Validated Thermal-Material Simulation to Predict Microstructure Evolution in Selective Laser Melting Additive Manufacturing of Nickel Alloys

A 3 Year $500k program to develop an integrated method to simulate additive manufacturing that leverages Rensselaer's expertise in materials processing and high performance computing.

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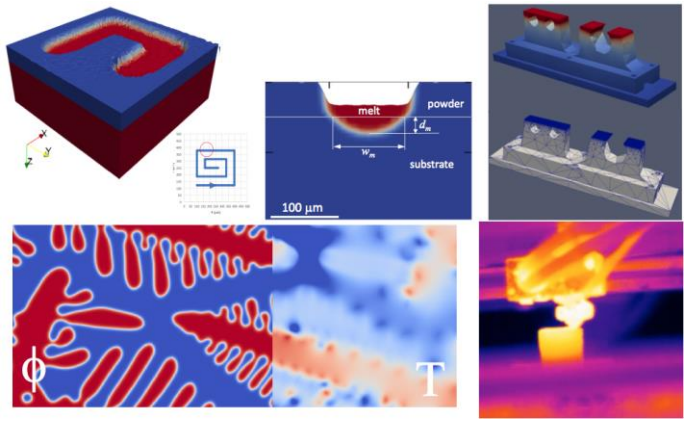

This program will simulate thermal processing, microstructure and chemical evolution, and then validate microstructure predictions with experimental AM/SLM processing.

Research Objectives

- Develop an integrated thermal-chemical-microstructural simulation approach for additive manufacturing.
- Increase ease of use of HPC through innovative software design and dissemination.
- Predict and validate micro-structure using experimental builds at Rensselaer and General Electric.
- Advance from TRL 2 to TRL 3.

Technical Innovations

- Develop finite element simulation of thermal transport, phase change, and defect formation during laser processing.
- Link thermal modeling to thermodynamic databases and classical solidification models for structure and segregation calculations.
- Develop thermodynamic descriptions suitable for morphology prediction using phase field to predict dendrite solidification, evolution, and non-equilibrium phase precipitation.

Potential Impact

- A thermodynamically consistent model will be capable of more accurate process design.
- Quantitative micro-structure prediction will enable property validation without the need for experimental iterations.
- In house validation platform will permit rapid model development cycle.