
Effect of thermal history on defects in brittle Fe-6.5wt%Si soft magnetic alloy produced by Laser Powder Bed Fusion

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Abstract

Optimization of radial flux machines with punched laminated sheets of electrical steel is well covered in the literature. Additive manufacturing, and in particular Laser Powder Bed Fusion (L-PBF), of soft magnetic should enable a less restrictive design of electrical machines, particularly for axial flux machines whose flux path is fundamentally 3D. Fe-6.5wt%Si is a good candidate in terms of magnetic and electrical properties as well as material cost. As a first step towards designing such complex parts, this alloy needs to be well characterized both mechanically, electrically and magnetically. However, this material tends to exhibit cracking, due to its brittleness, and pores during LPBF manufacturing. First, a detailed comparison of process parameters is carried out to understand the appearance of cracks and pores. Different parameters, laser scanning strategies as well as support structures are compared. Secondly, a thermal dynamic finite element method (FEM) simulation of L-PBF process is developed. It is validated using in-situ thermal measurements by a thermal camera. Subsequently, both mechanical and magnetic properties are measured on the best samples and compared based on their thermal history.

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