sponsored the event held by the Ohio Fuel Cell & Hydrogen Coalition. IMR Director of Innovation Jay Sayre discussed Ohio State's role in energy advancement, highlighting an active portfolio of fuel cell and hydrogen research, spanning advanced catalyst and membrane development to AI-driven exploration of natural hydrogen reservoirs.

2025 ARMY RESEARCH OFFICE REVIEW MEETING FOR ULTRA-WIDE BANDGAP RF ELECTRONICS CENTER

In January, IMR supported the 2025 Army Research Office Ultra-Wide Bandgap RF Electronics Center Review Meeting. The two-day event on Ohio State's main campus welcomed ARO representatives and dozens of experts from institutions of higher education across the country to discuss collaborative development of next-gen semiconductor devices for wireless communication and radar applications. The center facilitates collaboration between academic researchers and the U.S. Army to achieve the shared objective of developing the essential knowledge required to advance the next generation of RF electronics, delivering unprecedented capabilities in power, bandwidth, frequency flexibility, and size, weight, and power (SWaP) efficiency. Led at Ohio State by PI Siddharth Rajan, a Distinguished Professor of Engineering in Electrical and Computer Engineering, partners include experts from the Georgia Institute of Technology, MIT, Sandia National Laboratories, the State University of New York at Buffalo, the University of Arkansas, and UC Santa Barbara.

7TH UNITED STATES GALLIUM OXIDE WORKSHOP

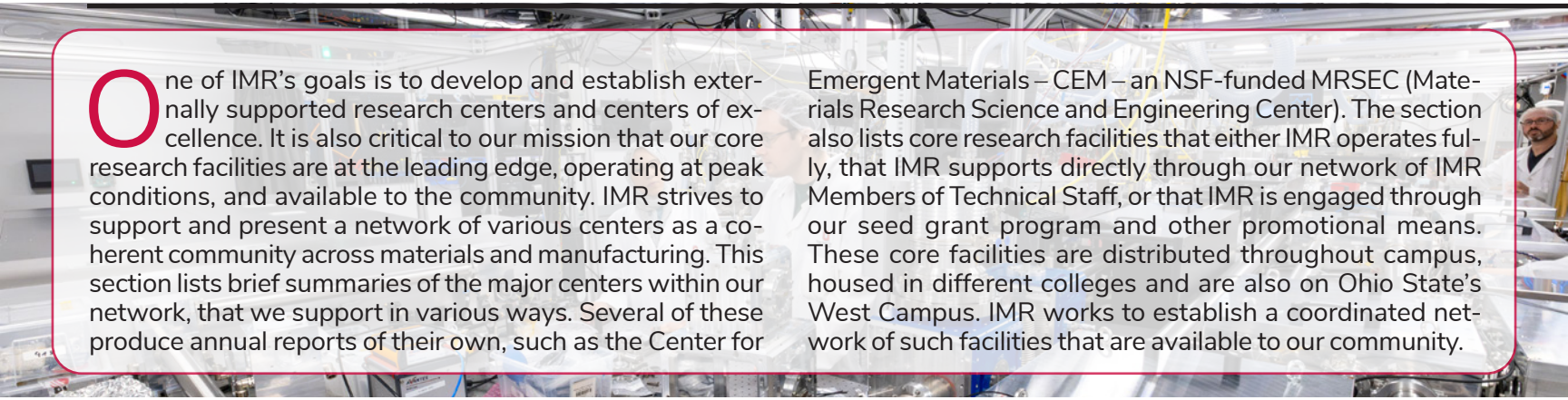
Ohio State hosted the 7th United States Gallium Oxide Workshop, or GOX 2024, a pivotal workshop that brought together leading Ga_2O_3 research experts from around the world to discuss the latest advances in materials, device, and circuit development within the rapidly evolving field.

As a premier event in this advancing field, GOX 2024 provided a platform for attendees and participants to report on recent breakthroughs, identify critical scientific gaps, and foster actionable coordination across government, industry, and academia. The goal was to enable the rapid transition of new technologies from research to real-world applications.

The August 2024 event at Ohio State's Knowlton Hall was co-chaired by Hongping Zhao, a professor in Electrical & Computer Engineering and Materials Science & Engineering at Ohio State; and Dr. Andrew J. Green, device team lead at the Air Force Research Laboratory Sensors Directorate.

"The Ohio State University is dedicated to excelling in semiconductor research and educating the next generations of workforce in this vital field." Zhao said. "We are honored to host GOX 2024 at Ohio State this year. I would like to extend my sincere gratitude to our distinguished speakers, sponsors, committee members, student volunteers, and all attendees. Over the course of this three-day event, we have witnessed tremendous progress in the development of Ga_2O_3 materials, structures, devices and circuits."

Affiliated Centers & Core Laboratories



One of IMR's goals is to develop and establish externally supported research centers and centers of excellence. It is also critical to our mission that our core research facilities are at the leading edge, operating at peak conditions, and available to the community. IMR strives to support and present a network of various centers as a coherent community across materials and manufacturing. This section lists brief summaries of the major centers within our network, that we support in various ways. Several of these produce annual reports of their own, such as the Center for Emergent Materials – CEM – an NSF-funded MRSEC (Materials Research Science and Engineering Center). The section also lists core research facilities that either IMR operates fully, that IMR supports directly through our network of IMR Members of Technical Staff, or that IMR is engaged through our seed grant program and other promotional means. These core facilities are distributed throughout campus, housed in different colleges and are also on Ohio State's West Campus. IMR works to establish a coordinated network of such facilities that are available to our community.

Bio-AFM Core Facility

Located in Scott Laboratory, the Bio-AFM Core Facility joined IMR's network in 2024, enabling capabilities that include electron microscopy and atomic force microscopy. This facility specializes in high-resolution characterization of biological materials. IMR is providing the lab with support through its first five years of operation.

Center for Automotive Research (CAR)

The Center for Automotive Research (CAR) is one of the nation's most consequential centers focused on vehicles and mobility. Primary areas of research focus are on automated and connected vehicles, electrification, propulsion and systems control, safety and security. IMR and CAR have multiple joint activities, most recently partnering with IMR's Battery Cell R&D Center, an advanced facility that fills the gap between fundamental battery materials research supported by IMR with systems-level impact work at CAR.

Center for Emergent Materials (CEM)

The Center for Emergent Materials (CEM) is an NSF MRSEC at Ohio State that engages researchers from multiple disciplines to work in teams on scientific problems too complex for a single researcher to solve. Established in 2008, CEM has two Interdisciplinary Research Groups (IRGs), and focuses on magnetoelectronics at the physics to nanodevice level. IMR is deeply engaged with CEM: first, by driving the process that led to its successful establishment in 2008 and, over the years, by sharing in many strategic programs and activities, including the multi-tiered seed grant program, the student poster sessions annually at the Ohio State Materials & Manufacturing Conference, the joint support of the Nanosystems Laboratory (NSL), the hiring of faculty into strategic positions within CEM, and many more interaction points too numerous to list. CEM is perhaps the center

we have interacted with the most through the years, as winning and maintaining a MRSEC was IMR's first primary goal. We are deeply symbiotic, even operationally, through our support of CEM staff and its international collaboration programs. One of IMR's current associate directors, Fengyuan Yang, is an IRG co-leader.

Center for High Performance Power Electronics (CHPPE)

The Center for High Performance Power Electronics (CHPPE) is a world-leading power electronics center, with multiple laboratories and faculty members. In CHPPE, researchers focus on the advancement of power electronics devices and circuits based on silicon carbide (SiC), gallium nitride (GaN) and silicon (Si) for high and very high voltage systems. IMR identified CHPPE as an area of strategic investment during the M&MS discovery theme program and have added critical faculty members to CHPPE, all of whom are also strategic members of IMR, establishing a strong partnership between IMR and CHPPE that have led to significant research impact in this area. IMR works with CHPPE on industry engagement and several large, externally supported programs from agencies such as ARPA-E and DARPA.

Center for Innovation Strategies (CIS)

The Center for Innovation Strategies (CIS) is housed in the Fisher College of Business. CIS collaborates across campus and in the community, as a facilitator and connector promoting innovation at Ohio State and beyond. IMR works closely with CIS in the area of innovation that leads to new products for industry partners and new research centers for the university. CIS is a co-developer of the IMR INNOVATE-O-thon model, and IMR and CIS collaborate thoughtfully and deliberately on innovation models applied across the entire university enterprise and external innovation ecosystem.

ElectroScience Lab (ESL)

The ElectroScience Lab (ESL) is a major center of excellence in Ohio State's College of Engineering and one of the largest radio frequency and optics research laboratories in the world. Since 1942, ESL has consistently maintained a national and international preeminence in electromagnetics. IMR leverages ESL faculty, research scientists and students to support innovation events and sponsored projects with our strategic partners in all aspects of electromagnetic and RF technologies. Linkages between ESL and IMR have become particularly important in several topics within advanced semiconductor electronics, and in particular, heterogeneous integration, where key challenges and opportunities abound between materials, devices, integrated optoelectronics and power management.

Fontana Corrosion Center (FCC)

The Fontana Corrosion Center (FCC) focuses on the study of aqueous corrosion in our effort to develop better methods to protect materials from the adverse impacts of the environment. IMR indirectly works with FCC not at an institute-center level, but more at the faculty support level via our seed and other programs.

Affiliated Centers & Core Laboratories

Infectious Diseases Institute (IDI)

The Infectious Diseases Institute (IDI) generates solutions to the detrimental effects of microbes on the health of humans, animals, plants, and the environment for the benefit of society. IMR and IDI collaborate in developing materials and manufacturing solutions to achieve a world free from the threat of infectious diseases.

Lightweight Innovations for Tomorrow (LIFT)

Lightweight Innovations for Tomorrow (LIFT) is a National Network for Manufacturing Innovation (NNMI) institute awarded to Ohio State, EWI and the University of Michigan, as a public-private partnership that works on advanced lightweight materials manufacturing technologies, workforce education and training programs in this area. Glenn Daehn, former IMR Director of Manufacturing Initiatives, has been the spearhead for LIFT at Ohio State. Through their member companies and CDME, IMR is engaged by seeking testing and services agreements, as well as other arrangements suitable for partner companies.

National eXtreme Ultrafast Science Facility (NeXUS)

The U.S. National Science Foundation National eXtreme Ultrafast Science Facility (NeXUS) at Ohio State is an NSF-supported open-access facility enables researchers to explore electron dynamics at unprecedented spatial and temporal scales through cutting-edge ultrafast laser technology. Our kilowatt-class ultrafast laser system generates Extreme Ultraviolet (XUV) and soft X-ray pulses, providing scientists from across the nation access to state-of-the-art capabilities for advancing fundamental research in physics, chemistry, and materials science. IMR spearheaded the proposal building campaign for this NSF funding.

National Gateway Ultrahigh Field NMR Center

Funded by the U.S. National Science Foundation, the National Gateway Ultrahigh Field NMR (nuclear magnetic resonance) Center features nine high-resolution Bruker spectrometers (600-1200 MHz) equipped with advanced capabilities: high sensitivity cryoprobes for biomolecular studies, high throughput sample changers for metabolomics, and solid-state probes for biomolecules and materials. A cutting-edge ultrahigh-field 1.2 GHz NMR spectrometer. The facility welcomes collaborations with academic institutions and industry partners nationwide. IMR spearheaded the proposal building campaign for this NSF funding.

Ohio Agricultural Research and Development Center (OARDC)

The mission of The Ohio Agricultural Research and Development Center is to enhance the well-being of the people of Ohio, the nation and world through research on foods, agriculture, family and the environment. The interaction between IMR and OARDC stems from IMR's Ohio Research Scholar Program (ORSP) – Technology-Enabling and Emergent Materials (TEEM). IMR supported the position for the hiring of Katrina Cornish into the Department of Horticulture and Crop Science (adjunct in Chemistry and Biochemistry). We continue to work with OARDC indirectly through Dr. Cornish and have supported multiple proposals and seed programs benefiting OARDC in the area of agriculture-based biomaterials and bioproducts.

Ohio Manufacturing Institute (OMI)

The Ohio Manufacturing Institute (OMI) develops industry-vetted policy recommendations to help the state and nation establish best practices to help the competitiveness of small- and mid-sized manufacturing enterprises (SMMEs). IMR works with OMI in a number of areas, including participation and support of workshops that shape the future of SMMEs. IMR faculty and staff also serve as co-PIs with OMI staff on federal and state grants that enable community-engaged learning to collaborate on solving advanced manufacturing issues to help address real-world skill gaps and occupational shortfalls in SMMEs industry sectors.

Reducing EMbodied-Energy And Decreasing Emissions (REMADE) Institute

The Reducing EMbodied-Energy And Decreasing Emissions (REMADE) Institute is a National Network for Manufacturing Innovation (NNMI) Institute public-private partnership. The goal of the REMADE Institute is to reduce the cost of technology essential to reusing, recycling and remanufacturing materials such as metals, fibers, polymers and electronic waste, as well as improve overall energy efficiency 50 percent by 2027, saving billions in energy costs. IMR has shared in Ohio State's contribution, based on expected participation in consortium projects — several of which have been awarded.

Simulation Innovation and Modeling Center (SIMCenter)

The Simulation Innovation and Modeling Center (SIMCenter) is an interdisciplinary research center for the virtual simulation and modeling of product performance and manufacturing processes, spanning from aerospace and mobility and over time to semiconductors and energy technologies. IMR's Associate Director for Manufacturing, Prof. Mike Groeber, is leading the SIMCenter and is working closely with our Battery Cell R&D Center to develop AI-assisted battery manufacturing efforts to accelerate optimal battery design and manufacturing.

Sustainability Institute (SI)

The Sustainability Institute (SI) integrates, supports and leads sustainability across the university. IMR and SI collaborate at the intersections of materials, manufacturing and sustainability to enhance our interdisciplinary community, research and innovation. This includes working together to develop new public- and private-sector partnerships and unique experiential learning programs.

Translational Data Analytics Institute (TDAI)

The Translational Data Analytics Institute (TDAI) creates and applies data analytics solutions to issues of global importance in partnership with the external community, while advancing foundational data science theories and methods. IMR and TDAI collaborate on supporting faculty possessing data science expertise that expand our interdisciplinary materials research community.

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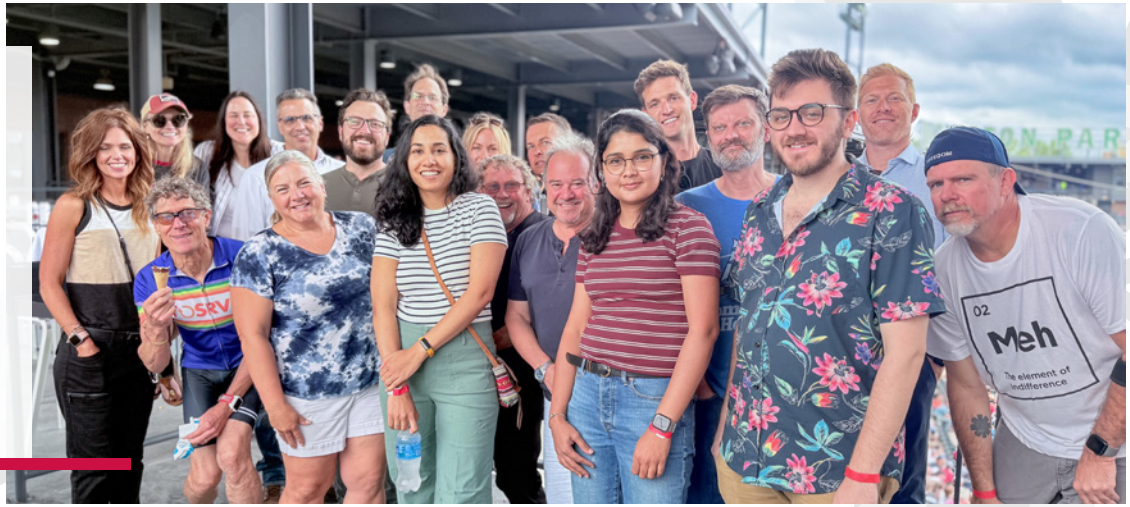
COLUMBUS – IMR benched the latter half of the work-day on Thursday, Aug. 21, 2025, for an afternoon at the ballpark to watch the Columbus Clippers rain on the Omaha Storm Chasers' parade, notching a 9–5 win at Huntington Park.



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Interested in becoming an IMR faculty member?

An IMR faculty member is part of a community spanning 46 departments at The Ohio State University. Members join an interconnected, interdisciplinary community of researchers that share IMR's vision of creating a global reputation of excellence and impact at Ohio State through world-class basic and applied materials research, technology advancement, and innovation.

Members have access to...

- Award funding opportunities from seed grant programs managed or co-managed by IMR, including Kickstart Facility Grants, Global Partnership Grants and OSU Materials Research Seed Grants.
- IMR proposal development assistance, which supports the development of competitive proposals from pre-solicitation to submission.
- IMR-supported core research facilities that IMR operates fully, supports directly through our network of IMR staff, or through which IMR is engaged via our seed grant programs and other promotional means.
- The latest news relating to materials-allied research through the IMR newsletter.

Interested in becoming an IMR faculty member? Contact Joanna Gardner at gardner.306@osu.edu.

WE GRATEFULLY ACKNOWLEDGE THE OHIO STATE MATERIALS AND MANUFACTURING COMMUNITY THAT CONTRIBUTED CONTENT FOR THIS REPORT.

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