Application of Additively Manufactured Lattice Structures for Convective Heat Transfer

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ABSTRACT

Lattice structures can augment heat transfer in engineering components creating the possibility for high-performance parts optimised for demanding thermal loading environments. However, practical insight regarding the introduction of this technology into complex engineering components is currently lacking. Experimental work has characterised the heat transfer properties for a range of structures and the data from this work is used to design and manufacture heat transfer components via laser powder bed fusion. Lattice structures are used to incorporate heat transfer capability into three demonstrator components: a GPU representing a high-power electronic chip; a compact fluid-fluid heat exchanger; and a gas turbine nozzle guide vane. The designs presented here enable increases in performance alongside improved packaging, in both shape and volume, whilst minimising mass. This capability is evaluated in the case of the GPU, showing improved cooling performance whilst achieving a 90 % mass and 93 % volume reduction. Furthermore, this paper serves as a guide for the introduction of similar structures in high value components.

1 INTRODUCTION

The use of lattice structures manufactured via metal additive manufacturing (AM) for heat transfer applications can enable high-performance heatsink components with a small footprint and low mass. To date, practitioners have mainly restricted the use of lattice structures to mechanical loading environments where the principle aim was to reduce the mass of a component whilst retaining high mechanical strength or stiffness. However, as the understanding of and confidence in metal AM