
Fraunhofer
USA
Fraunhofer Focus
2022

Fraunhofer Focus 2022

Foreword

This past year has brought new challenges, fascinating opportunities and somber reminders of the realities of our world. A healthy, prosperous future cannot be reached through technology solutions alone. We need to address societal issues, behavioral issues, and consumption practices on a global scale to ensure that we can live sustainably.

At Fraunhofer USA, we are working together with the best and brightest partners to identify and target strategic research fields that have high impact societal goals. Research and development efforts increase in value through appropriate and thoughtful transfer to commercial and industrial entities that bring technologies and products into the marketplace. Government sponsored programs can offer citizens the benefits of the latest research and technology to help address public sector concerns, such as water pollution and ground contamination.

Throughout our nearly 30-year history in the United States, Fraunhofer USA has remained steadfast in our commitment to address problems by thoughtful analysis, development of innovative processes, application and deployment of top-notch expertise and know how tailored to customer needs. We are ready to provide innovative solutions alongside our independent partner and Europe's largest Applied Research and Development Organization, Fraunhofer-Gesellschaft. Their 76 German research institutes and operations in 80 countries ensure that no matter the challenge, Fraunhofer has the experience, know-how and resources to meet the need. Our partner universities and other collaborators enhance and increase the bandwidth of expertise, state of the art equipment access, and scientific and engineering resources.

Whether it's cutting HVAC costs on multifamily residential properties by up to 80 percent using prefabricated panel blocks, using Artificial Intelligence combined with vision systems to grow diamonds, or developing software for drones to automatically monitor and report

on conditions of oyster beds, Fraunhofer USA and its global network proves day-by-day that we know how.

In this report, we present selected projects and staff to provide examples of the unified strength and excellence in all we do. Our bold and innovative employees are driven daily by the mission and societal impact of their work, and every potential customer brings us one step closer to solving those seemingly unsolvable obstacles we encounter in our daily lives.

Thank you for reading the *Fraunhofer USA Focus* report. Our people are what makes our organization exceptional and by highlighting just a few of their innovative and fantastic accomplishments, we hope to illustrate some of the potential for future engagement. Collaborative success is continued success, and we look forward to working together with you.

Sincerely,

Thomas Schuelke

Thomas Schuelke
President, Fraunhofer USA, Inc.

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Management Report

About Fraunhofer USA

Fraunhofer USA is a membership-based 501(c) (3) nonprofit applied research and development organization. Our sole member, Fraunhofer-Gesellschaft, is the world's largest applied research and development organization with nearly 30,000 employees and operations in 80 countries, with 76 research institutes alone in Germany, where their global headquarters is located.

Our three centers have established partnerships with Boston University (Fraunhofer USA Center for Manufacturing Innovation CMI), University of Maryland (Fraunhofer USA Center Mid-Atlantic CMA) and Michigan State University (Fraunhofer USA Center Midwest CMW). These relationships, as well as the work at our Digital Media Technologies office promoting Fraunhofer IIS audio and media technologies, ensures access to critical equipment, facilities and personnel to address all your technology business challenges.

The pinnacles of modern civilization are a direct consequence of the innovations created by previous scientific generations, and Fraunhofer USA carries that legacy forward in the work our employees conduct daily. Our staff combines decades of experience in applied research and development, with a focus on technology transfer. This transference of technology is important for reasons of economic independence, national security, technological sovereignty, pride in innovation and ethics, and so much more.

Organizations wishing to remain relevant must do so in a world that is rapidly changing. The acceleration in innovation can leave one with the feeling of whiplash, being pushed and pulled from one rapid innovation to another, with minimal room for consideration and evaluation of a project or product's effectiveness.

At Fraunhofer USA, our combined expertise in strategic research fields such as AI, hydrogen technologies, climatetech, bioeconomy, quantum technologies, next-gen computing, digital healthcare and more offers prospective customers that we have the expertise to address their challenges and related societal and business impact factors to offer the solution to their unique problems.

Let us be your bridge to innovation and help your organization cross those gaps. Our clients choose Fraunhofer USA due to the unmatched ingenuity of our scientists and engineers, who consistently approach each unique problem with curiosity and an utmost dedication to solving it.

Continued refinement and evaluation of current competences and research areas allows us to remain current on upcoming trends and challenges. We strive to always align our efforts with society's goals. To lead cultures forward, organizations should consider collaborating with one of the leading innovation engines operating today. At Fraunhofer USA, we lead the way but never stand in the way of the best answers. Our diversity is our strength and through our many bright minds, no challenge is too great.

Contract Research

The fulfillment of our mission, to offer customized, advanced technology research, development and deployment, would not be possible without our ability to serve market-driven technology needs, promote international cooperation in business, and establish our many and varied strategic alliances.

These alliances with our industry, government and academic partners allow us to carry out our vision in being a recognized national leader in applied research. Through our innovations, we lead strategic initiatives to master future challenges and achieve technological breakthroughs, creating societal impact by assisting in the energy transition, fostering a circular economy, and digitalizing value chains, among others.

Continuing our pursuit of these breakthroughs happens as a direct result of our investment in people. Their ability to come together to complete a mission enables the continual exchange of know-how, experiences and best practices among our research teams. This multidisciplinary approach leads to a diverse, robust set of competences. Fresh perspectives often result in efficient problem-solving, and our knowledge transfer provides our scientists with the opportunity to continue to learn and grow, staying ahead of changing technologies, trends and anticipating the movements of market forces.

These preparations allow us to forecast and target projects that are likely to have high commercial potential in the market, enhancing our societal impact across multiple industries.

We aim to fund our research expenditures in equal parts through strategic internal, publicly funded and industrial contract research projects. This way we ensure to continually feed the "solutions pipeline" with benchtop laboratory results (Technology Readiness Level [TRL] 3) while simultaneously working with industry on projects de-risking potential solutions (TRL 3-7) to encourage further investment and ultimate deployment. Our ability to work directly with Fraunhofer-Gesellschaft research institutes and foreign affiliates provides us with the unique position of offering customers direct access to one of the world's largest applied research and development organizations. This positioning places us as a vital component in consideration of overcoming regional, national, and global challenges, uncovering potential research areas and supporting economic and workforce development in each environment we conduct operations.

In this international competitive environment, our continued efforts alongside our extensive network of strategic partners help to strengthen transatlantic collaboration in areas such as education, innovation, research and more.

We look forward to working with you, and in this year's *Fraunhofer USA Focus*, there are selected research projects closely aligned with our strategic research fields, highlighting our anticipation of where innovative solutions will be required in the next few years. For projects not listed, or for information on how our research services can enhance your organization, visit www.fraunhofer.org and explore how we can contribute value to your organization.

Fraunhofer USA Centers

Our Research 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 University of Maryland, is in College Park, MD, and works on AI, 5G and other software development applications. Fraunhofer USA Center for Manufacturing Innovation CMI, partnered with Boston University, is in Boston 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 approximately 100 full-time staff, university faculty, and student interns. Fraunhofer USA's 2021 revenues were more than $23 million.

Fraunhofer USA Center Mid-Atlantic CMA

The Fraunhofer USA Center Mid-Atlantic CMA was formed in late 2020 by merging the former Fraunhofer USA Centers for Experimental Software Engineering CESE (founded in 1998) and Molecular Biotechnology CMB (founded in 2001). The former centers were reorganized to form the software and system engineering and biotechnology divisions of the new center.

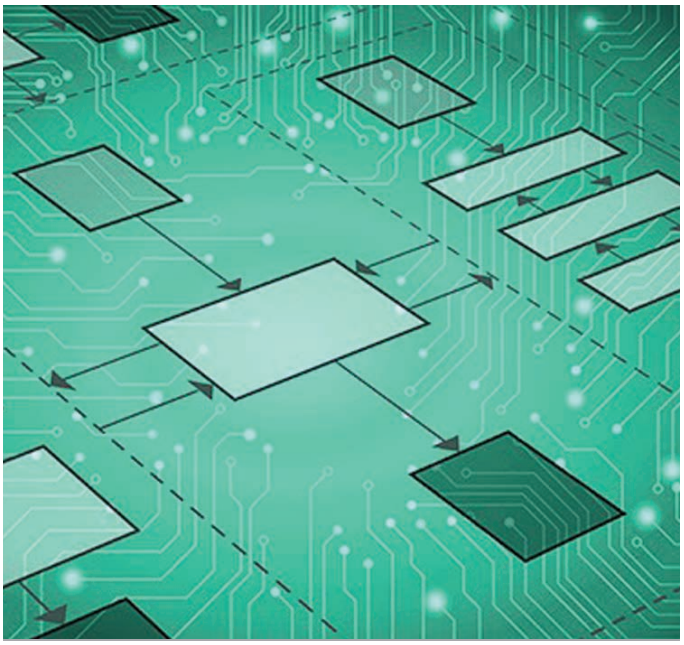
Scientific Focus and Strategy

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.

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.

The center leverages strategic partnerships with South Carolina, the Applied Research Lab for Intelligence and Security ARLIS at the University of Maryland, the National Institute for Innovation in Manufacturing Biopharmaceuticals NIIMBL, and a long-term relationship with the National Aeronautics and Space Administration NASA.

Strategically, the center is planning to improve communications and marketing efforts, to increase the use of transparent key performance indicators, and to maintain prime contractorship on at least one federal contract. Additionally, pursuing integration of AI in biotechnology projects is a developing field for the center.



Core Competences

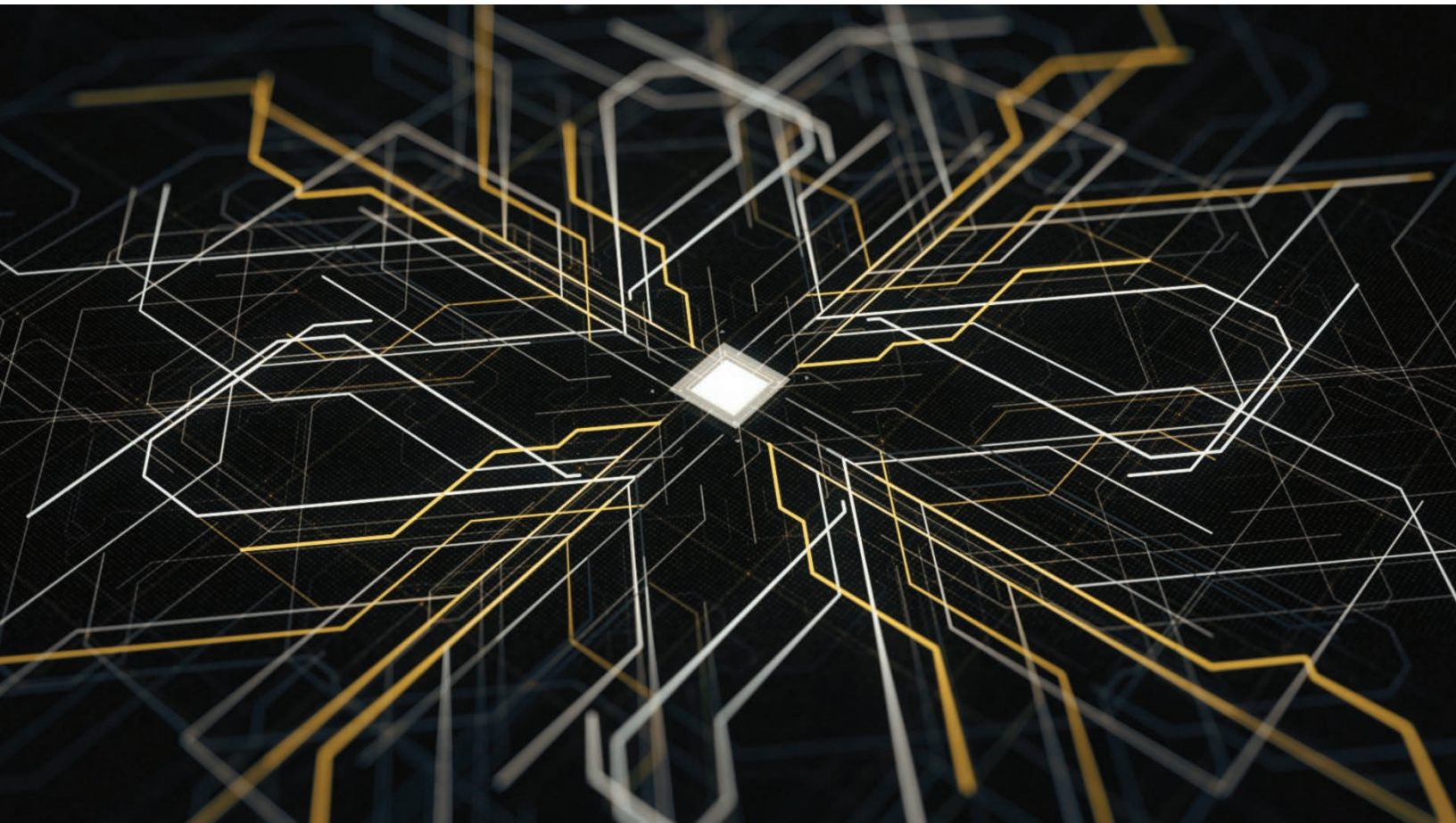
Information and Communication Technologies

- 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



Fraunhofer USA Center for Manufacturing Innovation CMI

The Fraunhofer USA Center for Manufacturing Innovation CMI was formed in 1994. In 2019 the center absorbed a building energy technology group from the former Fraunhofer USA Center for Sustainable Energy CSE.

Scientific Focus and Strategy

Fraunhofer USA CMI focuses on automation and instrumentation of systems in the industrial, energy, and biomedical technology sectors. Within the industrial technology sector, Fraunhofer USA CMI develops next generation automation systems for the aerospace/automotive, consumer products, photonics, materials processing and renewable energy markets. The center leverages expertise in engineering design and biological sciences to develop cutting-edge solutions in the biomedical space, and is active in microfluidics, biosensors, medical devices, tissue engineering, and laboratory automation.

Energy systems engineering focuses on building energy systems and grid integration. Building energy systems develops creative and quantitative means of analyzing and using data generated by an ever-increasing number of communicating sensors in buildings, combined with thermal modeling, to reduce energy consumption. In the field of grid integration, Fraunhofer USA CMI is focused on the development of efficient algorithms for integration of distributed energy sources, 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 the center 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.

These pursuits will enable the next generation of industry and government customers in their pursuit of more efficient supply chains, industrial electrification and decarbonization goals, and offers a showcase for Fraunhofer USA capabilities.

Core Competences

Production

- Mechanical and electronic design
- Plant engineering, automation, and instrumentation
- Data acquisition and analysis

Energy and Climate

- Model-based optimization
- Power grid integration of distributed energy sources

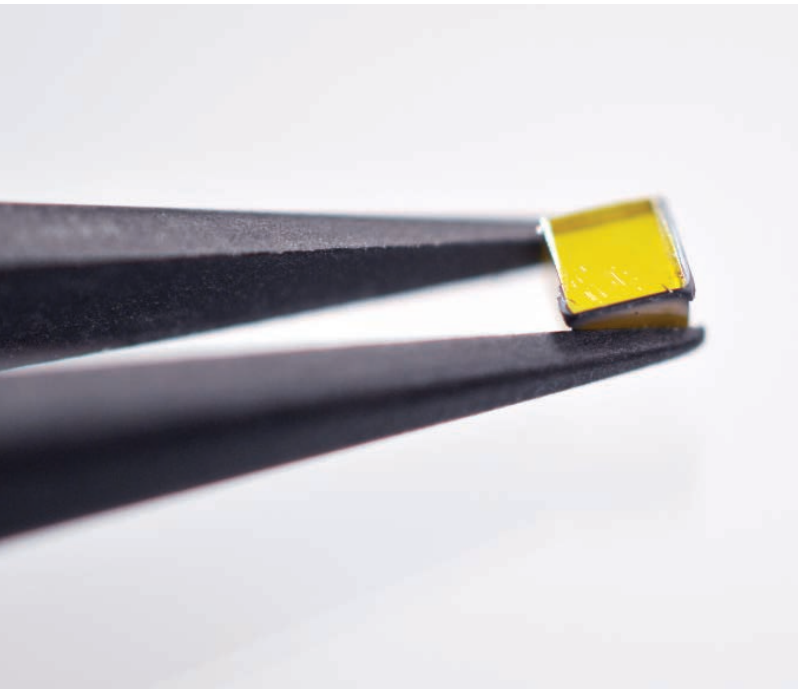
Health

- Microfluidics
- Tissue engineering

Research Fields

- Specialized production systems
- Healthcare devices and biosensors
- Building energy envelope
- Energy distribution systems

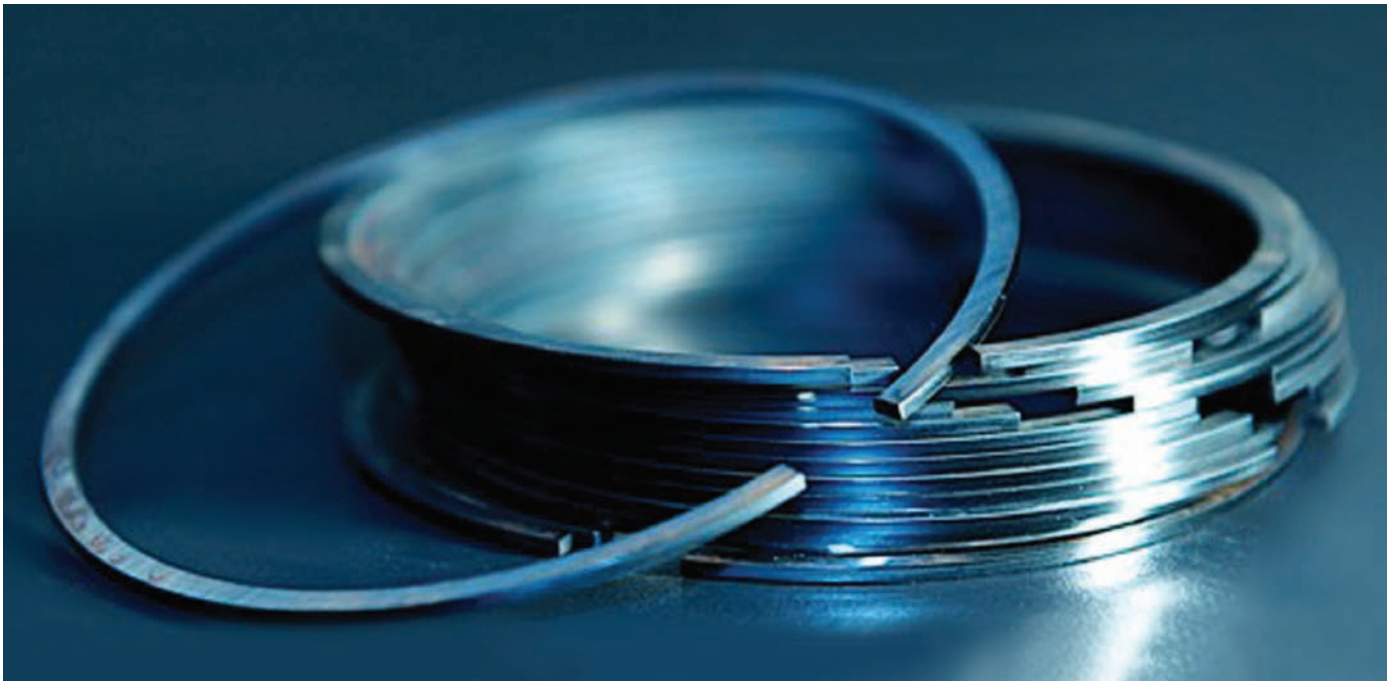
Fraunhofer USA Center Midwest CMW



The Fraunhofer USA Center Midwest CMW was formed in late 2020 by merging the former Fraunhofer USA Center for Coatings and Diamond Technologies CCD and Fraunhofer USA Center for Laser Applications CLA, both of which date back to 1998 and 1994, respectively. The former centers were reorganized to form the Coatings and Diamond Technology and Laser Applications Divisions of the new center.

Scientific Focus and Strategy

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

Materials

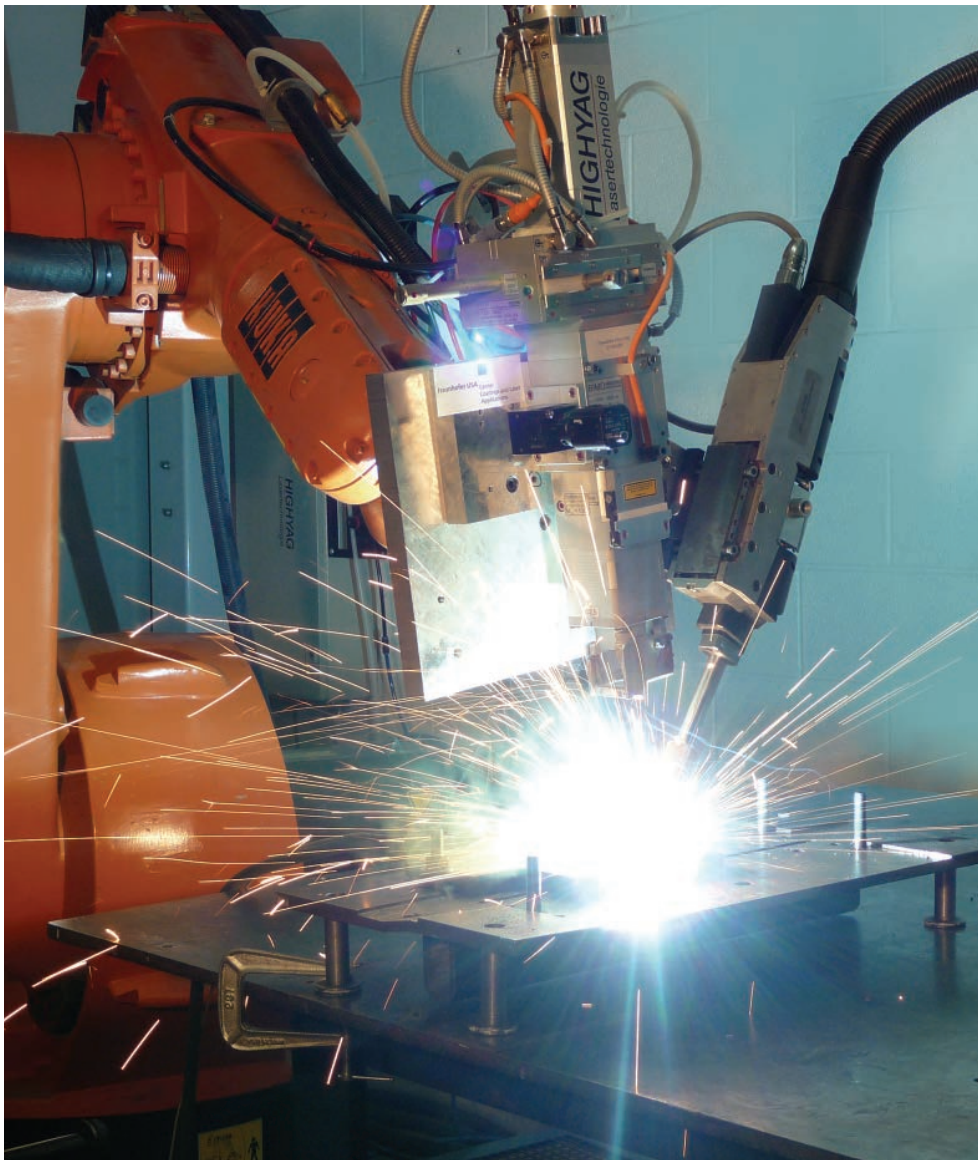
- Coating materials
- Diamond materials and applications
- Materials characterization

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



Fraunhofer USA Digital Media Technologies Office DMT

Fraunhofer USA also has a Digital Media Technologies Office DMT promoting state-of-the-art audio coding and multimedia real-time system technologies. Fraunhofer USA Digital Media Technologies DMT supports the Audio and Media Technologies division of Fraunhofer IIS in the United States.

For more than 30 years, they have 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. 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, Realception and JPEG XS.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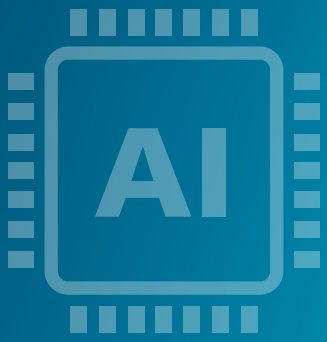
Fraunhofer
LC3 / LC3PLUS
FOR BLUETOOTH,
VOIP AND DECT
Fraunhofer
ENHANCED AUDIO FRONT END
PROCESSING



Selected R&D Projects

Research and Development Coordination

Fraunhofer USA engages in numerous pre-competitive strategic research projects to develop fundamental core competences and key-innovations to address technological, commercial, and social imperatives of our time. The topics of these projects are a result of two fundamental driving forces – the industry and its technology-pull roadmap and the government and its technology push-roadmap.

These newly advanced core competences and 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 to transfer technology and innovation into the market.

The advantages for the industry sector are de-risking of technology development investments, improving time-to-market while reducing capital expense and operational expense, improving 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, inter-disciplinary 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 2022 include, but are not limited to:

Future Wireless and related Technologies	■ 5G & 6G ■ IIoT and Distributed Manufacturing
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)
AI & Data Governance	■ Trustworthy AI and Ethics ■ AI Ergonomics and Human-AI Interaction ■ Federated Learning
Quantum Computing, Communication, Sensing & Imaging	■ Quantum Optimization, AI, Numerics ■ Photon Entanglement ■ Advanced Materials and Diamond ■ Quantum Communications Systems for Space and Terrestrial Networks
Climate Technologies & Sustainability & Agriculture	■ Carbon Capture and Carbon to X to Y ■ Renewable Energies and Storage ■ Sustainability in Production and Materials ■ Hydroponics, Aquaponics, Aeroponics ■ Agrophotovoltaics
Bioengineering	■ Waste and Toxin Processing (PFAS, etc.) ■ Plant Based Food and Cultivated Meat ■ Synthetic Biology and Genetic Engineering ■ Biomedical and Neural Engineering

Artificial Intelligence (AI)

Using AI to Predict Space Weather Events

In February 2022, a geomagnetic storm triggered by a large solar flare disabled dozens of newly launched satellites intended for satellite internet service. The level of damage was unprecedented and may have happened because there was no consideration of space weather alerts about recent solar flare activity. The flare was relatively moderate, experts said, warning more satellites could be knocked out in the future.

Satellites in Earth orbit represent a critical component of society's modern infrastructure. Failure of a satellite or a particular subsystem can significantly affect capabilities that civil, defense, and commercial sectors have come to rely upon. Though most satellite owners monitor the health of their systems and keep track of unusual problems their spacecraft experience, many anomalies are left undiagnosed and impossible to predict due to the complexities involved in collecting and processing massive amounts of situational data.

To address these concerns, software engineers at Fraunhofer USA Center Mid-Atlantic CMA are working with researchers at the University of South Carolina (UofSC) and BlueEyeSoft, an IT software solutions company based in Greenville, South Carolina which focuses on artificial intelligence and predictive analytics driven solutions for local enterprises as well as public services.

With funding from the U.S. Space Force and the South Carolina Fraunhofer USA Alliance (see page 7 for more information on this program), the 18-month Centralized Satellite Anomaly Prediction (C-SAP) project aims to predict and disseminate space weather events that can negatively affect satellite systems, their behavior, and communications.

By leveraging large amounts of historical and real-time data, artificial intelligence-driven models will help forecast space weather anomalies with the goal of providing near real-time updates to operators on potential anomalies, allowing them to take action to save or minimize the damage to spacecrafts.

Defect Detection Using AI Vision-Based Systems

Today's manufacturers need a visual inspection system that can rapidly detect defects in their manufacturing and assembly operations. It must also be affordable, reliable and scalable to the company's needs. The visual inspection system should easily adapt and integrate with the company's existing IT infrastructure using off-the-shelf hardware and software designed that is easily trained to handle new inspection tasks.

Working with a U.S.-based appliance manufacturer, software engineers at Fraunhofer USA CMA and Clemson University have developed and fielded NEXIS, an advanced automated system to help manufacturers identify and eliminate up to 99 percent of defects in assembly operations.

A stand-alone camera and software system that visually inspects parts assembly on a production line is the basis of the NEXIS system. NEXIS references a library of stored images of correctly installed parts and compares this with live images from the assembly line. If the system detects parts that do not meet the quality threshold, alerts notify the system operator in real time that the assembly does not pass inspection and requires immediate attention. The system operator can modify or increase the number of image examples of proper installation to increase defect detection accuracy or rapidly adapt to changes in the production line.

The tool allows the operator to request a number of possible new examples of proper installations, and the tool returns the most unique examples that it has recently seen. The operator uses their expertise to select the best examples to add and can immediately test the new set of examples on previous parts recorded by the station. NEXIS focuses on inspecting the specific locations of each part, reducing inspection time to get near real-time results. NEXIS has an inspection throughput of up to five parts in one assembly per second, allowing for the inspection of the entirety of the manufacturing line's output.

NEXIS is a cost-effective alternative for many manufacturing processes that is scalable and can rapidly adapt to changes in the production line. NEXIS saves time, reduces operational and warranty costs, reduces defects, improves quality, and increases production throughput.

Energy

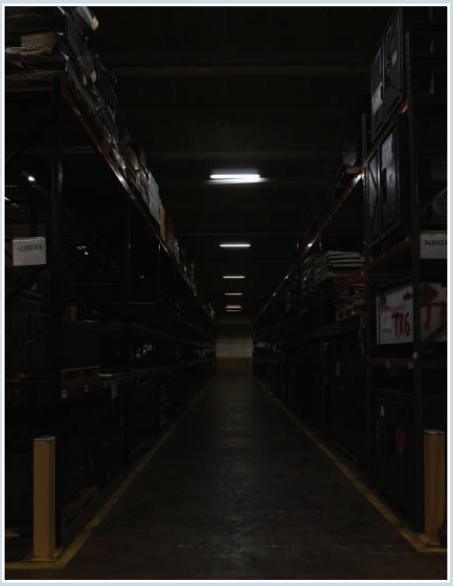
Integrating Homes into the Electric Grid

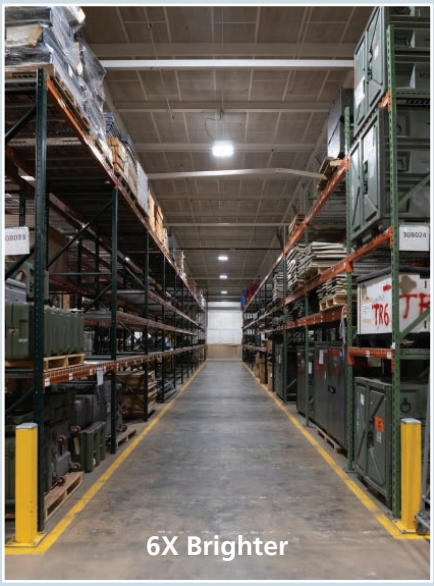
The concept of grid-integrated residential buildings usually implies new homes equipped with sensing and control technologies along with energy-efficient appliances and electricity storage. These enable optimal scheduling of flexible electric loads to minimize energy costs while providing grid services. However, such technologically advanced homes represent a tiny fraction of the U.S. housing stock.

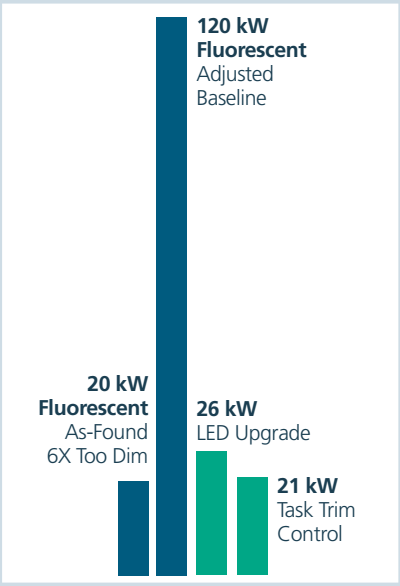
To address this discrepancy, the Energy Systems group at Fraunhofer USA Center for Manufacturing Innovation CMI is exploring the possibility of converting a portfolio of existing homes into a community of grid-interactive homes. The concept utilizes two sensors, a nonintrusive energy monitor and a communicating thermostat to obtain the disaggregated appliance power and communicating thermostat data streams. These are then used with weather-station data to automatically train a hybrid grey-box/ machine-learning model to accurately monitor and forecast device loads and perform model-predictive control (MPC)-based load management.

Throughout each day, each house-specific model monitors and forecasts major loads (HVAC, water heating, user-controlled appliances), their flexibility, and on-site PV power generation, to determine the optimal dispatch schedule of flexible loads. Doing so maintains the comfort of a home's inhabitants while minimizing home energy costs and providing grid services under different use cases and power tariff structures. For this U.S. Department of Energy (DoE) project, Fraunhofer USA researchers used heating-season data from twenty recruited homes to automatically calibrate a grey-box model for thermal load prediction and used a hybrid physics-based/ machine learning approach to predict home PV generation.

These multidisciplinary integrated solutions align with the DoE's roadmap for building and electric power decarbonization, providing cost and energy savings, environmental benefits, enhancing resilience.







More Light, Less Energy Using Fully Integrated Wireless LEDs

The United States Federal Government, including the Department of Defense (DoD), plans a total shift to carbon pollution-free electricity sources by 2030. To support this transition, Fraunhofer USA leads numerous technical projects aimed at reducing carbon emissions and promoting energy efficiency through advanced controls. One such project, led by Bryan Urban of the Fraunhofer USA Center for Manufacturing Innovation and sponsored by the DoD's Environmental Security Technology Certification Program (ESTCP), demonstrates an advanced lighting retrofit that couples efficient LEDs with wireless smart controls to deliver exceptional energy and cost savings.

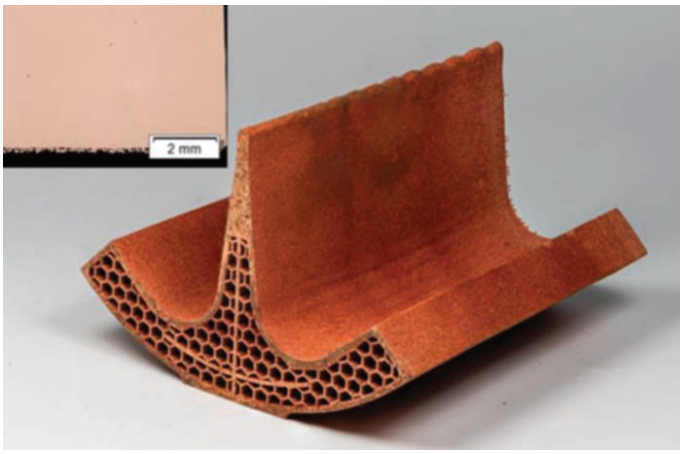
The DoD spends over $4 billion per year on energy to power its fixed installations worldwide, including more than 560,000 buildings. Many of these buildings still operate inefficient conventional lighting systems with basic or limited controls. Switching to LEDs can cut power use in half. Adding smart controls can cut usage even further, through adaptive occupancy and daylight dimming. Combined energy savings of more than 80 percent is possible, but adoption of smart controls is low. Adding smart controls to aging lighting systems is rarely justified. And adding third-party controls to an LED-only retrofit project can create new problems with compatibility, design, and installation.

State-of-the-art lighting systems overcome these challenges using fixtures with fully-integrated sensors and wireless controls. However, these systems pose new questions about cybersecurity, resilience, and practicality. As part of a multiyear validation effort, the Fraunhofer USA in partnership with Digital Lumens, deployed a fully-integrated wireless LED control system at Westover Air Reserve Base on three facilities, including a gymnasium, supply warehouse, and aircraft hangar, and covering a total floor area of 200,000 square feet (18,000 square meters).

The validation examined energy and cost performance, user acceptance, cybersecurity, and other practical considerations. Preliminary findings and lessons learned from this multi-year field monitoring effort suggest that smart connected lighting systems could play a significant role in providing DoD buildings with more light and less energy. The test buildings are expected to save up to $2 million in energy costs over a 20-year service life with simple payback period of less than two years.

While much is still to be done on industrial decarbonization and electrification of heavy industrial processes, research projects such as implementing new lighting schemes not only lead to less maintenance and lower costs, but can have unexpected positive results as well. The DoD users at the selected facilities noticed visible and transformational improvements in lighting conditions, which may lead to fewer safety incidents and personnel downtime, ensuring mission success for our federal government customers during this historic energy transition.

Resource Efficiency and Climate Technologies



Copper Laser Additive Manufacturing (CLAM)

Copper has unique material properties in terms of heat transfer and electrical conductivity which makes it extremely attractive for a wide range of potential industrial applications. Laser-based additive manufacturing is growing rapidly due to its ability to quickly manufacture parts with enhanced design features compared to traditional manufacturing methods.

Copper is ideal for many industrial applications as its heat transfer properties make it ideal for various space applications, and its electrical properties are ideal for electrical component applications.

However, the laser beam sources in industrial additive manufacturing machines are typically Fiber, Disk or Diode lasers that operate in the infrared (IR) range (~1 micron wavelength) of the electromagnetic spectrum. Copper, however, has a very low absorption rate in this range (less than 5 percent) which makes it difficult to achieve in-coupling of the laser beam.

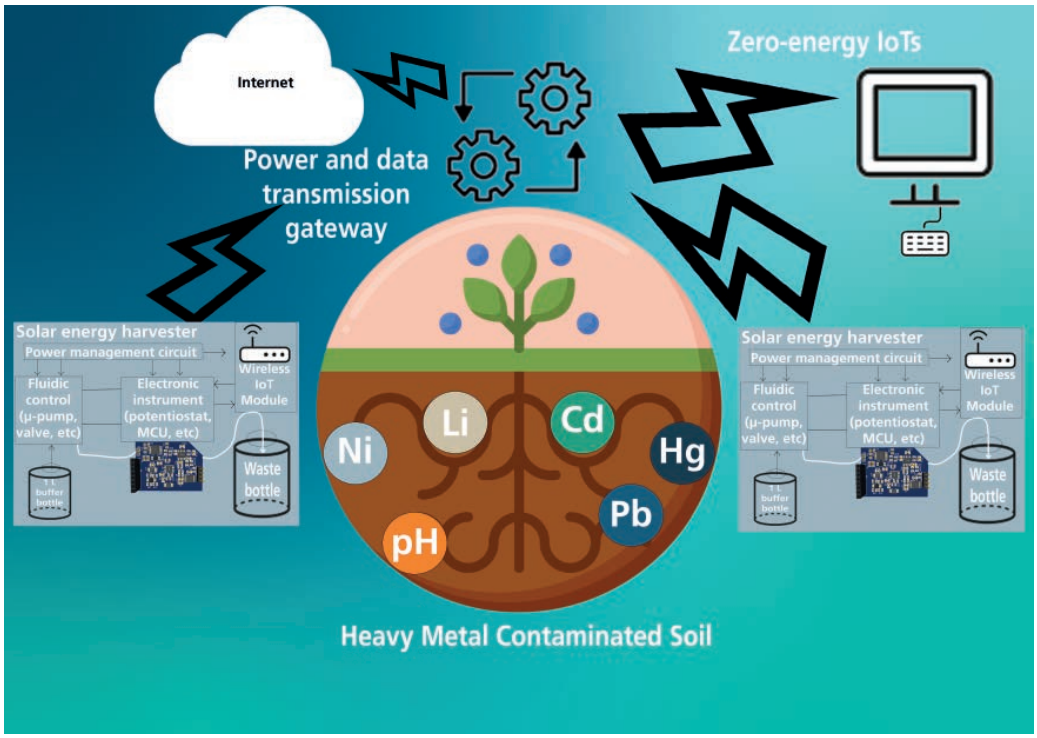
It's also now possible to operate multi-kilowatt high power lasers at much shorter wavelengths. Green lasers operate at around 515 nm whereas Blue lasers operate at around 450 nm. These shorter wavelengths enable superior absorption into copper-based materials with over 40percent absorption rates possible depending on the alloy type used.

Fraunhofer USA is collaborating with Fraunhofer IWS to evaluate the use of these new laser technologies for additive manufacturing of copper components. Fraunhofer IWS is focusing on Laser Powder Bed Fusion technology (L-PBF), whereas Fraunhofer USA CMW is focusing on Laser Direct Energy Deposition technology (L-DED).

L-PBF technology using green lasers can be used to manufacture copper parts with extremely intricate and complex geometries while L-DED technology is more suitable to additively manufacturing larger scale parts which is not possible with current L-PBF machines.

Work is ongoing to develop processes which can produce more complex structures and larger demonstration components using more advanced alloys such as CuZrZr, CuNiSiCr and GR-COP 42 (NASA developed alloy) for potential space and aerospace applications. Trials are also planned in both regular and inert gas atmospheres.

The planned culmination of this project is to produce large-scale demonstration components using a hybrid approach, combining L-PBF & L-DED laser additive technologies to tailor part features and material properties previously not possible.



Environment

Measuring Signals in the Soil

In collaboration with Prof. Wen Li, Fraunhofer USA CMW and Michigan State University have been awarded a 3-year research grant funded by the National Science Foundation and the United States Department of Agriculture to further develop tools to study chemical dynamics in the soil. The goal of the project is to further develop the next generation of sensors and instruments capable of measuring biological, chemical, and physical variables in situ, with a current focus on heavy metal detection. Additional goals include self-powered sensors that are integrated into a wider mesh network. Leveraging our diamond expertise, and in-house electronics experience, we will further develop an all-diamond electrochemical microfluidic sensor powered by our microcontroller potentiostat.

By developing an environmentally friendly and sustainable sensory platform buried in the soil, we can measure heavy metals in the ground water such as lead, mercury, cadmium, nickel and lithium. According to the Environmental Protection Agency (EPA), lead, mercury and cadmium are among the most toxic metals in the environment that can affect soil fertility, plant development, productivity, and human and animal health. Nickel and lithium are critical metals key to clean energy transitions, and their improper use can lead to soil and water pollution and bioaccumulation in food crops. Soil pH will also be monitored simultaneously since it is one of the key soil chemical properties influencing mobility, adsorption and desorption processes, and bioavailability of heavy metals in soils. Preliminary data for this proposal was made possible by joint research with the Michigan State University student intern program here at Fraunhofer CMW. Our students were able to help design and fabricate and program a low-cost Arduino based potentiostat that can perform heavy metal analysis and other electrochemical measurements. We are excited to take this project to the next step, through upscaling data throughput, and incorporating this system to perform real-world meaningful measurements.

PFAS Destruction Protects Great Lakes

As industry and government bodies continue to adapt to a changing world, water becomes increasingly important – clean water even more so. Fraunhofer USA, in collaboration with Michigan State University, is using advanced plasma technology to efficiently destroy per- and poly-fluoroalkyl substances, better known as PFAS or 'forever chemicals' due to their inability to effectively break down in the environment. These chemicals, designed by chemists to last longer, maintain their chemistry in watersheds and groundwater and are known to have significant adverse health effects. PFAS exposure may be linked to increased risk to certain cancers, immune system issues and many other potential health problems. A major pathway of human exposure to PFAS is via the consumption of contaminated water and wildlife (e.g., fish) because the commonly used PFAS have high aqueous solubility. PFAS have been found in many waters, including drinking, ground and surface water, industrial wastewater and landfill leachate.

This three-year project, funded by the Great Lakes Protection Fund, aims to take Fraunhofer USA research on PFAS and develop and commercialize an advanced plasma technology that can efficiently destroy per- and poly-fluoroalkyl substances (PFAS) in landfill leachate and wastewater. To do so, we will leverage the expertise and resources from research institutions and industry partners to expedite this technology transformation. The adoption of this plasma technology throughout the Great Lakes basin will enable the treatment of one million gallons of contaminated water per day. This project strongly supports the regional strategy for managing PFAS and protecting public health.

With more than two billion people lacking access to clean safe water and more than half the world's population expected to live in water-stressed areas by 2025, technology transfer in this area is vital to ensuring continued access to clean water for communities, states and regions, many of which have interstate water agreements. These agreements require stakeholders to anticipate future water needs and protect existing freshwater sources and technologies such as this to help reduce the burden of man-made chemicals that enter and contaminate the water cycle.

Virtual Power Plant Optimizes Solar Power Flow

Fraunhofer USA, alongside industry partners, has developed and piloted SunDial, a virtual power plant platform that enables integration of high-penetrations of solar PV within a distribution grid. As utilities transition from fossil fuels, renewable energy technologies will require a shift in mindset as to how best enhance power systems controls, increase efficiencies in energy and electricity consumption, maintain flexibility in energy demand. This ensures that systems are ready to scale up or meet demand on a moment's notice.

To accomplish the development of SunDial, a vendor-agnostic control platform known as the "Global Scheduler," or GS, optimally shaped the net load for a virtual portfolio of non-co-located distributed energy resources (DERs) based on defined policy objectives. By defining these objectives in plain language, the challenges associated with deploying solar PV on renewables-dominant distribution networks can be further mitigated while also providing grid-facing services capable of supporting both the bulk and local power systems. During the pilot, the GS dispatched ~200kW of flexible loads and a 0.5MW/1MWh energy storage system (ESS) based on forward-looking predictions of solar production (1.5MW, peak) and facility demand to address use cases including peak shaving, energy cost optimization, peak-power dispatch, and power firming while minimizing rapid changes in solar production.

Field testing during the 15-month pilot on a National Grid distribution feeder found that integrating highly granular time-series predictions may increase storage capacity relative to a non-predictive baseline by more than 20 percent. Furthermore, the results highlight the need to manage prediction uncertainty, which may be accomplished by planning for sufficient ESS reserve capacity. Flexible loads were dispatched repeatedly to supplement battery energy storage, comprising the equivalent of approximately 10 percent of additional available storage capacity. Though there are still several challenges impeding the scaling of these integrated systems, focusing on practical difficulties and solutions for efficiently integrating and characterizing flexible facility loads into a virtual power-plant platform will assist industry in continual improvements in the field of optimal power flow.

Bioeconomy

Smart Aquafarming Conserves Animal Ecosystems

In order to create sustainable value and protect dwindling resources, new technologies must mix with traditional aquafarming techniques to build lasting animal ecosystems. From a technological standpoint, dredging the sea bottom for oysters has changed little over the last 150 years. This method of harvesting shellfish, without the benefit of advanced geolocation and imaging technologies, leads to a wasteful expenditure of manpower, fuel and equipment. Modern advanced farming tools (imaging, geolocation, harvest data and its analysis) used by land farmers are now being applied to aquafarming operations.

The Smart Sustainable Shellfish Aquaculture Management (S3AM) project brings these technological advances to aquaculture, specifically for bottom culture oyster farming. Funded by a $10 million grant to the University of Maryland from the U.S. Department of Agriculture's National Institute of Food and Agriculture, the grant brings together food experts, researchers and oyster farmers to leverage technology and find a better, data-driven way to harvest sustainably.

Central to the S3AM project is the use of an underwater drone to collect images of bay bottom conditions e.g., bottom substrate quality, location and sizes of individual oysters and oyster beds. Image and sonar data is transmitted from the remotely controlled drone to a receiver aboard ship. Working with oyster farmers, researchers will then have the data on bottom conditions, oyster maturity and concentrations to better map and plan for smarter harvesting practices.

Fraunhofer USA CMA is developing a software platform to disseminate results from the research team and help oyster farmers optimize their harvesting operations. This application will help farmers generate harvest reports and collect valuable data to investigate new ways to optimize harvesting that maximizes yield and minimizes environmental impact.

By recording when and where oysters have been harvested, the GPS path taken, and the resulting yield, this will provide a useful historical log for farmers, which can then automatically generate harvest reports that are required to be filed by law with the Maryland Department of Natural Resources. Researchers at the University of Maryland will then compare that data with surveys of the water bottom and find ways to continually optimize harvesting methods.

Recent Scientific Publications

A.A. Talukder, N. Baule, M. Steinhorst, R. Rechenberg, Q. Fan, T. Schuelke, "Pulsed direct-current reactive sputtering of high Young's modulus [002] oriented aluminum nitride thin films", Thin Solid Films 751, 139239 (2022).

Advait Balaji, Bryce Kille, Anthony D Kappell, Gene D Godbold, Madeline Diep, RA Elworth, Zhiqin Qian, Dreycey Albin, Daniel J Nasko, Nidhi Shah, Mihai Pop, Santiago Segarra, Krista L Ternus, Todd J Treangen, "SeqScreen: accurate and sensitive functional screening of pathogenic sequences via ensemble learning", Genome Biology 23(1), 2022.

Brook Stacy, Jason Hauzel, Mikael Lindvall, Adam Porter, Mihai Pop: Metamorphic Testing in Bioinformatics Software: A Case Study on Metagenomic Assembly. MET@ICSE 2022: 31-33.

D. V. Tsu, M. Muehle, H. Köstenbauer, C. Linke, J. Winkler, "Optical properties of Mo and amorphous MoOx, and application to antireflection coatings for metals", JVST B, 40, 022209 (2022).

Gao, X.; Ram, S.; Philip, R.C.; Rodríguez, J.; Szep, J.; Shao, S.; Satam, P.; Pacheco, J.; Hariri, S. Selecting Post-Processing Schemes for Accurate Detection of Small Objects in Low-Resolution Wide-Area Aerial Imagery. Remote Sens. 2022, 14, 255. https://doi.org/10.3390/rs14020255.

Karr AF, Hauzel J, Porter AA, Schaefer M (2022) Measuring quality of DNA sequence data via degradation. PLoS ONE 17(8): e0271970. https://doi.org/10.1371/journal.pone.0271970.

Karr, AF (2022). Travel time reliability. Wiley StatsRef: Statistics Reference Online. Available online at https://onlinelibrary.wiley.com/doi/book/10.1002/9781118445112.

Leila Meshkat, Gudjon Magnusson, Madeline Diep, Mikael Lindvall, "Reliability-Aware Requirements Development for Autonomy Software", Annual Reliability and Maintainability Symposium, 2022.

Q. Wangda, P. Hu, J. Liu, H. Jin, K. Wang, "Lignin-based carbon fiber: A renewable and low-cost substitute towards featured fiber-shaped pseudocapacitor electrodes" Journal of Cleaner Production 343, 131030 (2022).

Rohan Reddy Mekala, M. Muehle, A. Srinivasan, E. Garratt, Mikael Lindvall, A. Porter, AI-Guided Feature Segmentation Techniques to Model Single Crystal Diamond Growth, Submitted to IEEE Transactions on Pattern Analysis and Machine Intelligence, 2022.

Rohan Reddy Mekala, M. Muehle, A. Srinivasan, Mikael Lindvall, A. Porter, Spatio-temporal State Prediction Using AI-Based Sequence Learning Algorithms for Single Crystal Diamond Growth, Submitted to IEEE Intelligent Systems, 2022.

T. Tran, Y. Kim, N. Baule, M. Shrestha, B. Zheng, K. Wang, T. Schuelke, Q. H. Fan, "Single-beam ion source enhanced growth of transparent conductive thin films" Journal of Physics D: Applied Physics 55, 395202 (2022).

V.Y. Maldonado, T. Schwichtenberg, C. Schmokel, S.E. Witt, J.A. Field, "Electrochemical Transformations of Perfluoroalkyl Acid (PFAA) Precursors and PFAAs in Landfill Leachates", ACS EST Water, 2, 4, 624-634 (2022).

Y. Kim, N. Baule, M. Shrestha, Q. H. Fan, "Growth of Highly Transparent Amorphous Carbon Films Using Beam Plasma Source" Coatings, 12, 1159 (2022).

Y. Zheng, M. Muehle, J. Lai, J. D. Albrecht, J.-H. Seo, "Bilayer metal etch mask strategy for deep diamond etching", JVST B, 40, 022210 (2022).

Z. Long, C. Shi, C. Wu, L. Yuan, H. Qiao, K. Wang, "Heterostructure Fe 2 O 3 nanorods@ imine-based covalent organic framework for long cycling and high-rate lithium storage" Nanoscale 14, 5, 1906-1920 (2022).

Z. Long, L. Yuan, J. Chen, L. Luo, C. Shi, C. Wu, H. Qiao, K. Wang, "A Durable Fluorine-Free MOF-Based Self-Cleaning Superhydrophobic Cotton Fabric for Oil-Water Separation" Advanced Materials Interfaces 9, 13, 2102427 (2022).

Z. Long, L. Yuan, C. Shi, C. Wu, H. Qiao, K. Wang, "Porous Fe2O3 nanorod-decorated hollow carbon nanofibers for high-rate lithium storage" Advanced Composites and Hybrid Materials 5, 1, 370-382 (2022).

Fraunhofer USA Programs and Partnerships

Fraunhofer USA Programs

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 three-year C2V Initiative will connect 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.

Currently in year two, the C2V Initiative will also create 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. A select group of corporate, academic, and government thought leaders will be invited to join the program's Carbontech Leadership Council (CLC) to foster commercialization opportunities and to identify avenues for technology validation, testing, and demonstration. Through participation in the CLC, corporations will 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.

Members of the CLC will create a technology roadmap for the future of the carbontech industry and will also have the opportunity to work closely with the highly-selective first cohort of startups participating in the C2V Initiative.

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 knowhow they provide forms the basis of a highly unique and proven technology acceleration model that will now be applied to carbontech as part of the C2V Initiative.

Fraunhofer USA State Alliance Program

The Fraunhofer USA State Alliance Program offer state governments, economic development agencies and academic institutions the opportunity to develop technical assistance programs based on the Alliance template and tailored to states' specific needs and interests.

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 established in 2018. Following an invitation from South Carolina's Secretary of Commerce, Fraunhofer USA has engaged in this promising alliance with the State's Department of Commerce, industry and local universities. The consortium includes Fraunhofer USA, the South Carolina Council on Competitiveness, Clemson University, the University of South Carolina, and Francis Marion University.

The program developed with the State of South Carolina supports the Fraunhofer USA corporate mission of providing cutting-edge technologies to companies and organizations of all sizes. The State Alliance Program, now in its third year, offers state governments, economic development agencies and academic institutions the opportunity to develop technical assistance programs based on the Alliance template and tailored to states' specific needs and interests.

The program works to assist local businesses with the challenges and opportunities presented by rapid technological change in manufacturing processes, product development and service delivery.

The State of South Carolina contributes $2 million to the South Carolina Fraunhofer USA Alliance per year. Overall, 14 projects have been implemented with a total value of $2.3 million, whereby $1.6 million were provided by the State of South Carolina and $700,000 through industry matches. Fraunhofer USA received a total of $1.4 million in funding to perform projects, the balance of which went to university partners.

South Carolina was an excellent choice to begin this initiative as it has more than 250 German companies such as BMW, Bosch, IFA, MTU. 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, and automation of manual production tasks to allow workers to focus on higher value add tasks. 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 projects address topics in various industry segments including aerospace, automotive, life sciences, and logistics. The technical areas include wearables, artificial intelligence, Industry 4.0, advanced quality management, and robotics.

Fraunhofer USA is currently in discussions with other key states that are considering their own Alliance programs with Fraunhofer USA due to the ongoing success of the South Carolina Fraunhofer USA Alliance.

Fraunhofer USA Partnerships and Memberships

University Partnerships

University of Maryland

The Fraunhofer USA Center Mid-Atlantic CMA has collaborated with the University of Maryland since 1997, specifically within the College of Computer, Mathematical and Natural Sciences. Founded in 1856, the University of Maryland has an enrollment of approximately 41,000 students, of which circa 11,000 are graduate students. The University of Maryland has become one of the nation's leading public research and innovation universities, with $1.1 billion combined research expenditures in FY21 with the University of Maryland, Baltimore.

Michigan State University

Since 2003, the Fraunhofer USA Center Midwest CMW and Michigan State University (MSU) have closely collaborated on applied research and development projects in the areas of diamond and coatings technologies. Michigan State University, founded in 1855, has a total of approximately 50,000 students, with more than 11,000 graduate students. Michigan State University is a top 100 global research university, with total research expenditures for MSU totaled approximately $713 million in 2020. Fraunhofer USA CMW collaborates closely with the College of Engineering and Natural Sciences.

Boston University

The Fraunhofer USA Center for Manufacturing Innovation 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 has a student body of more than 34,000 students of which circa 16,000 are graduate students. As a leading global research institution, BU has been awarded more than $579 million in grants and contract awards in 2021. 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.

American National Standards Institute

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 nonprofit 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 1400 members 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) who have 140 offices in 92 countries. In the United States, more than 2500 German companies maintain memberships with the GACC. The GACC assists with increasing the awareness of Fraunhofer's presence within the United States as well as providing visiting German delegations opportunities to meet with Fraunhofer USA experts.

Human Resources

A Great Career with Fraunhofer USA

Fraunhofer USA is a great place to work! We are proud of the number of long serving employees at the organization: 38% of our employees have worked here for 10 years or more, 24% have worked here for 15 years or more, and 13% percent have worked here for 20 years or more.

There are many considerations as to why employees stay at a particular place of employment. Here are some of the main reasons why employees want to not only work at Fraunhofer USA but build careers here.

Employees appreciate challenging and fulfilling work. Fraunhofer USA is a non-profit organization that has a mission that demonstrates its commitment to bettering societal conditions through applied research and development; "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." Employees can feel proud of their individual and group efforts towards making this mission a reality. Across the organization, employees at all levels and in all business areas have an important role. Fraunhofer USA provides a thriving environment for innovative and creative individuals.

Employees look for security to help ensure a good life for themselves and their families. As a non-profit, Fraunhofer USA has worked hard to keep employee benefits at a level that keeps the organization competitive, and employees and their families cared for and protected. Fraunhofer USA has had a defined contribution pension plan for more than 20 years funded with employer contributions. In addition, employees can participate in a voluntary contribution plan where they can elect to put away more money towards retirement. Employees appreciate the favorable medical and dental plans, short-term and long-term disability insurances and more. These benefits go a long way toward employee satisfaction.

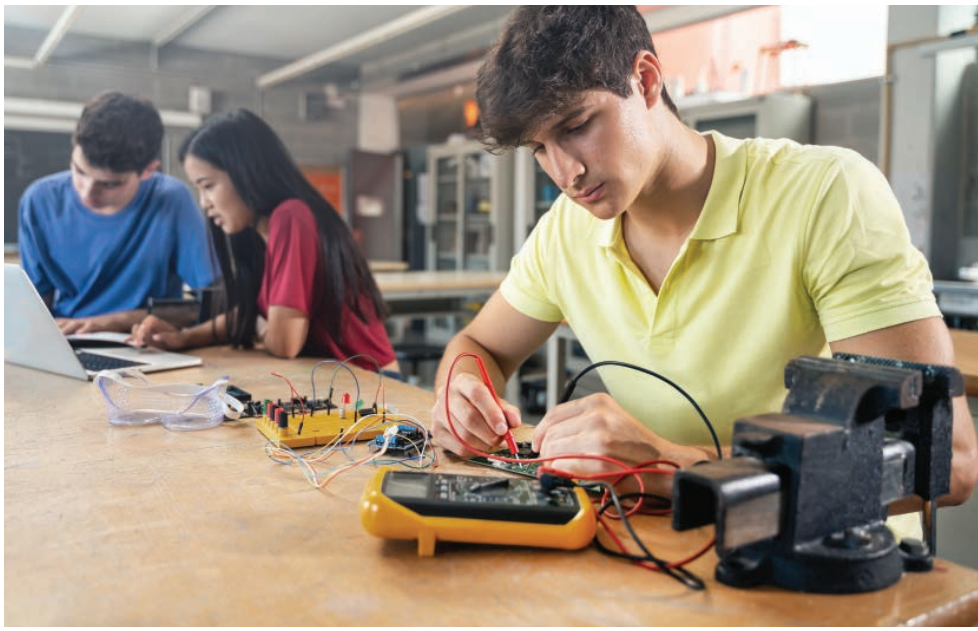
Personal growth and autonomy are important factors in employees choosing to come to, and stay with, a company. Fraunhofer USA is a small to medium-sized (SME) enterprise, and each person matters, with everyone entitled to have the opportunity to shine in ways that might be challenging in a larger company. In particular, scientists and engineers thrive in the R&D environment, where projects are as varied as our customers. Fraunhofer USA employees work to solve challenges, providing a large portfolio of expertise and ingenuity.

We are appreciative that our employees have chosen Fraunhofer USA and thank them for their amazing work and dedication.

Intern Program

As part of its mission, Fraunhofer USA is committed to offering opportunities for meaningful, hands-on internships to those studying in STEM fields to both international and domestic students. While COVID-19 impacted our internship program, we are already seeing a resurgence in intern candidates applying, with the hope that the restrictions and uncertainty associated with the pandemic will subside. The Fraunhofer USA J-1 Visa program, promoting international exchange, has received very positive feedback from participants. The following pages highlight the experiences of interns as narrated in their own words.

Intern Experiences



Alex R., Fraunhofer USA CMA – 5/2/22 to 11/2/22

I had two choices when I got the opportunity to intern at Fraunhofer USA CMA. Either I would stay in Reykjavík and do my bachelor's thesis there, or I could do what I always wanted – live and work in the U.S. for six months. I chose the latter and have not regretted it a single day. Fraunhofer USA provided me with an opportunity to apply my education to solve real-world problems. I was initially tasked with working in mobile app development, followed by a data science project, and soon after that, I was working on an NLP project. It felt great to be able to work in the fields that I enjoyed most, and how quickly Fraunhofer responded to my request was fantastic. I always felt that everything I said mattered. People were interested in having discussions with me and valued my input when making decisions. I was even asked twice to have a short presentation on novel technologies which many people had never heard of. In the office, there were frequent brown bags. A lunchtime meeting where teams from the company, or even other companies, introduce their projects, the various challenges they faced, and how they were able to solve them. This shows that the environment in Fraunhofer is characterized by continuous learning for interns and full-time employees alike. The relationship with the interns truly goes both ways where the interns learn from their experience and Fraunhofer gains a different perspective on problems. The past six months have been an unforgettable experience and one I fully expect to benefit me in all my future endeavors.

TJ, Fraunhofer USA CMI – 5/23/22 to 8/26/22

As a Ph.D. student in the final stages of my degree program, this internship provided me with a great learning experience and an excellent opportunity to get a glimpse of the impactful work researchers and engineers at Fraunhofer USA CMI are doing to solve real-world problems; and to say I learnd a lot during my time here would be an understatement.

During my internship, I worked on a project that looked at monitoring energy and water consumption of domestic equipment, where I was able to successfully develop and optimize algorithms to disaggregate appliance water consumption using monitored energy and water data. My supervisor and teammates gave me excellent guidance on how to progress in this task and I always felt my ideas were valued, even though I was an intern working here for a short time.

My desire to participate in field work was also well received and my supervisor enthusiastically facilitated opportunities to work in the field. I believe getting this practical experience is a key learning metrix for any young engineer and I am thankful for the opportunity.

It was incredibly inspiring to work with the group of people at Fraunhofer USA who truly care about the impact of their work, whether that be for improving energy efficiency, sustainability or designing advanced products and systems and I am excited to be able to carry these learnings during the rest of my degree program and beyond.

Jann L., Fraunhofer USA CMW – 1/10/2022 to 9/15/2022

My name is Jann and I completed a master's degree of chemistry, graduating November 2021 from the University of Würzburg, Germany. From the beginning of my master's in 2019, I wanted to do research in a different, English-speaking country, originally as part of my studies. The pandemic, however, affected these plans and I decided to shift them towards the time after graduation. Having previously worked at Fraunhofer-Gesellschaft, I knew that this kind of research and science fascinated and motivated me. I always wanted to seek greater applications than fundamental science, focusing on a more applied point, with an emphasis on making a better future. From the very first moment I saw the internship program at Fraunhofer USA, I knew that I wanted to apply, and thankfully, Fraunhofer USA CMW contacted me. The pandemic was still at large and nobody knew how or when it would end. Long story short, when I finally arrived in East Lansing, Michigan, I was very excited to get started in the Coatings and Diamond Technologies Division. My research has focused on the development of boron-doped diamond microelectrodes for neurotransmitter detection in the brain. As this topic was completely new for me, I learned a lot about electrochemistry, from the fabrication of microelectrodes under a microscope, to specific analyte measurement techniques and so much more. The welcoming atmosphere in the center and the help of all my colleagues, especially my supervisor James, made it easy for me to get settled and soon start working on my own projects that would concentrate on polymer coatings for sensitivity improvements on our electrodes. Besides work, I gained new insights into the American (student) life at Michigan State University and visited many cool places such as Chicago, Michigan's Upper Peninsula, Niagara Falls, and Toronto! This helped me to get an impression of what a beautiful continent North America is. While doing some of these trips alone, I also enjoyed spending time with interns from Spain, Sweden, Zimbabwe, and Germany. I will miss these friends and hope to see them again, maybe by visiting each other in our home countries. In the end, I am really grateful for this opportunity and all the people accompanying me on this journey. And I'm sure about one thing: this was definitely not the last time in the States for me!

Philip O., Fraunhofer USA CMA – 6/13/22 to 12/16/22

As a first-year master's student in Data science and AI at Chalmers University of Technology, I was left with two options during the spring of 2022: doing an exchange semester at a university in the Netherlands or exploring work life in America. After careful consideration, I chose to participate in a six-month internship at Fraunhofer USA and I have not regretted that decision for a second.

Since the fundamentals at Fraunhofer USA are a solution-oriented approach to every project, I have always been able to be part of the core solution to the problem at hand. There are many projects here and finding one that suited me was never a problem. Within these projects, I work with many experienced people, allowing me to learn from the best and contribute my own ideas.

The Fraunhofer USA internship has also given me a lot of other opportunities, including continued studies and connection to other departments across the globe, such as Singapore. Continued work, alongside my studies there created additional exchange student opportunities at NUS – National University of Singapore. The experience I have gained is not only valued by me but admired by others.

Valentina M. G., Fraunhofer USA CMW – 1/4/22 to 12/31/22

My experience at Fraunhofer USA has been amazing. I had the opportunity to work in many areas, such environmental, material science and I also participated in the development of sensors to detect COVID-19. During this time I have improved my English and I have obtained new knowledge in my professional field and other areas. Everyone was very nice in the office; they always helped me and cared about me. It is amazing to work in a place where you can meet people from many different countries. I worked with people from Asia, Africa, Europe, and, of course, America. I love travel, so meeting people from countries that I never heard before, is an incredible cultural experience. I am very grateful for this opportunity. In addition, this year I visited many places, and took many trips with others interns. We visited typical American festivals, like the Cherry Festival and the Bacon Festival. We participated the American Independence Day (4th of July) and other celebrations. In other words, I had the opportunity to experience true American culture and I am so happy. In conclusion, I want to thank Fraunhofer USA and my supervisor Suzanne for giving me this wonderful opportunity. Not only I have gained experience, I had an incredible year that I will never forget.

Hevar D., Fraunhofer USA CMW – 6/13/2022 to Present

With a fresh bachelor's degree in Physics at Chalmers University of Technology in Gothenburg, Sweden, I was faced with the decision to move on to my master's degree or to apply that stored knowledge and gain some practical experience. With an opportunity presenting itself at Fraunhofer USA CMW, the right choice quickly became clear.

Thinking about this choice today, I could not be happier with my decision. It turns out that Fraunhofer USA's mission, which is to be a bridge between academic and industrial research, was the best possible fit for me. It is the perfect workplace to experience R&D, where one has the possibility, and is also encouraged to explore their own ideas in the search for developing something original and meaningful. However, one has to consider the feasibility and actual utility of a product the goal of which is to be sold and implemented in a practical setting. For me, personally, this experience and dual perspective will greatly help me in deciding which master's degree to pursue, where often, a choice between an industrial and academic career needs to be made.

Currently, one of my projects is working on designing hardware circuitry for a portable, low-cost, microcontroller driven potentiostat which can be used for electrochemical measurements, coupled with programming the associated software in Python and Arduino (C++). The goal of the project is to develop an electrochemical measurement package that is cost-effective and user-friendly while still producing highly-accurate results that can compare to more expensive devices that are currently available on the market. This would result in making electrochemical measurements more economically and practically accessible, where it is needed the most.

Recently, we received a multi-million dollar grant in collaboration with Michigan State University, funded by the National Science Foundation (NSF) and the United States Department of Agriculture (USDA) titled "Signals in Soils" (see page 19). This project seeks to build a sensing platform to measure metals, pH changes and other chemicals in the soil and will therefore look to implement and adapt the portable potentiostat. Some adaptations are developed to make it more autonomous and sustainable as it will lay dormant, buried under ground, performing measurements upon receiving wireless commands, all while being powered by solar energy. The project will also pursue going from single-channel to multi-channel measurements, making measurements of multiple chemicals simultaneously more feasible. Clearly, we have many head-scratching days ahead of us, which I am absolutely looking forward to!

Furthermore, at Fraunhofer USA CMW, I have felt that I am very blessed by amazing colleagues. Every day, they help us experience American culture, and we often discuss and receive ideas for exploratory activities and trips one can do to maximize this cultural exchange. Throughout the internship, there are plenty of opportunities to go on trips. For example, on the 4th of July, we went on a road trip to the Upper Peninsula of Michigan and the nature was just absolutely stunning, not to mention the amazing US Navy's Blue Angels air show we got to see, followed by the fireworks. Michigan's Great Lakes, which to me look more like oceans, are also surely something to behold. It is safe to say that a classical American road trip has officially been crossed off the bucket list.

To reminisce, I would like to share my first moment stepping of the bus in East Lansing. I remember getting greeted and initiating conversations with random people walking down the street, this is very uncommon to me coming from Sweden. It was a great first demonstration of American openness and inclusiveness. I remember thinking that I have reached a place where everyone is incredibly welcoming, outgoing and friendly. I still do to this day.

This opportunity at Fraunhofer USA has given me four great months so far, and I am sure that it will give me another eight. I am greatly thankful for the opportunity to be here, and I will enjoy it to the fullest. Thank you, Fraunhofer USA!

Faces of Fraunhofer USA

Roselyn Ignacio, Fraunhofer USA CMW

Roselyn Ignacio joined Fraunhofer USA CMW in 2021 as a project engineer. Roselyn received her B.S. in Environmental Engineering and a minor in Mathematical Sciences from Michigan Technological University. At Fraunhofer USA, she aims to design and develop water treatment systems that facilitate the destruction of emerging contaminants.

Since arriving at Fraunhofer USA CMW, Roselyn has worked on various projects related to the electro-chemical and sonolytic destruction of perfluoroalkyl substances (PFAS) and other emerging contaminants in water using boron doped diamond (BDD) electrodes. This includes the investigation of using existing PFAS removal technologies (such as reverse osmosis, ion exchange, etc.) as an intermediary pre-concentration step prior to the destructive electro-chemical process as a treatment train approach for a more cost-effective and efficient PFAS degradation alternative. Currently, Roselyn is heavily involved in the Fraunhofer USA PACT program, where she works closely with Fraunhofer Institute for Biomedical Engineering IBMT in Germany to design a combined electro-chemical and sonolytic system for PFAS destruction. She has also worked with faculty at MSU to develop in-house synthetic leachate analyses for the two common PFAS compounds, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS).

Sandra Ösp Stefánsdóttir, Fraunhofer USA CMA

Sandra Ösp Stefánsdóttir holds a B.Sc. in Computer Science from Reykjavik University (RU) in Iceland and an M.Ps. in User Experience (UX) Design from the Maryland Institute College of Art (MICA). She joined the Fraunhofer USA CMA in Maryland in June 2018. She focuses on applying her skills to combine the technical aspects of software development with user experience to resolve issues between the disciplines.

Sandra began her career in information technology in 2017 when she worked for Icelandair Hotels' IT Department in Reykjavik. There, Sandra served as a Technician and Systems Administrator and transitioned to project management, designing and managing the company's entire POS register system. Sandra also worked as an IT consultant and a Teaching Assistant at RU.

Sandra has progressed at Fraunhofer USA CMA, transitioning from intern to full-time developer, to Project Manager, and Tech Lead, as well as managing the center's international intern program.

She currently spends most of her time working with MediGO, leading their mobile team. MediGO focuses on developing a variety of software products to digitally transform donation and transplant operations to reduce inequities and increase access to lifesaving organs and tissue.

Sandra Ösp comments, "Working at Fraunhofer USA has given me opportunities to lead and contribute to multiple projects with various focuses. It has enabled me to grow tremendously, and I have been able to gain a diverse experience you would not get simply anywhere."

Elliott Sprehe., Fraunhofer USA Headquarters

Elliott joined Fraunhofer USA as the Communications and Marketing Manager in the spring of 2022. Having most recently been awarded his MBA by Colorado State University, his background in internal information and media relations has left him with the skillsets needed to share the mission of Fraunhofer USA with its many varied stakeholders in industry, academia, governments, but also internally. Ensuring knowledge sharing is not getting trapped in information exchanges helps to aid the transfer of knowledge and technology amongst Fraunhofer USA staff and our customers.

Prior to joining Fraunhofer USA, his positions have included managing crisis communications response during COVID-19, responding to historically significant ransomware attacks and sharing the organizational missions with public audiences. Initial Fraunhofer USA efforts have included redesign and launch of the Fraunhofer USA intranet, updating brand design to reflect modern Fraunhofer design and establishing monthly pitch meetings to garner internal interest on projects of public interest. With a focus on data driven decision making, Elliott has also led the effort to engage internal stakeholders on the importance of relationship management, incorporating survey tools that integrate with Fraunhofer USA customer relationship management software, for quick access to relevant customer data and identification of customer sentiment.

Todd Van Dyke, Fraunhofer USA CMW

Todd Van joined Fraunhofer USA as a systems group project engineer in 2020. He earned his bachelor's degrees in Industrial Technology and Agriculture Systems Technology at Iowa State University. His agriculture and manufacturing background has given him a wide variety of knowledge and skills to fit his role at Fraunhofer USA. He is responsible for supporting the center by designing, troubleshooting, constructing, and modifying the systems throughout the laboratories. Utilizing his experience from industrial settings, he also focuses on continuous improvement and cost savings by applying lean manufacturing principles to the center. As an experienced engineer, wherever there is a need he is able to meet it.

Todd says, "At Fraunhofer USA being surrounded by scientists performing cutting-edge research allows me to continuously expand my knowledge and skillset. There's never a day that is the same and I enjoy learning new things from my coworkers. I'm also able to pass down information to interns and help them become better engineers and better individuals. Helping others advance is one of the best parts of my job, whether that is through their research or in life."

Josh Giltinan, Fraunhofer USA CMA

Joshua Giltinan received his Ph.D. from Carnegie Mellon University in 2019 and joined the Fraunhofer USA Center for Experimental Software Engineering (now Center Mid-Atlantic) in 2020. From 2014 to 2019 he was a research scientist in the Physical Intelligence department at the Max Planck Institute for Intelligent Systems in Stuttgart, Germany. His Ph.D. research focused on the control and manipulation of magnetic micro-scale robotics. His research interests additionally include microscale systems, autonomous robotics, materials for robotics, computer vision, artificial intelligence, and network systems that enable such technologies. At Fraunhofer USA CMA, Joshua works on state-of-the-art visual inspection systems for clients working on assembly lines with zero-defect requirements and networking systems with widely differing requirements: from satellite communication simulations to campus-scale 5G networks.

He is focused on both the orchestration of project research and development as well as customer-oriented meetings and idea generation. To advance visual inspection and autonomous system projects and to deploy state-of-the-art systems in small and medium sized businesses, he has worked closely with the business development team in the South Carolina Fraunhofer USA Alliance. Back in College Park, MD, he will lead the autonomous systems and network switching group at Fraunhofer USA CMA. In the fall, he co-teaches Software Engineering for Artificial Intelligence with Dr. Mikael Lindvall at the University of Maryland.

Jeff Urian, Fraunhofer USA

Jeff Urian is the corporate counsel and joined Fraunhofer USA in May 2022. Jeff is an engineer and an attorney. He loves technology and is thrilled to be learning about Fraunhofer USA's technologies and capabilities. In this role, he is responsible for ensuring the legal terms associated with projects align with Fraunhofer USA's goals and requirements. He actively works with everyone to understand goals and objectives, to educate on risk assessment so that others understand any concerns, and manages risk mitigation. He is also responsible for managing and protecting intellectual property.

Jeff has over 24 years of experience as an attorney, working at law firms and in-house for multi-national corporations. He also has over five years of experience in sales. Jeff received his bachelor's degree in Mechanical Engineering from Purdue University and Law Degree from Saint Louis University School of Law.

Outlook

For almost three decades, Fraunhofer USA has continued to innovate, evolve and continually challenge ourselves to discover those technologies that will change our world. Our unique organization is well positioned to take advantage of anticipated collaboration opportunities. These national, international and transatlantic connections are made greater with one of the world's largest applied research organizations offering their services to our U.S.-based customers, including those international customers operating in America. Fraunhofer-Gesellschaft, and their dozens of research institutes worldwide, provide governments and industry with the tools, personnel and knowledge to prepare organizations for our world's greatest challenges, both those known and anticipated, but also for those challenges yet to show themselves on the horizon. Our motivation is not just for the sake of exploration and investigation. We probe and quest to lay the future groundwork for expeditions of those who come after us, in the hopes that delving into experimentation establishes future generations dedicated to solving whatever great challenges come next.

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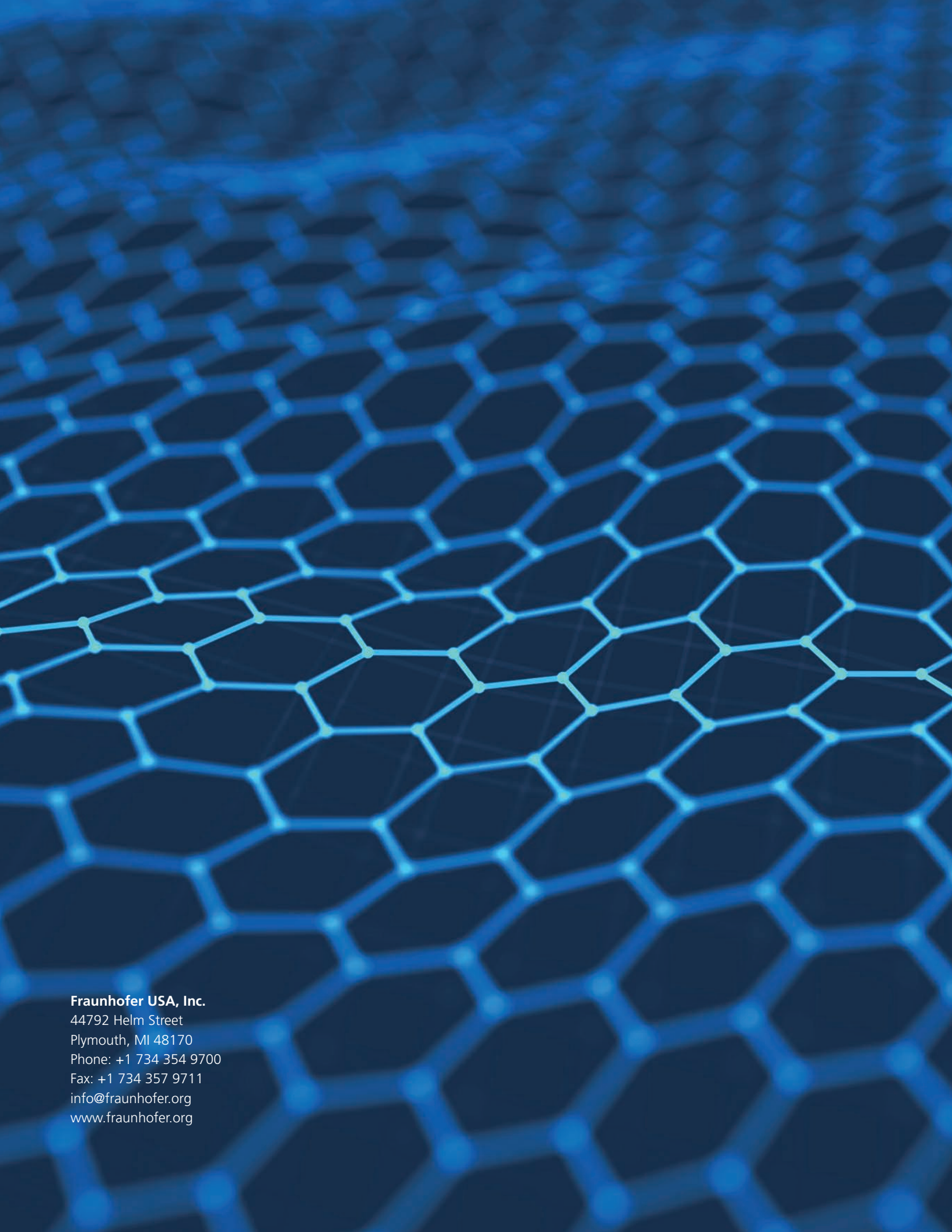

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