Influences of Laser Scanning Patterns on Deformation, Stress and Temperature in Laser Beam Powder Bed Fusion Manufacturing

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ABSTRACT

Laser beam Powder Bed Fusion (PBF-LB) additive manufacturing (AM) technologies are a process of manufacturing components by consecutively melting thin layers of powder in a layer by layer method based on three dimensional CAD files. Multiple industries, such as medical device (e.g. orthopaedic joint replacements) and aerospace, are rapidly adopting PBF-LB as a manufacturing process. The ability to accurately simulate this process and predict the thermal history and the final residual stress would constitute a considerable advancement in AM material knowledge and further advance product design for metal PBF-LB.

Multi-beams PBF is an emerging technology to shorten the part production time and improve the productivity efficiency [1, 2]. However to date, most of the current process modelling of PBF-LB are focused on the single laser scanning and the effects of multi-beams scanning strategies on part residual stress and distortion remain uncertain. The objective of this research is to computationally simulate the process of dual laser beams to identify optimum multi-beam PBF-LB process configuration.

In this research, a multi Gaussian scanning strategies subroutine was developed for the general purpose finite element solver ABAQUS/ CAE. First, the influences of multiple scanning strategies on residual stresses and distortions were studied. Second, three offset strategies were investigated to reveal the temperature field. Third, different layer-level scanning strategies were simulated and the final temperature, stress, deflection results were compared. Finally, the distortion and residual stress of multiple laser beams work together and separately to build two components at the same base plate simultaneously were compared. This research could be beneficial for the part scale process modelling of PBF-LB and inform machine operators of optimum process configuration for minimising part distortion.

REFERENCES

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