PROJECT SUMMARY 3014

Evaluation of Defects in Metal Laser Powder Bed Fusion (LPBF) Additive Manufacturing Using Multiple Layers

Image of laser powder bed fusion with two lasers during printing (note effluent from each melt pool).

PROBLEM

Metal LPBF systems with multiple lasers offer increased productivity over single laser systems. Parts that are uneconomical to produce with LPBF using a single laser system can be made cost competitive through the use of multiple lasers. While many manufacturers are offering commercially available equipment with two and four lasers, there is a gap in understanding potential material defects arising from the use of multiple laser systems. To accelerate industrialization of these multiple laser systems, it is critical to understand the material property implications resulting from these defects.

OBJECTIVE

The objective of this effort is to understand the metallurgical defects in multiple laser LPBF systems and apply nondestructive evaluation (NDE) methods that can be used to identify potential defects in service. The goal of this project is to deliver a test artifact, technical data package, and new standard as the foundation for end users to confidently implement new higher productivity metal additive manufacturing (AM) equipment. The project seeks to accelerate introduction of multiple laser LPBF systems for demanding applications.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to:

MATERIAL

ASTM PROCESS CATEGORY: Powder Bed Fusion

EQUIPMENT: Concept Laser M2

MATERIAL: IN 718

TECHNICAL APPROACH

A test artifact is being designed to examine material defects caused by the use of multiple lasers. Defects could include porosity due to overlap of laser paths, lack of fusion porosity from lack of laser overlap in the stitching region, additional spatter from multiple melt pools, or varying surface roughness due to variance in calibration. The artifact is also being designed to examine tolerance issues in overlap of the individual lasers, as well as other factors affected by the use of multiple lasers. Melt pool monitoring is being used to screen defects and micro-CT to characterize these defects, identifying porosity and other microstructural features in the test artifacts. Using a Concept Laser M2 LPBF machine with two 400W lasers, Proto Precision Manufacturing Solutions is printing the test artifact out of Inconel alloy 718. This particular alloy is of strong interest to the aerospace industry for AM. Greater understanding of productivity enhancement for IN 718 printing is also building on existing America Makes' programs aimed at maturing metal AM.

PROJECT START DATE

June 2018

EXPECTED END DATE

October 2019

EXPECTED DELIVERABLES

- Test artifact designed to characterize metallurgical defects in LPBF built parts using multiple lasers
- Technical data package including quantitative image analysis of metallurgical defects using in-situ thermal imaging and micro-CT
- Final report detailing material and process parameters used during the project and outlining all results from each task
- Draft standard for identifying and controlling metallurgical defects in LPBF with multiple lasers

FUNDING

$387K total project budget
($250K public funding/$137K private funding)

PROJECT PARTICIPANTS

Project Principal:
Ohio State University

Other Project Participants:
Proto Precision Additive Manufacturing Solutions
GE Additive

Public Participants:
U.S. Department of Defense
National Science Foundation
U.S. Department of Energy

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