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# Finite Element Analysis of Mechanical Properties of Additively Manufactured 17-4 PH Stainless Steel

**Authors :** Bijit Kalita, R. Jayaganthan

**Abstract :** Additive manufacturing (AM) is a novel manufacturing method which provides more freedom in design, manufacturing near-net-shaped parts as per demand, lower cost of production, and expedition in delivery time to market. Among various metals, AM techniques, Laser Powder Bed Fusion (L-PBF) is the most prominent one that provides higher accuracy and powder proficiency in comparison to other methods. Particularly, 17-4 PH alloy is martensitic precipitation hardened (PH) stainless steel characterized by resistance to corrosion up to 300°C and tailorable strengthening by copper precipitates. Additively manufactured 17-4 PH stainless steel exhibited a dendritic/cellular solidification microstructure in the as-built condition. It is widely used as a structural material in marine environments, power plants, aerospace, and chemical industries. The excellent weldability of 17-4 PH stainless steel and its ability to be heat treated to improve mechanical properties make it a good material choice for L-PBF. In this study, the microstructures of martensitic stainless steels in the as-built state, as well as the effects of process parameters, building atmosphere, and heat treatments on the microstructures, are reviewed. Mechanical properties of fabricated parts are studied through micro-hardness and tensile tests. Tensile tests are carried out under different strain rates at room temperature. In addition, the effect of process parameters and heat treatment conditions on mechanical properties is critically reviewed. These studies revealed the performance of L-PBF fabricated 17–4 PH stainless-steel parts under cyclic loading, and the results indicated that fatigue properties were more sensitive to the defects generated by L-PBF (e.g., porosity, microcracks), leading to the low fracture strains and stresses under cyclic loading. Rapid melting, solidification, and re-melting of powders during the process and different combinations of processing parameters result in a complex thermal history and heterogeneous microstructure and are necessary to better control the microstructures and properties of L-PBF PH stainless steels through high-efficiency and low-cost heat treatments.

**Keywords :** 17–4 PH stainless steel, laser powder bed fusion, selective laser melting, microstructure, additive manufacturing
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