Mitigation of porosity in laser powder bed fusion additive manufacturing

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Laser powder bed fusion (L-PBF) additive manufacturing (AM) is a promising technology for the production of complex metal parts. The L-PBF process is, however, prone to the formation of voids, that can compromise the mechanical properties of the final product. Advancements to in-situ sensing and data processing enables the detection of void formation mid-process. If sensing data can be processed efficiently and in real-time, there is the possibility to mitigate voids in-situ, without relying on post-processing methods, such as hot isostatic pressing (HIP). Mitigating defects in-situ reduces energy and material expense, limits the need for post-processing, and improves reliability and consistency in L-PBF. This study investigates localized re-melt as a potential method for void elimination. Surrogate voids were programmatically induced at known locations by decreasing the laser power when processing within predetermined regions over sequential layers. Different strategies for void mitigation with varying processing parameters were systematically assessed to determine the optimal parameters to repair the voids and improve the part density. We varied the size of the mitigation area relative to the size of the void and the laser power used for mitigation. Determining the proper mitigation parameters is critical to effectively heal voids and understand the limits of void mitigation. Optimal mitigation parameters, resulted in a significant reduction in void volume compared to the volume processed with the reduced laser power. These results indicate that voids detected during L-PBF AM can be reduced in volume or eliminated in-situ.