

## High-temperature annealing of L-PBF Inconel 718

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Heat-treatment is performed to harden the alloy to achieve the desired mechanical properties of components. Current research on heat-treatment temperatures of L-PBF manufactured Inconel 718 is primarily limited to the temperatures adopted from heat-treatment standards for conventionally produced components from Inconel 718 alloy. A broader heat-treatment range was investigated to determine the effect of annealing temperature on microstructure and mechanical properties. Samples were annealed in temperatures ranging from 1000 to 1200 °C, with annealing times of 10, 20, 30, 60 and 120 minutes. Scanning electron microscopy (SEM) and electron backscatter diffraction (EBSD) analysis were performed to analyze the effects of annealing temperature and time. It was found that  $\delta$  phase precipitated along grain boundaries during annealing at 1000 °C. Recrystallization was initiated between 10 and 20 minutes of annealing at 1050 °C and was completed after 60 minutes, with NbC carbides forming along the grain boundaries. A significant amount of twin boundaries was observed. For annealing at 1100, 1150 and 1200 °C, recrystallization was completed within 10 minutes, followed by grain growth and NbC precipitation along grain boundaries. Based on the microstructural analysis, specific annealing temperatures were selected to further investigate the impact of microstructural evolution on mechanical properties. One hour of annealing at 954, 1000, and 1100 °C was chosen, with 954 °C being the recommended annealing temperature by the L-PBF machines manufacturer, while 1000 and 1100 °C were selected as comparative temperatures. After annealing at 1000 °C, yield strength increased, whereas annealing at 1100 °C resulted in improved ductility. Additionally, after one hour of annealing at 1100 °C, the anisotropy of mechanical properties was significantly reduced.

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