Fatigue and fracture properties of Ti alloys from powder-based processes - a review

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Abstract

Titanium is the ideal lightweight structural metal for a great variety of engineering applications due to its characteristic combination of highest specific mechanical properties (maintained up to high operating temperatures), excellent corrosion resistance in different highly corrosive environments, and biocompatibility with the human body. Nevertheless, the widespread industrial use of titanium is greatly hindered by its high extraction and manufacturing costs with respect to other metallic counterparts such as steel and aluminium. The scientific community has devoted a great effort in understanding and developing more efficient processing methods for titanium. Most of these methods are powder-based (i.e. powder metallurgy and additive manufacturing) due to the intrinsic advantages that their use brings about such as high material yield, limited machining operations, and a high degree of freedom on alloy composition and structural complexity. Properties like fatigue and fracture toughness, especially of materials manufactured using new non-conventional metallurgical processing routes, are critical parameters for materials selection and structural design optimisation. Nonetheless, these properties have been highly disregarded in comparison to static properties (i.e. tensile behaviour) due to their more complex nature. This paper presents a systematic and critical analysis of the current scientific knowledge about fatigue and fracture properties of titanium alloys manufactured via powder-based methods. This review clarifies the effect that microstructural features inherent to each specific method, such as