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Effect of homogenization heat treatment on the microstructure, crystallographic texture, and mechanical behavior of a high-strength Inconel 625 alloy

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Inconel 625 were manufactured by laser powder bed fusion (LPBF) and underwent post-processing heat treatments aimed at optimizing the microstructure and mechanical behavior. Samples were heated to 1100°C and held at this temperature for exposure times of 1 and 3 hours, then air-cooled. Tensile tests at room temperature for both as-built and heat-treated conditions were conducted until failure, and stress-strain curves were determined. The microstructure was evaluated using optical microscopy (OM), scanning electron microscopy (SEM), and electron backscatter diffraction (EBSD). Additionally, aspects of the fracture surface were investigated via scanning electron microscopy. The results showed an increase in elongation, from approximately 45% in the as-built condition to 69% in the condition treated for 3 hours, at the cost of reducing the mechanical strength as the exposure time increased. The microstructure underwent changes both in terms of grain morphology and size. There was a transition from columnar grains present in the as-built samples, formed during the melting process, to an equiaxed morphology due to recrystallization. Grain analysis by EBSD showed a predominance of the {100} < 001 > orientation. Fracture surface observation indicated a change in the active failure mechanism. Thus, heat treatment with different exposure times modified the microstructure of the LPBF-manufactured material, resulting in changes in mechanical behavior, including mechanical strength, ductility, and active fracture mechanism.