U.S. AIR FORCE

USSF

AFRL

Materials and Manufacturing Directorate

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Chief Engineer

Mission

Accelerate the availability of advanced and cost-imposing materials & manufacturing technologies for the Airman and Guardian by driving the state of the possible and uniting the community

Vision

We invent the stuff that makes the future

Dedicated to the Digitization of the Materials Lifecycle

One-Stop for Materials & Processing Across Complete Lifecycle

- **DISCOVER**
  Identify cutting edge scientific phenomena
- **DEVELOP**
  Reduce the risk to implement new technologies
- **SCALE UP**
  Make it big (or small) enough & in sufficient quantity to meaningfully impact the application
- **MANUFACTURE**
  Produce it at a rate, cost and quality relevant for implementation
- **DEFENSE INDUSTRIAL BASE SUPPLY CHAIN**
  Create, modernize, or expand US industry capacity to meet DAF demand/requirements
- **DEPLOY**
  Transition war-winning technologies to DoD operators

RX Pillars of Investment

Objective: Focus personnel and resources to deliver materials and manufacturing solutions to the warfighter at the speed of relevance

RX Four Investment "Pillars":

- Research Teams

  Fundamental, competency-based R&D

- External Development

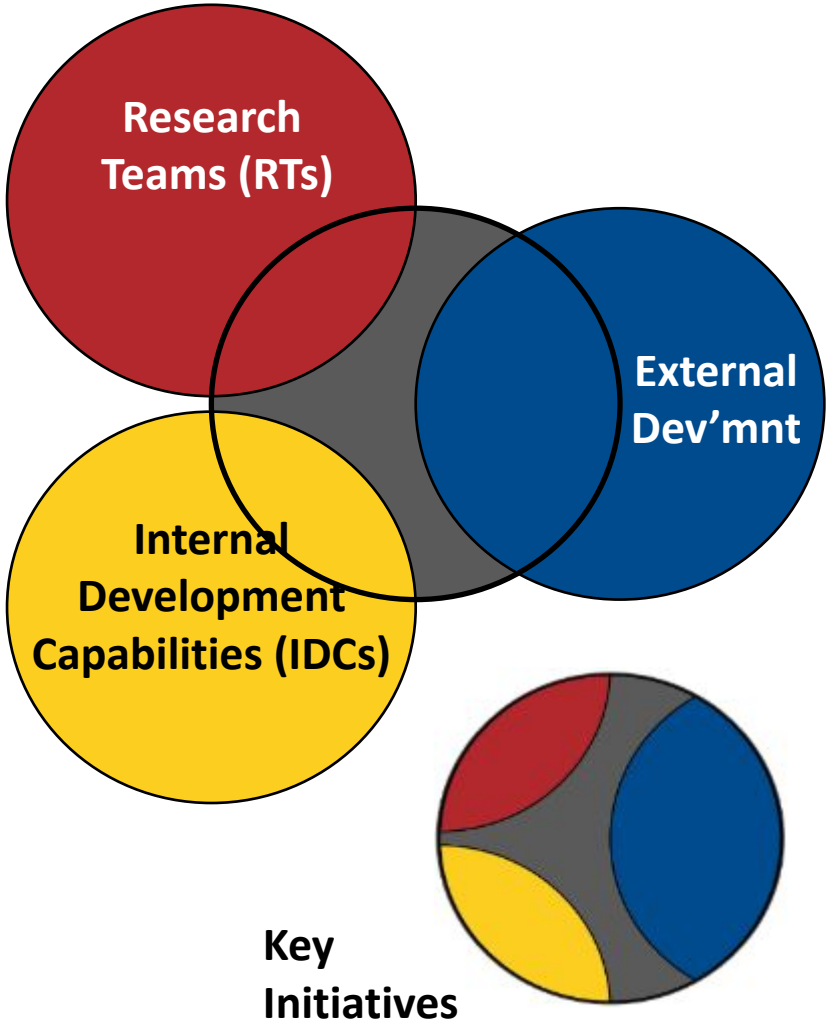
  6.2/6.3 executed external to RX through partnerships with industry, service research laboratories, and AFRL TDs

- Internal Development Capabilities

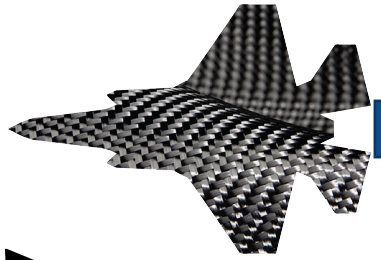
  Unique, RX in-house capabilities and facilities exploring partnerships with industry to accelerate risk reduction by assessment in novel environments

- Key Initiatives

  RX's Big Bets - Long term strategic investments aligned with DoD/DAF/AFRL priorities. Primarily 6.3 investments supported across RX & AFRL.



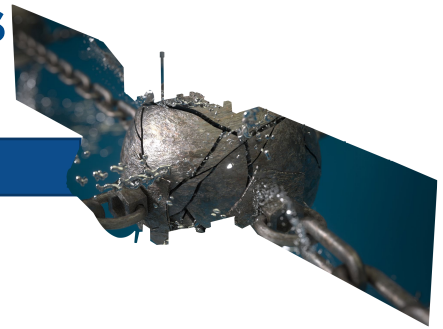
Research Teams: World-Class Scientists & Engineers



Composites

PMC Materials & Processing

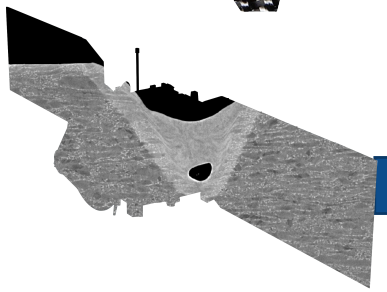
Ceramics Materials & Processing
Composites Performance



Soft Matter

Biological Materials & Processing

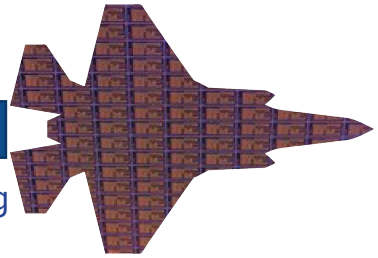
Polymer and Responsive Materials
& Processing



Metals

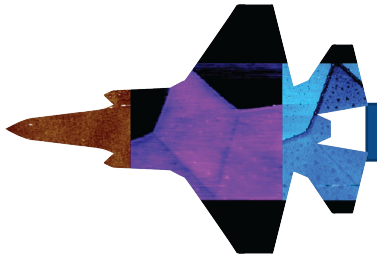
Metals Probabilistic Performance Prediction

Metals Materials & Processing



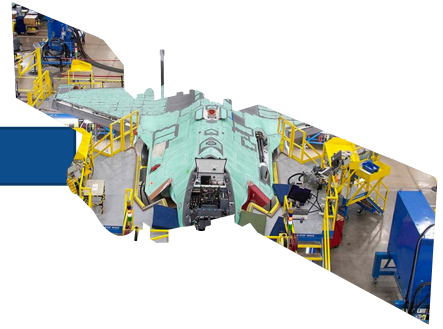
Semiconductors

Integrated Opto-Electronic Materials & Processing
Agile RF Electronic Materials & Processing



Inspection

Characterization Sensing and Analytics



Manufacturing

Digital Manufacturing

Optics

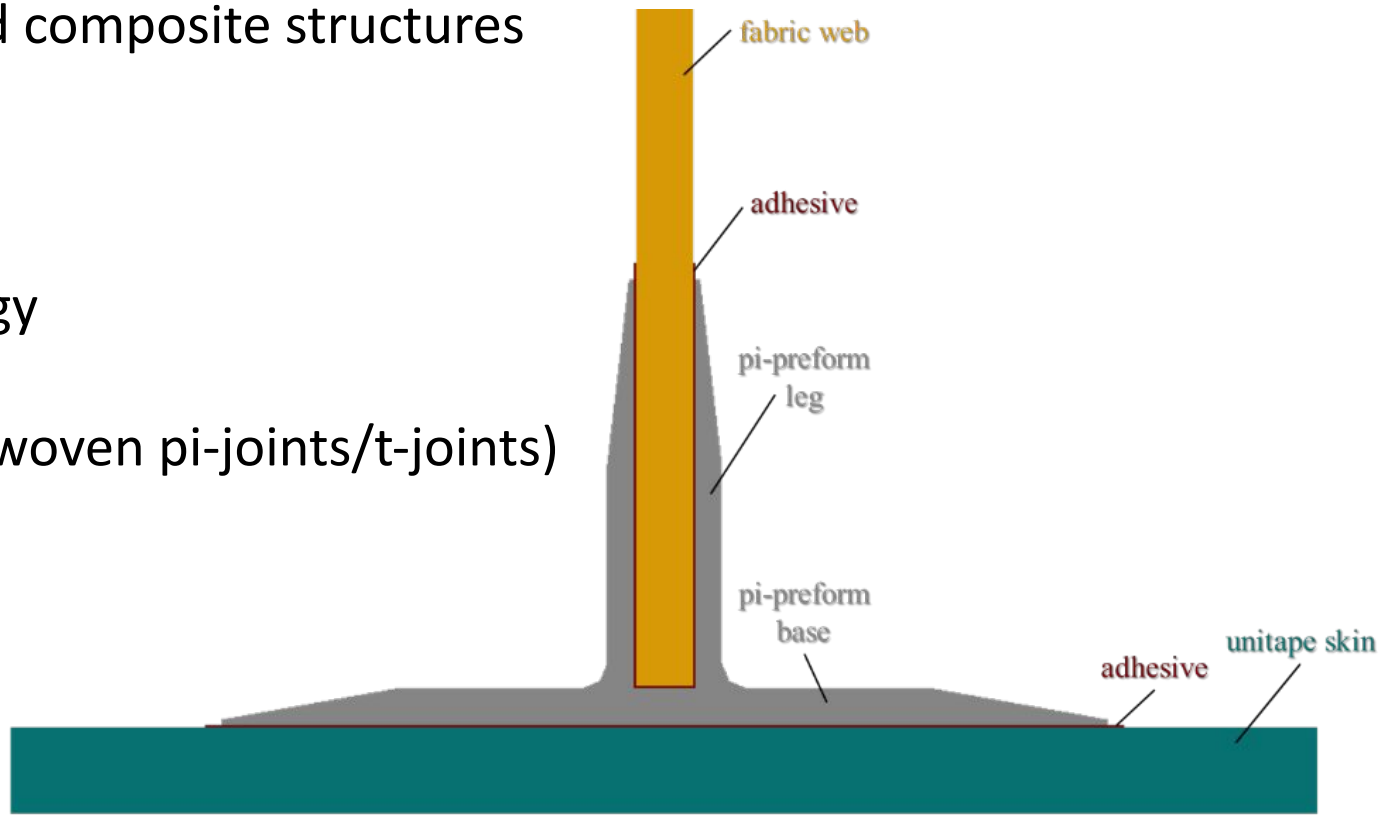
Structured Optical Materials & Processing

Non-Linear EM Materials & Processing

Pi Joints

Innovative Joint Technology for Composite Structures

- Theoretical advantages of integrated composite structures
  - Fewer parts
  - Faster assembly
  - Lower cost
- Advantages ***hinge*** on joint technology

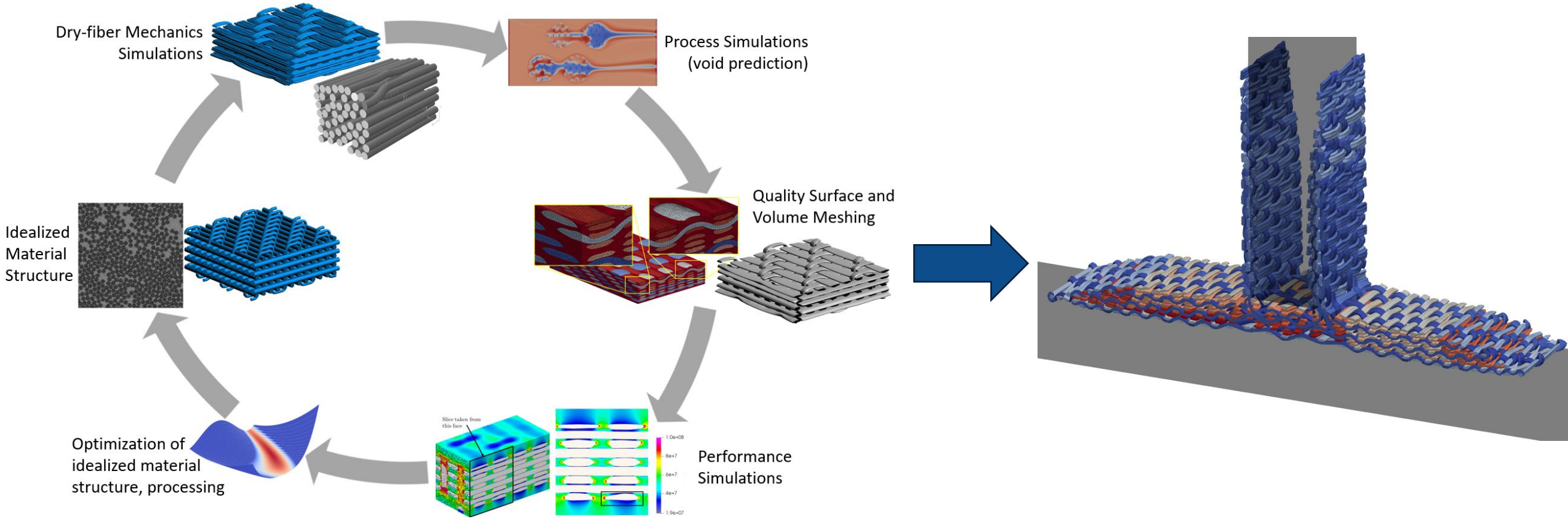


- Limited certified bonded joints (i.e. woven pi-joints/t-joints)
- Feature gaps for current joints:
  - Low-cost
  - Process insensitive
  - Robust terminations
  - Improved damage tolerance
  - Tailored performance for a specific load profile
  - Capable of joining substructures with complex geometries
  - Capable of joining highly dissimilar materials
  - Integrated sensing of bond-line/joint integrity
- We have an interest in ***widening*** what is possible with joint technology

Innovative Joint Technology for Composite Structures

AFRL

- ***Deep*** need for next-gen ICME design tools capable of component-level optimal design



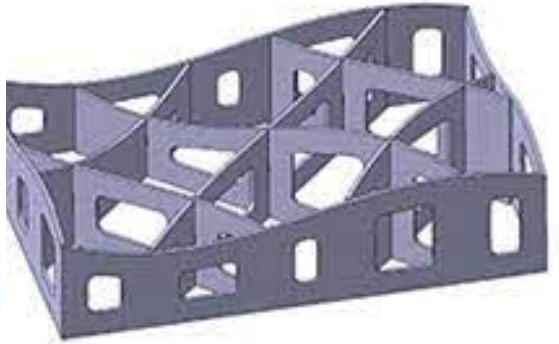
- Contributions to high-fidelity, high-performance computing tool ecosystem are highly desired!
- Outside of the box thinking encouraged!
  - New materials, new topology, mechanical features to assist joining, etc.
- Possible transition paths: ManTech, textile/additive manufacturers, AF programs, Prime OEMs

Complex Geometrically Shaped Heating Blankets

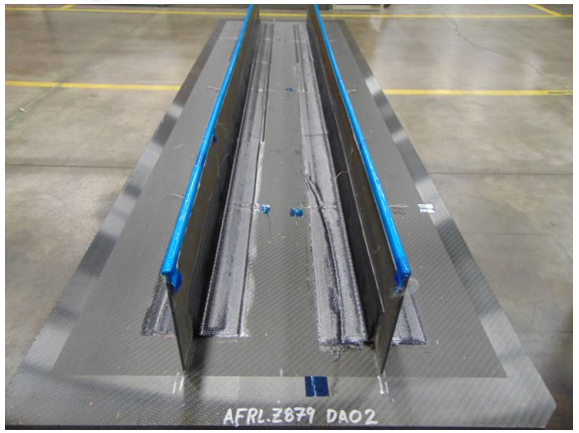
Complex Geometrically Shaped Heating Blankets

- Out-of-Autoclave Out-of-Oven secondary bonding of Composite Materials is crucial for cost effective, efficient fabrication and sustainment of composite structures in aerospace applications.
  - Fewer parts
  - Faster assembly
  - Localized controllable heating solutions
- Advantages ***hinge*** on Maintaining constant consistent temperature of complex parts/shapes

- Traditional heating methods:
  - Extensive thermal surveys
  - Large thermal gradients due varying geometry
    - Cold spots = rework, increase cost



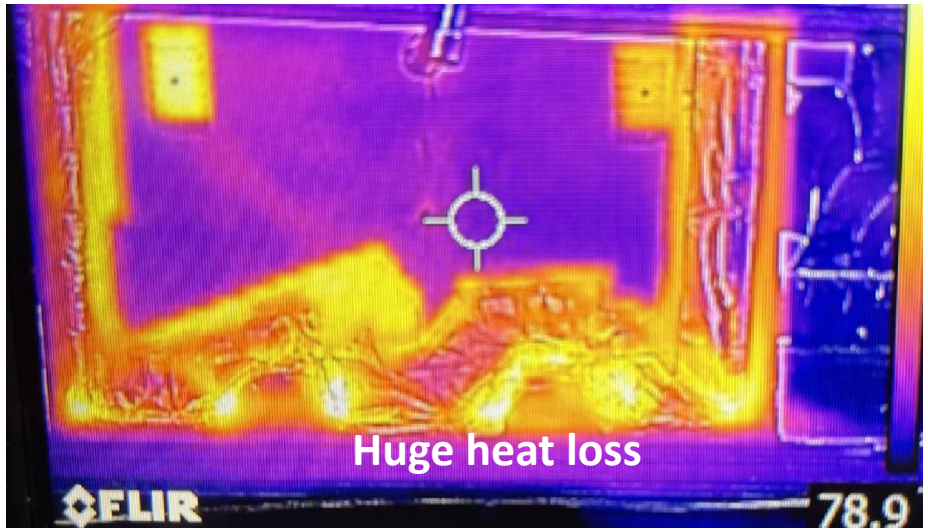
- Form factor heating blankets:
  - Self supporting conforming to trapezoidal shapes and 60°-120° corners
    - Composite hat stiffeners, Pi sections and egg crate structures
  - Delivering uniform temperature over 99% of blanket area
    - Multiple blankets of various sizes
  - Precise temperature controls



Direct Print Elastomeric Seals

Direct Print Elastomeric Seals

- Out-of-Autoclave curing, and secondary bonding of Composite Structures is critical for the advancement of composite materials in aerospace applications.
  - Fewer parts
  - Faster assembly
  - Huge reduction in mechanical fasteners
- Advantages ***hinge*** on Thermal Management
  - Heating complex parts/shapes
    - Maintaining constant consistent cure temperature
- Traditional sealing method
  - Wool rope sealed to oven with Kapton tape
- Direct Printing of Elastomeric Seals:
  - Customized sealing around compound geometry
  - Print-on-demand
  - Multiple uses = lower cost



QUESTIONS?

If you have additional questions or would like to connect with the AFRL/RX Chief Engineer Office, please email **AFRL.RX.ChiefEngineerOffice@us.af.mil.**