NASA STTR 2020 Phase I Solicitation

T12.06   Extensible Modeling of Additive Manufacturing Processes

Lead Center: JPL

Technology Area: TA12 Materials, Structures, Mechanical Systems and Manufacturing

Scope Title

Process Modeling of Additive Manufacturing

Scope Description

The subtopic of modeling of additive processes is highly relevant to NASA as NASA is currently on a path to implement additive processes in space flight systems with little or no ability to model the process and thereby predict the results. In order to reliably use this process with a variety of materials for space flight applications, NASA has to have a much deeper understanding of the process. NASA is currently considering these processes for the Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE), Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals (SHERLOC), ion engines and other spacecraft structural and multi-functional applications. Additive manufacturing of development and flight hardware with metallic alloys is being developed by NASA and its various partners for a variety of spacecraft applications. These components are expected to see extreme environments coupled with a need for high-reliability (e.g., manned spaceflight), which requires a deeper understanding of the manufacturing processes. Modeling of the additive processes to provide accurate dimensional designs, preferred micro-structures that are defect-free is a significant challenge that would dramatically benefit from a joint academic-industry approach. The objective would be to create process models that are compatible with current alloys systems and additive manufacturing equipment which will provide accurate prediction of outcomes from a variety of additive manufacturing process parameters and materials combinations. The primary alloys of interest to NASA at this time include: Inconel 625 & 718, stainless steels, such as 304 and 316, Al10SiMg, Ti-6Al-4V, and copper alloys (GrCop-84). It is desired that the modeling approach address a focused material system, but be readily adaptable to eventually accommodate all of these materials. Therefore, the model should incorporate modest parameter changes coupled with being easily extensible for future alloys of interest to NASA. NASA is interested in modeling of the Selective Laser Melting (SLM), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) processes.

References

Stranza, M. et al., Materials Letters, accepted (https://doi.org/10.1016/j.matlet.2018.07.141)

Vision 2040: A Roadmap for Integrated, Multiscale Modeling and Simulation of Materials and Systems, NASA/CRâ€”2018-219771

Keller, T. et al., Acta Materiala, (https://doi.org/10.1016/j.actamat.2017.05.003)

Expected TRL or TRL range at completion of the project

Proposed technologies should mature to TRL 1 to 2 by the end of Phase II effort.

Desired Deliverables of Phase II

Software

Desired Deliverables Description

A functional process model covering the specific area by the proposer, using open source or code shared with the Agency.

State of the Art and Critical Gaps

Additive manufacturing will be used for space flight applications. NASA, and its suppliers, currently have very little knowledge of what is happening with these processes. Modeling of these additive processes is essential for NASA to be able to use these processes reliably. NASA is currently working on a specification for these processes and modeling would help that effort as well.

Relevance / Science Traceability

Process modeling of additive manufacturing is relevant to Human Exploration and Operations Mission Directorate (HEOMD), Science Mission Directorate (SMD)), and Space Technology Mission Directorate (STMD), all of which have extant efforts in additive manufacturing. HEOMD is focusing heavily on the use of additive manufacturing for propulsion systems (e.g. RS-25, RL10) for SLS, SMD is using additive manufacturing on the Planetary Instrument for X-ray Lithochemistry (PIXL) on the Mars 2020 mission, the Psyche Mission, as well as various ESI initiatives through STMD.