Heat Treatment of Inconel 718 Produced by Powder Bed Fusion and Modified Laser Beam Shape

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One of the significant obstacles in the metal industry is productivity and lowering the part's environmental impact. The PBF (Powder Bed Fusion) process is a prime example, where laser beam shaping could increase process productivity and lower part's environmental impact. The research on laser beam shaping is motivated by the need to address the instabilities of the PBF process from the view of melt pool dynamics. Melt pool instabilities can cause defect formation, such as overheating, spatter, keyholing, and balling. However, changing the beam shape and process parameters could influence the microstructure and material's mechanical properties. In this work, we study the influence of heat treatment on Inconel 718 produced by standard Gaussian and modified laser beam shape during the PBF process. After different annealing temperatures, we characterized and compared the part's microstructural characteristics and mechanical properties. The microstructural characteristics were investigated by light and scanning electron microscopy. We performed standard tensile tests to see the influence of beam shaping and annealing temperature. Despite a two-fold increase in the volume energy density, the modified beam shape had little influence on the size and distribution of the cellular dendrites and Laves phase. Because the as-built microstructural characteristics are similar, the modified beam shape did not lead to different microstructural evolution during annealing. Modified beam shape produced larger crystal grains, which resulted in different tensile properties after annealing treatment.