PROJECT SUMMARY 3026.002

Corrosion of AlSi10Mg in Laser Powder Bed Fusion (LPBF)

Liquid cold plates, heat exchangers, and external aircraft components are of interest for this corrosion investigation by the team composed of Northrop Grumman Systems Corporation (NGSC) and University of Dayton Research Institute (UDRI).

PROBLEM

Defense systems are becoming increasingly electronic with embedded computing systems which require complex, lightweight, structurally integrated, cooling components. Laser powder bed fusion (LPBF) has unique advantages for manufacturing structurally integrated parts in such applications with advanced performance. However, current LPBF alloys like AlSi10Mg exhibit corrosion behavior, unique to additive manufacturing (AM), which is dependent on manufacturing artifacts such as roughness, surface porosity, the presence of protective films, and process melt pool solidification dynamics. This unique corrosion behavior is not well understood and creates a roadblock to Department of Defense (DoD) adoption of LPBF parts for mission critical defense systems in potentially corrosive environments.

OBJECTIVE

The objective of this project is to advance understanding of corrosion mechanisms of AlSi10Mg components produced by LPBF to facilitate adoption in DoD hardware. Specifically, the team seeks to research corrosion mechanisms of LPBF AlSi10Mg as they relate to several product lines; correlate results from screening testing to manufacturing key process input variables (KPIVs) and develop manufacturing best practices and corrosion mitigation strategies; validate the mitigation strategies on LPBF AlSi10Mg against the current manufacturing best practices for traditional wrought and cast aluminum alloys in order to evaluate their efficacy; and create a manufacturing process guideline, specific to corrosion mitigation of LPBF AlSi10Mg, to be disseminated to America Makes and DoD supply chain partners.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to: MATERIAL

ASTM PROCESS CATEGORY: Powder Bed Fusion

EQUIPMENT: EOS M290

MATERIAL: AlSi10Mg

TECHNICAL APPROACH

This project aims to reduce uncertainty associated with the potential failure of LPBF AlSi10Mg components due to corrosion as well to provide manufacturing guidance for these components. The technical approach is to define requirements based on DoD part families for AM at NGSC and UDRI. The team plans to identify and test corrosion mechanisms of concern to enhance understanding of AlSi10Mg corrosion as a function of heat treatment, surface roughness, and finish. Finish refers to chromate conversion coatings and/or primers. NGSC is conducting salt fog, humidity testing, and beachfront testing to understand localized corrosion susceptibility in these environments. UDRI is performing microbial-induced corrosion (MIC) and stress corrosion cracking (SCC) testing to understand these susceptibilities in JP-8 and chlorides, respectively. Corrosion mitigation strategies are being developed and tested based on corrosion screening results at NGSC and UDRI. Full component testing and analysis at NGSC and UDRI is planned; UDRI is focusing on internal environments, whereas NGSC is concentrating on external environments. Manufacturing process guidelines for corrosion prevention practices are being developed jointly between NGSC and UDRI for dissemination to America Makes and DoD supply chain partners. guidelines for corrosion prevention practices are being developed jointly between NGSC and UDRI for dissemination to America Makes and DoD supply chain partners.

PROJECT START/END DATE

June 2019 - September 2021

EXPECTED DELIVERABLES

- Corrosion-relevant requirements for all part families
- Printing files for components from each part family
- Print and post processing parameters of interest and relevant ranges
- Detailed test matrix for process parameters and corrosion modes
- Results of powder characterization and rheology testing
- Printed samples in accordance with test plans
- Corrosion data from screening tests to assess general susceptibility in several test environments
- Key interactions for process parameter relation to corrosion results
- Results of accelerated testing of key variables
- Final processing parameters and finishes for subsequent testing
- Coating and protection methodologies for application to AM components
- Test corrosion mitigation strategies according to refined test matrix
- Functional assessment of corrosion mitigation strategy
- Development of process guidelines for corrosion prevention of LPBF AlSi10Mg
- Final report

FUNDING

$664K total project budget
($443K public funding/$221K private funding)

PROJECT PARTICIPANTS

Project Principal:
Northrop Grumman

Other Project Participants:
University of Dayton Research Institute

Public Participants:
U.S. Department of Defense

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