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Fabrication and Characterisation of Additive Manufactured Ti-6Al-4V Parts by Laser Powder Bed Fusion Technique

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Abstract : In order to reduce fuel consumption and CO_2 emissions in the aviation sector, innovative solutions are being sought to reduce the weight of aircraft, including additive manufacturing (AM). Of particular importance are the excellent mechanical properties that are required for aircraft structures. Ti6Al4V alloys, with their high mechanical properties in relation to weight, can reduce the weight of aircraft structures compared to structures made of steel and aluminium. Currently, conventional processes such as casting and CNC machining are used to obtain the desired structures, resulting in high raw material removal, which in turn leads to higher costs and impacts the environment. Additive manufacturing (AM) offers advantages in terms of weight, lead time, design, and functionality and enables the realisation of alternative geometric shapes with high mechanical properties. However, there are currently technological shortcomings that have led to AM not being approved for structural components with high safety requirements. An assessment of damage tolerance for AM parts is required, and quality control needs to be improved. Pores and other defects cannot be completely avoided at present, but they should be kept to a minimum during manufacture. The mechanical properties of the manufactured parts can be further improved by various treatments. The influence of different treatment methods (heat treatment, CNC milling, electropolishing, chemical polishing) and operating parameters were investigated by scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDX), X-ray diffraction (XRD), electron backscatter diffraction (EBSD) and measurements with a focused ion beam (FIB), taking into account surface roughness, possible anomalies in the chemical composition of the surface and possible cracks. The results of the characterisation of the constructed and treated samples are discussed and presented in this paper. These results were generated within the framework of the 3TANIUM project, which is financed by EU with the contract number 101007830.

Keywords : Ti6Al4V alloys, laser powder bed fusion, damage tolerance, heat treatment, electropolishing, potential cracking
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