Improving the Properties of Titanium Alloy AM Parts via HIP

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ABSTRACT

Most parts built by additive manufacturing (AM) processes require secondary treatments to render them suitable for the intended critical purpose. Even with the most robust techniques, metal powder fusion processes still create small internal voids during the build cycle. The effect of post-build hot isostatic pressing (HIP) was evaluated on Ti 6/4 (titanium – 6% aluminum – 4% vanadium). Advanced characterization techniques such as computed tomography (CT) scanning x-ray, scanning electron microscope (SEM) fractography, and fatigue analysis were used to evaluate the effects on properties. Results demonstrate the removal of defects and the corresponding improvement in mechanical properties. This is especially important for critical components in industries such as nuclear, aerospace, medical, and subsea applications where fatigue is a major cause of premature failure. Additional work will concentrate on optimizing HIP parameters to produce the most advantageous microstructure for the intended purpose.

INTRODUCTION

Additive manufacturing using metal powders continues to be the fastest growing sector of the powder metallurgy (PM) industry. The concept of an additive versus subtractive manufacturing route holds many advantages with some of the most critical being the freedom to improve design and respond to engineering changes easily and quickly, the elimination of the bulk of material waste during forming, and the ability to create a near-net, or net shape, with alloys that can be very difficult, expensive and time-consuming to machine. It has also opened the door for designs and corresponding weight savings that are impossible to create with historical manufacturing methods.