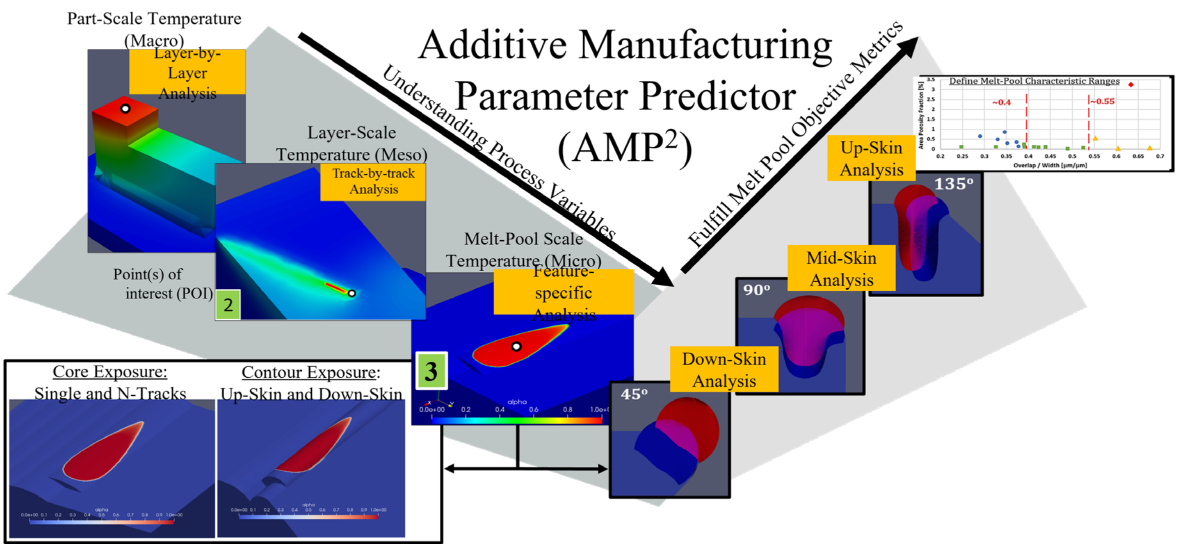
PROJECT SUMMARY 5542.007

High Temperature Enabling Additive Manufacturing, Phase 2: Enabling Robust Production Technologies by Modeling Additive Geometries with Novel Materials for Aerospace (ERuPTMAGMA)



Multi-scale modeling and advanced material technology for predictable, robust 3D printing improves higher performance, efficiency, and reliability for greater air fleet readiness.

PROBLEM

High efficiency turbines require an approach that circumvents material-related cracking and process-related distortion. Incorporating additively manufactured components into jet engines is hindered by material- and process-related challenges due to unpredictable properties. In addition, metal additive processes can generate internal stresses in structures that lead to warping and distortion. Commercially available computer models can help with this. However, there is a lack of commercial computer models that provide predictive power for robust, defect-free printing.

OBJECTIVE

The objective of this project is to develop a generalized process development framework that can be applied to printable alloy systems to measurably improve the performance of AM-built nickel superalloy components. This project seeks to:

- Develop and demonstrate software tools for metal AM prediction and process optimization that combines the following to eliminate component distortion and failure due to thermal stress
  - Material modifications
  - Process parameter development
  - Computational modeling
- Motivate application of thin-walled turbine combustor heat tiles that are difficult to print due to material cracking and warping

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to: PROCESS

ASTM PROCESS CATEGORY
Powder Bed Fusion

EQUIPMENT
Laser Powder Bed Fusion (LPBF) Printing

MATERIAL
Advanced Alloy 230 formulation (H230-RAM1)

TECHNICAL APPROACH

This project will develop and demonstrate a combination of new algorithms and existing process approaches to minimize residual stress and distortion to maximize the performance of complex, thin-walled AM components. Software inputs will be derived from real world data collected from sensors in printing process and specimen testing. Advanced alloy 230 formulation (H230-RAM1) developed by Elementum 3D (E3D) will be used to avoid cracking issues common when printing nickel-based superalloys. Milestones include:

- Down-select component model and finalize test plan
- Collect in-process build data and material properties
- Finalize predictive software for heat tile distortion
- Print and characterize demonstrator heat tile components
- Report and disseminate the results of the approach to enable similar efforts by America Makes consortium members

PROJECT START DATE

May 2023

EXPECTED END DATE

November 2024

EXPECTED DELIVERABLES

- Model for test article, test plan, tool codes
- Test build(s), sensor, and characterization data for model inputs, thermophysical properties
- Tool code and model predictions for heat tile geometry and confirmation test builds
- Build and sensor data, model validation data, printed heat tile component and characterization/ testing data
- Non-proprietary print geometries (if applicable)
- Physical demonstration artifacts (minimum of two)
- Final project report

FUNDING

$10,582,407 total project budget
($9,150,000 in public funding/$1,432,407 in private funding)

PROJECT PARTICIPANTS

Project Principal:
Elementum 3D (E3D)

Other Project Participants:
Rolls-Royce Corporation (RR)
Applied Optimization, Inc. (AO)
The Applied Research Laboratory at Penn State (ARL)

Public Participants:
U.S. Department of Defense