Effect of size on the limit strain of additive manufactured titanium

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Abstract

Additive manufacturing of metals has open a whole new range of complex functional geometries inaccessible by convectional production methods which are called to revolutionise several sectors (i.e., biomedical, aerospace, energy). These parts usually include a wide variety of characteristic elemental length scales from thin walls/struts to bulk regions. The different intrinsic aspects of the manufacturing process (heat fluxes) makes the properties of the material strongly size dependent. These dependencies are still unclear and further investigations are needed in order to assure the quality of the produced parts. In this work, the variation of the mechanical properties as a function of the component size and build orientation is addressed.

1 Introduction

Mechanical properties of additively manufactured components are different than those traditionally manufactured [1, 2]. The particulars of the selective laser melting (SLM) process create microstructures that are far from optimal from a performance perspective [3–5]. Substantial post-processing – usually in the form of heat-treatment or hot isostatic pressure processing – is necessary in order to obtain decent mechanical properties [6]. Moreover, it is well established that properties are affected by part geometry and processing parameters [7]. For example, differences in wall thicknesses introduce different heat gradients that result in differences at the microstructural level [8, 9]. The consequences of these on the mechanical properties of titanium are still not well established [10].