Optimizing LPBF processability of EN AW 7075 aluminium alloy

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This research aims to optimize the process parameters and material composition to enhance the Laser Powder Bed Fusion (LPBF) processability of EN AW 7075. The high-strength aluminium alloy EN AW 7075 poses significant challenges due to the alloy's susceptibility to hot cracking and porosity. Experimental investigations were conducted to explore the influence of varying laser power, scan speed, and preheating temperatures on the microstructure and mechanical properties of the alloy. Initial results revealed that conventional SLM parameters resulted in significant microstructural defects, including hot cracks and high levels of porosity. Preheating, intended to reduce thermal gradients and mitigate these defects, showed limited effectiveness. To address these challenges, a novel approach involving the modification of the alloy's chemical composition by adding silicon was employed. This modification aimed to reduce the solidification range and enhance the material's resistance to cracking. Silicon addition was found to refine the microstructure and promote the formation of a more uniform grain structure, which is less prone to hot cracking. Comprehensive microstructural analysis using Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM), along with mechanical testing, confirmed the enhanced processability and mechanical properties of the modified alloy. The analyses revealed that the modified alloy exhibited a finer and more homogenous microstructure, with significantly reduced porosity and crack density. Mechanical testing showed improvements in both tensile strength and ductility, indicating that the modified alloy could better withstand the thermal stresses associated with the LPBF process. These findings provide critical insights into the optimization of processing for high-performance aluminium alloys, highlighting the importance of alloy composition in achieving desirable microstructural and mechanical properties. The research outcomes suggest that by carefully adjusting the chemical composition and optimizing process parameters, it is possible to overcome the inherent challenges associated with LPBF of EN AW 7075.