PROJECT SUMMARY 5540.001

Additive Manufacturing Casting Replacement Optimization (AMCRO) – Heat Treating and Chemistry

Pictorial representation of the project's technical plan including descriptions of project responsibilities for each organization

PROBLEM

Commercially available feedstocks that are often used for wire-arc directed energy deposition (DED) were not designed to serve as bulk material and therefore may not perform similarly to the original, cast materials. Although post-build heat treating is desirable to promote homogeneity, reduce residual stress, and perhaps enable relaxation of the interpass temperature constraints that are typically required for welding, there are no standardized heat treatment procedures for commercially available wire-arc feedstocks.

OBJECTIVE

The objective of this effort is to develop and demonstrate an optimized wire-arc DED process and post-process heat-treating procedures for the casting replacement of HY-80 steel castings. This will be achieved by compiling available program data, determining and reviewing process/property relationships, and completing elemental refinement modeling with respect to MIL-100S-1.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to: MATERIAL

ASTM PROCESS CATEGORY
Directed Energy Deposition

EQUIPMENT
Wire-Arc DED

MATERIAL
HY-80, MIL-100S-1

TECHNICAL APPROACH

This effort is being led by the Pennsylvania State University Applied Research Laboratory (PSU ARL). The first task will be to perform computational modeling of the MIL-100S-1 alloy to identify equilibrium, non- equilibrium phases, and phase transformation temperatures to help inform the optimum wire-arc DED processing conditions and post heat-treating conditions. This task will also investigate optimum chemistries within the MIL-100S-1 specification to help reduce the quenching sensitivity to allow for more uniform properties between thick and thin sections. The second task will involve thermo-mechanical modeling of the wire-arc DED process to better understand the optimum build path to assure in-process heating is maintained at acceptable levels to minimize distortion. This will also model the heat-treating response to understand expected heating and quenching curves as a function of distance from the surface. With the information gained from tasks 1 and 2, task 3 will produce builds by wire-arc DED and the builds will be sectioned for heat treating evaluations. Finally, task 4 will conduct material characterization on samples to assess the impact of various wire-arc DED processing and heat-treating conditions used.

PROJECT START DATE

April 2023

EXPECTED END DATE

January 2024

EXPECTED DELIVERABLES

- Comprehensive final report containing, at a minimum, critical process parameters, lessons learned, standards used, and any deviations from those standards.

FUNDING

$493,829 total project budget
($293,786 in public funding/$200,043 in private funding)

PROJECT PARTICIPANTS

Project Principal:
Pennsylvania State University Applied Research Laboratory (PSU ARL)

Other Project Participants:
Questek
John Deere
Lincoln Electric

Public Participants:
U.S. Department of Defense