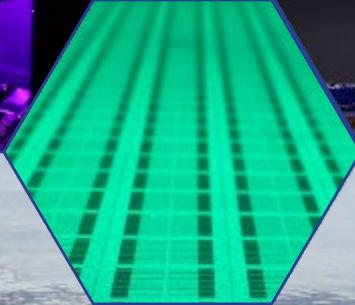
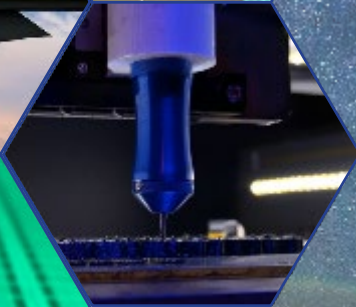
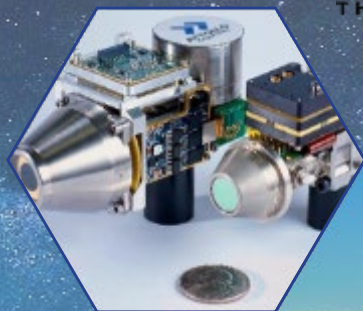
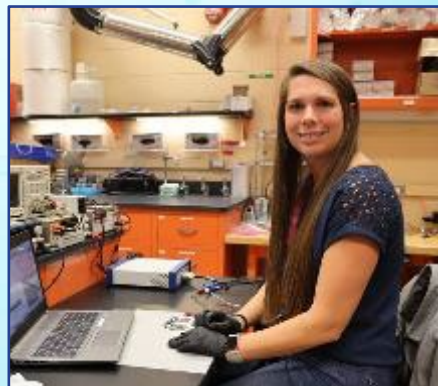
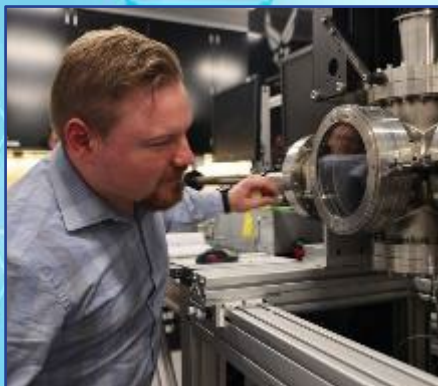


AFRL

THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER



THE MATERIALS AND MANUFACTURING DIRECTORATE



About This Book

This book highlights Air Force Research Laboratory (AFRL) Materials and Manufacturing Directorate successes as the foundational and principle expert for warfighter material needs. Materials, processes, and manufacturing are frequently enablers for technology advances and break barriers to technological progress. The following pages provide a brief insight into the Directorate and feature our mission, capabilities, and staff that help keep the United States Air and Space Forces the finest in the world.

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AFRL

RX MATERIALS & MANUFACTURING

Our Mission

Accelerate the availability of advanced and affordable materials & manufacturing technologies for the Airman and Guardian by driving the state of the possible and uniting the community.

Our Vision

We Invent the Stuff that Makes the Future

Materials and Manufacturing Directorate Overview

For over 115 years, the mission of the AFRL Materials and Manufacturing Directorate has remained the same. In peace and wartime, during economic growth, through recessions and depression, we have supported Air Force operations, developed materials and manufacturing technologies for Department of the Air Force customers, and created new materials processing technologies that enable future capabilities. Building upon a direct heritage from Orville and Wilbur Wright, the Materials and Manufacturing Directorate helps build the world's most powerful Air Force. Along the way, we have contributed significantly to the U.S. by creating many major technology advancements, enabling U.S. industries to thrive and surpass international competition. We consistently achieve this daunting task by weaving together three interconnected roles: the Materials and Manufacturing Directorate is a laboratory; we are a defense industry partner; and we are honest brokers and representation for the Department of the Air Force (DAF) acquisition and sustainment communities. In doing so, we cover the entire lifecycle of air and space materials and manufacturing. We are also a trusted advisor to national leadership to help establish technology policy for the Department of Defense. Connecting these different roles hasn't always been easy, and to many outside of the laboratory it can seem a little unusual that so many roles are funneled into a single organization. However, these roles produce a dynamic atmosphere that synergize into a whole that's greater than any individual part.



Hypersonic Cruise Missile

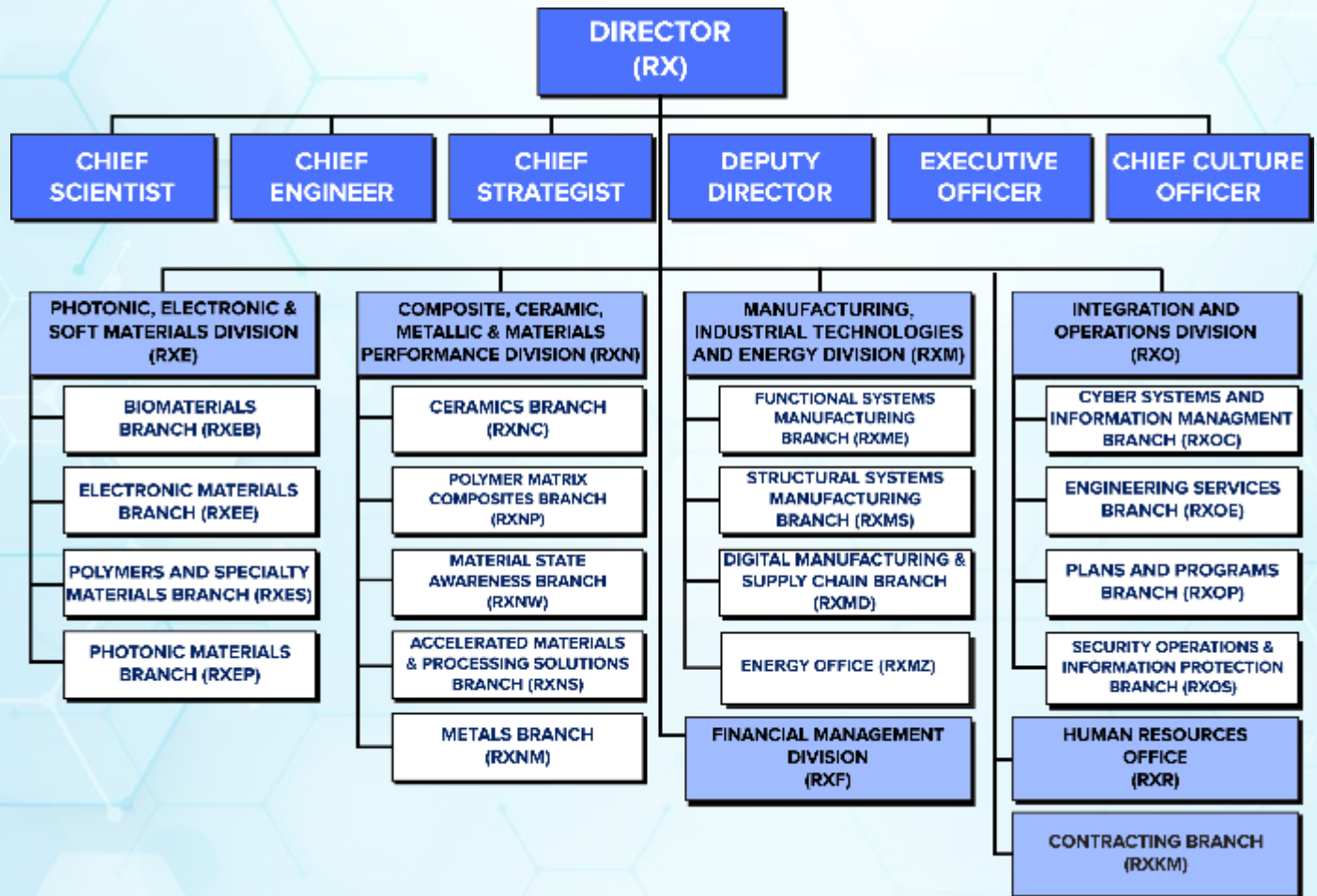


B-21 Raider



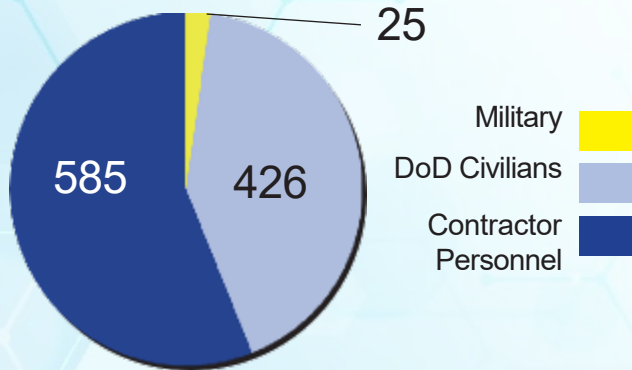
Space-based Infrared System (SBIRS)
Missile Warning Satellite

Materials and Manufacturing Directorate: Organizational Structure



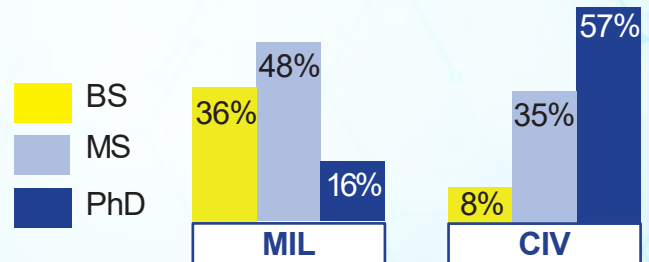
Materials and Manufacturing Directorate: Our People*

WORKFORCE



EDUCATION

(SCIENTISTS & ENGINEERS)



Approximately 20% of contractors hold PhDs

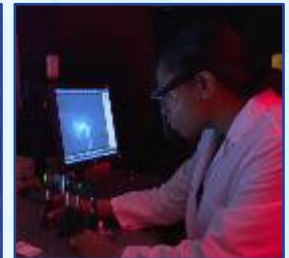
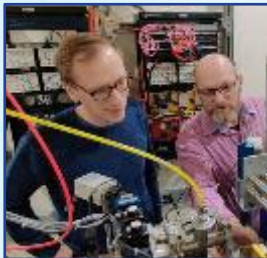
*As of Dec 2024

DEGREES AND SPECIALTY AREAS

Materials/Metallurgical Engineers
Chemists/Chemical Engineers
Research Physicists
Mathematicians

Aero/Astro Engineers
Civil/Industrial Engineers
Biologists/Microbiologists
Mechanical Engineers

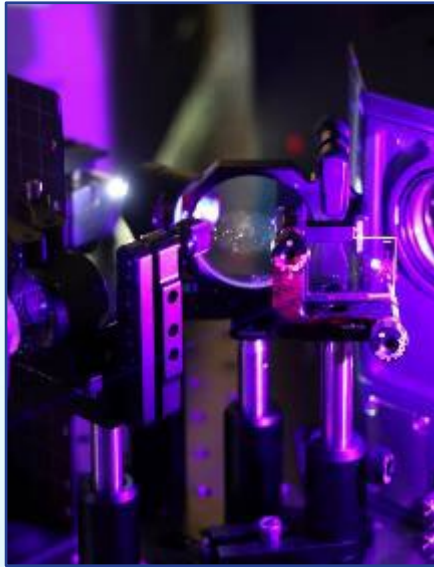
Computer Engineers/Scientists
Electrical/Electronics Engineers
Ops Research/Systems Engineers



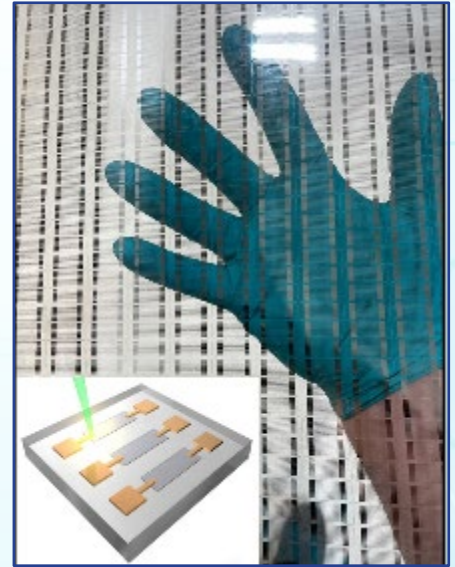
Photonic, Electronic & Soft Materials Division



Polymerized Liquid Metal Networks



Quantum Photonics

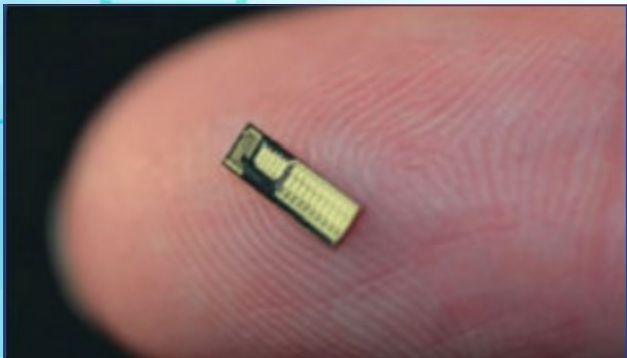


Laser-Written Circuitry

The Photonic, Electronic & Soft Materials Division leads research and development activities of materials for advanced battlespace awareness and sensing; materials for enhanced electromagnetic spectral dominance; and advanced materials and processes to support contested logistics. In partnership with industry and other government agencies, the Division combines subject matter expertise, extensive in-house laboratory facilities, and a portfolio of advanced development programs to mature and transition warfighter capabilities needed by the United States Air and Space Forces.

Electronic Materials

Establishes capability to affordably manufacture and develop electronic, magnetic, optoelectronic, integrated photonic, and quantum materials for Air Force and DoD weapon systems.



Silicon Photonics Chip

Polymers & Specialty Materials

Develops multifunctional, polymeric, and specialty materials and processes through research, development, and demonstration.



Soft Robot Finger

Biomaterials

Conducts critical foundational research and development of biological materials and processes, enabling a pervasive impact throughout a spectrum of operations and airpower capabilities.



Bio-cement

Photonic Materials

Advances a variety of photonic materials including optical coatings, metamaterials, liquid crystals, and nonlinear optical materials to control, manipulate, and protect against photonic energy.

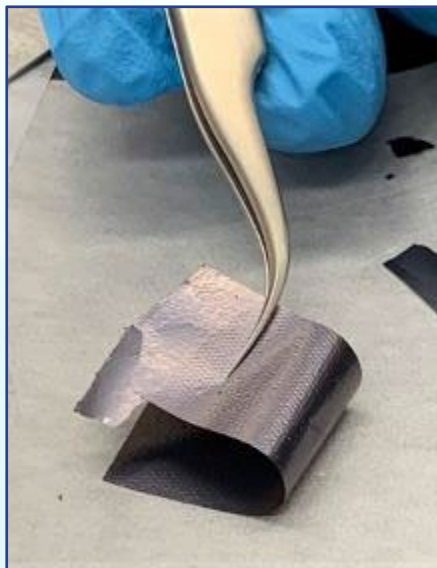


Metasurface Lens

Composite, Ceramic, Metallic & Materials Performance Division



Ceramics Parts in Rotary Detonation Engine Test



Sample of Mxene Polymer Film



Micro-Testing of a High Temperature Metal
With Side Induction Heating

The Composite, Ceramic, Metallic & Materials Performance Division conducts research and development to provide cradle-to-grave technologies, from inventing new materials to developing and transitioning systems solutions in the areas of polymer matrix composites, metals, ceramics, material state awareness, and rapid response analysis. The division also serves as the tip of the spear to solve time-urgent, challenging, electrical and structural materials and process problems to keep Department of the Air Force (DAF) systems safe and ready for combat.

Metals

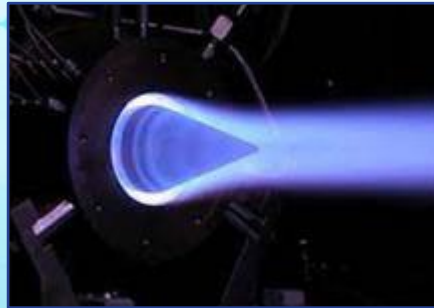
Executes metallic materials technologies for increased performance and efficiency, reduced cost, and accelerated manufacturing across Department of the Air Force systems.



Torch Test

Ceramics

Enables air and space dominance for the warfighter through discovery, development and transition of innovative, high performance ceramics using design, modeling, processing, and evaluation in extreme environments.



Ceramic Tail Cone in a Turbine Engine Test

Material State Awareness

Improves detection and sensing and enables novel characterization of initial and evolving state of materials in fielded and future Air Force systems.



Collaborative Robot for Nondestructive Evaluation (NDE)

Accelerated Materials and Processing Solutions

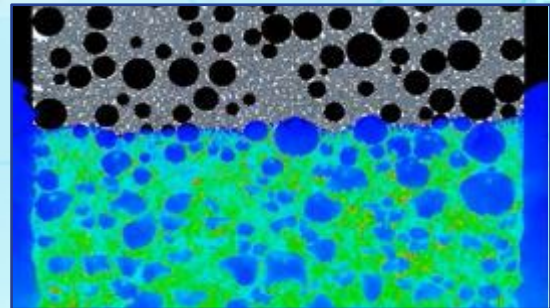
Provides unbiased, rapid response electrical and structural materials and process (M&P) consultation services and laboratory research support to DAF and DoD customers.



Additive Manufacturing

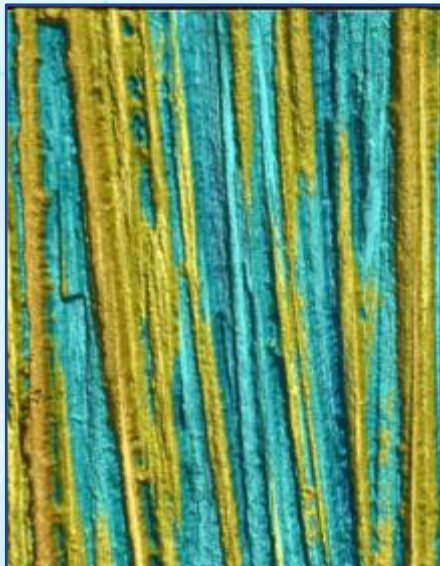
Polymer Matrix Composites

Conducts advanced analysis techniques to understand polymer matrix composite material response under specific conditions to determine the impact on Air Force systems and enhance system readiness.



Shock Physics Simulation Snapshot

Manufacturing, Industrial Technologies, and Energy Division



Composite Laser Ablation for Surface Preparation



Manufacturing of Large Scale Composites



TDI-J85 Turbojet Engine for Low-cost Attributable Aircraft

The Manufacturing, Industrial Technologies, and Energy Division is responsible for four programs that support the defense industrial base and DAF weapon systems across the entire lifecycle: Manufacturing Technology, Industrial Base Planning, Defense Production Act (DPA) Title III, and Energy Assurance. These programs work to identify, prioritize, and integrate DAF industrial base requirements to provide the manufacturing processes, techniques, systems, energy, and equipment needed for acquisition, production, operation, and repair of DAF systems. They provide technology transition support to science and technology (S&T) organizations for advancing producibility and affordability and are responsible for guiding, coordinating, facilitating, and integrating energy-focused science and technology programs across AFRL directorates. Additionally, they assist the United States Air and Space Forces with systems development and sustainment to ensure and enable a robust and responsive domestic industrial base.

Functional Systems Manufacturing

Manages programs to establish effective processes, materials, and procedures necessary for the agile and affordable manufacture of sensors, electronic devices, assemblies, and subsystems for use in DoD weapon systems.



Mid-Wave Infrared Imager

Digital Manufacturing and Supply Chain

Implements manufacturing technology and DPA Title III programs to create and maintain the domestic industrial capability and ensure AFRL researchers develop, maintain, modernize, and expand the defense industrial base for DAF platforms.



Augmented Reality-Enabled Cold Spray Robot

Structural Systems Manufacturing

Executes programs to establish and improve production to affordably manufacture DoD weapon system engines and structures within the defense industrial base, S&T organizations, DAF Life Cycle Management and Sustainment Centers, and the Space Systems Command.



Incrementally Formed Component
Manufactured by a Robot Blacksmith

The AFRL Energy Office

The AFRL Energy Office advances energy assurance through research and development of energy-related technologies to enhance the mission effectiveness of Department of Air Force operations and fixed installations. These technologies enhance weapon system capabilities and ensure resilient operations for Air and Space Forces.



GM Defense's Electric Ground Power Unit

Materials and Manufacturing Directorate: Research Teams

The Materials and Manufacturing Directorate funds research teams across a variety of materials science competencies in the three research-centric divisions. These peer-led teams include government S&E's, who are supported by staff scientists, post-doctoral associates, and full- and part-time students. The focus is on early technology readiness level activities, primarily on-site in our extensive research facilities as well as growth of government technical experts with deep technical roots. These teams are the major interface to the Air Force Office of Scientific Research, National Science Foundation and our academic linkages, and to subject matter experts across the Army and Navy defense laboratories and other national laboratories.



COMPOSITES

- Polymer Matrix Composites Materials & Processing
- Ceramics Materials & Processing
- Composites Performance



SOFT MATTER

- Biological Materials & Processing
- Polymers and Responsive Materials & Processing



INSPECTION

- Characterization Sensing and Analytics



MANUFACTURING

- Digital Manufacturing



SEMICONDUCTORS

- Integrated Opto-Electronic Materials & Processing
- Agile Radio Frequency Electronic Materials & Processing



OPTICS

- Structured Optical Materials & Processing
- Non-Linear Electromagnetic Materials & Processing



METALS

- Metals Probabilistic Performance Prediction
- Metals Materials & Processing

Internal Development Capabilities (IDCs)

Internal Development Capabilities are in-house user facilities focused on external development. These world-recognized facilities are widely used, not only among the larger AFRL enterprise, but also by external partners. Due to the unique capabilities these facilities bring to the DoD and beyond, they have been identified as areas for focused investment.

Rapid Response/ Failure Analysis



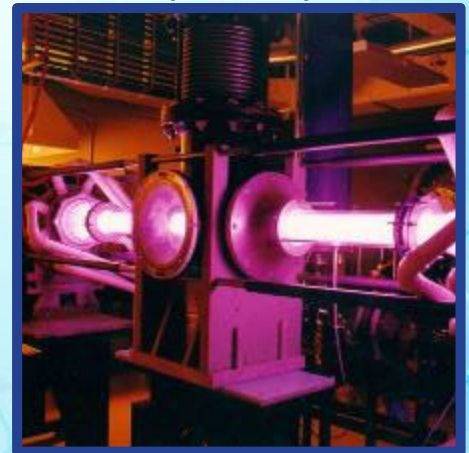
- Rapid research to solve most urgent materials and processing problems
- One-stop shop for developmental & operational systems
- Identify root cause, characterize & define specifications
- Rapidly prototype solutions with science & technology
- Support to AF Safety and Airworthiness

Special Test and Research (STAR) Lab



- One-of-a-kind facility to provide the US government with independent capability for specialty materials and process development, evaluation, and failure analysis
- Environmental durability characterization, to include erosion testing for high-speed flight and extreme environments

Laser Heated Materials Evaluation Laboratory (LHMEI)



- High-temperature characterization of materials exposed to laser sources
- Nation's largest Continuous Wave infrared laser
- Space environmental testing and simulation
- High-temp radio frequency aperture materials characterization

Internal Development Capabilities (Continued)

Comprehensive Optical Materials Phenomenology for Aerospace Survivability and Sensing (COMPASS)



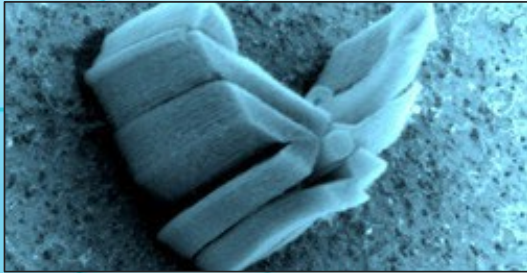
- Materials fundamental optical properties (reflection, transmission, absorption, emission, scatter) characterization with accuracy, precision, and ranges required to support basic research thru operational-level applications in survivability and sensing
- Realistic ground-based simulation and evaluation of orbital environment effects on spacecraft materials

Materials Characterization Facility (MCF)



- State of the art microscopy (Scanning electron microscope w/ electron back scatter diffraction/energy dispersive X-ray spectrometry, Cryo-Transmission Electron Microscopes/scanning transmission electron microscopy, energy-filtered transmission electron microscopy/electron energy loss spectroscopy)
- X-ray tomography capabilities (nano, micro)

Unique and World-Class Experimental Facilities



"Carpet" Of Carbon Nanotubes Patterned Into The Air Force Logo

Autonomous Research Systems (ARES)

- First-ever Robot Researcher for carbon nanotube synthesis using artificial intelligence and automation
- Capable of conducting experiments, analyzing results, and deciding which experiments to do next

Collaborative Automation for Manufacturing Systems (CAMS) Laboratory

- A unique, state-of-the-art facility that enhances efforts to research and develop advanced digital manufacturing technology
- Supports several platforms for autonomous manufacturing, including collaborative robotics and industrial extended reality hardware



Boston Dynamics Robot "Astro"



High-Throughput Molecular Cloning Equipment

Synthetic Biology Laboratory

- The Synthetic Biology Laboratory supports the development and production of novel biomaterials for the DoD
- Automated instrumentation to support high-throughput processes and accelerate synthetic biology

Unique and World-Class Experimental Facilities

Performance Characterization



DEEP Lab Lithography Bay

Devices for Emergent Electronics and Photonics (DEEP) Laboratory

- Rapid electronic and photonic materials prototyping facility
- Seamlessly integrate growth, characterization, and device fabrication
- New microelectronics class 100 cleanroom

Nano Computed Tomography (CT)

- 50 nanometer spatial resolution — First in US academic/ government setting
- Provides non-destructive 3D morphology of complex materials
- High contrast to quantify internal structure



ZEISS Xradia 810 Ultra X-ray Microscope



Large Volume Robotic Characterization System

Large Volume Robotic Characterization System (LEROY)

- First-of-its-kind robotic instrument to characterize the 3D microstructure, local texture, and chemistry of cast and wrought alloys and structural composites
- Rapidly provide property-controlling microstructural data for Integrated Computational Materials Engineering (ICME) programs

Materials and Manufacturing: Directorate Key Initiatives (KIs)

Key Initiatives are the long-term strategic investments aligned with DoD, DAF, and AFRL priorities that have a combination of directorate and multi-division ownership. KIs were created to use investments to drive synergy among the three fundamental investment pillars (Research Teams, IDCs, and External Development) to focus, and vertically integrate critical mass on a small set of S&T priorities. Electromagnetic Spectrum Survivability Technology, Specialty Materials Affordability, and Hypersonics were identified as the three inaugural KIs in 2022. During this investment shift, the directorate also adjusted its organizational construct to better align resources and expertise with AFRL and DAF priorities. This new organizational 'Construct By Competency' allows for cross-directorate collaboration through the entire "Discover to Deploy" spectrum. This shift in focus allows better alignment with AFRL's desire to drive investment portfolios with a "kill chain" focus, leading to the delivery of capability-based products.



Hypersonics



**Specialty Materials
Affordability**



**Electromagnetic Spectrum
Survivability**

Working with the Materials and Manufacturing Directorate

Whether you own a small business, teach at a university, or you're working with a prime defense contractor, the Materials and Manufacturing Directorate has agreements that will work for you. We rely on the collaboration we have with our valuable partners and we encourage you to work with us to solve some of the Air and Space Force's toughest science and technology challenges. Together, we can ensure our warfighters remain the best in the world.



Materials and Manufacturing Multiple Authority Announcement (MAA)

The AFRL Materials and Manufacturing Directorate MAA is a comprehensive announcement covering the majority of business opportunities for our range of science and technology areas. This MAA covers authorities Broad Agency Announcements (BAA), Commercial Solution Openings (CSO), Funding Opportunity Announcement (FOA), and other transactions. The most current MAA can be found by searching for "Materials and Manufacturing" on SAM.gov contract opportunities.



Air Force Independent Research and Development (IR&D) The Air Force IR&D Program was developed to provide a way for the Air Force to inform industry of warfighting capability gaps and technology needs, and to enable industry to inform DAF warfighters, acquirers, and science and technology developers of its research and development portfolios and corporate investments. Air Force IR&D effectively uses the Defense Innovation Marketplace as its primary means for exchanging critical data at different levels of security and distribution.



Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)



The Air Force SBIR/STTR program is designed to stimulate the research efforts of small businesses and universities, while providing the Air Force with cost-effective technical solutions to challenging Air Force problems. This program also encourages small businesses to market their SBIR/STTR technology in the private sector.



AFWERX As the innovation arm of the Department of the Air Force and powered by the Air Force Research Laboratory, AFWERX brings cutting edge American ingenuity from small businesses and start-ups to address the most pressing challenges of the DAF.



Technology Transfer and Transition (T3)

The Air Force Technology Transfer Program was created to ensure all Air Force science and engineering activities promote the transfer or exchange of technology with state and local governments, academia, and industry. These activities enhance the economic competitiveness of industry and promote the productivity of state and local governments while leveraging DoD research and development investment.

There are a variety of ways to partner with us, and we take a creative approach to exploring collaborative possibilities and long-term alliances. Whether our expertise is most useful as an extension of your own research and development efforts, or if the possibility of discovering something through collaborative research exists, we have the flexibility to be the kind of partner you need.



Gallium Conductive Stretchable Ink



Advanced Laser Eye Protection System (ALEPS)

**Total Active
Patents**



159

**Total Active
CRADA***



80

**Total Estimated
CRADA* value****



\$5.1M

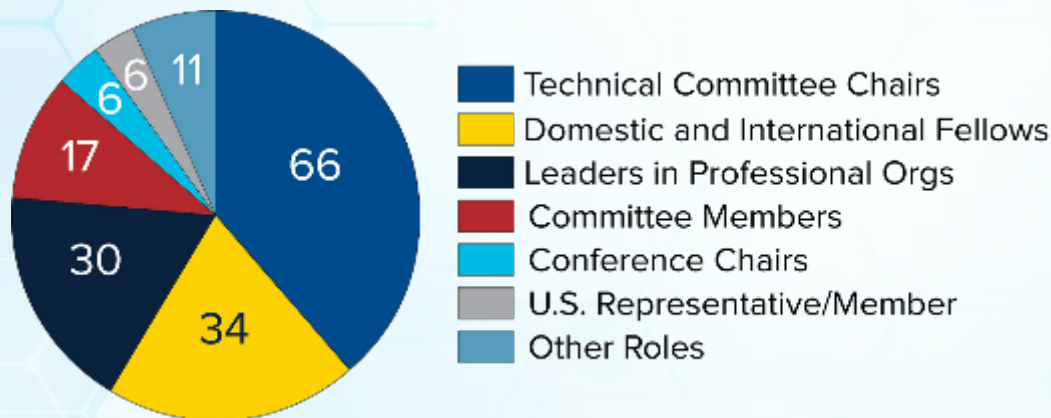


*Cooperative Research And Development Agreement

**Contributed to Academia and Industry

Professional Organizations/Societies

Materials and Manufacturing Directorate scientists and engineers are involved with a number of professional societies, committees and conferences often in lead rolls. These organizations provide platforms for professional development, networking, and information sharing.

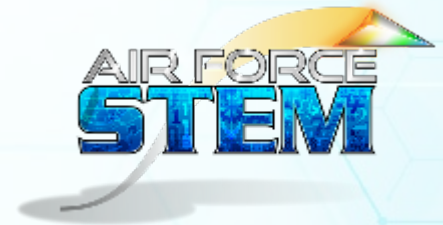


90+
Professional
Organizations,
Committees,
Conferences
and Boards

- Advanced Functional Fabrics of America
- American Ceramic Society
- American Chemical Society
- American Physical Society
- American Institute of Aeronautics and Astronautics
- American Society of Materials
- American Society of Mechanical Engineers
- American Society of Nondestructive Testing
- American Society for Composites
- American Society for Testing and Materials
- Board of Laser Safety
- Center for Biodevices
- Institute of Electrical and Electronics Engineers
- Human Factors and Ergonomic Society
- Institute of Industrial & Systems Engineers
- International Air Transport Association
- Joint Defense Manufacturing Technology Panel
- Materials Research Society
- Microscopy Society of America
- Nano Bio Materials Consortium
- National Academy of Engineering
- OSA-Optical Society of America
- Society for the Advancement of Material and Process Engineering
- Society of Manufacturing Engineers
- United States Advanced Ceramics Association
- Many more....

STEM Outreach – Developing The Next Generation Work Force

Preparing the next-gen workforce for careers in science and technology is vital to ensure future research and development for national defense. The Air Force provides many opportunities for on-the-job training and career preparation in science, technology, engineering, and mathematics (STEM) disciplines for college and university students and faculty, recent graduates, and even those still in middle and high school. The following programs offer a variety of challenging and rewarding experiences worth considering.



Pathways Program – Students and Recent Graduates

The Pathways Program offers federal internship and employment opportunities for current students, recent graduates, and those with an advanced degree. There are several paths available and those who complete the program may be eligible for conversion to permanent civil service employment.



Strategic Ohio Council for Higher Education (SOCHE) – College Students

SOCHE's Student Research Program provides year-long research internships at Wright-Patterson Air Force Base for undergraduate and graduate STEM students at either the Air Force Institute of Technology or the Materials and Manufacturing Directorate of the Air Force Research Laboratory.

AFRL Scholars Program - High School & College Students

The AFRL Scholars Program is administered by Universities Space Research Association (USRA). USRA's team is dedicated to ensuring quality programs are offered at all supported sites and that scholars and mentors have a fulfilling, worthwhile experience that promotes interest and career development in science, technology, engineering, and mathematics.



LEGACY Apprenticeship

The final phase of the LEGACY program sharpens the students' ability to multi-task and complete the research process. The students' polished professional skills will complement the objective, which is a smooth transition to the workforce.

Minority Leaders - Research Collaboration Program (ML-RCP)

The objective of AFRL ML-RCP is to enable, enhance, and expand the research capabilities of Historically Black Colleges and Universities and Minority Serving Institutions through collaborative research efforts with AFRL. The program has been recognized as a model for diversity engagements, enabling more than 900 students and 250 faculty participants from 52 partnering institutions to collaborate on AFRL directed research projects.



Premier College Intern Program (PCIP)

Designed to prepare participants for future mission critical and specialty positions in the Air Force through 10-12 week paid summer internships. Interns will complete special projects using cutting edge technology, while under the mentorship of senior managers.

National Security Innovation Network

The X-Force Fellowship is a summer internship program that provides undergraduate and graduate students, as well as recent graduates, a chance to serve their country by solving real-world national security problems in collaboration with the U.S. Department of Defense (DoD).



Department of Defense Science, Mathematics & Researcher Transformation Scholarship for Service Program (SMART) – High School & College Students

The SMART Scholarship-for-Service Program is a combined educational and workforce development opportunity for STEM students. SMART Scholars receive full tuition, annual stipends, a book & health allowance, a summer internship, an experienced mentor, and DoD employment.

Workforce Recruitment Program

A recruitment and referral program for college students and recent graduates with disabilities who are eager to demonstrate their talent in the workplace through internships, temporary, or permanent employment in the Federal Government.



AFRL STEM Student Employment Program (SSEP)

The STEM Student Employment Program provides internship opportunities for undergraduate and graduate students in STEM fields within DoD Science and Technology Reinvention Laboratories (STRs).



Direct Hire Authority (DoD DHA)

The Direct Hire Authority for the DoD for Post-Secondary Students and Recent Graduates allows for internships for qualified post-secondary students and recent graduates in non-STEM fields within the Materials and Manufacturing Directorate.

The United States Air Force Academy Cadet Summer Research Program (CSR)

The CSR provides opportunities for cadets to solve relevant problems, learn through real-world application of classroom principles, and build lasting collaborative relationships while participating in research at the various military, government, and civilian facilities throughout the world.



Center for Excellence in Education

The DoD Summer Lab Research Intern Program pairs college students with DoD lab internships, using a blend of virtual and in-person modalities to nurture careers of excellence and leadership in STEM for academically talented students.

Summer Faculty Fellowship Program (SFFP) – College and University Faculty

The SFFP offers hands-on exposure to Air Force research challenges through 8- to 12-week research residencies at participating Air Force research facilities for full-time STEM faculty at U.S. colleges and universities.





PALACE Acquire (PAQ) – College Students

The Palace Acquire program is an Air Force program to recruit, train, and develop college graduates to become professional Air Force Civilian Scientists and Engineers. PAQ provides training and development, mentoring, and real-world work experience leading to professional employment.

National Defense Science and Engineering Graduate Fellowship Program (NDSEG)

The DoD National Defense Science and Engineering Graduate Fellowship Program is a competitive fellowship that is awarded to U.S. citizens, U.S. nationals, and U.S. dual citizens who intend to pursue a doctoral degree aligned to the DoD services Broad Agency Announcements (BAAs) in research and development at a U.S. institution of their choice.



Designing Materials to Revolutionize and Engineer our Future (DMREF)

The mission of DMREF is to build a world-class materials science and engineering workforce proficient in the tools and techniques necessary to accelerate the discovery, development, and deployment of advanced materials.

National Science Foundation Summer Scholars Internship Program (SSIP)

The mission of the SSIP is to develop undergraduate and graduate student potential through exposure to relevant science and engineering policy, research, and education issues and programs; and to encourage students to earn graduate degrees and pursue careers in STEM fields.





Defense Associated Graduate Student Innovators (DAGSI)

DAGSI's mission is to develop and support world-class graduate engineering education and research programs, thereby contributing to Ohio's economic growth and development. The DAGSI partnership effectively expands regional engineering education and research opportunities at the master's and doctoral levels.

Air Force Science & Technology Fellowship Program (STFP)

The Air Force Science & Technology Fellowship Program offers nationally competitive fellowship awards to postdoctoral and senior scientists to perform collaborative research at U.S. Air Force research facilities across the country.



Acronym List

AFOSR.....	Air Force Office of Scientific Research
AFRL.....	Air Force Research Laboratory
DAF.....	Department of the Air Force
DPA.....	Defense Production Act
S & E.....	Scientists and Engineers
S & T.....	Science and Technology
STEM.....	Science, Technology, Engineering and Mathematics
T3.....	Technology, Transfer and Transition
TRL.....	Technology Readiness Level

AFRL Materials and Manufacturing Directorate
2977 Hobson Way
Wright-Patterson AFB, OH 45433



**AFRL Materials
and Manufacturing
Directorate Website**



**Director's
Action Group
Email**

