

Fatigue Performance of Additive Manufactured Alloys: Challenges and Opportunities for Aerospace Applications

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Abstract (*The abstract should be less than 250 words*)

Additive manufacturing (AM) has demonstrated to have great potential for aerospace applications since it is able to optimise design freedom for fabricating more complex geometry and lightweight integrated components, and to achieve higher fuel efficiency and reduced lead-time and the cost of ownership of the ADF assets. Although AM has been successfully applied for many secondary structures or other non-critical applications, most aircraft fracture-critical components are currently still machined out of forged metal alloys. This is mainly because of the confidence in understanding the mechanical properties (specifically fatigue strength and fracture toughness) of forgings adequately and accurately. Given this conventional manufacturing often resulted in typical buy-to-fly ratios more than 10:1 with lengthy lead times and high cost, there is a demand for further R&D to unlock the potential of AM especially for aircraft fracture-critical structures and parts.

This paper attempted to outline the various technical challenges to be considered in the qualification of AMed alloys for aerospace applications, focusing on critical load bearing components. Although, in recent years, extensive R&D efforts have been devoted to achieving lower cost fabrication of Ti-6Al-4V parts using AM, this review has found that the fatigue strength of most AMed Ti-6Al-4V materials published so far is equivalent to that of casting counterparts. Some promising opportunities in using post processing technologies to enhancing fatigue performance of AMed Ti-6Al-4V alloys were overviewed and discussed. The post processing technologies discussed include post heat-treatment, hot isostatic pressing, and surface enhancement technologies such as shot peening and deep surface rolling. The mechanics and mechanisms of how these post processes enhance fatigue performance of AMed alloys were explored from a perspective of certification specifications and requirements in accordance with airworthiness standards.