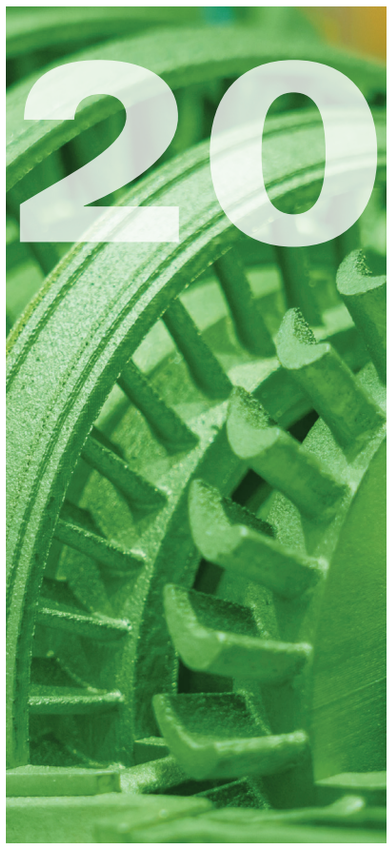
# IPB | UCONN TECH PARK


UCONN | SCHOOL OF ENGINEERING

UCONN | RESEARCH

# CONTENTS



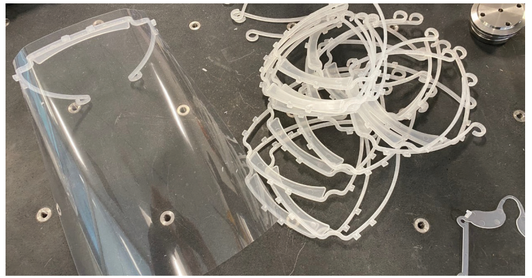



## Welcome From the Executive Director

To enter the Innovation Partnership Building (IPB) at UConn Tech Park is to begin a journey that is fascinating and awe-inspiring. As you explore the IPB, you will easily recognize its distinguishing features as a focal point for cutting-edge research, particularly its high-tech equipment, including some of the world's most powerful electron microscopes, 3D printers that use metal alloys analogous to those used in aerospace manufacturing and much, much more. We continually question and probe in the pursuit of novel ideas and solutions, within a dynamic, energetic environment that cultivates industry collaboration and innovation. Our 14 academic research centers provide many opportunities for faculty, research partners and students to perform applied research across diverse areas of expertise, from cybersecurity to sophisticated weather modeling, to clean energy. Many of our students gain valuable work experience while making productive contributions to applied research and development programs. I am extremely pleased to welcome you to our building and share with you our 2019-2020 Annual Report.

The world has abruptly changed as we move into our third year of operation at the IPB. COVID-19 has left its imprint around the globe. In early spring 2020, as more and more organizations and individuals became immersed in the struggle against the virus, the IPB readily found ways to support the fight against this pernicious disease.

Joe Luciani, Director of the IPB's Proof of Concept Center, collaborates with small businesses to help them create new products. When he learned of an acute shortage of PPE, he knew he had the right resources and expertise to help out. He switched gears to focus on this critical work and began to develop a way to 3D print and laser cut masks and shields for healthcare workers. In collaboration with other university departments and Wepco, a local small business, Joe ultimately produced 10,000 face shields for UConn Health healthcare workers caring for COVID-19 patients.



Jeff McCutcheon, Center Director for the IPB's Fraunhofer USA Center for Energy Innovation, took a break from his current research as well, using his expertise to work on patient ventilators. He led a UConn School of Engineering (SoE) team that developed a prototype of an emergency

ventilator to help ease potential shortages during the outbreak. The team collaborated closely with Connecticut aerospace manufacturer Whitcraft LLC who has produced the device and sent it to UConn Health for testing. Meanwhile, another team from McCutcheon's lab at the IPB has produced 1,400 bottles of hand sanitizer and donated them to local senior living facilities and a nearby soup kitchen. Their ultimate goal is to produce 20,000 bottles of the hand cleaner.

At the IPB, we are proud of the innovations that helped in the fight against COVID-19 and we were gratified to make our resources available: expertise, raw material, equipment. Our scientists responded promptly to support the state's needs during this crisis, even catching the eye of U.S. Congressman Joe Courtney.

> *Eastern CT ingenuity at work – UConn School of Engineering teams up with Eastford, Connecticut's Whitcraft Co. to build "Made in CT" ventilators. Nice job!*
>
> – U.S. Rep. Joe Courtney

As part of a major research university, we recognize our critical role in supporting the state economy. The COVID-19 projects are excellent examples of the IPB serving the state through its partnerships and research collaborations. In fact, the IPB had made significant strides even before the pandemic, establishing two major research centers that are helping to strengthen and grow the aerospace and naval industries, some of the largest industries in the state.

The Air Force Research Laboratory Research in Advanced Manufacturing (AFRL-RAM) is a collaboration with AFRL that supports the state's mission and state industry in aerospace by improving key manufacturing technologies. This $13.5 million contract will support over fifteen projects, twenty-two faculty and thirty-five undergraduate students, graduate students and post docs in research areas aimed at improving aerospace manufacturing. The projects span topics such as casting, composite manufacturing, metal additive manufacturing and characterization, predictive machining models as well as the industrial internet of things (IIoT).

The National Institute for Undersea Vehicle Technology (NIUVT) is a partnership founded by the Universities of Connecticut (UConn) and Rhode Island (URI) to enhance performance and reduce costs associated with advanced technology integration in the undersea domain. NIUVT leverages over $15 million of Office of Naval Research investment alongside industry support to engage in substantive research, technology transition, and workforce development, positioning themselves to successfully develop the personnel and knowledge needed to drive the undersea ecosystem of tomorrow.

We are enthusiastic to continue offering Connecticut businesses new ways to take advantage of our unique capabilities. We look forward to developing the innovative ideas, knowledge and technology that push our state to the forefront.

Even though times may be tough, we're ready to help, and we're open for business.



# Innovation, meet Creativity

*Heather Elliott-Famularo*
*DMD Department Head)*

*Maria Raykova*
*DMD Graduate Assistant*

*Yucheng Hang*
*DMD Graduate Assistant*

For many of us, an artist and a high-tech research scientist are not an intuitive match. But Professor Heather Elliott-Famularo, Digital Media and Design (DMD) Department Head, is confident that interactions between these groups are perfectly normal and highly valuable, and in January 2019 she was intent on making a connection. "We need more happening between art and engineering," she casually mentioned to a colleague at a faculty function. Her colleague turned to her and said with conviction, "Let's make it happen." That colleague turned out to be Executive Director of the IPB, Professor Pamir Alpay.

Heather and Pamir got the ball rolling right away, laying the groundwork for the first "art-meets-science" GA program, a unique opportunity for DMD graduate students to interact with research scientists at the IPB. Heather explains, "We were really excited about creating a means for DMD students to utilize their digital skills while being influenced by research at the IPB, to apply creative concepts to scientific inquiries." She is enthusiastic that "The new program will provide greater exposure to both sciences and humanities, ultimately helping our graduates develop a richer portfolio."

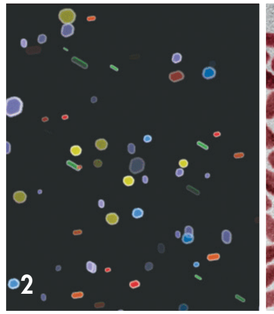
In fall 2019, first-year DMD Master of Fine Arts students Yucheng Hang and Maria Raykova eagerly kicked off the program at the IPB, a building full of electron microscopes, 3D printers, robots and much, much more. They were assigned to the microscopy wing and over the course of the year they created striking designs and artwork, partnering closely with IPB researchers. Their work includes 18 instrument-specific posters that are on permanent display at the IPB, designs for a mural infographic and an IPB microscopy virtual hallway. They also created the imaginative designs displayed here, based on the IPB researchers' microscopy images. Captions on p.42.

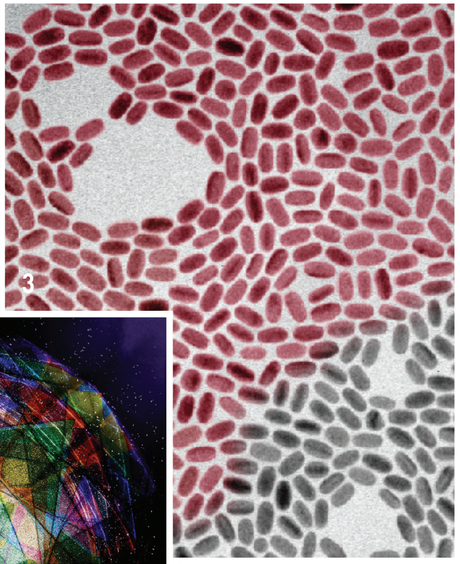
Maria and Yucheng commented on the value of this uncommon type of collaboration and their excitement in participating:

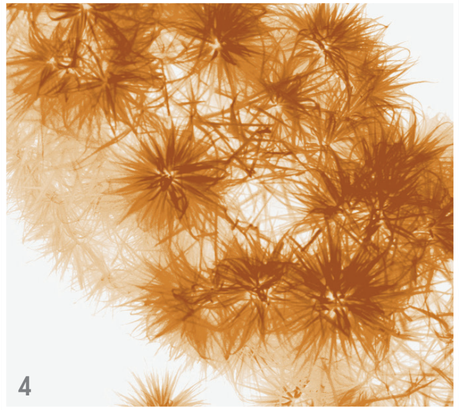
"I feel honored to be one of the first DMD students to work at the IPB, helping to bridge the arts and sciences at UConn. Throughout this year, I was pushed beyond my comfort zone and I am grateful to the staff of the IPB for the time, knowledge, and images they generously contributed to support my creative work." -Maria Raykova

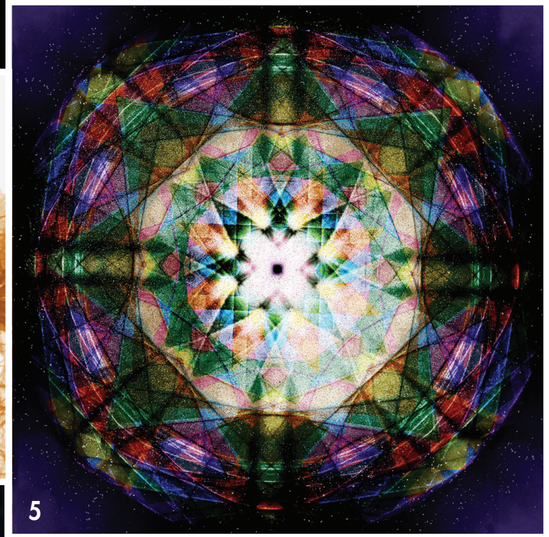
"As a graduate assistant in the IPB, I had valuable opportunities to apply my art and multimedia skills to a scientific field that I was not familiar with. All these attempts and experiences are fresh and exciting to me. I also appreciate all the kind and collaborative people here; they create a wonderful working environment." -Yucheng Hang

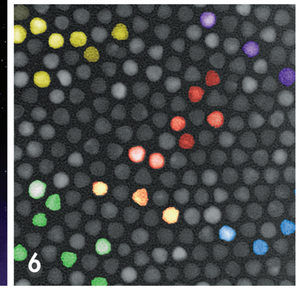
Pamir concurs, "It was a fascinating, enlightening year for both artists and scientists – we have undeniably made the art-meets-science connection."

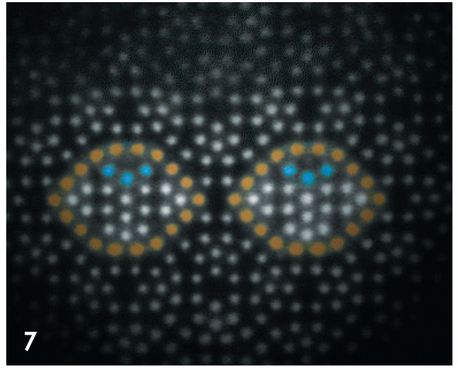




# Quick Facts

## ENERGY

- Utility Companies
- Energy Storage
- Water Filtration
- Clean Energy
- Sustainability

## CYBER

- Cybersecurity
- Hardware Assurance
- Cyber-physical Security
- Big Data
- Information Technology

## MATERIALS

- Electron Microscopy
- X-Ray Tomography
- Custom Materials Design
- Aerospace Materials

## MANUFACTURING

- Aerospace
- Naval
- Supply Chain
- Manufacturing Simulations

## DATA SCIENCE

- Finance
- Insurance
- Engineering

## ARTIFICIAL INTELLIGENCE AND ROBOTICS

- Artificial Intelligence
- Robots
- Machine Learning
- Industry 4.0



## APPLIED RESEARCH AND DEVELOPMENT

**~ $100M** at the IPB including

ThermoFisher SCIENTIFIC · EVERSOURCE · Pratt & Whitney "Dependable Engines" · COMCAST · Fraunhofer USA · Collins Aerospace · United Technologies · Department of the Navy ONR Science & Technology · synchrony · National Institute for Undersea Vehicle Technology · AFRL The Air Force Research Laboratory: Lead · Discover · Develop · Deliver

## >600 UCONN AFFILIATES ACROSS CAMPUS

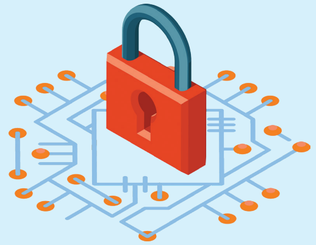

## STATE OF THE ART EQUIPMENT

| SPECIALTY | # AT THE IPB |
|---|---|
| Electron microscopy | 7 |
| X-ray characterization | 2 |
| Focused ion beam milling | 6 |
| Reverse engineering | 4 |
| Optical and digital microscopy | 2 |
| 3D printing | 10 |
| Materials testing | 11 |
| Manufacturing and materials processing | 7 |
| Robotics/automation | 1 |

## GLOBAL IPB TEAM FROM

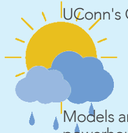

## CYBERSECURITY

- Your smart card can be hacked in ~30 seconds – 1,000x faster than seven years ago.
- Cybercrime-related damage is projected to hit $6 trillion annually by 2021.
- The average cost of a malware attack on a company is $2.4 million.
- By 2021, ransomware damage costs will rise to $20 billion and a business will fall victim to a ransomware attack every 14 seconds.
- In 2018, Under Armor reported that its "My Fitness Pal" was hacked, affecting 150 million users.



## WEATHER MODELING

UConn's Outage Prediction Model



**1.8M** customers benefit

Models are generated by a computer powerhouse equivalent to

➲ **68** laptops performing simultaneous calculation

Storage space for

➲ **10.5M** hours of music

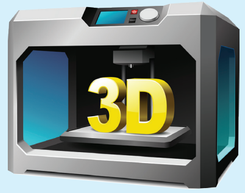
## MECHANICAL TESTING

The Gleeble thermal-mechanical simulator tests materials under extreme conditions

Heats/cools objects at **10,000** degrees per second

Has **10** tons of crushing power,

or **100** x the power of the human bite




## SPECIALIZED 3D PRINTING

Our custom-built 3D printers are capable of printing:

- Food customized to meet individual nutritional needs and satisfy discriminating taste buds
- Pharmaceutical tablets that can bring personalized medicine to the next level
- Superalloys for the aerospace industry
- All grades of polymers & plastics

# Overview

The Innovation Partnership Building is a state-of-the-art research center and one of UConn's key research assets.

There are numerous advantages of working with IPB researchers:

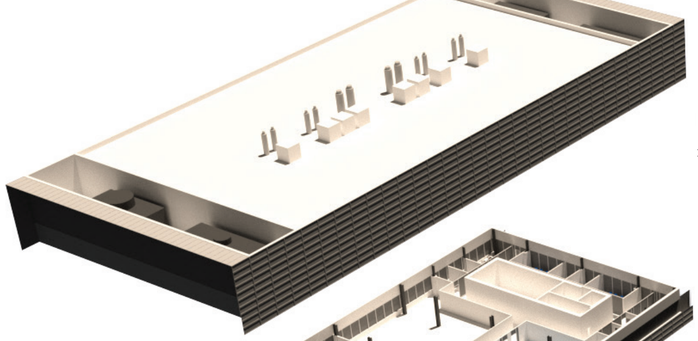
- Collaboration with world-class scientists
- Top-tier graduates and undergraduates
- Extensive specialized hi-tech equipment in a single building
- State-of-the-art labs
- Meeting space and common areas
- Innovative community

Within its 113,700-square-foot expanse, the IPB operates and maintains over $45 million of specialized high-tech instrumentation, strategically collocated in a single building on North Campus. The design and structure of IPB's core lab spaces are customized to create an optimal operating environment for this highly sensitive, sophisticated equipment.

## OUR MISSION

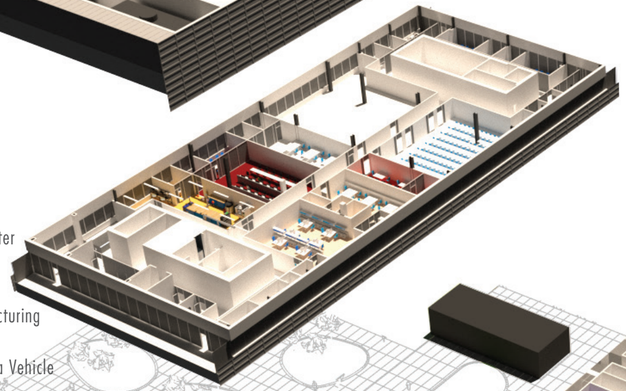
**The Innovation Partnership Building at UConn Tech Park fosters expansion of academic-industry partnerships to address emerging needs of industry, cultivates research and technological innovation, and promotes economic growth in the state of Connecticut.**





### ROOF

» Mechanical Infrastructure

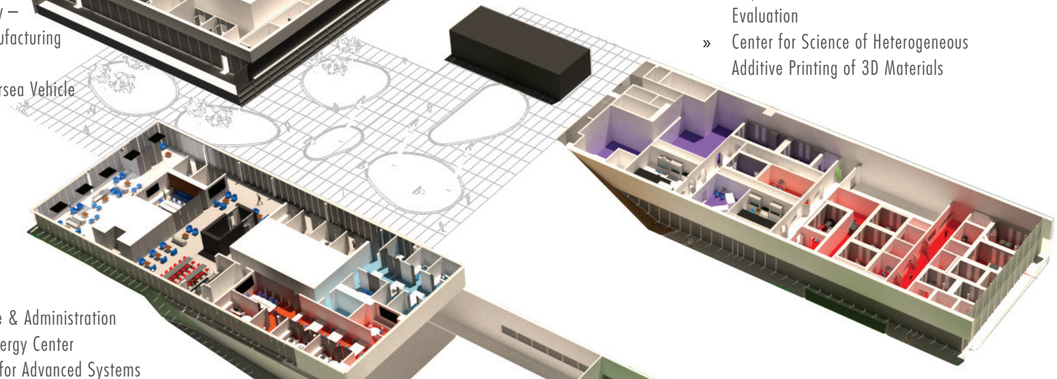


### 3RD FLOOR

» Proof of Concept Center
» Connecticut Manufacturing Simulation Center
» Connecticut Cybersecurity Center
» Eversource Testbed
» Air Force Research Laboratory – Research in Advanced Manufacturing
» Multifunction Space
» National Institute for Undersea Vehicle Technology

### 1ST FLOOR - SOUTH WING

» Thermo Fisher Scientific Center for Advanced Microscopy and Materials Analysis
» DENSsolutions Center for IN-siTu/ Operando Electron Microscopy
» Reverse Engineering Fabrication Inspection and Non-Destructive Evaluation
» Center for Science of Heterogeneous Additive Printing of 3D Materials



### 2ND FLOOR

» Main Entrance & Administration
» Eversource Energy Center
» UTC Institute for Advanced Systems Engineering



### 1ST FLOOR - NORTH WING

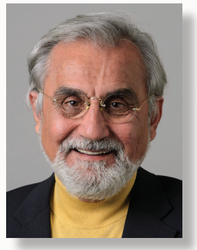
» Pratt & Whitney Additive Manufacturing Center
» Connecticut Center for Applied Separations Technology
» Center for Materials Processing Data

# People
# Center Directors

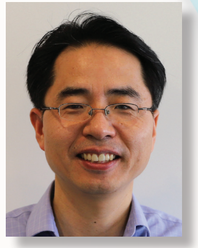
**PAMIR ALPAY**
Collins Aerospace Center
for Advanced Materials
AFRL Research in Advanced Manufacturing
Department of Materials Science
and Engineering

**EMMANOUIL ANAGNOSTOU**
Eversource Energy Center
Department of Civil and
Environmental Engineering

**GEORGE BOLLAS**
UTC Institute for Advanced
Systems Engineering; AFRL Research
in Advanced Manufacturing
Department of Chemical and
Biomolecular Engineering



**HADI BOZORGMANESH**
Enterprise Solution Center
School of Engineering



**JEONGHO KIM**
Connecticut Manufacturing
Simulation Center
Department of Civil and
Environmental Engineering

**JOSEPH LUCIANI**
Proof of Concept Center
Quiet Corner Innovation Cluster

**ANSON MA**
Center for Science of Heterogeneous
Additive Printing of 3D Materials
Department of Chemical
and Biomolecular Engineering

**JEFF MCCUTCHEON**
Connecticut Center for Applied
Separations Technology
Department of Chemical and
Biomolecular Engineering

**JOHN CHANDY**
Connecticut Cybersecurity Center
(CHEST, Comcast)
Department of Electrical and
Computer Engineering

**RICHARD CHRISTENSON**
National Institute for Undersea
Vehicle Technology
Department of Civil and
Environmental Engineering

**LESLEY FRAME**
Center for Materials Processing Data
Department of Materials Science
and Engineering

**RAINER HEBERT**
Pratt & Whitney Additive Manu-
facturing Center; AFRL Research in
Advanced Manufacturing
Department of Materials Science
and Engineering

**LAURENT MICHEL**
Connecticut Cybersecurity Center
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Department of Computer Science
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**SINA SHAHBAZMOHAMADI**
Reverse Engineering Fabrication
Inspection & Non-Destructive Evaluation
Department of Biomedical Engineering

**STEVEN L. SUIB**
UConn Thermo Fisher Scientific
Center for Advanced Microscopy
and Materials Analysis
Department of Chemistry

**YUANYUAN ZHU**
UConn DENSsolutions Center for IN-siTu/
Operando Electron Microscopy
Department of Materials Science
and Engineering

# People

**PAMIR ALPAY**
Executive Director
IPB I UConn Tech Park

## BUILDING MANAGEMENT & SAFETY

**BEN ANACLETO**
Laboratory Services Manager

**BRIAN CARDINAL**
Building Manager

## PROJECT MANAGEMENT

**ALEXANDRA MERKOURIOU**
Project Manager AFRL-RAM

## SCIENTIFIC AND TECHNICAL SUPPORT

**MARK BIRON**
Additive Manufacturing Center

**DAVID T. MANAN**
Finite Element Technician
Connecticut Manufacturing
Simulation Center

**JOSEPH LUCIANI**
Proof of Concept Center
Quiet Corner Innovation Cluster

**DANIELA MORALES**
X-ray Laboratories

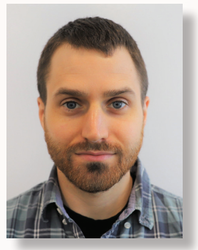
## ADMINISTRATIVE SUPPORT, MARKETING, AND FINANCE

**RAELENE DEROBERTIS**
Executive Administrative Assistant

**MELANIE NOBLE**
Executive Administrative Assistant

**AMANDA KLAR**
Fiscal Manager

**HEIKE BRUECKNER**
Graphic & Website Design



**LUCAS PARENT**
Electron Microscopy
Research Scientist

**ROGER RISTAU**
Lab Manager
CAMMA

**HAIYAN TAN**
Electron Microscopy
Research Scientist
CAMMA

**EDWARD WAZER**
Laboratory Director
Fraunhofer

**LICHUN ZHANG**
Microscopy Specialist
CAMMA

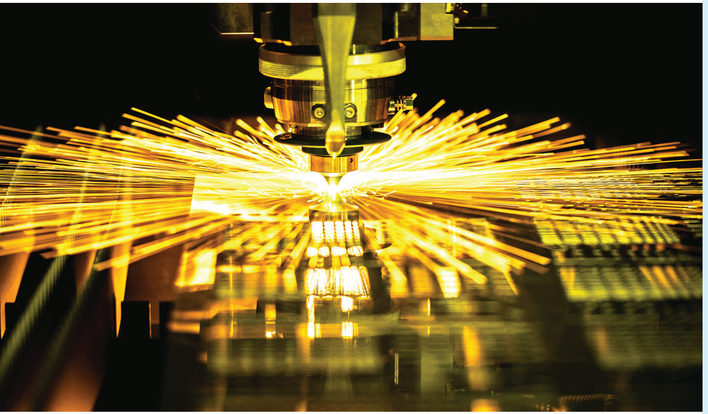
RESEARCH CENTER

# Air Force Research Laboratory – Research in Advanced Manufacturing (AFRL-RAM)

Air Force Research Laboratory – Research in Advanced Materials (AFRL-RAM) is a collaboration supported by a four-year contract with the Air Force Research Laboratory. Working with industry partners Pratt & Whitney, Aero Gear, GKN Aerospace, Collins Aerospace and Sikorsky, the center will help the U.S. Air Force and their contractors further improve manufacturing technologies. It will apply highly specialized expertise in manufacturing simulation, extensive materials analysis, and process modeling to achieve its objective of improving the performance of key technologies used by aerospace manufacturing companies.

## Areas of Expertise

- Manufacturing simulation
- Material property data modeling
- Materials analysis and characterization
- Uncertainty quantification of manufacturing processes



**PAMIR ALPAY**
Co-director AFRL-RAM
Department of Materials Science and Engineering

**RAINER HEBERT**
Co-director AFRL-RAM
Department of Materials Science and Engineering

**JOHN CHANDY**
Co-director C3 (CHEST, Comcast)
Department of Electrical and Computer Engineering

**GEORGE BOLLAS**
Co-director AFRL-RAM
Department of Chemical and Biomolecular Engineering

**ALEXANDRA MERKOURIOU**
Project Manager AFRL-RAM

**LAURENT MICHEL**
Co-director C3 (Comcast, Synchrony)
Department of Computer Science and Engineering

Faculty: 7
Post-doctoral Fellows: 2
Graduate Students: 10
Undergraduate Students: 4
Staff: 2

Faculty: 10
Researchers: 4
Post-doctoral Fellows: 2
Graduate Students: 30
Undergraduate Students: 17
Staff: 1



RESEARCH CENTER

# Connecticut Cybersecurity Center (C3)

The purpose of the Connecticut Cybersecurity Center (C3) and its member centers is to break new technology grounds and advance the state-of-the-art with novel solutions to prevent, detect and cope with the plethora of attacks that threaten information technology systems holding our data.

- The Comcast Center of Excellence for Security Innovation focuses on networking products deployed in businesses and homes.
- The Center for Hardware and Embedded Systems Security and Trust (CHEST) is an industry-supported consortium tackling research issues in hardware security.
- The Synchrony center addresses threats to financial organizations.
- The Center for Voting Technology Research (VoTeR) supports the State of CT to ensure the safety of elections conducted with electronic terminals.

## Areas of Expertise

- Security assessment of IoT and embedded devices such as routers, gateways, switches, VPNs, home security solutions, etc.
- Secure networking protocols expertise such as secureBGP or secure DNS
- Biometrics and key extraction
- Hardware root of trust and Physically Unclonable Functions (PUFs)
- Counterfeit electronics detection and prevention and supply chain risk management
- Anti-tampering and anti-reverse engineering
- Secure processor architectures
- Machine learning approaches to cybersecurity
- Formal techniques for security verification and validation
- Cryptography and coping with Kleptography
- Cryptographic attacks, side-channel attacks and defensive measures.
- Safely outsourcing computation to the cloud
- Multi-party computation

RESEARCH CENTER

# Eversource Energy Center

EVERSOURCE

The Eversource Energy Center is a dynamic partnership between UConn and Eversource where weather, climate and energy intersect. At the center, innovative state-of-the-art research, technology and software are leveraged to solve real-world challenges for utility customers. With these tools, researchers develop high-resolution models for weather and outage forecasting, and 3D aerial and ground imagery. Their science-based output improves storm readiness and response to help keep communities energized. Next generation research is also mitigating storm hazards, improving reliability of delivering power, shortening and preventing outages and increasing the resilience of the electric grid.

Through research and teaching, the center is advancing future approaches to storm outage forecasting, best practices for healthy and storm-resistant forest design, and new technologies for storm resiliency improvements.

## Areas of Expertise

- Storm outage modeling to predict a storm's impact on the power grid by evaluating the timing and location of outages. This allows pre-staging of repair crews and equipment to expedite power restoration.
- Developing software to support the safe integration of renewables (e.g., solar, wind) into the utility grid.
- In response to climate change, evaluating sea level rise and flooding potential. The goal is to protect critical infrastructure networks including transportation, water and electricity.
- Applying tree biomechanics and social science research to promote the resilience of the power grid and the beauty of local forests.
- Physical and cyber security research for monitoring and protecting the interconnected electric grid.
- Laser technology to improve grid operations by creating a 3D picture of utility equipment and the surrounding environment.




**EMMANOUIL ANAGNOSTOU**
Director Eversource Energy Center
Department of Civil and Environmental Engineering

**RAINER HEBERT**
Director Pratt & Whitney Additive Manufacturing Center
Co-director AFRL RAM
Department of Materials Science and Engineering

Faculty: 23
Researchers: 8
Post-doctoral Fellows: 2
Graduate Students: 34
Undergraduate Students: 25
Staff: 1

Faculty: 5
Graduate Students: 6
Undergraduate Students: 2

RESEARCH CENTER

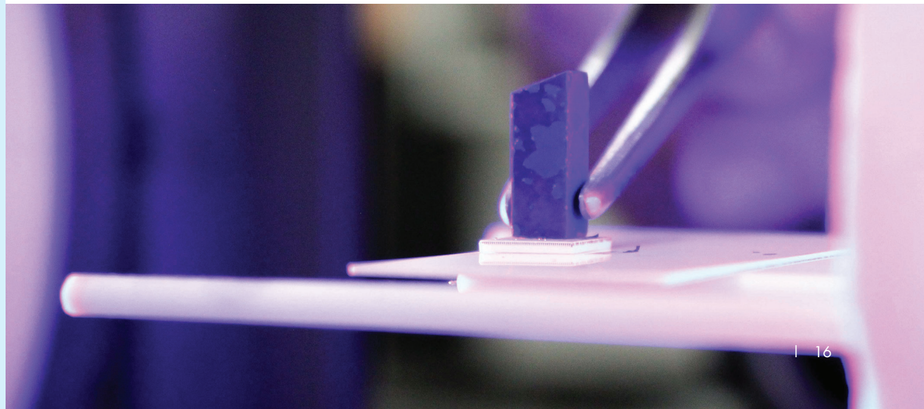
# Pratt & Whitney Additive Manufacturing Center (PW AMC)

The Pratt & Whitney Additive Manufacturing Center (PW AMC) is a center for research on fundamental characteristics of additive manufacturing. A collaborative effort between Pratt & Whitney and UConn, its activities focus primarily on materials science interests such as rapid solidification, microstructure and phase formation, and alloy development for additive manufacturing. A suite of unique thermophysical property measurement instrumentation supports research activities.

PW AMC engages with government agencies and with industry in a broad range of settings such as traditional research grants, purchase orders, or fee-for-service work. The center maintains substantial collaborations with aerospace companies and other organizations in the context of naval applications.

## Areas of Expertise

- Powder analysis, environmental effects on powder dynamics. PW AMC uses custom rake systems and powder bed equipment to investigate the spreading behavior of powders.
- Ab-initio calculations of surface phase diagrams, surface tension, diffusion pathways.
- Alloy development for additive manufacturing: methodology development combining first-principles calculations with thermodynamic- and kinetic studies as well as experimental validation.
- Microstructure characterization of additively manufactured parts using electron microscopy.
- In-operandi measurement of temperature changes during powder bed heating and solidification with ultra-short time resolution.
- Measurement of thermophysical properties (thermal diffusivity, specific heat, viscosity, thermal expansion) to temperatures between 1,600°C and 2,800°C.



*Sample positioning for thermal expansion measurement*

RESEARCH CENTER

# National Institute for Undersea Vehicle Technology (NIUVT)

The National Institute for Undersea Vehicle Technology (NIUVT) is a unique partnership established by University of Connecticut (UConn) and University of Rhode Island (URI). The institute leverages the collective engineering talents, capabilities, Infrastructure, and equipment of UConn, URI, the Naval undersea ecosystem, and the undersea technology industry. NIUVT's key objectives are to enhance performance and reduce costs of the shipbuilding process while ensuring that advanced technologies are fully integrated into the next generation of undersea vehicles and their supply chains.

NIUVT also builds upon the experience and expertise of UConn and URI to engage in research, technology transition, and workforce development programs alongside government and industry partners in the extensive, regional undersea domain. Through these activities, NIUVT will develop the personnel and knowledge needed to accelerate critical research and enhance U.S. superiority in submarine and other undersea technologies.

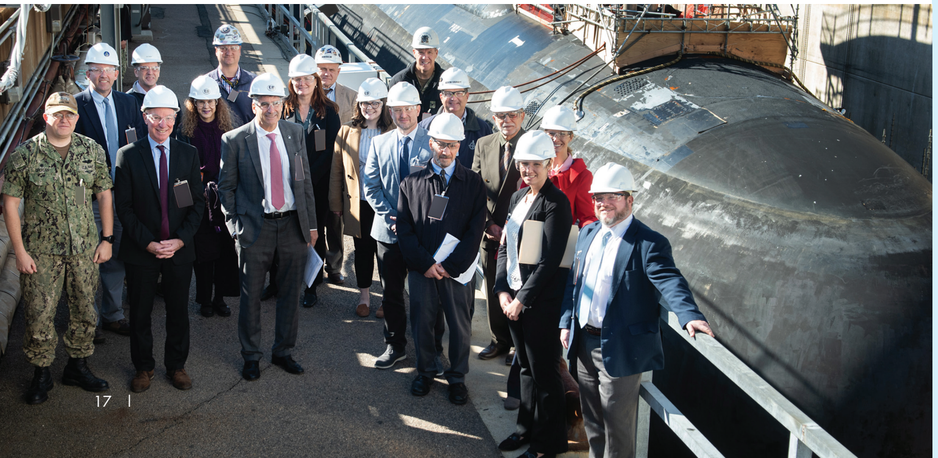
**RICHARD CHRISTENSON**
Co-director NIUVT
Department of Civil and
Environmental Engineering

**ERIK BRINE**
Executive Director NIUVT

## Areas of Expertise

- Acoustics, sensors and signal processing
- Advanced materials and structures
- Advancing manufacturing processes
- Cybersecurity
- Human factors
- Marine hydrodynamics
- Propulsion enabling technologies
- Structural integrity, vibration and control
- Systems engineering/modeling
- Unmanned Underwater Vehicles (UUVs)
- Underwater energy systems
- Underwater shock

**ARUN SHUKLA**
Co-director NIUVT
Department of Mechanical,
Industrial and Systems Engineering
University of Rhode Island



Participating Faculty: 27
Graduate Students: 9
Undergraduate Students: 17
Staff: 3



# Erik Brine Makes Waves at National Institute for Undersea Vehicle Technology

As an Air Force pilot for over two decades, Erik Brine has served his country from thousands of feet in the air. Now Brine is focused on research and development activities to safeguard our national defense from the depths of the ocean floor.

In September 2019, Brine became the executive director of the National Institute for Undersea Vehicle Technology (NIUVT). NIUVT is a collaborative effort between academia, industry, and government founded by partners General Dynamics Electric Boat and the schools of engineering at the University of Connecticut (UConn), and the University of Rhode Island (URI).

NIUVT's mission is to enhance performance and reduce costs associated with advanced technology integration in the undersea domain. These activities include conducting advanced research, facilitating workforce development, and accelerating technology to meet the needs of industry in the defense sector. The institute's regional academic and industry horsepower are further strengthened by the expertise and close relationships with Naval Undersea Warfare Center (NUWC) and the Undersea Warfighting Development Center, which are pillars of the Navy's undersea community.

In 2018, the Navy announced plans to purchase 301 new ships by 2048, including an increase in submarines from 48 to 66. This significant ramp-up in submarine production could place strain on the 600 small and medium companies that are suppliers to the submarine industry. NIUVT aims to help alleviate that stress and allow for greater innovation, performance, and cost savings.

"UConn and URI have a strong record of supporting the naval community in Connecticut and Rhode Island through workforce development and collaborative research. NIUVT will bring this to the next level and we are very pleased that Erik has joined our team to help lead this growth and development," says Dean Kazem Kazerounian, UConn School of Engineering.

Before joining NIUVT, Brine served as an expert on defense, technology, and veterans issues in both the legislative and executive branches. He spent time at the State Department supporting the bureaus of Political Military Affairs, International Security and Nonproliferation, Arms Control Verification and Compliance, Counter-terrorism, Conflict Stability Operations, and Intelligence and Research. He worked in the Pentagon in the Office of the Secretary of Defense and was an advisor to Senator Tim Kaine on defense and veterans issues. Most notably, he served at the White House as a budget and policy advisor overseeing $93 billion of Department of Defense Research and Development investments and industrial policy issues. Brine remains a colonel in the Air Force Reserve and co-founder/president of a non-profit called Operation Encore that supports singer-songwriters and musicians from veteran and military communities.

Through these experiences, Brine says he recognized the need for better partnership and resource sharing between academia, industry, and government to compete for international defense dominance. A major priority for NIUVT will be to foster an active ecosystem, leverage state-of-the-art facilities at UConn and URI, and connect the right people to improve national defense and the economy, he says.

"Along with space, the undersea domain is really one of the final frontiers of exploration for military and commercial utility. That's one of the things that got me excited about the opportunity to lead NIUVT," says Brine. "NIUVT will play a critical role in allowing the U.S. to compete on an international scale by leveraging coordinated investments in research, workforce, and technology to address major challenges in this dual-use environment."

NIUVT is located throughout the Northeast's "blue tech corridor" at UConn's Innovation Partnership Building at UConn Tech Park, UConn's Avery Point campus, URI's Narragansett Bay Campus, and in URI's new engineering building. NIUVT was established in 2017 to develop the personnel and knowledge to accelerate critical research and enhance U.S. dominance in submarine and other undersea technologies.

"As a main supplier of workforce to Division Newport, we need to continue our work with the URI College of Engineering, as well as other regional universities like UConn to help us build the workforce we need into the next century," says NUWC Chief Technology Officer Vic Ricci. "NIUVT is set up to foster collaboration in cross-disciplinary teams, not limited to engineering, that will truly bring engineering education to a new standard that will drive innovation."

"The collaborative research and workforce development initiatives that have resulted from our partnership with UConn and the Navy have been a great benefit to our students at URI," says Dean Raymond Wright, URI College of Engineering. "Erik's 20-plus years of experience in national security and military leadership will help strengthen those partnerships and create more opportunities for our students and faculty going forward."

NIUVT will grow considerably in 2020, with the addition of about 50 total faculty and students. To date, the institute has received $10.5 million in federal funding. NIUVT will also have the opportunity to compete for another $10 million made available by the 2020 National Defense Authorization Act that was passed by Congress recently.

- Jessica McBride, Office of the Vice President for Research

# UTC Institute for Advanced Systems Engineering (UTC-IASE)

United Technologies

The UTC Institute for Advanced Systems Engineering (UTC-IASE) is a coordinated effort by United Technologies Corporation and University of Connecticut focused on enhancing the capability and capacity of engineers with "systems thinking" in the nation and worldwide. It produces, disseminates, and commercializes new science and technology in the field of cyber-physical systems engineering through transformative research, education, and workforce development. The institute serves as a hub for world-class research, project-based learning by globally-distributed teams of students, and industrial outreach activities focused on model-based systems engineering of complex systems that are built from and are dependent on the synergy of computational and physical components. Research applications are broad and include, e.g. smart buildings and cities, aerospace systems, manufacturing and energy industries, robotics and cybersecurity.

## Areas of Expertise

The institute builds on its research and educational programs in the foundational scientific areas of:
Requirements formalization and systems engineering

- Physics and data driven modeling
- Advanced system control and optimization
- System diagnostics, prognostics, and health management
- Uncertainty and big data
- Systems engineering principles of cybersecurity

The UTC-IASE focuses on three technology areas drawing on its fundamental knowledge base:

- Platform-based requirements formalization
- Hybrid and heterogeneous acausal modeling of cyber and physical systems
- Information and big data management and stewardship

These technologies enable progress in the areas of embedded, autonomous and modular systems, which depending on the application domains of interest (e.g. smart buildings and cities, aerospace systems, manufacturing and energy industries, robotics and cybersecurity) are incompatible with today's discipline-based structure of research and education.



**GEORGE BOLLAS**
Director UTC-IASE
Co-director AFRL-RAM
Department of Chemical
and Biomolecular Engineering

Faculty: 7
Affiliated Faculty: 45
Graduate Students: 13
Undergraduate Students: 5
Staff: 1

**PAMIR ALPAY**
Director Collins Aerospace
Center for Advanced Materials
Co-director AFRL-RAM
Department of Materials Science
and Engineering

Faculty: 4
Post-doctoral Fellows: 1
Graduate Students: 10
Undergraduate Students: 3

*New aluminum alloys for metal 3D printing were designed using novel materials genomics tools developed by researchers from UConn, Collins Aerospace, and Pratt & Whitney.*



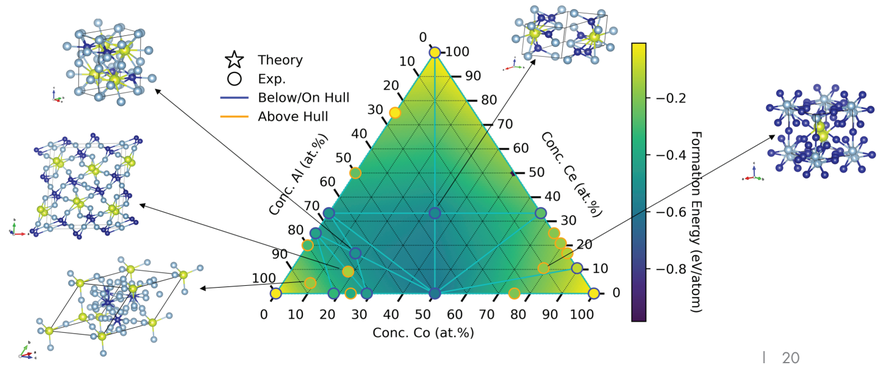
# Collins Aerospace Center for Advanced Materials

Collins Aerospace

Collins Aerospace Center for Advanced Materials is a collaboration between Collins Aerospace and UConn that has continued for over two decades. It offers educational funding to graduate and undergraduate students as well as post-doctoral fellows in areas related to materials development and characterization and provides opportunities for firsthand interactions with an industrial partner whose focus is on advanced aerospace and defense products. The center has three main research thrusts: (1) design and development of custom aerospace alloys that lend themselves to additive manufacturing using computational and experimental tools, (2) processing of high temperature ceramic composites for extreme environments and (3) quasicrystal-strengthened alloys for structural applications.

## Areas of Expertise

- Materials-by-design, materials genomics
- Ab initio calculations of materials properties, surface phase diagrams, precipitation
- Advanced materials characterization (x-ray diffraction, high resolution transmission electron microscopy)
- Thermo-physical property measurements (thermal diffusivity, specific heat, viscosity, thermal expansion), measurement of mechanical properties under extreme conditions (high temperatures, high strain rates)
- Metal additive manufacturing
- Corrosion resistance
- High-T composites, ceramic matric composites
- Chemical vapor deposition (CVD), chemical vapor infiltration (CVI), sol gel deposition, and polymer impregnation processing



# Meet the Researcher: George Bollas

Consider the complexity of a modern passenger airliner. An aircraft is a self-contained "system-of-systems," consisting of a diverse assortment of interdependent subsystems and components working together. Electrical, hydraulic, flight control, fuel handling, cabin pressurization, and engine systems are all crucial parts of a functional aircraft, each with their own constraints and requirements in addition to those of the aircraft as a whole.

The complexity of engineering interconnected systems like aircrafts — or, for that matter, power plants, smart buildings, and modern manufacturing facilities — has led many industries to migrate toward formalized systems engineering, considering large systems holistically.

Led by George Bollas, the United Technologies Corporation Institute for Advanced Systems Engineering (UTC-IASE) has been solving these real-world problems for industry since 2013.

Bollas, who is a professor of chemical and biomolecular engineering in UConn's School of Engineering, focuses his research on process design, simulation, optimization, control, and diagnostics. These research interests align seamlessly with the needs of industry partners like United Technologies Corporation.

Located in the Innovation Partnership Building (IPB) at UConn Tech Park, UTC-IASE is working on some of the most pressing challenges for businesses and research sponsors using innovative approaches to model-based systems engineering.

"We have converted it to something that is self-sustained and can work with United Technologies at many levels, but also engage other satellite industry partners, the state, and federal agencies to have a greater impact," says Bollas.

**Location, Location, Location**

At the IPB, students from different departments and research groups in the School of Engineering who are working on different projects managed by the UTC-IASE can come together in a central location. Much like the complex operations the students are researching, their individual projects and skills all work together to make systems more efficient. Bollas says this allows for close collaboration and frequent discussion of what each individual group is tackling.

> We call this integration of undergraduates, graduate students, and professional engineers a 'talent eco-system'
>
> — George Bollas

"For the first time we're all in one place," Bollas says. "To develop that culture for students, where they work next to each other, day and night, and all that good competition that comes out of it is very positive for the mindset and culture both at UConn and when these students go out in the workforce."

Industry often focuses on measurable outcomes, seeking means for producing their products better, faster, and at reduced cost. Awareness of these tangible impacts helps students understand the importance of their research, says Bollas.

"In many cases, you know from the get-go that you are going to help a company solve a $10 million-a-year problem. It's very exciting for the students to work on something that they understand has immediate value and impact on such a huge scale," Bollas says.

Many of the students at the UTC-IASE go into careers with United Technology Corporation or other companies in the area of manufacturing, energy, aerospace, building, and robotics. The experience contributes to the preparation of graduate and undergraduate students for these careers as they learn to communicate with industry partners effectively and consistently.

"It's a natural next step," Bollas says. "It's very helpful to know where they might be going, what they're going to face in industry or academia."

In addition to graduate research, UTC-IASE exposes UConn students to business professionals through a training program that was originally designed for employees of the corporation. Bollas says this training is critical, since the entire concept of systems engineering works to un-train students from thinking about problems in terms of their own specificity.

"In both research and training, we emphasize the concept of system-level thinking. One needs to understand what the entire system looks like – from architecture to requirements, design, commissioning, performance, and maintenance. This approach relies on thinking of the entire life-cycle of a system from design to decommissioning."



To accomplish this, UTC-IASE offers training of professionals through a formal Graduate Certificate and a Master of Engineering program in Advanced Systems Engineering. These programs are offered to geographically dispersed professionals as well as students at UConn who are interested in developing a unique and valuable set of skills in the areas of model-based systems engineering of cyber-physical systems.

"We're helping lifelong learning for the existing engineering workforce," Bollas says. "We're helping them understand what is the state-of-the-art, and some of the approaches and solutions to the problems they are dealing with in their everyday work. We call this integration of undergraduates, graduate students, and professional engineers a 'talent eco-system' that can produce and sustain a modern engineering workforce in the state and for the nation."

**Big Problems, Real Solutions**

Bollas is currently collaborating with Collins Aerospace to improve fault detection and isolation methods. The advanced detection algorithms Bollas and his research team are developing are optimized for actively identifying faults during aircraft operation and helping to reduce false alarms. This project has already led to two patent applications filed jointly by UConn and Collins Aerospace.

"We're transferring what we develop here at the university to actual industry environments, where we have access to all the data, constraints, requirements, and system-specific details. We do this through internships and sabbatical leaves, and this has really been a wonderful model for technology transfer," Bollas says. "I'm not sure we'd be aware of the significance and limitations of our research if we weren't working with a technology leader like UTC."

Bollas again points to the importance of location, both in Connecticut and at the IPB, to help the institute grow.

"There are so many opportunities generated for the institute just because we are located here," Bollas says. "We're working with several other IPB centers and their industry partners since they are more and more focused on 'smart' processes for manufacturing."

Bollas is referring to a paradigm shift dubbed Industry 4.0 or "smart manufacturing," which places emphasis on cyber-physical systems. Cyber-physical systems include physical machines controlled by


*George Bollas (standing), professor, and Amy Thompson (left), associate professor in residence, speak to UConn students at the IPB. (Al Ferreira/UConn Photo)*

computer-based algorithms that are deeply ingrained in the so-called Internet of Things. To remain competitive, companies like Collins Aerospace and Pratt & Whitney have been investing in the development of smart manufacturing technologies in their respective industries. By having access to test beds at the Connecticut Center for Advanced Technology and the Pratt & Whitney Additive Manufacturing Center in the IPB, the UTC-IASE researchers working on smart manufacturing projects with the Department of Energy provide a better picture of how well their research, algorithms, and solutions will work when used in an industrial setting.

"Smart manufacturing solutions are sometimes easy on a computer, but when you actually have to deploy these advanced technologies, it's very helpful to have test beds we can use right here at the IPB," Bollas says.

Bollas says he is proud of laying a strong foundation for future growth through partnerships with industry and federal agencies on such a large scale. Moving forward, he has no doubt that the research collaborations taking place at UTC-IASE will continue to generate innovative, real-world solutions that help Connecticut and its industry partners grow.

- Anna Zarra Aldrich '20 (CLAS), Office of the Vice President for Research

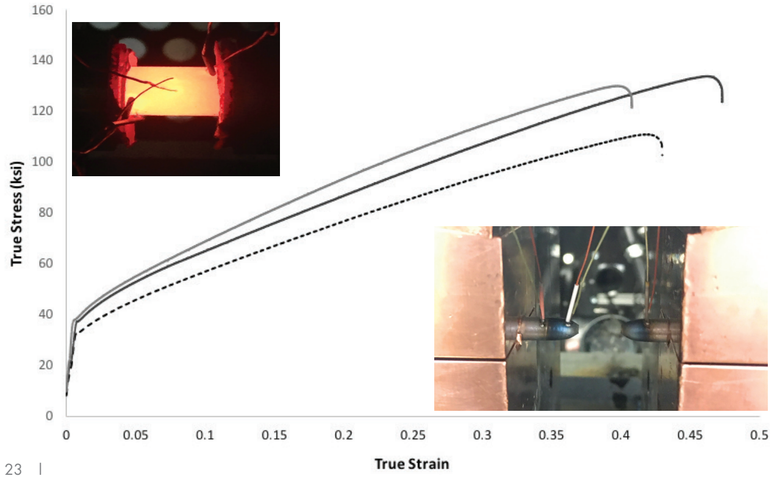
# Center for Materials Processing Data (CMPD)

Center for Materials Processing Data (CMPD) is a multi-university research center and consortium dedicated to producing and curating pre-competitive transient material property data used in materials process simulations and process design. The center is member driven with portfolio projects proposed by member companies and carried out by the academic members – UConn, Worcester Polytechnic Institute (WPI), and University at Buffalo. The goals of the center include the development and dissemination of best practices for materials data management, data exchange, and integration with computational methods, and the center serves as a hub for accelerating the transition from knowledge discovery in materials science to implementation in manufacturing.

## Accomplishments

Over the past year, the center has achieved the following:

- Established by-laws and forms for member agreement and project selection.
- Established a memorandum of understanding (MOU) among the founding members of the CMPD. The founding members include UConn, WPI, University at Buffalo, ASM International, and Pratt and Whitney.
- Created a list of potential companies to join the consortium.
- Identified a pilot project for the center that involves all academic members and a potential member company (Concurrent Technologies Corporation). The pilot project focuses on the digitization of the Atlas of Formability, supplemented with forming experiments carried out on the Gleeble by Rainer Hebert's research group at the IPB.




**LESLEY FRAME**
Director CMPD
Department of Materials Science and Engineering

Faculty: 2
UConn graduate students: 2
WPI faculty: 2
WPI graduate students: 1
UB faculty:1
UB graduate students: 1
ASM: 3
Industry Members: 3

**Flow Stress Behavior**

*Flow stress measurements on several steel alloys using the Gleeble 3500 at the Innovation Partnership Building.*



# New UConn Research Center Provides Reliable Data, Realistic Simulations for Manufacturing Industry

The University of Connecticut recently launched the Center for Materials Processing Data (CMPD) with their university and industry collaborators.

The center will provide the manufacturing industry with valuable data about how their materials will perform, eliminating much of the time and cost-intensive trial and error upon which the industry has relied for years.

UConn is working with the Worcester Polytechnic Institute and the University at Buffalo, each bringing unique expertise and workforce to the center projects. Another key player is ASM International, one of the world's largest associations of materials engineers and scientists. ASM International serves as the materials data archive, enabling easy access to data by industry members and non-members.

CMPD works with businesses in the manufacturing industry, like UTC Pratt and Whitney, to provide reliable transient material property data representing how materials respond under dynamic and realistic processing conditions. Currently, industries rely on material data gathered under static conditions that may not accurately reflect the variations in load, temperature, and atmosphere that materials undergo during manufacturing.

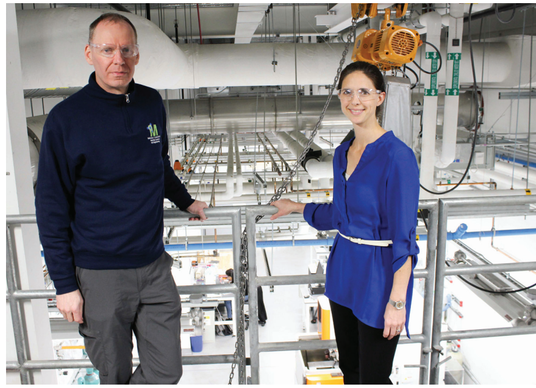
"The center provides an opportunity for the materials engineering community to take a deep dive into the specific challenges of gathering transient material property data," says Lesley Frame, CMPD director and assistant professor in UConn's Department of Materials Science and Engineering. "There are three equally important pieces to this goal: the first is generating accurate materials property data; second, we need to curate these data and qualify and compare against published materials data; and third, we need to demonstrate modeling applications of how we can reliably use these data. This is where the center comes in."

One of UConn's greatest contributions to the center is the state-of-the-art equipment in its Innovation Partnership Building (IPB) at UConn Tech Park.

"UConn has an arsenal of equipment at IPB that is perfect for gathering dynamic material property data," Frame says. "We're able to leverage these resources to answer questions about materials behavior that are very difficult to answer with basic equipment."

One industry application of the type of data produced through CMPD projects is with digital twins, which are digital replicas of real world entities. Researchers and industry professionals are beginning to use digital twins of a given material during manufacturing to characterize what is happening to it on a microscopic level as it is processed. The digital twin allows researchers to understand and document changes in structure and properties for materials through a computer model in a way that is just not possible with the physical material itself. However, these digital twins are only as accurate as the data fed into the models. When material data is collected under static conditions, but then fed into a model that is meant to characterize a dynamic material response, there will inevitably be some error in the result. Better data means more reliable models and better predictions of material behavior during processing.

When industry members join CMPD, they have access to every step of the projects. Industry members help to govern the center, they recommend and choose projects, and they continue to advise and participate in projects as they evolve. Industry members also have access to the resulting data.



*Rainer Hebert and Lesley Frame from UConn's Department of Materials Science and Engineering in the Innovation Partnership Building at UConn Tech Park. (Carson Stifel/UConn Photo).*

"The entire field is interested in generating and using more materials data," Frame says. "There's an industry-wide shift to be able to model and predict the behaviors of materials rather than doing trial and error for process development."

"UConn's leadership in CMPD will help further cement the University as a hub for innovation in the fields of manufacturing research and materials engineering," says Pamir Alpay, executive director of the Innovation Partnership Building.

"CMPD is huge in terms of everything we're doing at IPB on manufacturing technologies. It's a massive effort that will serve a large community and it will make a big impact. It will become a point of priority for UConn."

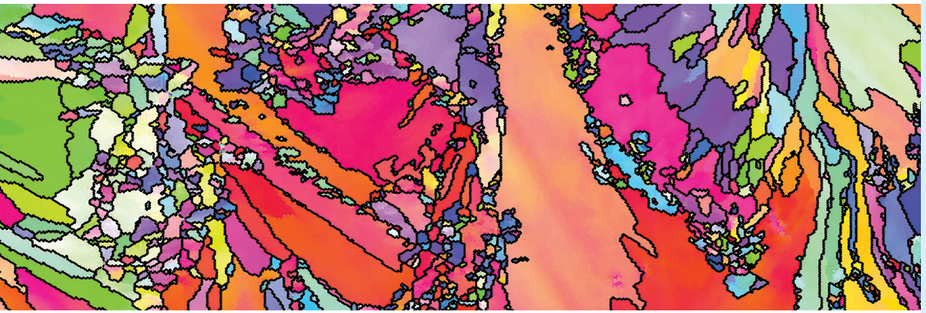
- Anna Zarra Aldrich '20 (CLAS), Office of the Vice President for Research

# UConn Thermo Fisher Scientific Center for Advanced Microscopy and Materials Analysis (CAMMA)

Thermo Fisher Scientific Center of Advanced Microscopy and Materials Analysis (CAMMA), a partnership between Thermo Fisher Scientific and UConn, is one of the world's foremost facilities for electron microscopy. It offers researchers training resources, research funding, and access for its high-end microscopy equipment, which is also available for collaborative research with industry partners. CAMMA's nine microscopy instruments include the Titan Themis for single atom resolution with spherical aberration correction and the Talos TEM for atomic resolution imaging and elemental analysis. Scientists use CAMMA's sophisticated materials characterization tools to conduct leading research in areas such as biomedical materials, powder analysis, and clean energy.

## Areas of Expertise

- Metallurgy
- Semiconductors
- Magnetic materials
- Adsorbents
- Catalysts
- Sensors
- Biomaterials
- Polymers
- Synthesis
- Characterization
- Batteries
- Electrochemistry
- Thermal analyses
- Absorption
- Emission
- Diffraction
- Scattering
- Alloys
- Flexible electronics
- Emulsions micelles surfactants
- Separations
- Academic industrial interactions
- Technology transfer



**STEVEN L. SUIB**
Director CAMMA
Department of Chemistry

Faculty: 41
Post-doctoral Fellows: 22
Graduate Students: 124
Undergraduate Students: 1
Staff: 3

*Electron Backscatter map of crystal orientation of steel formed by additive manufacturing.*

**SINA SHAHBAZMOHAMADI**
Director REFINE
Department of Biomedical Engineering

Faculty: 1
Affiliated Faculty: 16
Researchers: 7
Post-doctoral Fellows: 1
Graduate Students: 10
Undergraduate Students: 6
Staff: 1





# Reverse Engineering Fabrication Inspection & Non-Destructive Evaluation (REFINE)

Reverse Engineering Fabrication Inspection & Non-Destructive Evaluation (REFINE) lab houses state of the art light, X-ray, electron and ion microscopes. The lab focuses on "correlative microscopy" where information from multiple imaging modalities can be integrated in order to reach a much deeper understanding of imaged samples. REFINE lab's instruments can "talk" to each other, enabling researchers to gain a multi-dimensional, multi-resolution and multi-scale perspective about the studied sample. REFINE is working closely with industries in areas of electronics and hardware security, biomedical devices, batteries and energy storage, aerospace, advanced coatings, and additive manufacturing.

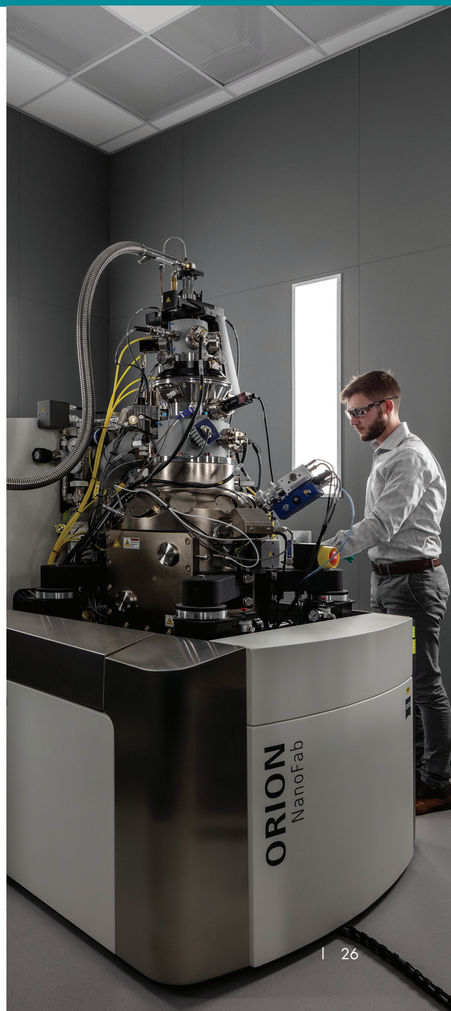
## Areas of Expertise

**Applications**

- Hardware Security
- Circuit Edit and IC Debugging
- Semiconductor and Lithography
- Batteries and Energy Storage
- Failure Analysis and Forensic Analysis
- Advanced Coatings
- Biomedical Devices

**Methods**

- 3D X-ray Tomography
- 3D FIB Tomography
- 3D EDS
- 3D SEM Imaging
- Non-destructive Methods
- Correlative Microscopy
- In Situ Imaging
- Computational Microscopy
- Light and Confocal Microscopy



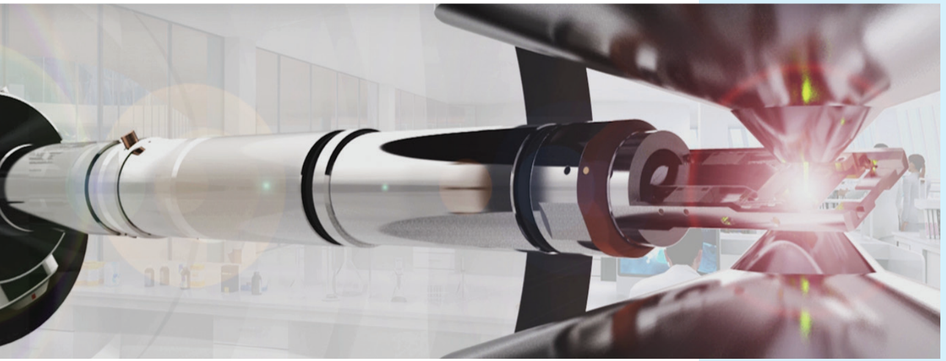
# UConn DENSsolutions Center for IN-siTu/ Operando Electron Microscopy (InToEM)

The IN-siTu/Operando Electron Microscopy (InToEM) center is a partnership between UConn and DENSsolutions, one of the world's leading suppliers of state-of-the-art MEMS-based In Situ systems. These advanced systems deliver stimuli like heating, biasing, gas and liquid into transmission electron microscopes (TEM), essentially transforming the TEM from a sophisticated imaging instrument into a comprehensive research laboratory on a chip.

At the InToEM center, material scientists, chemists, physicists, computer scientists and engineers working together at the frontier of understanding materials dynamics. These new in-situ/operando microscopy capabilities and collaborations hold promising potential for transformative research in nanomaterials synthesis, heterogenous catalysis, corrosion and alloy degradation, fuel cells and many other material systems important to everyday life.

## Areas of Expertise

- Catalysis
- Nanostructure growth
- Phase transformation
- Redox reaction
- Defect motion
- Thermal effect
- Material degradation
- Kinetics
- Calorimetry
- Residual gas analysis
- Computer vision
- Real-time object tracking



**YUANYUAN ZHU**
Director InToEM
Department of Materials Science and Engineering

**STEVEN L. SUIB**
Co-director InToEM
Department of Chemistry

Faculty:2
Graduate Students: 1

*"Lab on Chip" in-situ TEM gas and heating system*





# Center for Science of Heterogeneous Additive Printing of 3D Materials (SHAP3D)

The Center for Science of Heterogeneous Additive Printing of 3D Materials (SHAP3D) is a named National Science Foundation (NSF) industry/university cooperative research center (I/UCRC) dedicated to additive manufacturing. Co-founded by UConn, University of Massachusetts, and Georgia Institute of Technology, the center strives to develop critical insight into the fundamental structure-processing-property relationships to control the integration of diverse materials, decrease cost and increase reliability at all stages of additive manufacturing. SHAP3D provides a platform in which companies and federal agencies may cost-effectively collaborate on shared, pre-competitive research topics by leveraging R&D investment to access world class facilities, faculty and graduate students.

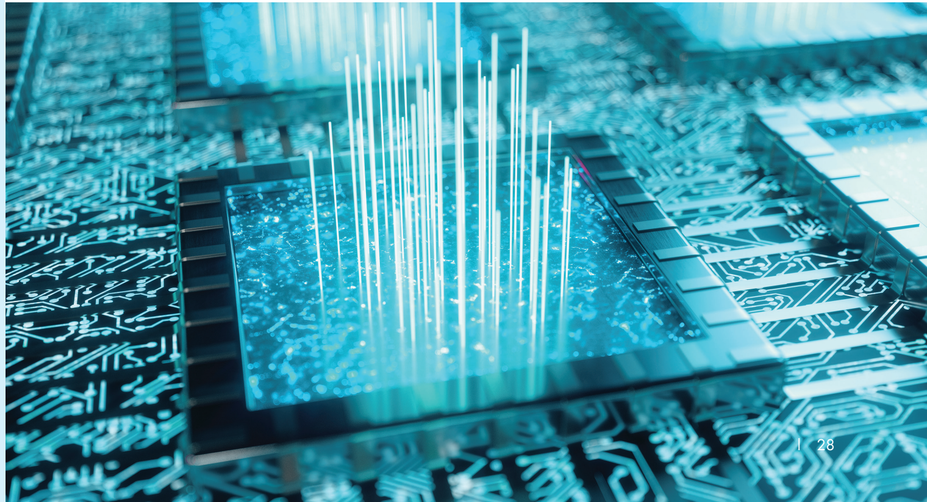
More than 50 faculty members from three universities are affiliated with SHAP3D.

## Areas of Expertise

- Multi-material 3D printing
- Machine learning and automated defect detection
- Data-driven modeling for material selection and process optimization
- In-situ process monitoring and closed loop manufacturing
- Characterization of feedstock materials and printed parts
- 3D printing for flexible electronics, food, and pharmaceutical applications

**ANSON MA**
Site Director SHAP3D
Department of Chemical and Biomolecular Engineering

Faculty: 15
Post-doctoral Fellows: 2
Graduate Students: 3



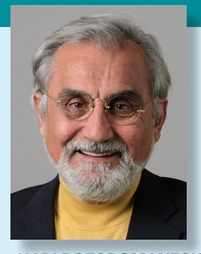
# Enterprise Solution Center (ESC)

The Enterprise Solution Center (ESC) is an innovation hub that connects small and medium manufacturing enterprises (SMMEs) to science and engineering resources at UConn and to major original equipment manufacturers (OEMs).

**Our Approach**

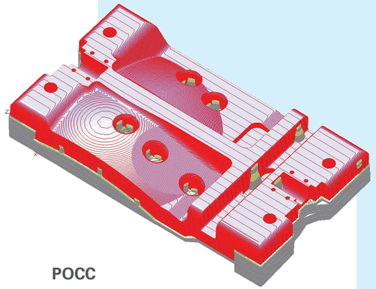
The ESC comprises three component organizations, Quiet Corner Innovation Cluster (QCIC), Proof of Concept Center (POCC) and Connecticut Manufacturing Simulation Center (CMSC), taking an integrated approach to co-development of technology products and services to support the competitiveness of SMMEs and the OEMs.

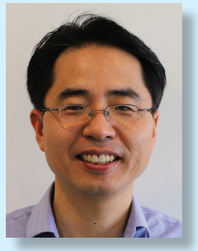
- Proof of Concept Center (POCC) offers state-of-the-art prototyping and fabrication equipment that facilitate new product development for a wide range of industries.
- Quiet Corner Innovation Cluster (QCIC) partners with SMMEs to promote business growth through innovation, enhanced R&D, and updated business capabilities.
- Connecticut Manufacturing Simulation Center (CMSC) provides SMMEs with affordable technical assistance for computer-based design, finite element modeling and simulation, testing, and validation, with capabilities in modeling a variety of manufacturing processes, including machining, forming, forging, and casting.



**HADI BOZORGMANESH**
Director ESC
School of Engineering

**JOSEPH LUCIANI**
Director POCC
Director QCIC





**JEONGHO KIM**
Director CMSC
Department of Civil and Environmental Engineering

**JEFF MCCUTCHEON**
Fraunhofer USA Center for Energy Innovation CEI
Department of Chemical and Biomolecular Engineering

## Areas of Expertise

**QCIC**

- Business process optimization
- Technology development
- R&D commercialization
- Product development
- Business model development
- Prototyping and proof of concept
- Market research
- Rapid prototyping
- Research and development evaluation
- Materials science

**CSMC**

- Finite element modeling and simulation
- Analysis of residual stresses and distortions
- Machining simulation (turning, milling, cutting)
- Sheet metal forming simulation
- Hot press forming simulation
- Heat treat simulation
- Metal forging simulation
- Casting simulation

**POCC**

- Design, prototyping, and verification
- Product development
- Design for manufacturing
- Additive manufacturing for prototyping
- Additive manufacturing for manufacturing
- Laser cutting / abrasive water jetting
- CNC machining
- Reverse engineering

**ESC**
Faculty: 9

**CMSC**
Faculty: 7
Graduate Students:3
Staff: 1

**POCC**
Graduate Students: 1
Undergraduate Student: 1
Staff: 1

Faculty: 1
Graduate Students: 3
Staff: 4





# Fraunhofer USA Center for Energy Innovation CEI

The Fraunhofer Center for Energy Innovation (CEI) is dedicated to applied research in membrane technology. The CEI is part of Fraunhofer USA, Inc., a 501 (c) (3) not-for-profit organization that aims to close the innovation gap from the lab to the market and develop and validate technologies for industrial innovation in the United States. The CEI's focus on membrane technology allows it to provide R&D services across numerous industrial sectors.

## Areas of Expertise

- Polymeric Membranes
- Ceramic Membranes
- Energy efficient water treatment
- Power-to-gas processes
- Biogas purification processes
- Solid oxide fuel cells
- Flow Batteries
- Electrolyzers
- Combined heat and power processes
- Liquid biofuels processing and dewatering
- Organic solvent nanofiltration

# Instrumentation

## South Wing

First Floor

The labs in the South Wing feature:

- Perfect vibration isolation
- Perfect EMI isolation
- Acoustic noise mitigating wall panels
- Regular exhaust and corrosive exhaust in equipment chase
- Secure key card access doors
- 60-inch monitor screens

### REFINE EQUIPMENT

Exceptional state-of-the-art equipment including correlative multiscale workflows with X-ray, optical, ion and electron microscopy

**Focused Ion Beam Milling**
- Zeiss Crossbeam 340 w/ Laser
- Zeiss Orion Nanofab

**3D Xray Tomography**
- Zeiss Xradia Versa 520
- Zeiss Xradia MicroCT 400

**Optical and Confocal Microscopy**
- Zeiss Smart Proof
- Zeiss Smart Zoom

**Circuit Edit**
- FEI Micrion Vectra 986

**X-Ray Analytics**
- Rigaku SmartLab X-ray Diffraction System
- Rigaku ZSX Primus IV XRF Spectrometer

### THERMO FISHER SCIENTIFIC CAMMA EQUIPMENT

One of the foremost electron microscopy facilities in the United States, capable of analyzing materials on several scales

**Electron Microscopy**
- Titan Themis ACEM
- Talos F200X S/TEM
- Verios 460L SEM
- Teneo LV SEM
- Aspex Explorer VP SEM
- Tecnai T-12 TEM

**Focused Ion Beam Milling**
- Helios PFIB Dual Beam
- Helios 460F1 Dual Beam
- Strata 400S Dual Beam

### InToEM EQUIPMENT

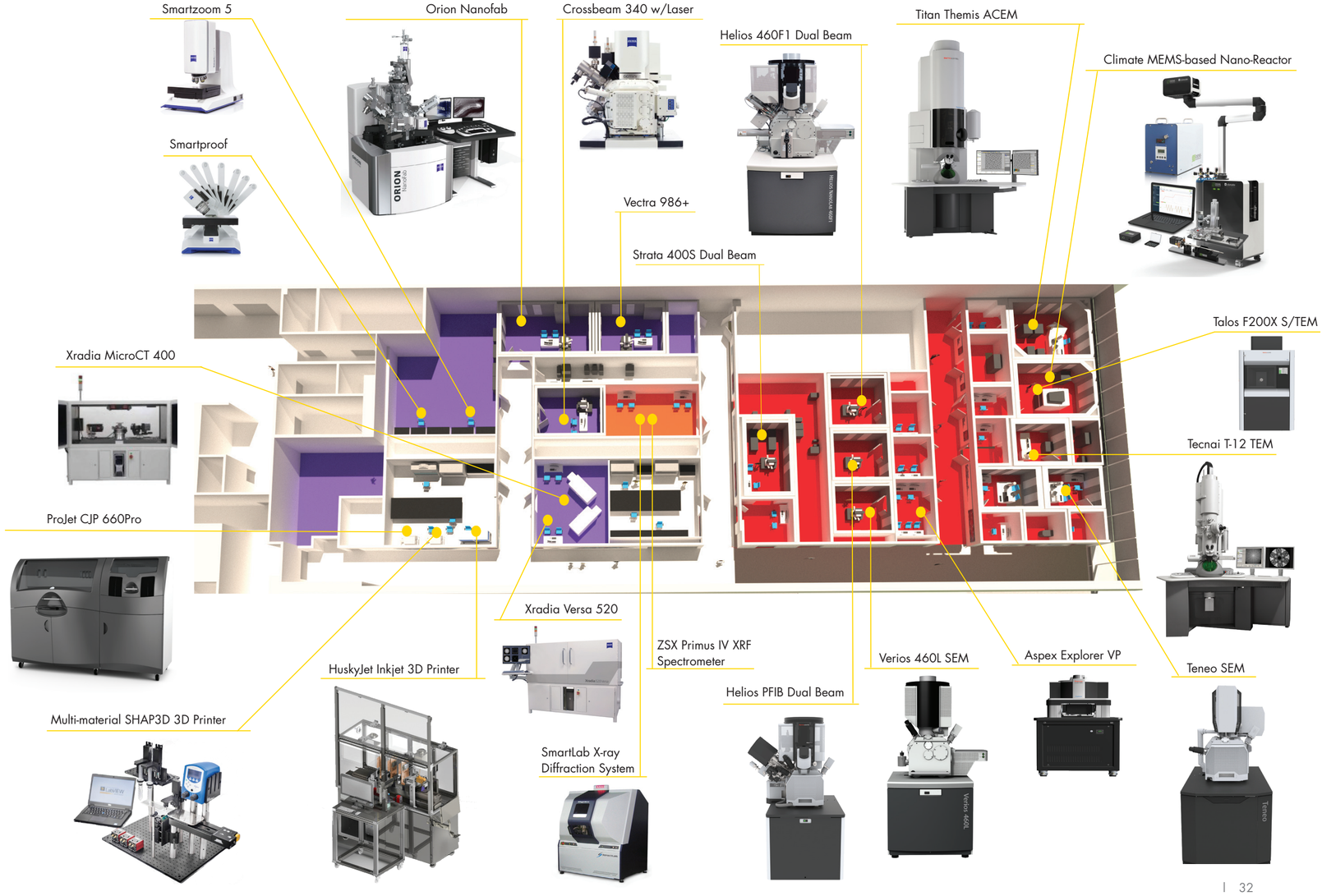
Sophisticated MEMS-based in-situ environmental TEM systems

- DENSsolutions Climate MEMS-based Nano-Reactor
  - Dynamic gas supply system
  - 1-bar MEMS gas-cell with integrated micro-heater
  - *In-situ* calorimetry
  - *In-situ* residual gas analysis

### SHAP3D EQUIPMENT

Named National Science Foundation (NSF) collaborative center housing state-of-the-art 3D printers, specializing in multimaterial printing and autonomous digital manufacturing

**3D Printing**
- Pilot-Scale HuskyJet Inkjet 3D Printer
- Multi-material SHAP3D 3D Printer
- 3D Systems ProJet CJP 660Pro



# Instrumentation

## North Wing

First Floor

### PRATT & WHITNEY ADDITIVE MANUFACTURING CENTER

The Pratt & Whitney Additive Manufacturing Center (PW AMC) primarily addresses materials-related, fundamental challenges of metal additive manufacturing. Combining commercial and custom-built powder bed additive manufacturing machines as well as highly specialized characterization equipment, the center advances the knowledge of powder raking, melting, and solidification. The fundamental research of these topics is applied to alloy development, verification and validation of additive manufacturing simulation software. On a more applied side the center supports the private and public sector with help in qualifying the additive manufacturing process.

### PW AMC EQUIPMENT

**Materials Testing**

- Gleeble 3500 (thermo-mechanical simulation system)
- Retsch Camsizer XT (Powder Size Distribution Analyzer)
- TA Instruments EM 1600 (Laser Flash)
- TA Instruments EM 2800 (Laser Flash)
- TA Instruments ODP 868 Optical Dilatometry Platform
- LECO ONH 836 (Oxygen-Nitrogen-Hydrogen Analyzer)
- LECO CS 844 (Carbon Sulfur Analyzer)
- Anton Paar Furnace Rheometer System FRS 1800
- Netzsch Pegasus DSC 404 F1
- Mettler-Toledo Flash DSC 2+
- Correlated Solutions VIC 3D Non-Contact Strain Measurement System

**3D Printing**

- Arcam A2X
- EOS M270
- 3DSystems ProX300
- IPG Photonics metal powder bed test bed machine

**Manufacturing and Materials Processing**

- MRF Arc Melter
- Agie Charmilles Wire EDM

# Instrumentation

## Proof of Concept Center & Connecticut Manufacturing Simulation Center

3rd Floor

The Proof of Concept Center and Connecticut Manufacturing Simulation Center house state-of-the-art simulation, prototyping and fabrication equipment that facilitate design and development of fully functional prototypes for a wide range of industries.

### POCC EQUIPMENT

**3D Printing**

- Stratasys Connex350
- Stratasys Design F370
- Formlabs Form 2

**Manufacturing and Materials Processing**

- Universal Laser Systems ILS 12.150D
- ICONIC CNC Router
- Haas CNC Mill
- Haas CNC Lathe
- OMAX Protomax Waterjet

**Robotics/Automation**

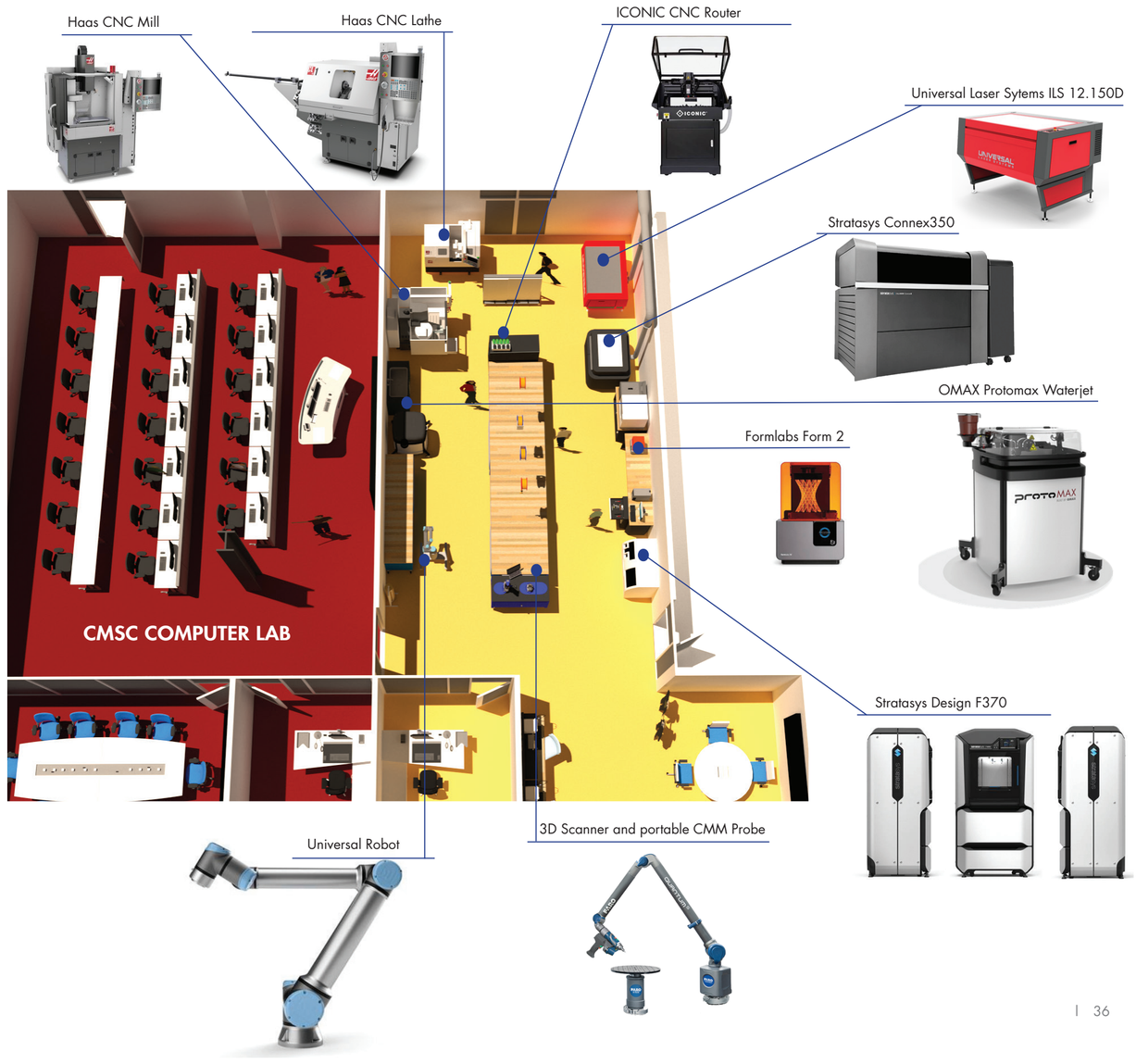
- Universal Robot

**Reverse Engineering**

- Faro Quantum 3D Scanner/Arm

### CMSC EQUIPMENT

- 12 Dell Precision Workstations with 10-core Xeon processors/64GB of ram with priority access to 14 nodes, i.e. 504 cores, on UConn's high performance computing (HPC) cluster
- Modeling and simulation software suites include ANSYS, Solidworks, and ABAQUS
- MSC Software Suite
  - » Adams
  - » MSC Apex
  - » MSC Nastran
  - » Simufact Additive
  - » Simufact Forming
  - » Simufact Welding



# Innovation Partnership Building Visitors To Date

## ACADEMIA

- Ashesi University, Ghana
- CentraleSupelec, France
- Clemson University
- College of Technology (COT) - Connecticut State Colleges & Universities
- ETH Zurich, Switzerland
- Georgia Tech
- Indian Higher Education Knowledge Delegation
- Istanbul Technical University, Turkey
- Massachusetts Institute of Technology
- Purdue University
- Southern Connecticut State University
- Technion - Israel Institute of Technology
- Tokyo University of Science, Japan
- Université Fédérale Toulouse Midi-Pyrénées, France
- University of Bridgeport
- University of California, Los Angeles
- University of Colorado
- University of Florida
- University of Maryland
- University of Massachusetts Amherst
- University of Massachusetts Lowell
- University of Nottingham, UK
- University of Rhode Island
- University of Virginia
- Worcester Polytechnic Institute
- Yale Entrepreneurial Institute
- Yale Office of Cooperative Research
- Yale University

## GOVERNMENT AGENCIES AND LEGISLATORS

- US Senator Richard Blumenthal
- US Senator Chris Murphy
- US Congressman Joe Courtney
- US Senator Richard Blumenthal Senior Policy Advisor and Staff
- US Senator Chris Murphy Lead Staff Delegation
- US Congressman Joe Courtney Military Legislative Assistant
- US Congressman Ralph Abraham Legislative Assistant
- US Senator Deb Fischer Defense Team
- CT Senator Kevin Witkos
- CT Senator Cathy Osten
- CT Representative Christopher Davis
- Air Force Research Laboratories (AFRL)
- Army Research Laboratory Northeast
- Army Research Labs
- Brookhaven National Laboratory
- Department of Economic and Community Development (DECD)
- Department of Energy
- Department of Navy SBIR STTR
- Economic Development Specialist, Town of Wallingford
- Federal Bureau of Investigation
- German Delegation from Boston Consulate
- Lawrence Livermore National Laboratory
- National Renewable Energy Laboratory (NREL)
- NAVAIR
- Naval Surface Warfare Center - Crane Division
- Naval Undersea Warfare Defense Center (UWDC)
- NAVSEA Warfare Centers
- Navy Research Laboratories
- North Haven Economic Development Commission
- Southeastern CT Legislative Delegation
- Town of Berlin
- US Army Futures Command
- US Army Natick
- US Commissioner for Patents
- US Small Business Administration

## INDUSTRY

- 3M
- ABB
- Acme Wire Products Co, Inc.
- AddUp Solutions
- Advanced Manufacturing LLC
- Advanced Robot Solutions
- Aero Gear Inc.
- Altek Electronics Inc
- Amastan Technologies
- Amazon Lab126
- Anton Paar
- ARsome Technology Group
- Associated Spring
- AVANGRID
- Ballard Power
- Barnes Group
- Bead Industries
- BMA Ambiental (Brazilian delegation)
- Boehringer Ingelheim Inc
- Boeing
- Brainstorm
- Cabot Corporation
- Cadenza Innovation
- Campbell Soup Company
- Carlyle Johnson Machine Co, LLC
- Chasm Technologies
- Cigna
- CMT Materials
- CNC Software
- Cognizant
- CohnReznick LLP
- Collins Aerospace
- Convergent Mission Solutions
- Crimson Rook LLC
- Cronin
- Crunch Technologies
- Cyient
- Dante Solutions, Inc
- Deloitte

*Women in Manufacturing (WiM) Connecticut Chapter*

- Disruptive
- Dive Technologies
- Dur-A-Flex
- Dynamic Systems Inc. (Gleeble)
- ELDOR Group
- Electric Boat
- Ensign-Bickford Aerospace & Defense Company
- Enviro Power LLC
- Eversource
- Exxon Mobil
- Fraunhofer USA
- GE Appliances
- GE Power, Gas Power Systems
- General Dynamics Electric Boat
- Gentex
- Gerber Technology
- Giner, Inc
- GKN Aerospace
- Godman Energy
- Greentown Labs
- GSW Software (Brazilian delegation)
- H2Sonics
- Hampford Research
- Hartford Steam Boiler Inspection and Insurance Company
- Health eSense
- Henkel
- Hitachi Cable
- Honeywell
- Hub55 (Brazilian delegation)
- Hubbell Commercial and Industrial Group
- Hydrogen South Africa (HySA) Systems
- Imcorp
- InCHIP
- Infosys
- InYou Health (Brazilian delegation)
- Jonal Laboratories, Inc.
- Kaman
- Kidde
- Komatsu Ltd.
- Kurimoto, LTD (Japan)
- KX Technologies LLC
- Learn to Fly (Brazilian delegation)
- Line Master Switch
- Lite Sheet
- Loos & Co, Inc.
- M Cubed
- Macroscopic Solutions
- Marmon
- Marmon Water
- Mastercam
- Medigate
- Methods Machine Tools
- MetLife
- Metro Hartford Alliance
- Microsemi
- Mirion Technologies
- Mistras Group
- Moore Engineering
- Morgan Stanley
- MSC Software
- MSC Software /ACMT
- N&N Manufacturing
- Navatek
- Nel Hydrogen
- NERAC
- NGK-NTK
- Northrop Grumman
- Nustreem
- NY & New England SCORE
- Opus 12
- Otis
- OutSecure
- Owl Cyber Defense

# Innovation Partnership Building Visitors To Date

- Parrillo Consulting LLC
- Physical Electronics
- Platinum Equity
- Pratt & Whitney
- Precision Combustion, Inc.
- Proton OnSite
- Qualitech Systems, Inc.
- Queralt
- QUEST
- Raytheon
- RC-Film Co.,Ltd.
- Revision Military
- Rite Solutions
- Schwerdtle
- Shipman & Goodwin LLP
- Siemens
- Sikorsky Lockheed-Martin
- Simsbury Bank
- Skyre
- Solar Turbines
- Sonalysts
- Sperry Rail Services
- Stanadyne LLC
- Stanley Black and Decker
- Synchrony
- Synectic
- TechStars
- TERA-print
- Thayer Mahan
- The Carlyle Johnson Machine Company
- The Hanover Insurance Group
- The Lighting Quotient
- Thermofisher Scientific
- Tinnova (Brazilian delegation)
- Torrecom Partners, LP
- Travelers
- Trumph
- TTM Technologies
- U3 Advisors
- Ulbrich
- Unilever
- United Technologies Corporation (UTC)
- United Technologies Research Center (UTRC)
- Updike, Kelly & Spellacy, P.C.
- Weber Metals
- Welco Realty, Inc.
- Wepco Plastics, Inc.
- Whitcraft LLC

## OTHER

- Advanced Regenerative Manufacturing Institute (ARMI)
- Advanced Robotics for Manufacturing (ARM) Institute
- AFRL Industry Advisory Board
- ASM International - Hartford Chapter
- Clean Energy Smart Manufacturing Innovation Institute (CESMII)
- Connecticut Business & Industry Association (CBIA)
- Connecticut Center for Advanced Technology, Inc. (CCAT)
- Connecticut Conference of Independent Colleges (CCIC)
- Connecticut Economic Resource Center (CERC)
- Connecticut Innovations
- CONNSTEP
- CTNext
- Deshpande Foundation
- Fraunhofer ISE
- Hartford Business Journal
- International Council on Systems Engineering (INCOSE)
- IPB Advisory Board
- John and Donna Krenicki
- National Institute of Standards and Technology Manufacturing Extension Partnership (NIST MEP)
- Naval and Maritime Consortium
- New Haven Manufacturers Association
- Quinnipiac Chamber of Commerce
- Rebooting New England
- Sam Quigley-Lyman Allyn Art Museum
- Science of Heterogeneous Additive Printing of 3D Materials (SHAP3D)
- The Mitre Corporation
- Women in Manufacturing Group, CT Chapter
- Women in Manufacturing (WiM) Connecticut Chapter
- YEI Innovation Fund



# Small Business Support

As a land grant university, UConn has a responsibility to serve the citizens of the State and support economic growth for Connecticut businesses of all sizes. Executive Director of IPB, faculty, and staff are fully committed to this promise, and continually strive to establish new business collaborations and strengthening current research partner relationships with businesses of any size, from fledgling startups to global leaders, whose success will benefit the citizens of the State of Connecticut.

## ENTERPRISE SOLUTION CENTER

Quiet Corner Innovation Cluster (QCIC) supports business growth potential of small and medium-sized technology and manufacturing enterprises (SMEs) in the state of Connecticut. QCIC establishes partnerships with SMEs to enhance or expand their product and service offerings by leveraging UConn's extensive R&D capabilities and office of commercialization. Participating SMEs collaborate with UConn faculty who specialize in their area of focus.

Several of IPB's research centers participate in QCIC partnerships addressing unique industry challenges. QCIC is funded by the US Economic Development Administration (EDA), UConn, and Connecticut Innovations.

## PROOF OF CONCEPT CENTER

POCC has provided expert guidance to facilitate new product development, from conceptualization and ideation to creation of fully functional prototypes, for small and medium-sized companies in Connecticut. POCC's state of the art prototyping and fabrication equipment empower partners to accelerate the discovery of novel products and services.

### POCC PARTNERSHIPS

Acme Wire Products Co., Inc.

TRANS-TEK INCORPORATED

AERO GEAR Insist on Excellence

LINEMASTER® AMERICA'S FOOT SWITCH LEADER

LOOS & CO. INC.

control station

CARLYLE JOHNSON

## CONNECTICUT MANUFACTURING SIMULATION CENTER

CMSC has provided manufacturing simulation services to manufacturing companies in Connecticut. These projects are focused on engineering analysis and design, and manufacturing modeling and simulations. By collaborating with an engineering team in each company, CMSC is tackling real manufacturing industry problems and provides technical solutions. CMSC's modeling and simulation capability and service to Connecticut manufacturers promotes innovation and economic growth.

### CMSC PARTNERSHIPS

JONAL LABORATORIES

AERO GEAR Insist on Excellence

SPERRY

DUR-A-FLEX INNOVATION FROM THE FLOOR UP

GE POWER

Stanadyne

Barnes GROUP INC

Whitcraft LLC

# Advisory Board

The Advisory Board works hand in hand with UConn leadership to shape the strategic direction that guides the IPB | UConn Tech Park to success. We are fortunate to have established this well-balanced complement of accomplished professionals and leaders from diverse backgrounds including academia, business, engineering, and manufacturing. Their input and expertise will accelerate our programs, foster new partnerships and enable us to keep our finger on the pulse of innovation in our R&D undertakings.

**KEVIN BOULEY**
President & CEO
Nerac, Inc.

**KENNETH BOWES**
Vice President
ISO Policy, Siting and Compliance
Eversource

**ISAAC COHEN**
Executive Director
Collins Aerospace Program Office
United Technologies Research Center (UTRC)

**BONNIE DEL CONTE**
President/CEO
CONNSTEP

**DAVID FOORD**
Director of Marketing
Thermo Fisher Scientific

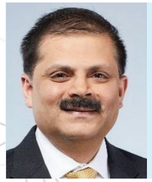
**COURTNEY HENDRICSON**
Vice President of Partnerships
AdvanceCT

**LAURA JAWORSKI**
State of CT Dept. of Economic and Community Development (DECD) Office of International and Domestic Business Development

**TANIA B. KASHYAP**
Director, Materials Engineering
Collins Aerospace

**GLEB REZNIK**
Deputy CISO
Synchrony

**SONIA TULYANI**
Senior Director
Materials and Process Engineering
Pratt & Whitney



**VENKAT VEDULA**
Executive Director
Additive Manufacturing
UnitedTechnologies Corp. (UTC)





**linkedin.com/company/uconn-tech-park/**

**techpark.uconn.edu**

## INNOVATION, MEET CREATIVITY

Image captions (page 4)

Original images and artwork are at linkedin.com/company/uconn-tech-park/

1. M. Raykova. Polycrystalline ceramic. Courtesy of Roger Ristau.
2. Y. Hang. Solid-state de-wetted gold microparticles. Courtesy of Tyler Flanagan.
3. M. Raykova. AuCu Alloyed Nanorods. Courtesy of Xudong Wang.
4. Y. Hang. K-OMS-2 crystal clusters. Courtesy of Xueni Huang (sample) and Lamya Tabassum (image).
5. M. Raykova. Kikuchi lines in a convergent beam diffraction pattern (CBED) of CrNb. Courtesy of Roger Ristau.
6. Y. Hang. CdSe-CdS core-shell quantum dot. Courtesy of Xudong Wang.
7. M. Raykova. Microporous material (MoVTeNbO). Courtesy of Yanliu Dang.
8. Y. Hang. Semiconductor integrated circuit. Courtesy of Haiyan Tan.

## REALIZATION

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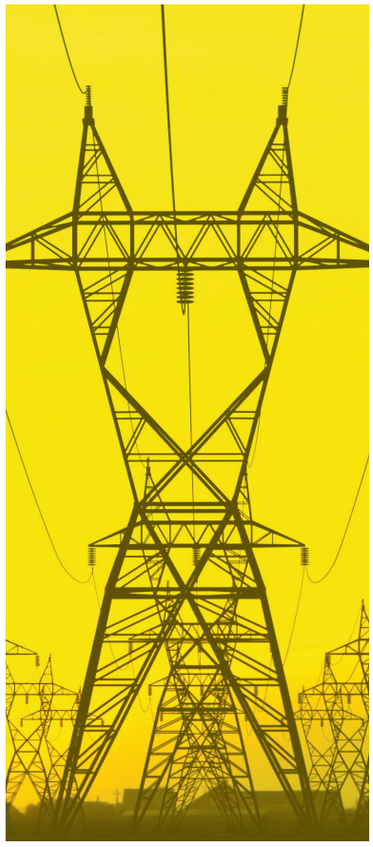
INNOVATION. COLLABORATION. INSPIRING GREAT IDEAS.

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