Print faster in Powder Bed Fusion Ti-6Al-4V using Hot Isostatic Pressing (HIP)

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ABSTRACT

The Powder Bed Fusion (PBF) printing process offers many advantages compared to conventional subtractive manufacturing techniques. However, a major drawback is slow print time. This limitation may prevent its implementation into many industries. This manuscript will cover techniques where the PBF process can be performed significantly faster, resulting in a higher amount of porosity in the as-printed condition which is then eliminated by hot isostatic pressing (HIP). The printing process speed is increased by modifying print parameters or by printing just the shell of a geometry, then HIPing the material to full density for desired mechanical properties. Density measurements, micrographs, mechanical property testing results, HIP simulation and measurement of time savings will be presented.

INTRODUCTION

Additively manufactured (AM) processes such as Laser (L-PBF) and Electron Beam PBF have drawn significant attention in many industries. These technologies have expanded the design window for complex components and provide rapid prototyping capabilities. With continuous improvement of equipment and optimized print parameters near maximum density can be achieved in the as-printed condition. Despite these advancements the resulting microstructure still exhibits internal defects such as gas porosity, keyhole defects, and lack-of fusion potentially having a negative impact on mechanical properties and reliability. Consequently, critical AM components used in the aerospace and medical industry often receive a post-process HIP. HIP is a process technique that has been applied for many decades in a wide range of industries and applications [1]. It is a high temperature and pressure technique that offers a process route to collapse and heal such defects, further increasing part density and improving mechanical properties such as fatigue, creep, ductility, and fracture toughness [2-6]. Eliminating the natural variation of defects in the part also contributes to reduced property scatter rendering more predictive properties.