

Improving Build Rate Productivity for Cobalt-Chrome Molybdenum Alloy in Laser Powder Bed Fusion Systems

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ABSTRACT

The majority of commercially-available Laser Powder Bed Fusion (LPBF) systems currently utilize 400watt lasers, with certain larger systems alternatively incorporating 700 or 1000 watt lasers. Typically, these systems are not operated at full power, suggesting that productivity enhancement should be possible if process conditions are controlled appropriately. Here we demonstrate using Cobalt Chrome Molybdenum (CCM) alloy that an increase in build rate by at least 25% is possible with current LPBF system configurations. Further, by incorporating Hot Isostatic Pressing (HIP) following additive manufacturing, up to 50% or higher productivity enhancements are possible. This equates to a basic build rate increase of 5 to 10 cc/hr over the current rate of ~ 20 cc/hr. Preliminary results including micrographs and mechanical properties using Carpenter Additive CCM-MC powder are presented.

INTRODUCTION

The leading metal additive manufacturing technique today is laser powder bed fusion (LPBF), whereby lasers provide the energy source for fusing powders to form components on layer by layer basis. Under typical commercially-available settings, these systems do not operate at full laser power, since high laser fluence can cause melt pool geometry to approach keyholing, leading to cavitation and therefore porosity in the build [1]. Likewise, excessive splatter due to vaporization recoil effects from the melt pool can also lead to increase in porosity [2, 3]. However, the underutilization of laser power suggests an opportunity to push to higher efficiencies by elevating laser power and carefully controlling other parameters such as: layer thickness, bead spacing, linear beam speeds, and beam focus, which can be adjusted on some systems using programmable collimators.

For the following discussions laser power (P_l) will be given in Watts, laser beam linear velocity (V_b) in mm/s, layer thickness (T_l) in mm and consecutive bead spacing, hatch spacing (H), in mm. Build rate (BR) is calculated in equation 1 as: