ITT Reference No: RQ0000017124

ITT Issue Date: 16th September 2022

Advanced characterisation and simulation of additively manufactured Scalmalloy

Technical Approach

[redacted]

28th September 2022

Introduction

This work will develop a fundamental understand and modelling tools to enable exploitation of additively manufactured (AM) aluminium-magnesium-scandium (Scalmalloy) within DSTL. Specifically, through microstructural analysis and physics-based modelling, the work will develop a **digital twin** of AM Scalmalloy that be exploited in designing with this material.

The work will involve:

1. Interpretation of the process – microstructure – property relationship through assessment of the SLM processing window, advanced characterisation of sample microstructure (grain size, homogeneity and defects) and mechanical testing
2. Developing modelling tools to understand and predict the performance of additively manufactured Scalmalloy
3. Analysing and predicting the thermal stability of additively manufactured Scalmalloy
4. Liaising with DSTL an [redacted]ovide regular project updates and an end of project written report (see deliverables).

Work-packages

WP1: Process window optimization

Mechanical properties of Scalmalloy AM samples manufactured using different process parameters will be assessed. The mechanical properties will be correlated to the microstructure and defect population in the samples. This will be used to identify the optimum parameter process window to obtain the desired properties.

WP2: Understanding microstructure

A detailed investigation of the microstructure and local composition will be performed using electron microscopy and microprobe. This will be used to understand heterogeneity and provide quantitative measurements of the microstructure to compare with model predictions.

WP3: Process/microstructure/property models

A computational fluid dynamics model for the AM process will be coupled to a microstructure model to predict the critical microstructural parameters, in particular the size, spacing, and distribution of the strengthening Al_3X precipitates. This will enable a **digital twin** of the AM part to be constructed. The microstructural models will be linked to a classical model to predict strength. The model will be calibrated against measured data gathered in WP2 and tested for unseen conditions. The model will be applied to predict the effect of changing build strategies or geometries. It will also be used to predict the long-term stability of the microstructures to thermal exposure.

WP4: Microstructural stability

Long duration heat treatments will be performed to assess the microstructural stability of the AM Scalmalloy parts. Mechanical properties will be tracked over time, and the results will be compared to model predictions from WP3.

Deliverables and Timeline

Deliverables

Presentations to be delivered at 0 months, 3, 6, 9 months. Final review, presentation and report to be delivered at 12 months.

Indicative timeline

WP	M1	2	3	4	5	6	7	8	9	10	11	12
1												
2												
3												
4												

Resource Requirements

The project requires 12 months work from an postdoctoral researcher (PDRA) to deliver on the workpackages (Grade 6).

The project requires extensive use of electron microscopy and mechanical testing facilities within the Royce Institute and Department of Materials at the University of Manchester. These costs are stated in Table 1.

The project will require the use of consumables needed for experiments. Travel and subsistence costs are required for travel to meetings with project partners to deliver updates and the final presentation. International travel is required to discuss results with overseas collaborators.

Technician support and laboratory costs are required to support the experimental work to be carried out within Royce and University of Manchester.

Appendix 1

Item	Cost
Salary PDRA (6.33)	[redacted]
Travel and subsistence	[redacted]
Consumables	[redacted]
Electron microscopy (Royce)	[redacted]
Laboratory, technician and related cost	[redacted]
TOTAL	£152369.08

Table 1: Cost summary