POSTER EXPOSITION

Loughborough University

Poster 7

In-situ tempering to improve the metallurgy of additively manufactured tool steel components

Anna Tholen

AUTHOR OF POSTER:
Anna Tholen

INSTITUTION:
Loughborough University

OTHER AUTHORS:
Dr Rebecca Higginson, Loughborough University
Nick Jones, Renishaw Plc
Dr Ravi Aswathanarayanaswamy, Renishaw Plc

ABSTRACT:

Macroscale, fatigue-type cracking is a prevalent issue in additively manufactured hot work tool steels. Tool steel alloy, H13, can maintain excellent wear resistance at elevated temperatures for sustained times, making it ideal for metal and polymer casting dies. Laser powder bed fusion (LPBF) additive manufacturing (AM) offers considerable advantages to the manufacture of H13 dies by reducing the technical challenges of machining high hardness material. However, due to rapid and cyclical heating and cooling in the LPBF AM process, H13 cannot achieve its optimal microstructure of tempered martensite and fine carbide precipitates. The resultant microstructure of untempered martensite renders the material brittle and thus susceptible to cracking during LPBF AM fabrication.

A protocol for in-situ heat treatment was developed to facilitate the evolution of H13's optimal microstructure during the LPBF AM process. Macroscale cracking was minimised to enable a relative density of 99.999%, and residual stresses were reduced and homogenised throughout the fabricated samples. It was therefore shown that by utilising in-situ heat treatment, functional H13 components can be produced by LPBF AM, exhibiting the optimal microstructure and mechanical properties.

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