NASA SBIR/STTR Technologies

T12.04-9977 - Multiple High-Fidelity Modeling Tools for Metal Additive Manufacturing Process Development

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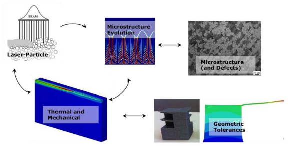
Identification and Significance of Innovation

All of the NASA centers are involved in developing additive manufacturing (AM) capability. AM offers the potential for flexible small-volume manufacturing, rapid prototyping, and repair. Despite significant investment by government and commercial entities, a number of issues and concerns need to be resolved, the most significant being reliability and repeatability. Development and qualification of a process for a new component still requires a time consuming trial-and-error based optimization over as many as 20 process parameters, with multiple dominant inputs including laser power, laser scanning speed, and raster spacing in large areas. There can be issues with both material quality on the microscale and distortions on the scale of the component. CFDRC is developing high-fidelity simulation tools that will give the SLM engineer critical insights into build parameters and design effects, leading to reduced time and cost to fabricate compliant components.

Estimated TRL at beginning and end of contract: (Begin: 2 End: 3)



Technical Objectives and Work Plan

The overall objective of the Phase II program is to develop and deliver efficient, validated high-fidelity simulation codes capable of addressing various critical phases of SLM processing. Specific technical objectives are as follows:

1.Enhance the fidelity of the modeling tools by implementing model improvements identified during the Phase I research;

2.Validate the capability to predict component scale distortions and local microstructure from process parameters by acquiring, analyzing, and testing the models against, in-situ process data and ex-situ characterization of fabricated components.

3.Develop effective procedures for applying the modeling tools and process sensitivity information to assess feasibility of successful fabricating component design and build approach combinations;

4.Improve computational efficiency and throughput of the modeling tools by further leveraging solution adaptive meshing and parallel computing technologies, and by model reformulation to take advantage of symmetries and periodicity in space and time where possible.

The Phase II effort will improve scalability to aerospace component dimensions and develop validated model parameters. The resulting toolset will be capable of efficiently predicting the dimensional and microstructural properties of SLM components from process conditions, while addressing important design and build features.

NASA Applications

Additive manufacturing technology projects, expertise, and capabilities are present at all NASA centers. MSFC, LRC, and GRC are developing AM of metals. The NASA Additive Manufacturing Working Group has participants from all of the NASA centers. Ames recently created the "Space Shop," modeled after the "fab lab" concept at MIT. There is now AM capability on the ISS and multiple directorates have an interest in space-based AM.

Non-NASA Applications

AM is expected to replace many conventional manufacturing processes with market growth in every manufacturing sector. The technology has achieved market readiness in dental and prototyping industries with aerospace following closely behind. There are also opportunities in other high-value engineering applications such as production of patient-specific biocompatible implants.

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NON-PROPRIETARY DATA