Fraunhofer USA

Focus 2025

Fraunhofer USA Focus 2025

Foreword

Message From The President

In 2025 we continued pursuing our mission to serve market-driven technology needs and to provide customized advanced technology solutions to our partners across industries. To highlight a cross-section of our activities to the reader, this report contains selected applied research and development project summaries, which include tech-to-market examples and also underline our university, government, and transatlantic collaborations. You will find stories describing application solutions developed for industry sectors such as energy, materials, healthcare, and information technology. More specifically, you will read about diamond-like carbon coatings for cancer therapy, high throughput tissue processing, automated assessment of antibiotic tolerances, artificial intelligence driven real-time quality control in manufacturing, additive manufacturing of multi-material heat exchangers, microscopy enhanced by artificial intelligence and augmented reality, super insulating low-cost retrofit solutions for residential buildings, and the synthesis of diamond nano-particles through an efficient gas phase process.

As a non-profit organization, our general purpose is to make a positive impact on society. We do this through applied research and development and by transferring know-how, results and solutions to companies, from small to large, who then advance the ways they do things and contribute to investments, job creation, growth, and prosperity. We cannot do this alone. For more than a quarter of a century we have enjoyed strong partnerships with major research powerhouses such as Boston University, the University of Maryland, and Michigan State University. The combined resources of these institutions, together with the depth and breadth of the Fraunhofer network (75 institutes and 32,000 employees), enable us to address a vast range of technology needs that our industry partners ask for. It also allows us to expose university students early on to working with us on multidisciplinary applied research, which is a very hands-on way of workforce development in the engineering world.

A jewel in our collaboration portfolio is the South Carolina Fraunhofer USA Alliance. Here we work together with South Carolina's Department of Commerce, South Carolina's Council on Competitiveness, and local research universities to do just what we do best: bringing advanced technology solutions to local industries. In September 2025, the Alliance received great recognition in form of the prestigious The Carolinas Gateway Award issued by the German American Chamber of Commerce. The award recognizes outstanding contributions to German American business through investment, job creation, and a strong commitment to quality, innovation, and community.

Our networking and cooperations do not stop here. We are a proud foundation member of Automation Alley, a non-profit technology business association. With a focus on advanced manufacturing, a global outlook, and a regional focus, Automation Alley supports local companies to thrive in a rapidly changing digital economy, which aligns very well with our aim to provide specific technology solutions to individual companies. Furthermore, we are deeply engaged in a nationwide innovation network through our national membership with the German American Chamber of Commerce and in the Association of University Research Parks (AURP).

All in all, we have had a very successful year fulfilling our purpose and I hope you will enjoy reading about our extraordinary staff, our research projects, and our progress in 2025.

Sincerely,

Thomas Schuelke

Thomas Schuelke, Ph.D.
President, Fraunhofer USA, Inc.

Contents

Mission

Fraunhofer USA offers customized, advanced technology research, development and deployment. Fraunhofer USA shall serve market-driven technology needs; promote international cooperation in business; establish strategic alliances with industry, government and academic partners.

Vision

Fraunhofer USA, like its founder and funding partner Fraunhofer-Gesellschaft, is a national and international leader of applied research. As an innovation driver, we lead strategic initiatives to master future challenges and thus achieve technological breakthroughs.

About Fraunhofer USA

Founded in 1994 by Fraunhofer-Gesellschaft, Europe's largest applied research and development organization, Fraunhofer USA conducts applied research and development for customers in industry and for state and federal government.

What is Applied Research?

Applied research is the systematic investigation of solving practical problems or developing new technologies, products, or processes for specific real-world applications. By bridging the gap between theoretical knowledge and practical implementation, we facilitate applied research and technology transfer by collaborating closely with industry, government, and academic partners. As a legally independent affiliate of Germany's Fraunhofer-Gesellschaft, Europe's largest applied research and development organization, Fraunhofer USA fosters innovation by conducting research that aligns with market needs, providing access to advanced facilities and resources, and enabling technology transfer through partnerships pursuing shared societal goals. By bridging academia and industry, it accelerates the translation of cutting-edge research into practical solutions, thus enhancing technology adoption, economic competitiveness, and societal development.

Societal Impact

Our applied research services have a significant societal impact by driving innovation, economic growth, and improved quality of life. By facilitating the transfer of advanced research findings and technologies from the laboratory to the marketplace, Fraunhofer USA can:

Promote Economic Growth
The technology transfer process generates new products, processes, and services that lead to job creation, increased productivity, and enhanced competitiveness in industries. This contributes to local, regional, and national economic growth.

Enhance Industry Competitiveness
By enabling industries to adopt cutting-edge technologies and research-driven solutions, Fraunhofer USA helps businesses stay competitive in global markets, driving growth and sustainability across various sectors.

Address Societal Challenges
Many of Fraunhofer USA's technology transfer outcomes address critical societal challenges, such as healthcare, energy, environment, and transportation. These solutions improve public health, resource efficiency, and overall well-being.

Catalyze Research Collaboration
Fraunhofer USA's partnerships foster collaboration between academia, research institutions, and industries. This collaborative environment accelerates innovation, encourages knowledge exchange, and creates a ripple effect of positive impacts.

Provide Education and Workforce Development
The technology transfer process often involves training and upskilling the workforce in new technologies. This contributes to a skilled workforce, supporting employment opportunities and overall societal advancement. The Fraunhofer USA Internship and Research Scholar programs help ensure that the next generation of scientists and engineers receive hands-on training, jump-starting their careers and impact.

Disseminate Knowledge
The transfer of research findings and technologies to practical applications increases the dissemination of scientific knowledge, contributing to public awareness and understanding of complex issues. Fraunhofer Principal Investigators may publish, with permission, in scientific journals or other professional publications.

Strategic Research Goals

Fraunhofer USA develops required innovations and core competences to address technological, commercial, and social imperatives of our time. The topics of these projects are a result of two fundamental driving forces – industry and its technology-pull roadmap, and the government and its technology push-roadmap.

These key innovations are then deployed in the U.S. R&D market where Fraunhofer USA engages with industry clients or the public sector in contract R&D projects as well as public-private partnerships (P3) for technology transfer.

As a result of this activity, Fraunhofer USA helps the industrial sector to de-risk their technology development investments, improve time to market, enhance their competitiveness while reducing capital and operational expense, and improve quality and quantity of the product, enabling scalability and transferability of a process, reducing technology development and device integration costs.

The advantages for the public sector are access to a team of experienced, professional, interdisciplinary researchers and scientists able to provide scalable and transferable solutions, and access to researchers with both an academic and industrial mindset and experience.

Topics of strategic relevance for Fraunhofer USA through 2025 include, but are not limited to:

Future Wireless and Related Technologies
- 5G and 6G
- IIoT and Distributed Manufacturing
- Edge Computing and Mobile Edge Computing (MEC)
- Terahertz Communications
- Ultra-Low Power AI for IoT Devices

Electrification and Hydrogen Technologies
- Battery Technologies and Energy Storage
- EVs and Power Semiconductors
- Industrial Electrification and Decarbonization of Industrial Processes
- H2 Technologies (H2 Production Efficiency and Application)
- Smart Grid Technologies
- Green Hydrogen Production
- Solid-State Batteries
- Thermal Energy Storage and Management

AI and Data Governance
- Trustworthy AI and Ethics
- AI Ergonomics and Human-AI Interaction
- AI Robustness Testing
- Federated Learning
- Explainable AI (XAI)
- AI for Cybersecurity
- Privacy-Preserving AI and Differential Privacy

Bioengineering
- Plant Based Food and Cultivated Meat
- Synthetic Biology and Genetic Engineering
- Biomedical and Neural Engineering
- Organ-on-a-Chip Technology
- Bioinformatics and Computational Biology
- Microbiome Engineering

Industry 4.0 and Advanced Manufacturing
- Digital Twins
- Additive Manufacturing
- Vision Inspection and Predictive Maintenance
- Process Automation
- Robotics
- Collaborative Robots (Cobots)
- Industrial Internet of Things (IIoT) Security
- Design for Disassembly and Recyclability

Quantum Computing, Communication, Sensing and Imaging
- Quantum Optimization
- AI, Numerics
- Advanced Materials and Diamond
- Quantum Communications Systems for Space and Terrestrial Networks
- Quantum Sensors for Precision Measurement

Climate Technologies, Sustainability and Agriculture
- Carbon Capture and Carbon to X to Y
- Renewable Energies and Storage
- Sustainability in Production and Materials
- Aquaponics
- Aeroponics
- Agrophotovoltaics
- Microgrids and Distributed Energy Resources
- Precision Agriculture and AI-driven Farming
- Waste and Toxin Processing (PFAS, etc.)
- Waste-to-Resource Technologies
- Biosensors and Wearable Health Monitoring
- Antibiotic Resistance and Tolerance

The People Behind the Innovation

At Fraunhofer USA, people drive innovation. Our scientists, engineers, and researchers are leading experts in their fields who have chosen to dedicate their careers to solving the challenges that matter most. They are the architects of breakthrough technologies, the collaborators who bridge research and application, and the mentors who inspire the next generation of innovators.

Expertise Meets Purpose

What draws world-class talent to Fraunhofer USA is the opportunity to pursue meaningful work with real-world impact. Our staff members are not simply executing predefined research agendas; they are empowered to explore, to question, and to push boundaries. This intellectual freedom, combined with access to state-of-the-art facilities and a collaborative network that spans industry, academia, and government, enables our teams to tackle problems that others might consider impossible.

From advancing sustainable manufacturing processes to developing next-generation communication systems, our employees work at the intersection of applied research and practical implementation. They understand that their expertise is only as valuable as the solutions it creates, and they take pride in seeing their research translate into technologies that strengthen industries, protect the environment, and improve quality of life.

A Culture of Collaboration and Growth

Clients choose to work with Fraunhofer USA not only because of our cutting-edge facilities and capabilities, but because of the people they collaborate with. Our staff brings deep technical knowledge, creative problem-solving, and a genuine commitment to partnership. Whether working alongside industry leaders on proprietary research or contributing to public-sector initiatives, our teams approach every project with curiosity, rigor, and a drive to deliver results that exceed expectations.

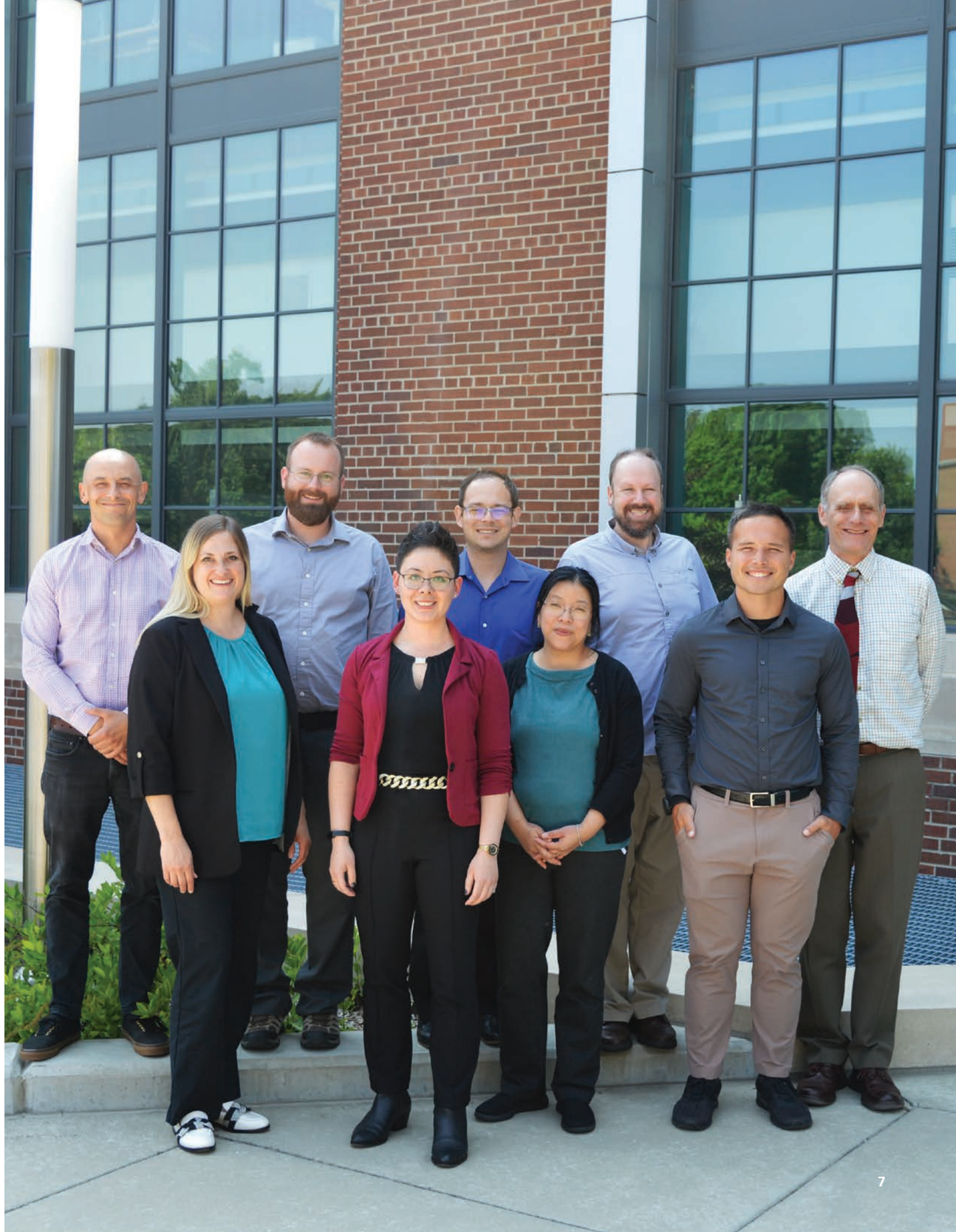
This collaborative spirit extends to education and mentorship. Throughout their careers at Fraunhofer USA, our researchers work closely with interns, research scholars, and graduate students, sharing knowledge, fostering critical thinking, and helping shape the scientists and engineers who will lead tomorrow's innovations. These mentorship opportunities are not peripheral to our mission; they are central to it, ensuring that our impact extends beyond individual projects to the development of future leaders in applied research.

Innovation in Action

Throughout this report, you will see cutting-edge breakthroughs and transformative projects. Behind each one are dedicated professionals who bring passion, expertise, and an unwavering commitment to progress. At Fraunhofer USA, our people are our greatest asset, and their work is what makes everything possible.

The Future Is Built on "Why"

In a world that demands bold thinking and rapid adaptation, Fraunhofer USA's commitment to solving for "why" is more than a philosophy, it's a strategy for progress. It's how we have delivered innovation for over 30 years to our customers and how we will continue to shape the future of science, engineering, and society.

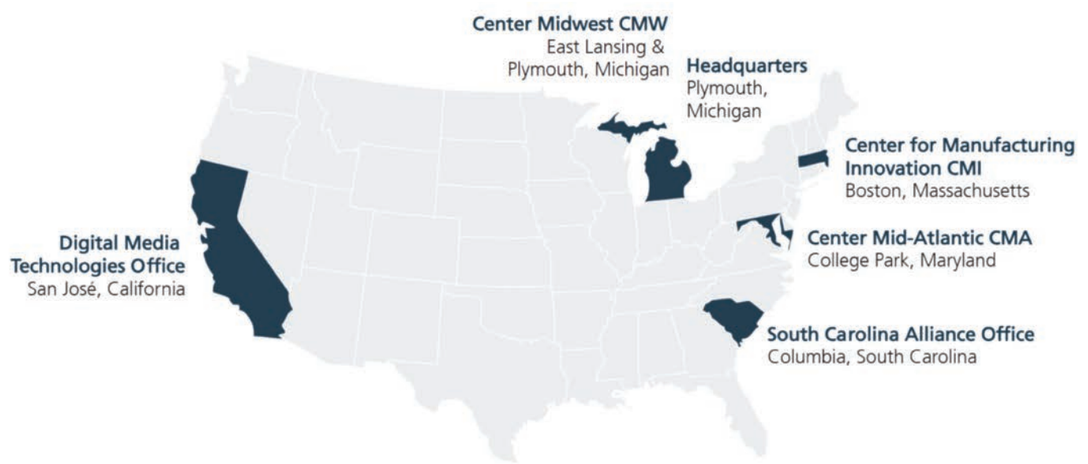


Principal Investigators from across Fraunhofer USA gather to present their scientific advances.

Fraunhofer USA Research Centers and Offices

Fraunhofer USA Locations

Fraunhofer USA is headquartered in Plymouth, Michigan, with three dedicated research centers located around the United States. Fraunhofer USA Center Midwest CMW, partnered with Michigan State University, has two locations in Michigan specializing in coatings and diamond technologies and laser applications. Fraunhofer USA Center Mid-Atlantic CMA, partnered with the University of Maryland, is in College Park, Maryland, and works on software and software systems with a focus on real-world applications of artificial intelligence. Fraunhofer USA Center for Manufacturing Innovation CMI, partnered with Boston University, is in Boston, Massachusetts and is active in energy systems, Industry 4.0-style automation and biotechnology applications. Center directors are professors at our nationally ranked partner research universities. Additional Fraunhofer USA offices are located in California and in South Carolina – the Fraunhofer USA Digital Media Technologies Office DMT and South Carolina Fraunhofer USA Alliance, respectively. Fraunhofer USA employs 100+ full-time staff, university faculty, and student interns. Fraunhofer USA's forecasted revenues for 2025 are expected to be $27 million+.



Fraunhofer USA Center Mid-Atlantic CMA

Scientific Focus

Fraunhofer USA CMA develops and uses innovative, effective and scalable approaches to software and systems engineering, delivers powerful testing and verification strategies and tools, uses state-of-the-art measurement and code analysis methods, and develops and tests artificial intelligence-based systems for use in manufacturing, health, and life sciences applications.

Among others, Fraunhofer USA CMA has developed successful collaborations with other Fraunhofer USA centers leading to joint projects utilizing competences in the physical, materials, and engineering sciences. Seeking the combination of complementary competences across centers is a key strategy for Fraunhofer USA to create sustainable technology leadership.

Fraunhofer USA CMA leverages strategic partnerships with South Carolina, the Applied Research Lab for Intelligence and Security (ARLIS) at the University of Maryland, and the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), among others.

Core Competences

Information and Communication Technologies

- Model-based software and systems engineering
- Software safety and security methods and tools
- Software design and development
- Software process analytics and improvement

Research Fields

- Applications, software, and systems
- Infrastructure of AI-based systems
- Internet of Things
- Autonomy

Project Examples

Near-Edge AI Real-Time Laser Welding Process Control

Development of an AI-based low-latency process with multimodal process monitoring to adjust parameters in real-time. By leveraging advanced AI and real-time monitoring, we can achieve unprecedented levels of speed, efficiency, and quality in industrial laser processing.

Stabilizing Automated Vial Filling

Providing expertise in data science and AI model development to identify the root causes for out-of-range filled vials and creating predictive AI models to control and stabilize the process. The solution was scaled across other production areas.

Testing and Enhancing AI Image Analysis Systems

Quantifiable performance analysis and evaluation of an AI-based image analysis system with subsequent performance enhancement. Synthetic image generation to achieve higher accuracy and robustness.

Statistical Process Control of Welding Robots

For 100% quality management and predictive maintenance process parameters of an automated welding process are monitored to predict the quality of each weld.

Fraunhofer USA Center for Manufacturing Innovation CMI

Scientific Focus

Fraunhofer USA CMI focuses on three pillars of our economy: industrial systems, sustainable energy systems, and biomedical systems. Within industrial systems, Fraunhofer USA CMI develops next-generation automation solutions for a variety of industries, including aerospace, photonics, consumer products manufacturing, automotive, materials processing, and others necessitating high-precision and intelligence. Within the biomedical space, engineers and biologists work side-by-side, leveraging our combined expertise in engineering design and biological sciences to develop biosensors and medical devices, microfluidics, laboratory automation, and microassays.

Our focus in sustainable energy is on the reduction of energy consumption in buildings, and efficient grid integration. More specifically, our work in the energy reduction of buildings focuses on creative and quantitative means of analyzing and using data generated by an ever-increasing number of communicating sensors, combined with thermal modeling, to reduce energy consumption. In the area of grid integration, Fraunhofer USA CMI is focused on the development of efficient algorithms for integration of distributed energy resources (DERs), such as solar, wind, hydro, storage, etc., into the grid, as well as reduction of strain on the grid through load balancing.

A unique advantage of Fraunhofer USA CMI is the combination of energy, manufacturing, and biomedical competences. For example, the center leverages its automation and manufacturing expertise to facilitate cost-effective sustainable energy solutions to meet our decarbonization goals as a nation.

Core Competences

Industrial Systems

- Turn-key next-generation automation systems
- Control systems
- Real-time control software development
- Precision motion
- Mechatronics

Energy and Climate

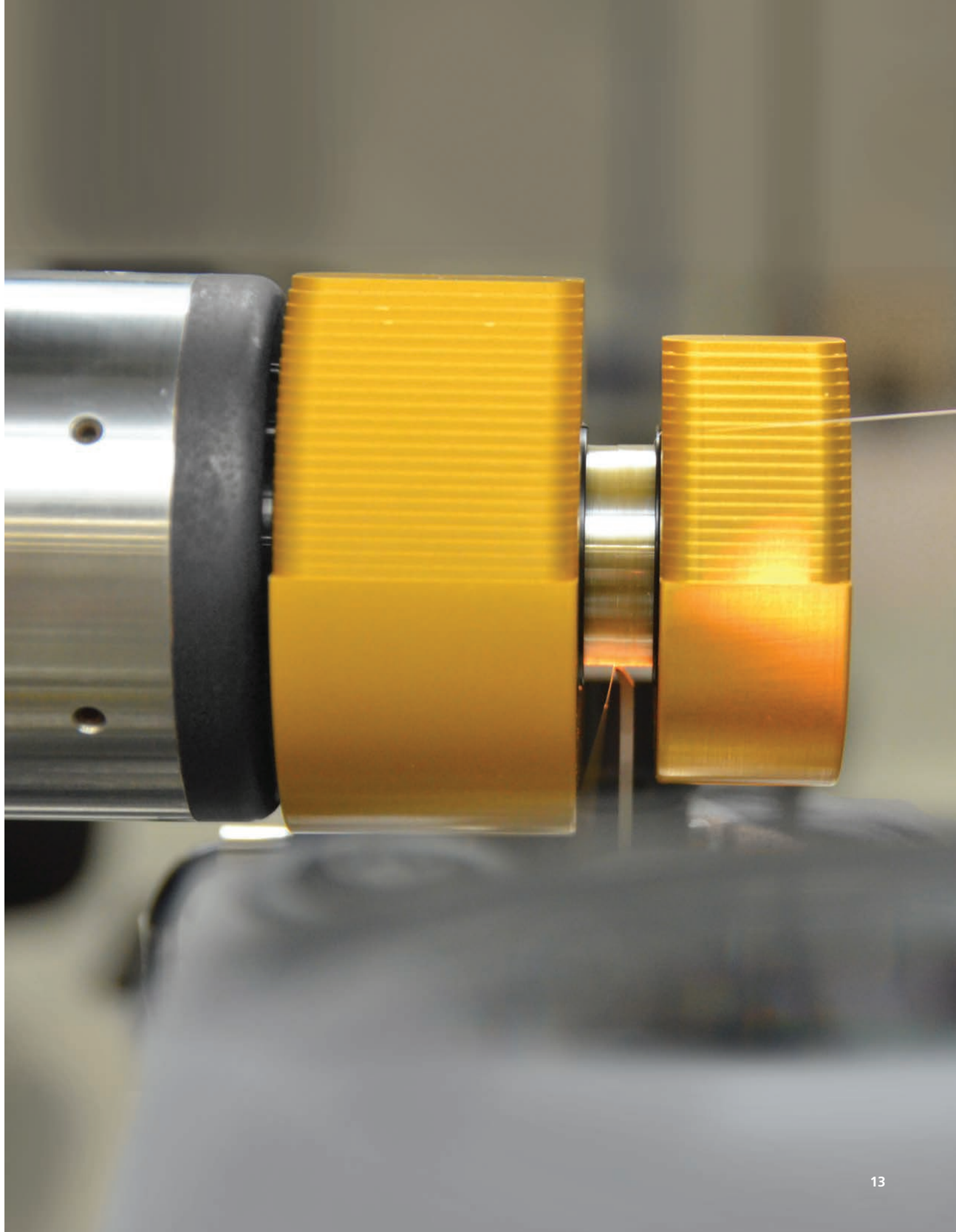
- Building performance assessment
- Building control algorithms
- Power grid integration of distributed energy resources
- Cost-effective construction techniques
- Deep energy retrofits

Biomedical Systems

- Lab automation and instrumentation
- Massively parallel sample preparation
- Point-of-care diagnostics compatible with high-volume manufacturing
- Microfluidics
- Tissue engineering

Research Fields

- High-precision motion
- Tissue engineering
- Antibiotic susceptibility
- Model-based building optimization
- Deep energy retrofits
- Production of low-cost biosensors
- Grid load balancing



Fraunhofer USA Center Midwest CMW

Scientific Focus

Fraunhofer USA CMW performs applied research and development projects in the fields of diamond and coating materials, surface engineering, 3D printing and additive manufacturing technologies, and power laser applications. Projects involve research and development of materials, processes, devices and systems, with a focus on bridging the innovation gap between laboratory research and customer applications. Customers include government organizations and commercial clients from multiple sectors such as the manufacturing, semiconductor, biomedical, and energy industries. Fraunhofer USA CMW sets a high priority on quality management and is ISO 9001 certified.

Core Competences

Light and Surfaces
- Surface engineering
- Coating processes and systems
- Vacuum and plasma technologies
- Direct energy powder deposition
- High-power robotic laser systems
- Laser welding and joining technology

Materials
- Coating materials
- Diamond materials and applications
- Materials characterization

Microelectronics
- Electrochemical sensors and methods
- Microfabrication

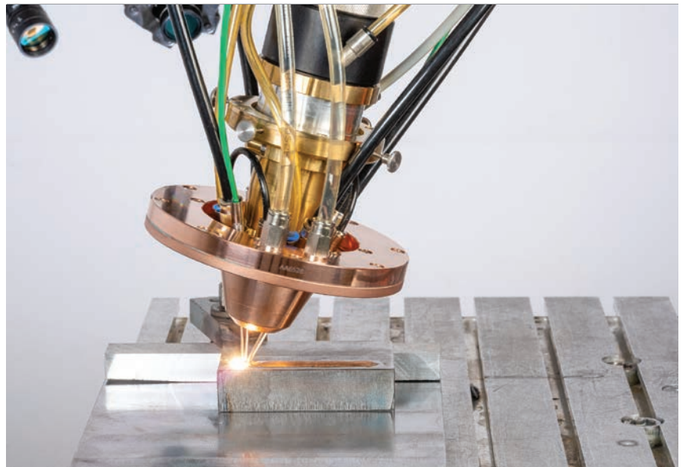
Research Fields
- Power and radio frequency electronics
- Clean water
- Quantum systems
- Wear, friction, and corrosion
- Optical thin films
- Thermal barriers
- Biomedical sensors and devices
- Additive manufacturing and 3D printing

Technologies

Diamond
- Diamond technologies enable advancements in power and RF electronic devices, enhancing performance and reliability in demanding applications
- Innovative solutions for thermal management, particle detectors, and electrochemical sensors leverage diamond's exceptional properties for improved efficiency and durability
- Advancements in synthesis systems and quantum systems drive next-generation technologies in materials science

Coatings
- Enhanced wear, friction, and corrosion resistance on metal, glass, and polymer surfaces
- Multifunctional coatings with features such as optical transparency and/or antireflective, self-cleaning capabilities, nanostructuring, and enhanced electrochemical capabilities
- Plasma source design and engineering for novel coating materials and applications

Laser
- Developing laser cladding and additive manufacturing processes for improved part performance and efficiency
- Advanced process development for laser welding and joining processes, including remote welding with machine vision and machine learning (AI) technologies
- Advanced process monitoring and control systems



Fraunhofer USA Digital Media Technologies Office DMT

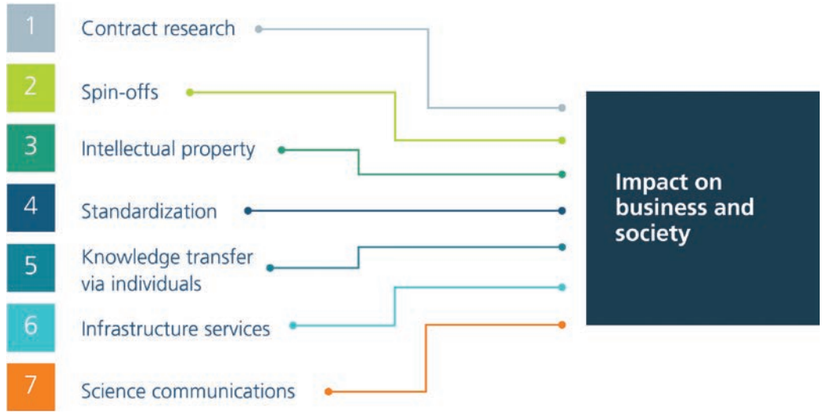
For more than 35 years, the Fraunhofer Institute for Integrated Circuits IIS has been shaping the globally deployed standards and technologies in the fields of audio coding and moving picture production. Fraunhofer IIS systems and tools help create, transmit, and provide excellent audio and video content as well as enable high-quality, real-time communication. Fraunhofer USA DMT promotes state-of-the-art technologies and supports the Audio and Media Technologies division of Fraunhofer Institute for Integrated Circuits IIS in the United States.

Today, almost all computers, mobile phones, and consumer electronic devices are equipped with Fraunhofer IIS technologies and are used by billions of people around the world every day. It all started with the creation of mp3, then evolved with the co-development of AAC and HE-AAC. Now, the fourth generation of best-in-class audio technologies – MPEG-H Audio, EVS, LC3/LC3plus and xHE-AAC – elevates the media experience to new heights. In terms of audio signal processing, Symphoria and the Sonamic product family provide enveloping and enhanced sound in cars, while the upHear product family dramatically improves 3D audio playback or recording quality of professional and consumer devices.

Fraunhofer technologies also power digital radio in the form of the ContentServer, which combines audio encoding, multimedia data management, and multiplexing. In the field of moving picture technologies, establishing the Digital Cinema Initiative test plan boosted the creation of professional tools for digital film and media production, such as easyDCP. The JPEG XS solutions facilitate the transfer to all-IP workflows.

Work with Us

For over 30 years, Fraunhofer USA has established itself as a key player in the world's largest R&D economy, building deep relationships with U.S. federal agencies, state governments, and industry leaders. Working closely with our founding partner, Fraunhofer-Gesellschaft, Europe's largest applied R&D organization, we combine German engineering excellence with American entrepreneurial drive to accelerate technological advancement.



Fraunhofer customers commercialize more innovations and increase their sales and returns. Fraunhofer activities demonstrably create jobs, generate industry investments and, increase government revenue.

Evaluations

We offer expert assessment services including:

- **IVV**
- **Scale-up studies**
- **Techno-economic analysis**
- **Life cycle assessments**

Joint Government Funding

Fraunhofer USA can support companies applying for government funding in the form of joint proposals or as R&D subcontractors with letters of support. We participate in both large-scale government programs as well as SBIRs & STTRs and follow all pertaining government regulations for such funding.

Contract R&D

We provide a complimentary needs assessment. If suitable, we collect necessary information under an NDA to develop a service proposal.

Our Proposals Include:

- **Phased, risk mitigation approach**
- **Clear deliverables and milestones**
- **Cost breakdown**

Our flexible IP policies accommodate both large and small companies.

Bridging the Gap: How to Engage with Fraunhofer USA

Fraunhofer USA employs several strategies to bring technology to market for our government and industry customers. By partnering with industry leaders to identify market needs and co-develop solutions, our joint collaborations often lead to the commercialization of technology by integrating it into existing products or launching new products altogether. We can support startup companies based on promising technologies developed in their labs and showcase our research outcomes at industry events or trade shows. We are also actively engaged in technology transfer programs that aim to transition research findings into practical applications, often with government support and grants. We often generate intellectual property through the work of our research scientists, and this technology is also available for licensing to interested companies. By offering our collective expertise in market analysis, business planning, and technology validation, we bridge the gap between research and commercialization, further fostering innovation and economic growth.

Information for Industrial Clients

For 30 years, large and small companies have turned to Fraunhofer USA for assistance in solving their most challenging problems. Through our structured and rigorous approach, we mix emerging research with state-of-the-art technologies to develop custom solutions not available in the marketplace. We work in many industry sectors, including but not limited to: biotech/biomedical, consumer products, aerospace, materials, additive and advanced manufacturing, automation, energy, and any other sectors interested in Industry 4.0 technology solutions. Our clients typically engage with us in two ways:

Joint Government Funding

Fraunhofer USA can support companies applying for government funding, in the form of joint proposals or as R&D subcontractors with letters of support. We participate in both large-scale government programs as well as SBIRs and are in compliance with all pertaining government regulations for such funding.

Contract Research and Development

We offer a free-of-charge assessment as to whether our organization can help address your needs and then provide a proposal as to how we can be of service, typically under a non-disclosure agreement. All of our proposals include a phased approach to mitigate risk, a clear statement of deliverables, milestones, and cost. We have a flexible and transparent intellectual property policy which works well for both large and small companies.

SC FRAUNHOFER USA ALLIANCE

SC COUNCIL ON COMPETITIVENESS · SOUTH CAROLINA · Fraunhofer USA

South Carolina Fraunhofer USA Alliance

After years of fruitful partnership with the State of South Carolina, including state funding of three research projects between Fraunhofer IESE and selected state universities, the South Carolina Fraunhofer USA Alliance was formally established in 2019 by the South Carolina Department of Commerce. The Alliance is a collaboration of the Council on Competitiveness ("SC Competes"), a statewide non-profit organization that provides administration, industry and academic engagement, and management to the Alliance, Fraunhofer USA, representatives from key industries, and South Carolina academic partners such as Clemson University, College of Charleston, and the University of South Carolina.

The State of South Carolina has provided support which also advances the Fraunhofer USA corporate mission of providing cutting-edge technologies and advanced applied research to companies and organizations of all sizes in order to support them in being as globally competitive as possible. This program, now in its fifth year, offers state governments, economic development agencies, and academic institutions the opportunity to develop technical assistance programs based on the Alliance template and is tailored to the states' specific needs and interests.

Fraunhofer USA Scientists and Advisory Council Members at Annual Internal R&D Summit

The program works to assist local businesses with the challenges and opportunities presented by rapid technological changes. Initially targeting manufacturing processes, product development and service delivery, the Alliance has now also reached the life sciences and the material sciences. The State of South Carolina provides approximately $2 million to the South Carolina Fraunhofer USA Alliance per year in 1:1 funding to match industrial monies. To date, more than 30 projects have been co-funded with matching monies for the automotive, energy, aerospace, life science, and logistics sectors of the state. South Carolina is home to more than 220 German companies such as BMW, Bosch, Continental, Schaeffler, MTU, Mercedes Benz Vans and more. Representatives from BMW and KION (Linde Group) currently both serve on the South Carolina Fraunhofer USA Alliance Review Board providing "voice of industry" perspective.

Since its inception, the Alliance Program team has worked with companies involved in aircraft subsystems, bicycle manufacturing, thermoplastics, appliances, shipping and logistics, telemedicine, auto assembly, and many others. Projects have focused on reducing defects in assembly operations, image analysis, workforce training and onboarding process improvements, capturing data and integration of data sets for better insights into operations, automation of manual production tasks to allow workers to focus on higher value, growing enzymes for healthcare, reducing operational costs to be able to reshore operations from Asia, supporting and guiding companies during the transition from the traditional automotive to the EV industry.

The variety of industries and challenges addressed speaks to the Alliance Program team's capacity and capability to take on tough issues facing companies large and small, and delivering success where off-the-shelf solutions do not exist. The technical areas include artificial intelligence for manufacturing, Industry 4.0, advanced quality management, production technology, sustainability, advanced materials, and automation and robotics.

For more information on the South Carolina Fraunhofer USA Alliance contact Dr. Marcel Schaefer at mschaefer@fraunhofer.org.

C2V Year 4 Cohort Members and Program Leaders

Fraunhofer USA TechBridge Program

The Fraunhofer USA TechBridge program works with corporations and startup companies to identify and de-risk promising technologies to solve industry challenges. By performing targeted technical searches and conducting validation and demonstration work, TechBridge evaluates and prepares innovative early-stage products for investors and industry.

The current TechBridge program, known as the Carbon to Value Initiative (C2V Initiative), is a unique partnership between Fraunhofer USA, Greentown Labs, and the Urban Future Lab at New York University-Tandon. The C2V Initiative drives the creation of a thriving innovation ecosystem for the commercialization of carbontech solutions that capture, convert, and sequester carbon dioxide (CO_2) into valuable end products or services.

Now entering its fifth year, the C2V Initiative has supported 35 groundbreaking startups that have raised over $580 million in follow-on funding, leading to numerous successful partnerships and 600+ new business relationships, technology advancement, and industry growth. The initiative connects innovative young companies with industry leaders in chemicals, advanced materials, energy, and other sectors that can provide resources and market access necessary to enable rapid commercialization of carbontech.

A key component of the C2V Initiative is the Carbontech Leadership Council (CLC), an invitation-only group of executive leaders across diverse industry sectors driving the future of carbontech. Startups selected to participate gain access to the CLC, benefiting from customized workshop programming and access to resources and mentorship from the Urban Future Lab, Greentown Labs, Fraunhofer USA and Fraunhofer-Gesellschaft networks.

The C2V Initiative creates a first-of-its-kind collaborative ecosystem among carbontech innovators and leading corporations with the end goal of making carbontech cost-effective and achieving its deployment at scale. Through participation in the CLC, corporations both advance their sustainability goals and take a leadership role at the forefront of a new industry, as the world seeks to rapidly decarbonize in response to climate change.

Program lead partners Fraunhofer USA, Urban Future Lab, and Greentown Labs have strong experience jointly curating, testing, and launching successful game-changing climate solutions into the marketplace. The combination of incubation space, innovation services, technical testing capacity, and know-how they provide forms the basis of a highly unique and proven technology acceleration model that is being applied to carbontech as part of the C2V Initiative.

Research Scholar Program

Fraunhofer USA offers a research scholar program. International researchers can come to the United States through our J-1 Research Scholar program and perform applied research at Fraunhofer USA. This program offers post-doc positions, and provides opportunities for early career scientists and engineers to obtain hands-on experience, which can facilitate knowledge transfer and support the progress of science and technology to the greater benefit of society.

Intern Program

Fraunhofer USA is committed to offering opportunities for meaningful, hands-on internships for both international and domestic students studying in STEM fields. Over the last 30 years, Fraunhofer USA has hosted thousands of interns from many countries and backgrounds, supporting and encouraging curious minds as they lay a solid foundation to help support the critical STEM fields that we all rely upon. Internships are available for U.S. and international interns at our three research centers. Interns are closely mentored and find the experience very rewarding. Fraunhofer USA has a J-1 visa program that provides us with the capability to obtain an intern's visa if the intern is not authorized to work in the U.S.

Select R&D Projects

Highlighted research showcases Fraunhofer USA's ability to bring technology to market, collaborations with university and government partners, and our efforts to progress transatlantic collaboration in science and technology.

Bringing Technology to Market

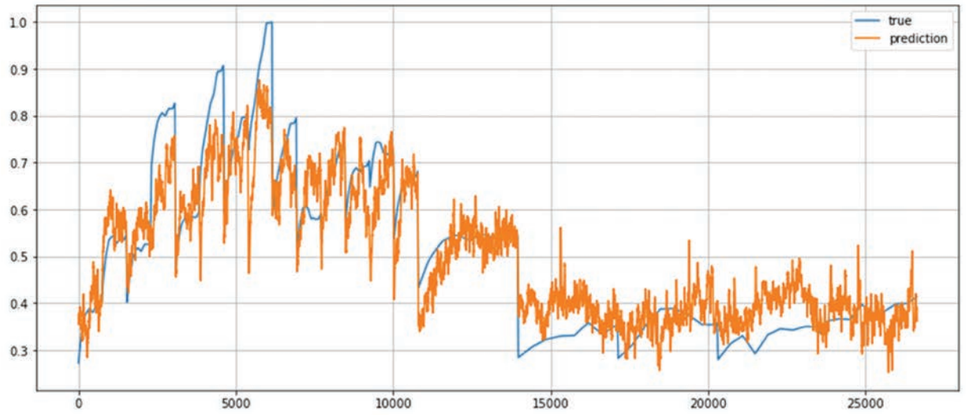
Diamond-Like Coatings for Cancer Therapy

Fraunhofer USA Center Midwest CMW

Solid tumors account for the vast majority of the over 600,000 deaths annually from all cancers, excluding non-melanoma skin cancers, in the U.S. They are particularly hard to detect and treat, making them one of the leading challenges facing the U.S. health system. The efficacy of treatment can be improved by minimizing invasive surgery and limiting treatment to the affected tissue site(s). However, this remains a major challenge and is the objective of many innovative cancer therapies. Immunolight, a Michigan-based company, has developed an innovative approach that marks a true paradigm shift in cancer treatment. By repurposing psoralen – a well-established drug traditionally used for skin conditions and cutaneous T-cell lymphoma – they are positioning it as a front-line therapy for a broad range of solid tumors. The treatment is delivered by directly injecting psoralen into the target tumor along with energy converters to activate the drug. This intra-tumoral injection is followed by exposure to a low dose of X-ray energy from a standard radiation therapy system. This process of activating psoralen inside a deeply embedded tumor required multiple breakthroughs in chemistry and physics. Immunolight developed the energy converting materials which efficiently absorb X-ray energy and convert it to UV light inside the tumor. Once activated by UV, psoralen binds to DNA and induces apoptotic cell death, which can lead to a pronounced immune response to cause stabilization of disease or partial or complete remission. Critically, this treatment approach has no substantial side effects, unlike chemotherapy.

Fraunhofer USA CMW supported Immunolight in developing a vacuum thin film coating process to deposit diamond-like carbon (DLC) on the surface of the energy conversion material. The coating must be bio-compatible and UV transparent in the 320 to 360 nm range to activate psoralen, which was successfully achieved. In general, DLC coatings have been increasingly adopted for biomedical applications such as surgical instruments and implants due to their hardness in combination with low friction. This amorphous form of carbon is well-suited for the physiological environment of mammalian bodies and can prevent bacterial growth, inflammation, and other allergic rejections. This vertically integrated approach to develop a functional bio-interface was very helpful for Immunolight to finalize the development of their innovative cancer treatment and to speed up the qualification process.

Inside of a physical vapor deposition reactor, where the medical device in powder form glows green (left) and diamond-like carbon coated energy converting micro-particles (center and right).



Monitoring of laser welding, showing the ground truth of subsurface weld depth (blue trace) closely tracking the predicted results provided by the ML model leveraging acoustic and thermal signatures (orange trace) with less than 10% error.

Harnessing Quality 4.0 for Predictive and Real-Time Quality Assurance for Welding Processes

Fraunhofer USA Center Mid-Atlantic CMA

Just as Industry 4.0 has transformed manufacturing by embedding digital technologies into every stage of production, so Quality 4.0 has emerged to use smart technologies to improve product quality and manufacturing operations. It integrates real-time, non-destructive process monitoring, edge computing, and advanced analytics, often powered by machine learning (ML) and artificial intelligence (AI), to create a proactive and predictive approach to ensuring product quality. Instead of traditional end-of-line quality inspections, Quality 4.0 shifts the focus to in-line, process-centric quality assurance (QA), leveraging continuous data collection from smart sensors to capture critical process parameters and IIoT devices to monitor manufacturing processes as they unfold. This approach to QA enables manufacturers to detect deviations in products at an early stage in their manufacture, reveal deviations that may not be detectable by standard screening of the final product, deploy AI/ML-based predictive analytics to forecast final product quality and make process adjustments to mitigate arising deviations. The cumulative effect of this approach is to reduce the likelihood of defects and costly rework, more easily identify root causes of product defects, identify high-risk processes requiring intense quality monitoring, and reduce the need for post-production quality assessments. Thus, implementing Quality 4.0 into manufacturing processes leads to major cost savings.

Computer scientists and engineers at Fraunhofer USA CMA have developed ML and AI tools to introduce Quality 4.0 approaches into two welding use cases important in the automotive industry: spot welding and laser welding. Resistance spot welding is widely used to join metal sheets via localized fusion. Fraunhofer USA CMA utilized AI algorithms to analyze large datasets gathered from strategically placed sensors during production, thus identifying patterns, trends and deviations from established norms and predicting final weld strength and bonding quality. By continuously monitoring process parameters in real-time, AI-powered statistical process control (SPC) systems could alert operators to potential quality issues, enabling timely adjustments to prevent defects and optimize production efficiency. This Quality 4.0 approach has been tested with major automotive manufacturers in the U.S. It reduces the cost of manual weld quality verification by up to 55% and can be integrated into existing spot-welding lines with minimal hardware modifications.

In collaboration with their colleagues at the Fraunhofer Institute for Material and Beam Technology IWS in Dresden, Germany, Fraunhofer USA CMA has also applied Quality 4.0 to high-precision laser welding, which is used across many industries requiring high strength, minimal distortion and fine detail, including the automotive industry. The team deployed a high-speed thermal camera to capture temperature gradients across the weld zone and an acoustic sensor to record emitted ultrasound waves. A system of AI models were developed utilizing different ML architectures that correlated sensor outputs with key weld parameters. This allowed for parameters such as laser power or scanning speed to be tuned on the fly to address detected anomalies, with the number of weld defects reduced by up to 30%. The approaches deployed here by Fraunhofer USA CMA to introduce Quality 4.0 to welding use cases will also be applicable across a very wide variety of other processes and many manufacturing industries.

High Throughput Tissue Processing for Industry

Fraunhofer USA Center for Manufacturing Innovation CMI

Biological and chemical assays are critical for sample analysis across the biological sciences, including for diagnostic purposes, and to assess the effects of alternative experimental conditions. In many cases, such as when assessing the effect of a therapeutic drug candidate at the whole cell level, the requisite assays require isolated, viable primary cells extracted from target animal tissues. Such whole cell assays are critical in basic research, and also in the development of drugs and biologics through the pre-clinical and clinical pipelines. They are therefore important in academia and in the biotechnology and pharmaceutical industries.

To provide input for these assays, extraction of the viable cells needs to be a finely tuned process, to ensure tissue dissociation without full homogenization, resulting in mass cell rupture. It also needs to be a relatively rapid process in order not to become a major bottleneck in the process flow. With currently available methods, significant time is expended dissociating tissues to extract viable cells, often with the use of enzymes to digest the extracellular matrix. Indeed, common commercially available platforms take about forty-five minutes to process only eight tissue samples. Furthermore, for widespread practical use, the extraction process should be versatile to accommodate multiple tissue types, and fit into industrial process flows with other standard laboratory equipment.

Fraunhofer USA CMI had previously built a tissue dissociator capable of simultaneously processing twenty-four samples within two minutes. Under a project conducted for the Cambridge, Massachusetts-based pharmaceutical company, Moderna, the center recently advanced the development of this instrument to expand the range of processed tissues that it could handle and make the instrument compatible with currently available automation modules. The instrument is comprised of an automated version of a mortar and pestle style design, common to standard grinding processes used in laboratories. The automated version allows for rapid grinding down of tissues without the need for time-consuming enzymatic digestion. The mortar function is provided by a standard disposable 24-well plate, allowing seamless integration with existing workflows and liquid handling systems. The pestle function is provided by a custom manufactured array made from autoclavable materials for easy between sample cleaning and resetting of the system. As a further development, the lengths of pestles were extended to allow for use with both standard wells and deeper wells for higher volume samples.

Highlighting the flexibility of the platform, system testing generated high numbers of viable cells from a wide variety of tissues, including spleens, lymph nodes, cancerous tumors, and even more challenging tissues such as femurs and nasal cavities. Thus, tissues with tough connective material, small tissues, and calcified bones could be thoroughly dissociated using this equipment. Comparisons to commercially available controls demonstrated higher performance ratings for the Fraunhofer USA CMI developed dissociator. Moderna said of the instrument's performance, "We finally finished analysis from the most recent studies with the Fraunhofer machine. I am pleased to say that the results show they are working great…thank you for all your help. Please also extend many thanks to the whole team! We are very excited to have these machines in house and see how much it will change our lives."

Instrument for tissue dissociation (left), the array of pestles for tissue dissociation (upper right) and lung tissue prior to and after dissociation (lower right).

University and Government Collaboration

University Partnerships

Boston University

Fraunhofer USA CMI has collaborated closely with Boston University (BU) since the center's inception in 1995. The center is located on the BU Charles River campus. Boston University is identified as an institution of "very high research activity" in the Carnegie classification of Institutions of higher education. Fraunhofer USA CMI collaborates directly with several of BU's schools and colleges, including the College of Engineering, the Medical School, the Business School, and the College of Arts & Sciences. Boston University has a student body of more than 38,000 students of which circa 18,000 are graduate students. As a leading global research institution, BU has been awarded more than $579.5 million in research awards in FY 2024.

Michigan State University

Since 2003, Fraunhofer USA CMW has operated in tandem with Michigan State University (MSU) on applied research and development initiatives across Fraunhofer USA CMW's core competences, on both government- and industry-sponsored projects. MSU, the nation's pioneering land grant institution, has over 50,000 undergraduate students and over 10,000 graduate students. MSU's College of Engineering and College of Natural Science collaborates closely with Fraunhofer USA CMW on both research projects and student training for next-generation materials manufacturing.

University of Maryland

The University of Maryland (UMD), College Park is a public land grant university that was founded in 1856. UMD ranks among the top 20 U.S. Research institutions in the National Science Foundation's higher Education and Research Development (HERD) Survey. The HERD survey ranks universities engaged in sponsored research.

Fraunhofer USA CMA has collaborated with the University of Maryland since 1997, specifically within the College of Computer, Mathematical and Natural Sciences. The College of Computer, Mathematical, and Natural Sciences at the University of Maryland educates 10,000+ future scientific leaders in its undergraduate and graduate programs each year. The 10 departments and nine interdisciplinary research centers in the college support and develop scientific discovery with annual sponsored research funding exceeding $250 million.

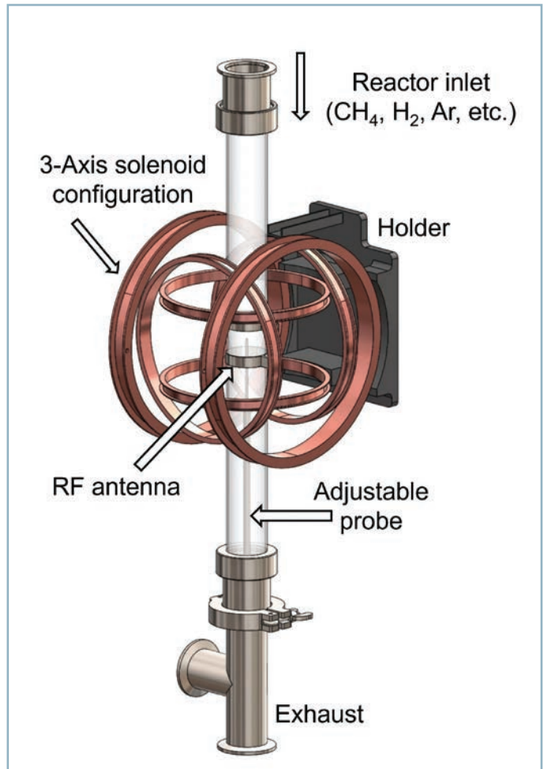
Synthesis of Diamond Nanoparticles from the Gas Phase

Fraunhofer USA Center Midwest CMW

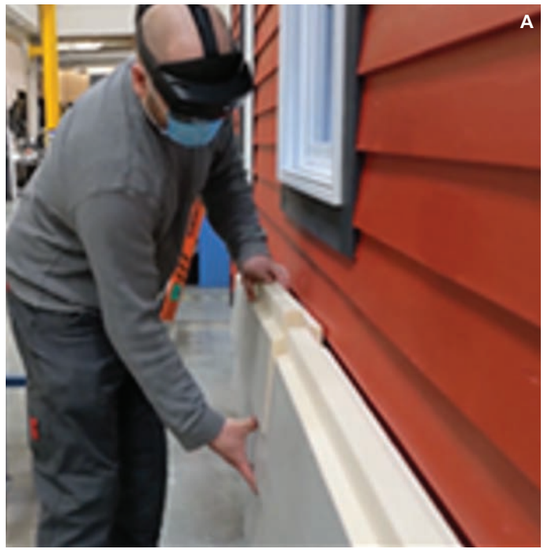
There is a significant and urgent need for new materials for a wide range of industrial and medical applications. These are driven by demands for improved sensitivity and specificity among other criteria. To address these, recent research focuses on the development of novel nanoparticles which can overcome limitations with current materials and enhance the precision of surface interactions. Diamond nanoparticles (DNPs) have been demonstrated as an effective material for a wide variety of applications, including bioimaging, drug delivery, and cancer therapies. To realize the commercialization of DNPs for these applications it is necessary to develop synthesis routes that result in particles with well controlled properties and characteristics. Many of the material properties and characteristics of DNPs are dependent on their size, shape, and surface morphology. Currently, the most common methods to produce DNPs are through detonation and ball-milling. These top down approaches, while successful at producing large quantities of particles, often feature either broad size or shape distributions, limitations on selection of particle size, and lack of control over composition. Radio frequency (RF) plasma synthesis offers an attractive alternative to these top down approaches since continuous flow-through reactors can be used to controllably produce intrinsic and doped nanoparticles with functionalized surfaces and narrow size distributions.

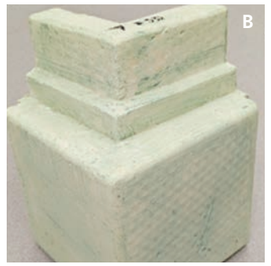
Under a project funded by the US Department of Energy and in collaboration with colleagues at Michigan State University, Fraunhofer USA CMW is developing a path to synthesize DNPs directly out of the gas phase utilizing a RF plasma process. To date, there has been difficulty in utilizing RF plasma synthesis to generate DNPs. This is in part due to a lack of fundamental knowledge related to the growth mechanisms of nanoparticles in low temperature plasmas. While many mechanisms have been proposed, there is a dearth of systematic studies that integrate experimental data into predictive modeling or simulation. Studies are required that will collect information about the plasma characteristics, gas species, and synthesized material to build predictive models for nanoparticle synthesis. Direct evidence for DNP nucleation and growth directly from the gas phase without the influence of a substrate is fairly limited. Furthermore, information related to the nucleation and growth dynamics of particles in plasma could have important implications for conventional diamond film growth.

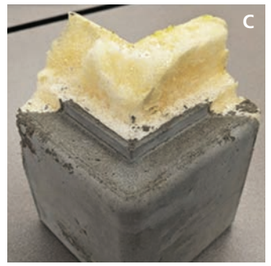
The objectives of Fraunhofer USA CMW's project are to measure various parameters, including the electron and ion energy distribution functions, plasma density, gas temperature, and gas species during DNP synthesis by the RF plasma process, and to map these conditions onto the characteristics of the synthesized nanoparticles, thus identifying process conditions suitable for DNP synthesis. The reactor being used for this work is composed of a quartz tube with external ring electrodes that capacitively couple RF power from a power supply to the plasma. Magnetic coils located externally to the quartz tube are placed in a Helmholtz configuration to provide a uniform magnetic field in the active region of the reactor. Three independent sets of coils, each aligned along a principal axis, generate a magnetic field with controllable strength along each principal axis. A mixture of hydrogen, methane, and argon gases are used for the growth of the DNPs and pressure is monitored and regulated. Particles are collected on substrates by acceleration of their flow through a nozzle where they are deposited via a process of inertial impaction. Initial results have shown that the plasma characteristics can be shifted with the strength of the magnetic field produced by the coils, offering promise for the development of a DNP synthesis pathway. .



Schematic diagram of a reactor used to generate DNPs.







Using augmented reality to guide the fitting of panels in an experimental demonstration of the cladding approach (A), foam alone (B), and co-molded foam and concrete corner pieces (C) and (D).

Design of Super-Insulating Blocks for Low-Cost Retrofitting of Residential Buildings

Fraunhofer USA Center for Manufacturing Innovation CMI

Millions of existing homes in the northeast of the United States have little or no wall insulation and current technologies to improve insulation either have severe limitations or are cost-prohibitive at large scale. Drill-and-fill wall insulation only increases whole wall thermal insulation to an R-value of about 11 and cannot be used in masonry structures lacking a wall cavity or with no or challenging access to such a cavity. Interior insulation systems are disruptive and invasive, consume valuable indoor floor space and create hygrothermal risk during warmer months. Adding continuous insulation to outside walls is preferable to the above solutions but is currently very costly, since insulating boards need to be custom cut on site by skilled labor and followed up with the application of a stucco finish coat.

Under a project funded by the New York State Energy Research and Development Authority, Fraunhofer USA CMI developed an insulated architectural masonry-like panel block, that when used to clad existing smaller masonry and wood-frame residential buildings, adds continuous exterior insulation to reach a thermal insulation R-value of at least 20 in an appealing and cost-effective manner. The blocks are pre-fabricated using digital processes to analyze terrestrial scans of buildings, allowing for accurate building dimensions to be obtained, an appropriate set of blocks to be designed and fabricated, and an augmented reality experience to be created to guide the installation of the blocks onto the building. This process eliminates on-site cutting of insulation, cladding and trim, and facilitates on-the-job guidance of labor, thus significantly reducing installation costs.

Through this project, Fraunhofer USA CMI identified compression co-molding of the concrete-based manufactured stone shell and foam backing as the most promising process to manufacture the insulated panel blocks. The center then developed a conceptual production molding process and production line for high-throughput manufacturing at minimal possible cost. Cost modeling indicates that the masonry-like panel blocks should be cost-competitive for energy efficient building retrofits. In the course of completing this project, Fraunhofer USA CMI also demonstrated that their digital processes to analyze scans of wooden buildings could be extended to masonry buildings. The project also allowed for market research, whereby the center identified key customers for the technology among homeowners and contractors and identified additional preferred design attributes, comprising high aesthetic quality, low-visibility seams, and surface durability.

Transatlantic Collaboration

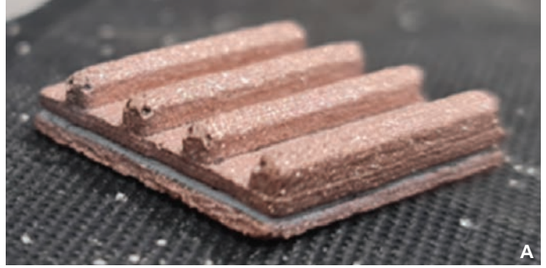
Fraunhofer USA exemplifies the power of transatlantic cooperation in applied research and development. Through our unique partnership with Fraunhofer-Gesellschaft in Germany, we create a vital bridge between two of the world's leading innovation ecosystems. This collaboration goes far beyond traditional institutional partnerships – it represents a strategic alliance that accelerates technological advancement and creates lasting positive impact for both continents.

The strength of our model lies in its ability to combine German engineering excellence with American entrepreneurial spirit and market dynamics. By leveraging the vast capabilities of Fraunhofer-Gesellschaft's network in Germany while maintaining deep connections to U.S. industry and research communities, we create unique opportunities for breakthrough innovations that benefit society on both sides of the Atlantic.

Our transatlantic collaboration model enables rapid deployment of cutting-edge technologies and expertise where they are needed most. Whether addressing global challenges in sustainable energy, advanced manufacturing, or digital transformation, this partnership allows us to pool resources, share knowledge, and accelerate the development of practical solutions.

The impact of this collaboration extends far beyond our immediate institutional boundaries. By fostering deep connections between European and American innovation ecosystems, we help strengthen the broader transatlantic relationship, contributing to economic growth and technological advancement in both regions. This international cooperation is particularly crucial in today's interconnected world, where the most pressing challenges require global solutions and coordinated efforts.

At its core, Fraunhofer USA's mission is driven by the belief that transatlantic cooperation in applied research and development is essential for advancing society's wellbeing. By bridging the innovation landscapes of Europe and North America, we help ensure that groundbreaking research translates into tangible benefits for people on both continents and beyond.



A copper diamond-ceramic heat sink fabricated with gel-casting (A). Pellets utilized by the ExAM 255 printer, and a demonstrator of copper and ceramic prints (B). Installation of the ExAM 255 printer with Vincent Morrison, the managing director of New Aim3D (left), and James Siegenthaler, the lead scientist from Fraunhofer USA CMW on the project (right) (C).

Additive Manufacturing for Multi-Material Heat Exchangers

Fraunhofer USA Center Midwest CMW, Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM (Dresden)

The trend toward electronics miniaturization and higher-efficiency thermal heat exchangers presents major challenges in electronic packaging, cooling, and temperature control. As a result, heat flux directly impacts both consumer electronics and the manufacturing tools used to fabricate these devices, driving industrial-scale challenges. On average, global heat flux demands have risen by 7.8% per year over the last decade. This increase is driven by advanced microelectronics applications such as artificial intelligence, and demands are projected to continue growing, with the global thermal management market expected to reach $12-14 billion by 2030.

One leading solution to manage increased heat flux and mitigate damage to electronic components is the integration of advanced heat exchanger materials and custom-shaped structures that cannot be produced through traditional subtractive manufacturing. By leveraging additive manufacturing and combining advanced materials, such as copper–diamond composites or layered copper–ceramic heat spreaders, custom thermal transfer devices can provide improved heat flux management. This reduces thermal mismatches, minimizes assembly-related heat loss, and ultimately extends device lifetimes.

To address these needs and advance multi-material integration of copper, ceramics, and copper–diamond composites, scientists at Fraunhofer USA CMW, in collaboration with colleagues at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, have developed novel additive manufacturing approaches. Two distinct processing competencies have been established to create complex copper and ceramic structures:

Gel Casting: Metal or ceramic powders are cast using a gelatin binder into 3D-printed molds. After post-processing and sintering, this approach yields dense, complex geometries and multi-material stacks composed of copper, alumina, and copper–diamond. Based on the mold structure a variety of complex structures can be fabricated.

Extrusion-Based 3D Printing: A polymer-based feedstock has been developed to suspend metal or ceramic powders within a printable plastic matrix. Using traditional extrusion, complex multilayered structures were fabricated simultaneously. Following debinding and sintering, this method also produced dense copper, alumina, and copper–diamond components of various geometries that could be used for thermal transfer interfaces.

While presenting these results at a conference, our team initiated a collaboration with New Aim3D GmbH, an additive manufacturing company based in Rostock, Germany. This partnership enabled Fraunhofer USA CMW to become the first U.S. customer for their ExAM 255 industrial pellet-based 3D printer and positioned our facility in East Lansing, Michigan, as a demonstration site for interested manufacturers. The ExAM 255 offers production-ready scalability, allowing our research to transition from technologically challenging and expensive filament-based printing to industrially viable pellet-based additive manufacturing of metals and ceramics.

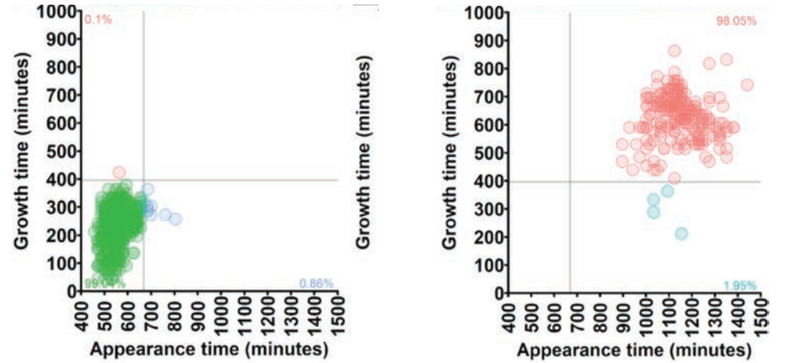
Together, our team has demonstrated novel heat spreaders with broad application potential, enabling our partners to mitigate heat, reduce costs, and unlock new design freedom through additive manufacturing.

Automated Assessment of Antibiotic Tolerance

Fraunhofer USA Center for Manufacturing Innovation CMI , Fraunhofer Institute for Production Technology IPT

Diseases caused by infectious bacteria and fungi are a highly significant and growing threat. Despite the development of broad spectrum antibiotics over the last century, reduced efforts and successes in developing new antibiotics and increasing ineffectiveness of licensed antibiotics to stem the disease burden are creating a crisis in global health. Indeed, the World Health Organization estimates that antimicrobial resistance and the related phenomena of tolerance and resilience are directly responsible for well over one million deaths and contribute towards an additional five million deaths annually worldwide. Although important in stemming disease, licensed antibiotics are increasingly failing as a major treatment option across the world, with treatment failure primarily caused by two major phenomena, resistance and tolerance, of which tolerance is largely ignored. Tolerance refers to a situation under which bacteria functionally slow down or become dormant in the presence of an antibiotic used for treatment until that antibiotic dissipates to levels that no longer affect the bacteria, after which they revert to their active state and reinfect the patient. Unlike antibiotic resistance, antibiotic tolerance is not screened for in clinical laboratories and current assays used in research laboratories are labor intensive, have low throughput and can give highly-variable results between test sites.

To address this issue and develop a technology that can be used to detect antibiotic tolerance in high throughput clinical settings, scientists at Fraunhofer USA CMI have been working with their colleagues at the Fraunhofer Institute for Production Technology IPT in Aachen, Germany to develop an automated high-speed light microscope-based instrument to measure antibiotic tolerance in a platform that is agnostic to the actual antibiotic used. Bacteria from clinical isolates under investigation are grown on media in microwells that allow for phase contrast imaging. Then, image analysis algorithms, trained on large datasets of bacteria, are used to detect tolerance. The bacteria used for training purposes are from clinical samples obtained from a medical school and hospitals in the Boston area. The training datasets comprise images of these bacteria grown in the presence or absence of antibiotics and focus on lag periods and growth rates. The project is currently midway through its anticipated timeframe and is showing promising results. It is anticipated that an automated high throughput system to address antibiotic tolerance will be highly attractive to the clinical microbiology market.



Growth dynamics for populations of tolerant bacteria grown under optimal conditions (top left) and stressful conditions (top right) where it can be seen that bacterial growth lags and occurs at a slower rate under stressful conditions. Rapid automated scanning of samples in microwells (bottom right).

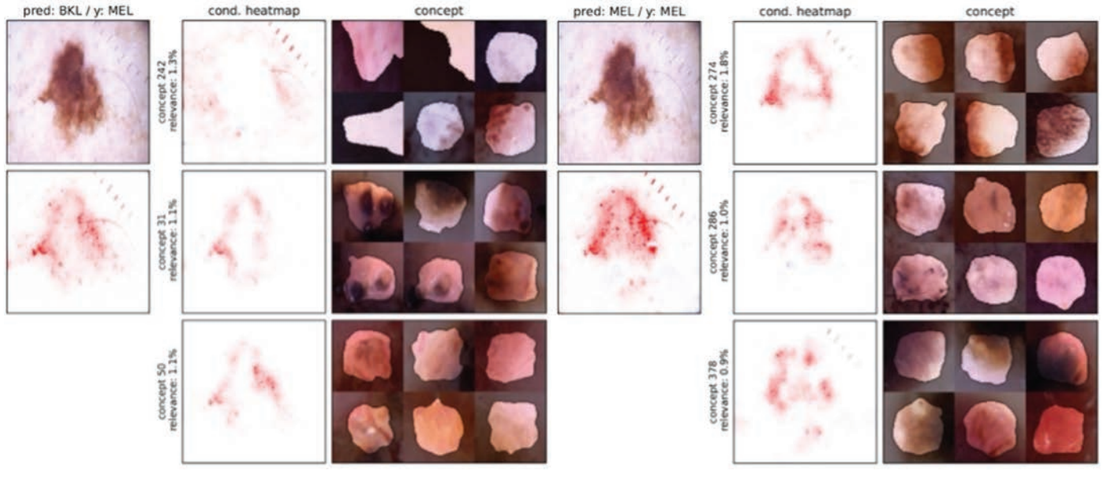
Microscopy Enhanced by Artificial Intelligence and Augmented Reality

Fraunhofer USA Center Mid-Atlantic CMA, Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut HHI

Modern medical optical instruments such as microscopes are becoming increasingly digital, but the data that is generated is not yet fully utilized by the emerging technologies of artificial intelligence (AI), machine learning (ML) and augmented reality (AR). For instance, AI/ML models can rapidly detect patterns in sensor data, such as malignant skin moles observed by microscopy, and digital sensors can exploit wavelengths beyond the visible spectrum to extract information that is invisible to the human eye. This AI-inferred and hyperspectral information can be fully utilized and presented to human users in real-time with AR. For this purpose, appropriate visualization is crucial to make different tissue types distinguishable, such as to differentiate between pathological and at-risk tissue, without overlapping other essential image information. Thus, there is large untapped potential in leveraging novel AI and AR tools for real-time analysis of digital microscopy data, which can assist physicians by providing supplementary information for diagnosis and surgery.

Although the latest AI/ML methods are very powerful and can make highly accurate predictions, they are often opaque. This lack of transparency and interpretability reduces their value to physicians. Furthermore, the AI/ML models can be misled during their training by confounding factors in the training data that are irrelevant to the actual diagnostic or supportive task to be performed by the physician. Additionally, these models are often insufficiently robust, since their performance can decline when given inputs that differ slightly from the training data, such as differences in the configuration during image acquisition. These flaws can lead to incorrect diagnoses and ultimately to a lack of confidence in diagnoses made using AI. Because of the opacity of the AI/ML models that are difficult to interpret, it has been challenging to identify and rule out such flaws.

Computer scientists at Fraunhofer USA CMA have been working with their colleagues at the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI in Berlin to develop a modular toolbox to integrate state-of-the-art AI models for the classification of microscopic and close-up images with robustness evaluation and improvement methodology along with concept-based explainable AI techniques, thus providing transparent, interpretable and robust AI/AR tools that enhance the efficacy of diagnostics and surgical procedures. Specifically, innovative methods for AI-based image analysis and synthetic image generation, real-time AR assistance, and explainable AI tailored for medical applications, have been developed in-house. Key outcomes for the project include advanced AI models for tissue classification based on multispectral data, data augmentation techniques to enhance AI/ML model training and real-time AR visualization for surgical assistance. Together, these comprise a suite of capabilities to support trustworthy, safe and robust AI in the medical domain.

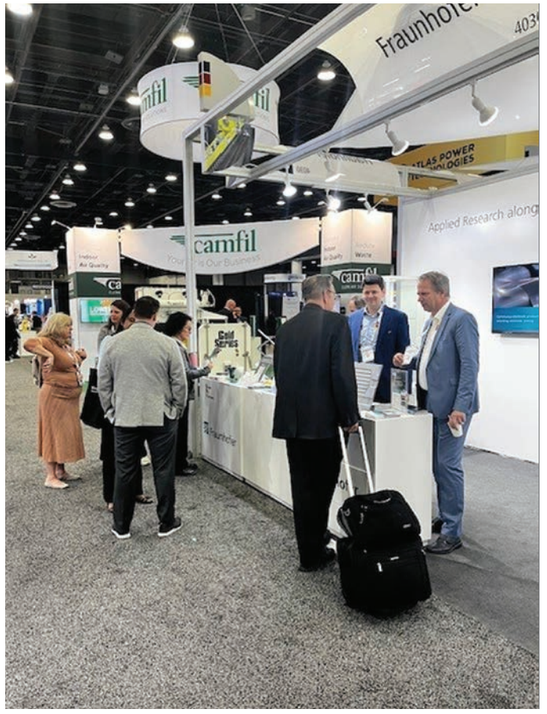


Analysis of a test sample using a concept relevance propagation explainability method. The sample was misclassified as non-cancerous by a baseline AI model (left panels) but was later correctly classified as a melanoma by the augmented model (right panels). The output of the explainability tool shows heatmaps that correspond to features the AI models used for their determination. The augmented AI model focused on the correct regions and was not distracted by irrelevant details.

Engagement with Fraunhofer Institutes

When U.S. clients partner with Fraunhofer USA, they gain access to far more than just the resources in the U.S. They connect with an entire ecosystem of innovation spanning 75 research institutes across Germany, each bringing world-class expertise in applied research and technology development. Fraunhofer USA serves as the essential bridge, bringing these German innovations directly to the U.S. market and facilitating collaborations that address the most pressing challenges facing American industry.

Our relationship with Fraunhofer-Gesellschaft enables us to mobilize resources and expertise from across the Atlantic precisely when and where our clients need them. Through joint projects, strategic technology development initiatives, and pre-competitive research programs, we ensure that cutting-edge innovations developed in Germany can be rapidly translated into solutions for U.S. industry. This transatlantic collaboration extends beyond individual projects to encompass personnel exchanges, knowledge transfer programs, and coordinated market engagement activities that strengthen both American competitiveness and German-U.S. scientific cooperation.



Fraunhofer USA/Fraunhofer Battery Alliance booth at The Battery Show North America 2025 in Detroit, MI

Bringing German Innovation to U.S. Markets

Fraunhofer USA actively showcases German technologies and connects international experts with U.S. industry stakeholders through strategic participation at major industry events. In 2025, our joint engagement efforts brought German research excellence directly to American decision-makers across multiple critical sectors.

At the **SC Spring and Fall Summits**, we convened leaders in South Carolina's advanced manufacturing ecosystem to explore collaborative opportunities addressing regional industry challenges. The **SVC TechCon** featured experts from Fraunhofer IST, FEP, and IWS, presenting advanced coating technologies and surface engineering solutions to companies seeking competitive advantages in manufacturing and materials processing. During **Automate 2025**, we joined forces with Fraunhofer IAPT, IWU, IWS, and IPA to demonstrate next-generation automation, robotics, and additive manufacturing capabilities that help U.S. manufacturers modernize their operations and remain globally competitive.

Our **5th Executive Summit** brought together leadership from Fraunhofer IZFP and IWU for two days of intensive collaboration with U.S. industry partners, fostering discussions on quality assurance, manufacturing innovation, and technology adoption strategies. At **The Battery Show North America 2025** in Detroit, we coordinated the Fraunhofer Battery Alliance's presence, representing 27 German institutes with on-site participation from Fraunhofer FFB, IWU, and IWS. This engagement connected German battery technology expertise with automotive and energy storage leaders navigating the electric vehicle transition and seeking advanced solutions for energy storage challenges.

These events represent more than conference participation. They create pathways for technology transfer, forge new partnerships, and demonstrate how transatlantic collaboration can accelerate innovation adoption in U.S. markets.

Excellence in German-American Partnership

Fraunhofer USA's mission to bridge German and American innovation ecosystems extends beyond individual research projects. It encompasses recognition of successful partnership models, active engagement in science diplomacy, and sustained connections with German industry seeking to expand their presence in U.S. markets. In 2025, these efforts resulted in significant recognition for our collaborative programs, expanded relationships with federal research organizations, and deepened ties between German companies and American innovation hubs.

Dr. Marcel Schaefer, Fraunhofer USA, Kelly Baird FhUSA SC Alliance, Fred Monk SC Department of Commerce (ret), Suzanne Dickerson - Phenogy, Susie Shannon president & CEO SC Competes, Manuele D'Aversa, President & CEO Zeltwanger

South Carolina Fraunhofer USA Alliance Receives Gateway Award

On September 13, 2025, aboard the historic USS Yorktown Aircraft Carrier in Mt. Pleasant, the German American Chamber of Commerce of the Southern U.S. (GACC South) hosted its first joint Carolinas Gateway Awards Gala, uniting North and South Carolina in a single black-tie celebration. The event recognizes organizations that strengthen German-American business ties through innovation, investment, and collaboration. This year, the South Carolina Gateway Award was proudly presented to the SC Fraunhofer USA Alliance, a unique initiative that has become a cornerstone of innovation in the state. Managed by SC Competes, in partnership with the South Carolina Department of Commerce and Fraunhofer USA, the Alliance exemplifies how industry, academia, and government can join forces to deliver cutting-edge applied research with real-world impact.

The Alliance was designed to unite South Carolina's most competitive industry sectors, including advanced manufacturing, life sciences, and energy, with Fraunhofer's renowned applied research expertise. Its funded projects span a wide range of topics, from artificial intelligence, data analytics, and digitization, to materials science, Industry 4.0, automation, sustainability, and life sciences.

Through this initiative, South Carolina companies gain access to the knowledge and global research capabilities of Fraunhofer-Gesellschaft, while benefiting from a 50% project cost-match program supported by the SC Department of Commerce. This model not only lowers barriers to innovation but also ensures rapid return on investment and lasting economic benefits.

Since its launch in May 2019, the SC Fraunhofer USA Alliance has become a proven success story with a total project volume of around $12 million, supporting 35 collaborative projects. These projects have addressed the needs of 24 companies and have engaged six universities and technical colleges, three South Carolina–based for-profit firms, and nine Fraunhofer institutes in Germany for their execution. Projected cumulative savings for participating companies over five years exceed $140 million, demonstrating the program's strong return on investment and tangible benefit to South Carolina's economy.

As part of the 2025 German Research and Funding Roadshow, we were glad to host delegates at Fraunhofer USA CMW in East Lansing during their visit to Michigan State University.

With more than 220 German-affiliated companies operating in South Carolina, the Alliance serves as a vital bridge between the state and Germany's innovation ecosystem. Many of these companies are already familiar with Fraunhofer's expertise, and the Alliance makes it easier to translate that research excellence into solutions tailored to local industry needs.

Receiving the Gateway Award highlights the SC Fraunhofer USA Alliance's success in uniting industry with academia, South Carolina with Germany, and top-notch research with real-world economic outcomes. It is a recognition not just of past achievements but also of the Alliance's role in shaping the future of innovation in South Carolina.

Advancing Science Diplomacy and Research Connections

Fraunhofer USA actively strengthens the research ties between the United States and Germany through strategic partnerships with leading German research and funding organizations. In 2025, we collaborated with the German Embassy in Washington, D.C. and the German Research Foundation (DFG) to host a delegation from the German Federal Government focused on research and technology cooperation. These high-level engagements facilitate policy discussions, identify collaborative opportunities, and reinforce the strategic importance of transatlantic scientific exchange.

Beyond federal partnerships, Fraunhofer USA joined forces with the German Academic Exchange Service (DAAD), the Alexander von Humboldt Foundation (AvH), and DFG to conduct roadshows across the American Midwest and Southwest. These multi-university visits connected German research funding opportunities with faculty and researchers at leading U.S. institutions, fostering new collaborations and highlighting pathways for international mobility and joint research projects. By bringing together research administrators, faculty members, and alumni of German research programs, these roadshows strengthen existing networks and create new bridges between American universities and Germany's research ecosystem. Such initiatives ensure that cutting-edge research continues to flow across the Atlantic, enriching both nations' scientific communities and advancing shared priorities in innovation.

Connecting German Industry with American Innovation

Through our partnership with the German American Chamber of Commerce (GACC) and the broader network of German Chambers of Commerce Abroad (AHK), Fraunhofer USA facilitates connections between German industry and U.S. innovation ecosystems. For example, in 2025, we hosted a delegation from Thuringia, coordinating visits to leading research institutions and companies across the East Coast. These engagements provide German companies with direct access to American research capabilities, emerging technologies, and potential partners, while showcasing how Fraunhofer USA's applied research expertise can support their expansion into U.S. markets. This work complements our research mission by ensuring that innovations developed through transatlantic collaboration find pathways to commercialization and that German industry remains connected to the cutting-edge research happening in the United States.

Outlook

In addition to industry, more than 20 federal agencies continue to fund R&D in the United States. The federal government maintains its commitment to research and development through appropriations that support critical national priorities. For fiscal year 2025, Congress has set Pentagon research, development, test and evaluation spending at approximately $141 billion, underscoring the sustained focus on defense and national security capabilities. This funding supports next-generation capabilities in critical technology areas including trusted AI and autonomy, space, integrated sensing and cyber, integrated network systems, microelectronics, advanced materials, directed energy, hypersonics, biotechnology, and quantum technologies.

The government continues to apply proven innovation models, particularly lessons from the Defense Advanced Research Projects Agency (DARPA), which has demonstrated success in transformative technology development through its unique approach to project selection, personnel management, and intellectual property frameworks. These models are being adapted across federal agencies to enhance returns on R&D investments.

Federal R&D priorities continue to focus on maintaining technological competitiveness, with particular emphasis on areas critical to national security and economic strength. Key areas receiving sustained investment include energy dominance, quantum information sciences, high-speed computing, and artificial intelligence.

Industry investments in research and development continue to demonstrate robust growth, independent of federal funding cycles. The business sector performed an estimated $693 billion in R&D in 2022, accounting for 78% of total U.S. R&D. Of business R&D spending, approximately 6% was allocated to basic research, 15% to applied research, and 79% to development. This sustained industry commitment reflects the private sector's recognition of R&D as essential to maintaining competitive advantage in global markets.

The manufacturing sector continues to lead industry R&D investment, though growth patterns vary across technology sectors. Advanced manufacturing, semiconductors, artificial intelligence, and biotechnology remain areas of significant private sector focus, driven by market demands and technological opportunities rather than government mandates.

The alignment between government and industry research priorities reflects shared recognition of key technological challenges and opportunities. Both sectors face ongoing needs for skilled workforce development, technology transfer mechanisms, and intellectual property management frameworks. The focus on dual-use technologies, those with both defense and commercial applications, continues to drive efficiency in R&D investments.

Fraunhofer USA, in partnership with Fraunhofer-Gesellschaft (Europe's largest applied research and development organization) and its university collaborators, remains positioned to support these evolving R&D priorities. Our expertise in advanced manufacturing, materials science, and Industry 4.0 technologies aligns with enduring national needs for industrial competitiveness and technological innovation.

Our approach to forming flexible, interdisciplinary teams and managing complex intellectual property arrangements makes us a valuable partner for both government and industry research initiatives. We continue to bridge the gap between fundamental research and practical applications, facilitating technology transfer and commercialization.

Looking toward 2026 and beyond, technological competition will continue to drive R&D investments across both public and private sectors. Areas such as artificial intelligence, quantum computing, advanced materials, and biotechnology will remain critical to both economic competitiveness and national security. The emphasis on maintaining technological leadership through innovation, rather than through protectionism alone, ensures continued demand for research partnerships and international collaboration.

Fraunhofer USA remains committed to advancing technological innovation through our unique position bridging European and American research ecosystems. Our global perspective, combined with deep understanding of both scientific fundamentals and market requirements, enables us to contribute meaningfully to solving complex technological challenges. Through continued collaboration with partners across government, industry, and academia, we support the development and deployment of technologies that enhance American competitiveness and address societal needs.

Fraunhofer USA Partners and Memberships

A3- Association for Advanced Automation

A3 is North America's largest automation trade association representing more than 1,300 organizations involved in robotics, artificial intelligence, machine vision and imaging, motion control and motors, and related automation technologies.

American National Standards Institute (ANSI)

Fraunhofer USA is a member of ANSI and supports interests of the Fraunhofer-Network in standardization matters in the United States.

Automation Alley

Automation Alley is a World Economic Forum Advanced Manufacturing Hub (AMHUB) and a non-profit Industry 4.0 knowledge center with a global outlook and a regional focus. Based in Michigan, Automation Alley is very well connected to manufacturing companies throughout the midwestern U.S. providing its more than 1,400 members with the knowledge necessary to adopt new Industry 4.0 technologies. Fraunhofer USA technical experts will have the opportunity to present new technologies to the members of Automation Alley through seminars, presentations, and at their yearly international conference Integr8.

Association of University Research Parks

The Association of University Research Parks (AURP) is the United States' leading organization of universities, municipalities, federal labs, and corporations. It brings together this diverse group of members to foster communities of innovation that provide society with jobs, resources, and technologies. This aligns very well with the Fraunhofer mission to create a better, stronger society through technology. Fraunhofer USA will use the AURP network to help grow the Alliance Program as well as build new relationships with universities and corporations.

German American Chamber of Commerce

Fraunhofer USA is a national partner of the German American Chamber of Commerce (GACC). The GACC is part of a global network of German Chambers of Commerce Abroad (AHKs) which has 150 offices in over 90 countries. In the U.S., more than 2,500 German companies maintain memberships with the GACC. The GACC assists with increasing the awareness of Fraunhofer's presence within the U.S. as well as providing visiting German delegations opportunities to meet with Fraunhofer USA experts.

NAATBatt International

The Trade Association for Advanced Battery Technology in North America.

NAATBatt International is a non-profit trade association comprised of companies, organizations, and research institutions dedicated to advancing, commercializing, and producing cutting-edge battery technologies in North America. Its mission is to support the growth of electrochemical energy storage innovations and to help revitalize advanced battery manufacturing across the continent.

Fraunhofer USA was honored to receive a 30-Year Member Certificate from the German American Chamber of Commerce Midwest

Financial Highlights 2024

Total Contract Revenue & Partner Support:

$21,973,971

Total Internal Research Spending:

$2,064,452

Total Operating Budget:

$25,158,591

Governance and Advisors

Fraunhofer USA Contact Information

Fraunhofer USA Headquarters
44792 Helm Street
Plymouth, MI 48170 USA
Phone: +1 734 354 9700
Fax: +1 734 354 9711
info@fraunhofer.org
www.fraunhofer.org

Fraunhofer USA Center Midwest CMW
Center Director: Prof. Dr. Wen Li

Coatings and Diamond Technologies Division
1449 Engineering Research Complex
East Lansing, MI 48824 USA
Phone: +1 517 432 8709
cmw@fraunhofer.org
www.cmw.fraunhofer.org

Laser Applications Division
46025 Port Street
Plymouth, MI 48170 USA
Phone +1 734 738 0550
laserinfo@fraunhofer.org
www.cmw.fraunhofer.org

Fraunhofer USA Center Mid-Atlantic CMA
Center Director: Prof. Dr. Adam Porter

5700 Rivertech Court, Suite 210
Riverdale, MD 20737 USA
Phone: +1 301 314 6070
cma@fraunhofer.org
www.cma.fraunhofer.org

Fraunhofer USA Center for Manufacturing Innovation CMI
Center Director: Prof. Dr. Andre Sharon

15 St. Mary's Street
Brookline, MA 02446 USA
Phone: +1 617 353 1888
cmi@fraunhofer.org
www.cmi.fraunhofer.org

MARKETING OFFICE
Fraunhofer USA Digital Media Technologies DMT
General Manager: Mr. Jan Nordman

100 Century Center Court, Suite 504
San Jose, CA 95112 USA
Phone: +1 408 573 9900
codecs@dmt.fraunhofer.org
www.fraunhofer.org

Fraunhofer USA, Inc.
44792 Helm Street
Plymouth, MI 48170
Phone: +1 734 354 9700
info@fraunhofer.org
www.fraunhofer.org