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PROCEEDINGS

Uncovering the Mechanisms by Which Hot Isostatic Pressing Improves the Mechanical Properties of LPBF Ti-6Al-4V

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ABSTRACT

Hot isostatic pressing (HIP) is often utilized to obtain laser powder bed fused (LPBF) Ti-6Al-4V with good mechanical properties. To uncover the underlying mechanisms by which HIP improves the mechanical properties, several mechanisms are considered and examined against experimental data sets available in the literature. The results suggest that HIP improves mechanical properties by both reducing defect sizes below a critical threshold and altering the microstructure surrounding defects. Based on these findings, a pore healing model was developed, and optimized HIP processing parameter range (temperature, pressure, and soaking time) were proposed. Severe plastic deformation driven dynamic recrystallization during HIP resulted in fine equiaxed α grains around the healed pores and increased fatigue crack initiation resistance. Motivated by this finding, we intentionally introduced high initial porosity in LPBF Ti-6Al-4V by adjusting the applied volumetric energy density and then subjecting the samples to HIP treatment. In this way, the heterostructures consisting of hard fine equiaxed α grains and soft lamellar α grains were introduced. Compared to HIPed fully-dense LPBF samples, this heterostructured Ti-6Al-4V exhibits enhanced ductility while maintaining comparable tensile strength. The mechanistic understanding provides guidance on parameter optimization of combined LPBF-HIP process for further improving the mechanical properties of LPBF Ti-6Al-4V.

KEYWORDS

Laser powder bed fusion; titanium alloy; build defects; hot isostatic pressing; dynamic recrystallization

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