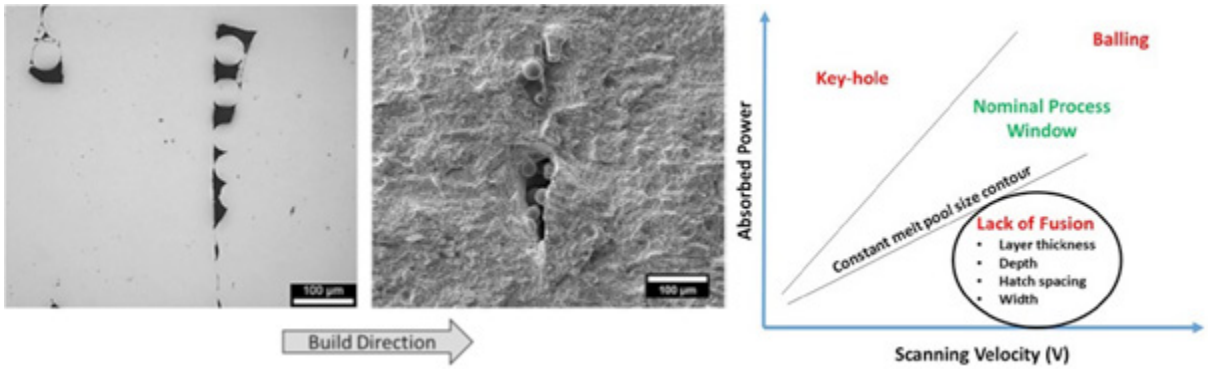
PROJECT SUMMARY 3012

Accelerating MAMLS Direct Part Production: Effect of Defects in Laser Powder Bed Fusion AlSi10Mg



Lack of fusion defects shown (sectioned view and surface) that may have an effect on the physical properties of an additively manufactured part based on the absorbed power to scanning velocity ratio.

PROBLEM

The USAF is interested in the use of laser powder bed fusion (LPBF) to produce replacement parts, but the strength and fatigue life capability of airframe parts can be significantly degraded by the presence of rogue flaws from the LPBF process. Mechanical failures of aircraft components can be attributed to three primary causes: fatigue, corrosion, and stress corrosion cracking. The LPBF process can produce defects that contribute to these types of failures, so the impact of these flaws needs to be addressed in the design of AM parts to make sure they satisfy structural requirements. It is critical to know if these rogue flaws can be reliably detected by in-situ sensors as well as nondestructive evaluation (NDE).

OBJECTIVE

The objective of this program is to study the effects of lack of fusion defects and powder contamination in the LPBF process. Several applications have been identified involving casting type alloys such as AlSi10Mg. The program is building on the results of a previous effort under Phase 2 of the Maturation of Advanced Manufacturing for Low-Cost Sustainment (MAMLS) program by utilizing the baseline processing conditions, including post processing.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to: MATERIAL

ASTM PROCESS CATEGORY: Powder Bed Fusion

EQUIPMENT: 3DS ProX 320, UTC ATLAS

MATERIAL: AlSi10Mg

TECHNICAL APPROACH

The project is divided into two technical tasks to research the creation, detection, and effect of lack of fusion (LoF) defects, and to study the effects of powder contamination. New deposition parameters are being developed to create repeatable LoF defects of various sizes and flaw densities to determine properties and detectability by several inspection methods such as computed tomography (CT), radiographic testing (RT), and process compensated resonance testing (PCRT). Laser power and velocity parameters are being developed to create repeatable LoF defects of various sizes and defect densities to determine NDE detectability. Testing of these materials is to include tensile, fracture toughness, fatigue, fatigue crack growth, and corrosion testing (specifically salt fog and stress corrosion cracking tests). In addition, these effects are being modeled via lifetime modeling. For powder contamination samples, small measured quantities of Inconel 718 powder are being mixed into AlSi10Mg powder. Contaminated samples are to undergo mechanical testing and corrosion testing. The powder contamination results are being compared to baseline and LoF results.

PROJECT PARTICIPANTS

Project Principal:
Youngstown State University

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

Other Project Participants:
Pennsylvania State University
University of Dayton Research Institute
Case Western Reserve University
Oerlikon
3D Systems
Boeing Company
Lockheed Martin
Vibrant

PROJECT START / END DATE

May 2018 - May 2020

EXPECTED DELIVERABLES

- Data management plan
- Final project report with technical data
- ACADEMI module on manufacturing realities
- Process parameters and methodologies for ProX320
- Physical specimens ProX320
- Sensor data ProX320 specimens
- Salt fog testing data ProX320 specimens
- Salt fog with sulfuric acid testing data ProX320 specimens
- Immersion testing data ProX320 specimens
- Intergranular corrosion testing data ProX320 specimens
- Stress corrosion testing data ProX320 specimens
- Metallography data – optical and SEM ProX320 specimens
- Process parameters and methodologies for ATLAS
- Physical specimens ATLAS
- Sensor data ATLAS specimens
- Tension data
- High cycle fatigue – HCF data
- Toughness data
- Fatigue crack growth data
- Effects of powder contamination on tension/fatigue
- Lifing analysis results
- Radiographic testing results of NDE coupons
- Radiographic testing results of NDE parts
- PCRT results and data for AlSi10Mg data samples NDE coupons and parts

FUNDING

$1.53M total project budget
($1M public funding/$534K private funding)

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