National Aeronautics and Space Administration

NASA

Engineering Directorate Materials & Processes Laboratory Capabilities

Partnership Forum Presentation
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H. DeWitt Burns

Deputy Director, Materials & Processes Laboratory

MARSHALL SPACE FLIGHT CENTER

NASA Marshall Space Flight Center
Materials & Processes Laboratory

Lab Lead Engineers Office

- SLS Element Design Lead Engineers
- Human Landing System Lead
- Advanced Manufacturing Lead
- In-Space Manufacturing Lead

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Engineering Support Office

- M&P Technical Information System (MAPTIS)
- Materials Usage Agreements (MUAs) & Materials Usage List (MIUL)
- Small projects – ISS payloads, ECLSS
- Physical Sciences Infomatics Database

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Materials Analysis & Test Division

- Fracture Control and Damage Tolerance
- Nondestructive Evaluation
- Mechanical Testing / Hydrogen Test Facility
- Tribology / Metrology
- Chemistry & Contamination Control

Division Chief: Freida Lowery
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Metallic Materials & Processes Division

- Materials Diagnostics & Failure Analysis
- Materials Science & Metallurgy
- Advanced Metals Processing & Technologies
- Welding & Manufacturing

Division Chief: Dr. Sandeep Shah
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Nonmetallic Materials & Advanced Manufacturing Division

- Space Environmental Effects
- Ceramics & Ablatives
- Polymeric Materials – Adhesives & Coatings
- Additive Manufacturing & Digital Solutions
- Advanced Composites Manufacturing

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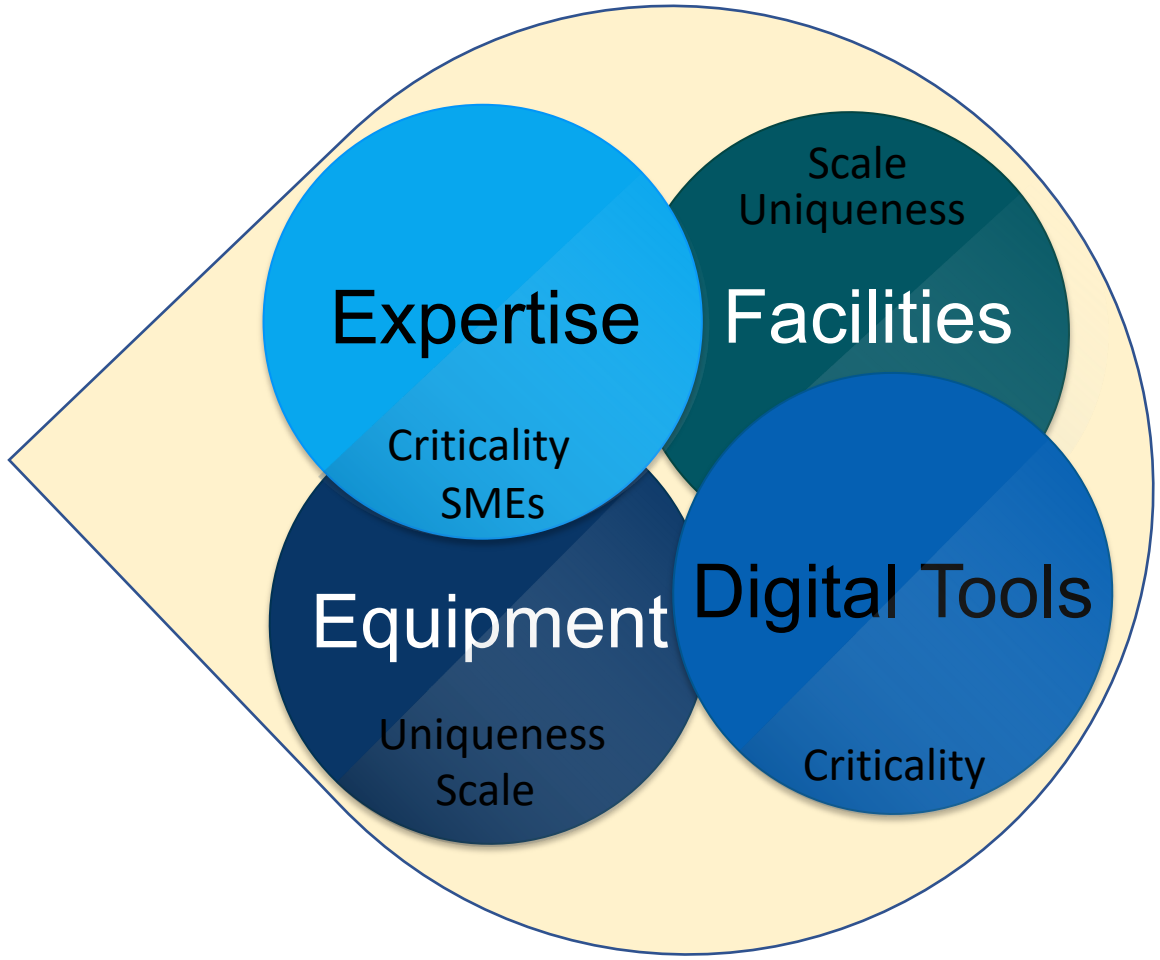
M&P Laboratory partnerships utilize general and specialized capabilities to provide partners tailored solutions to materials, processing, manufacturing, and digital system application challenges.

CAPABILITIES



Today

SLS

In-Space Prop

Advanced Manufacturing

ECLSS/Habitat

Lander & Surface Sys

Science

Tomorrow

SLS

In-Space Prop

Advanced Manufacturing

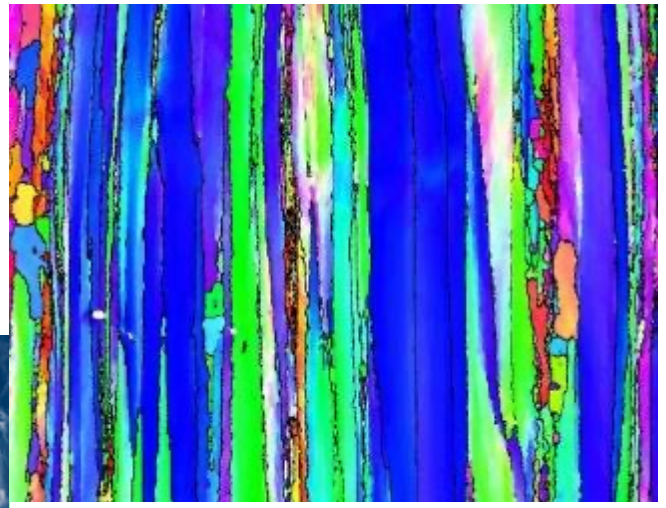
ECLSS/Habitat

Lander & Surface Sys

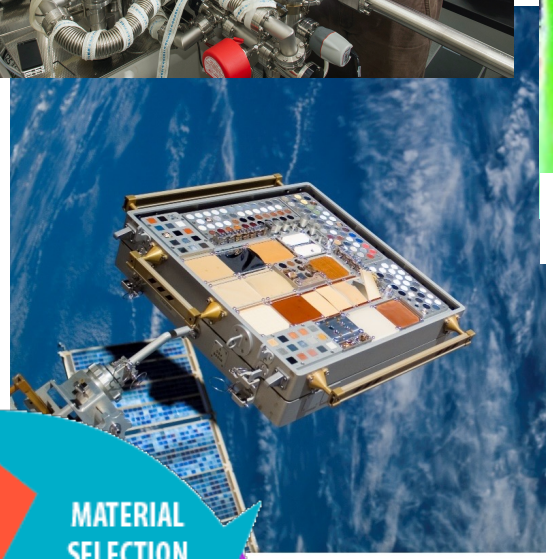
Science

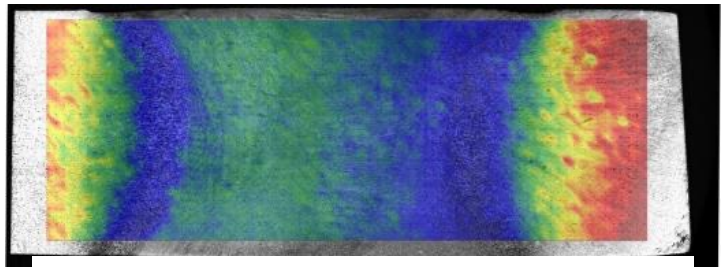
Selected Materials Capabilities

- Materials Diagnostics and Failure Analysis
- Sophisticated Metallurgical Analyses / Characterization
- Fracture Control and Damage Tolerance – customized testing supporting analyses
- High Temperature Materials
- Ionic Liquids Research
- Materials Flight Experiments
- Materials and Processes Technical Information System (MAPTIS)
- Mitigation for Materials Obsolescence
- Development of Material Usage Agreements (MUAs), Material Usage List (MIUL)

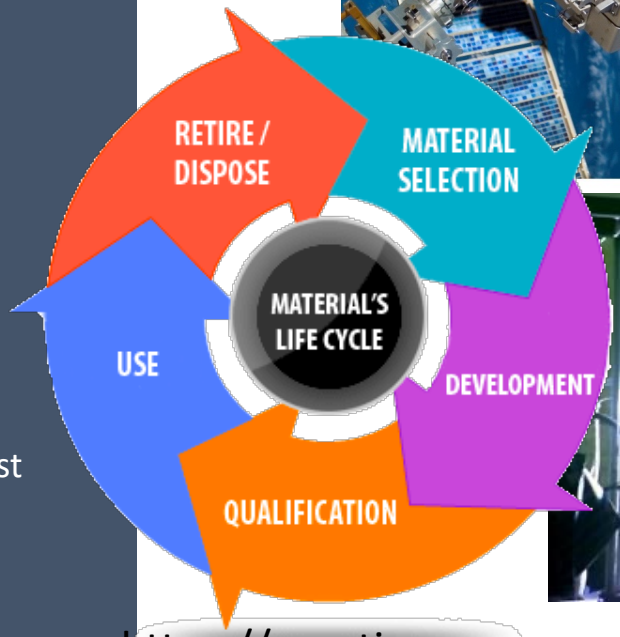


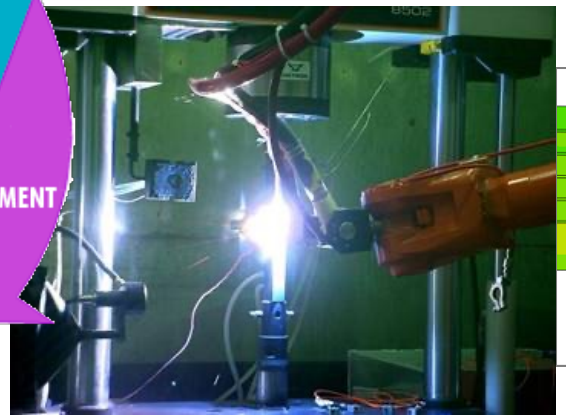
Grain Size Analysis in a Rolled Aluminum Plate
(SEM/EBSD)

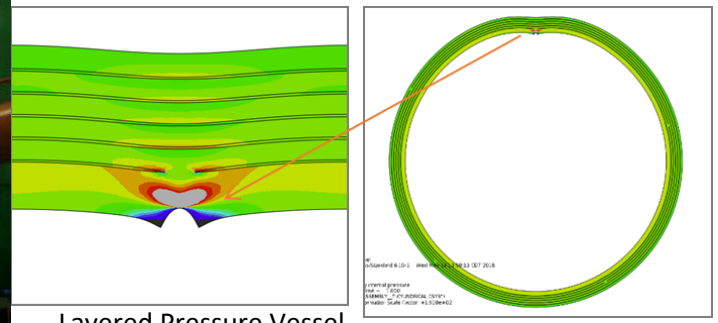




Microhardness Mapping of a Friction Stir Weld
(Blue = Low Hardness, Red = High Hardness)





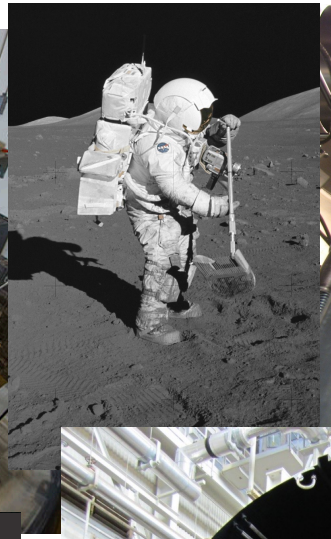


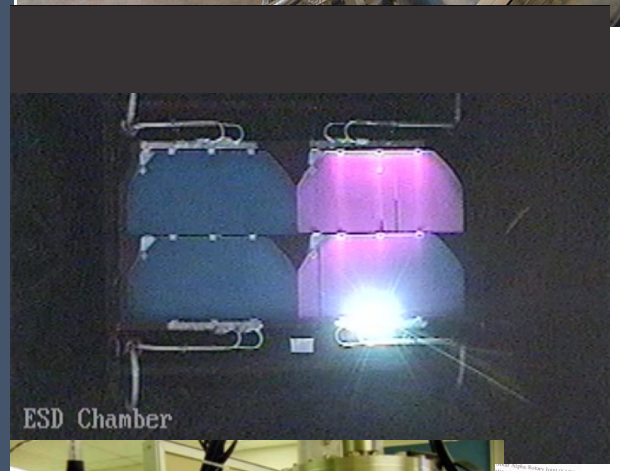
Layered Pressure Vessel
2D Fracture Modeling

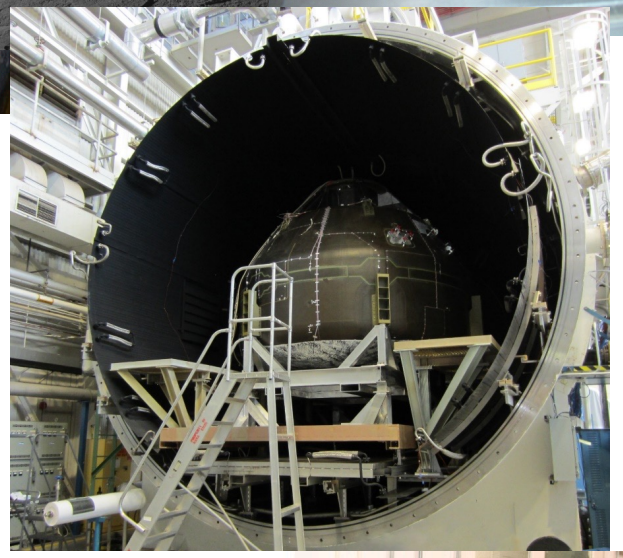
https://maptis.nasa.gov

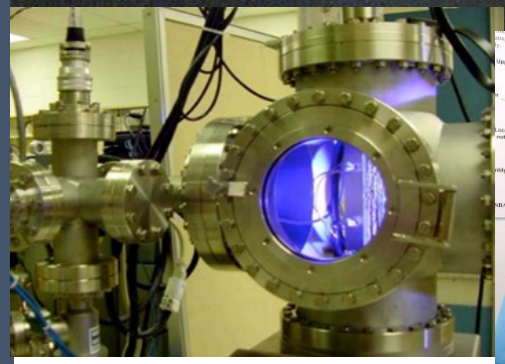
Selected Test Capabilities

- Space Environmental Effects (SEE) –
  - high vacuum with thermal extremes,
  - ionizing and non-ionizing radiation,
  - plasma
  - atomic oxygen
- Lunar Surface Simulation -
  - SEE coupled with regolith bed
    (~2 ft dia x 4 ft chamber)
  - New full scale system level capability
    (20 ft dia x 28 ft chamber)
- Hydrogen Test Facility (nationally unique)
- Mechanical Testing
- Impact Testing –
  - launch and ascent debris
  - weather encounter
  - micrometeoroid and orbital debris
- Tribology / Metrology
- Investigative Chemistry & Planetary Protection



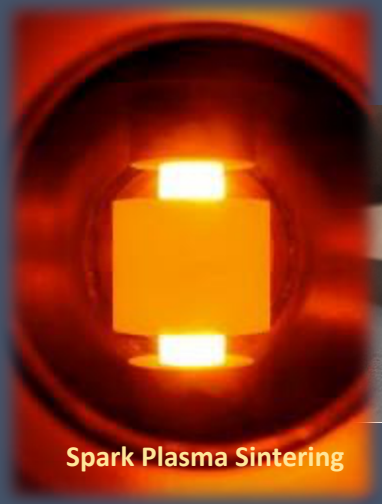


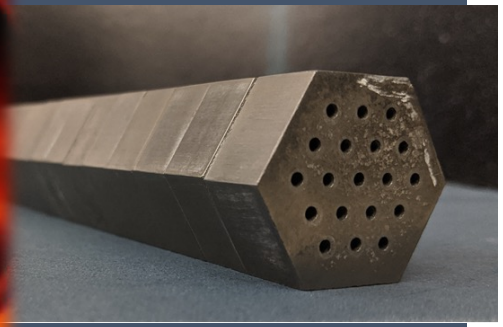


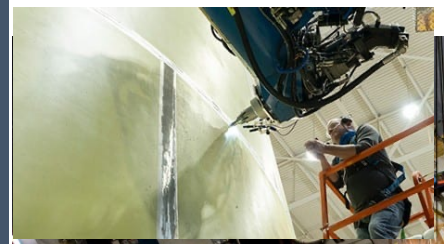


Selected "For Space" Advanced Manufacturing Capabilities

- Welding
  - Large scale FSW production
  - Modular / Flexible Tooling
- Additive Manufacturing
  - Powder Bed Fusion
  - Large scale DED
  - Standards and certification
- Composites Manufacturing
- Thermal Protection System Applications
- Space Nuclear Propulsion Fuel Elements
- Manufacturing Support – e.g. Non-Destructive Eval

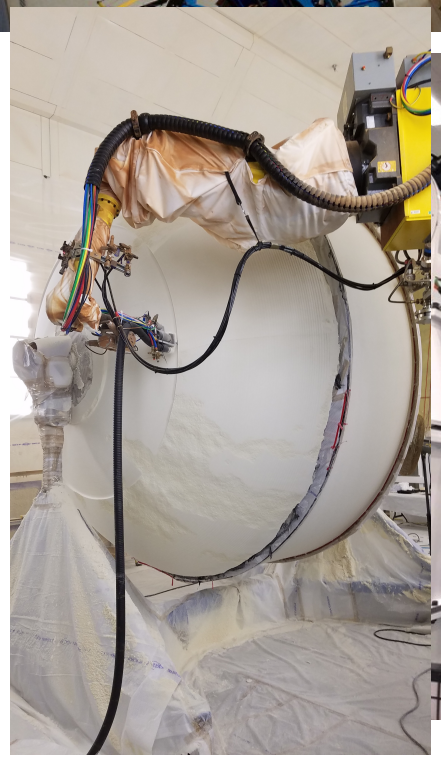


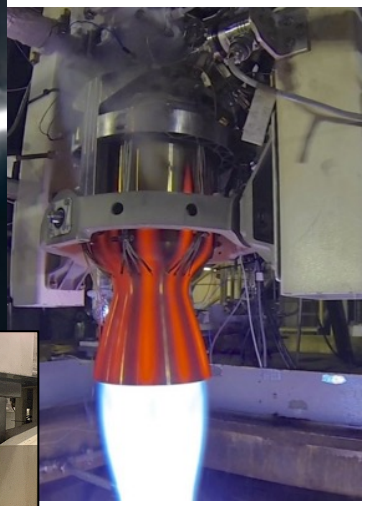




NASA MSFC EM Materials & Processes Lab

Combustion Chambers





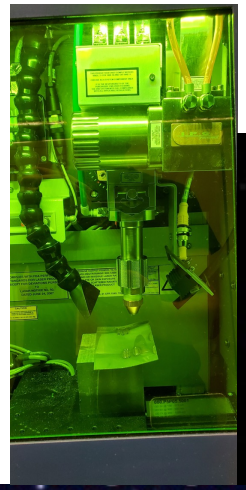
Selected "In Space" Advanced Manufacturing Capabilities

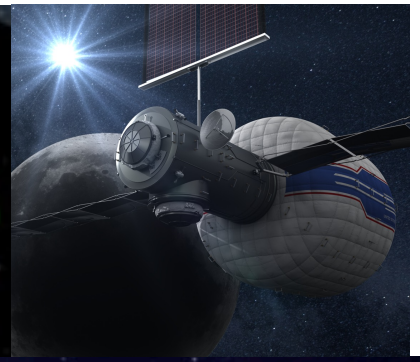
- In-Space Manufacturing
  - On-orbit Servicing And Manufacturing (OSAM)
  - Lunar surface excavation/construction
  - In-Situ Resource Utilization (ISRU)
- Joining / Welding
  - Laser and e-beam welding – manufacturing and repair
- Additive Manufacturing
  - AM with In-Situ Resources
  - 3D printed printable inks for electronics & sensors
- Digital Transformation

  Interest in AI / ML for remote operations
- Manufacturing Support

  Non-Destructive Evaluation

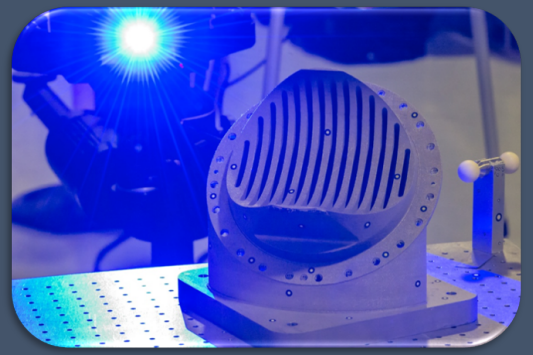
M&P capabilities will play a major role in maximizing component re-use, recycling and in-situ resource utilization.



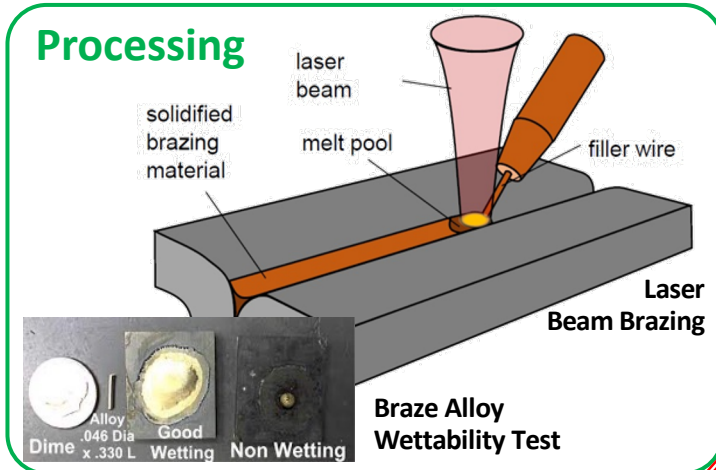


Selected Digital Transformation Capabilities

- Digital Transformation - Interest in applications of
  - Artificial Intelligence
  - Machine Learning
  - Model Based Engineering
  - Autonomy & Remote Operations
  - Digital Twin
- Manufacturing Support
  - Structured lights scanning
  - Simulations for optimizing production flow and human factors
  - Paperless production systems
- Additive Manufacturing – In process monitoring and feedback

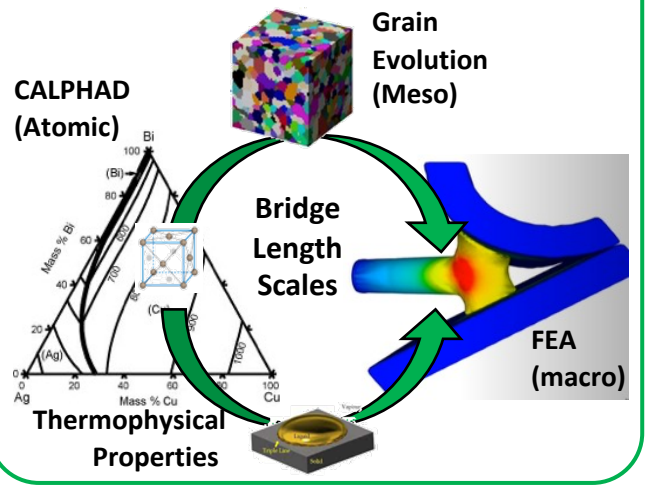


Processing



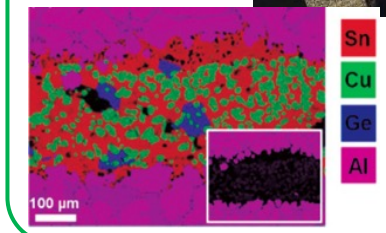
Braze Alloy Wettability Test

Computational Modeling



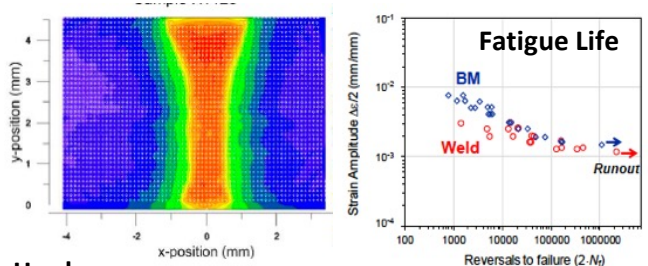
Structure

Microstructure



Chemical Segregation

Properties & Performance



Hardness

Conclusion

- MSFC Engineering has excellent, deep, and many unique technical capabilities.
- We want to partner with you on implementing new and emerging technologies to accelerate space system development and application.
- We stand ready to assist academic institutions, other government agencies, and the commercial aerospace community in our region and around the country to deliver space fairing systems.

"If everyone is moving forward together, then success takes care of itself." --Henry Ford.

“When you need to innovate, you need collaboration.” – Marrisa Mayer

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