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IN-SITU LOCALIZED REINFORCEMENT PROCESSING THROUGH LASER POWDER BED FUSION ON TI6Al4V ALLOY

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Abstract

Laser Powder Bed Fusion (LPBF) is a state-of-the-art additive manufacturing process for fabricating complex metal components. In literature, the primary area of research in LPBF has been to investigate improvement in part quality, through reduction in process induced defect and microstructural changes. In present work, the aim was to study how process parameters can be modified to provide spatially tailored properties within a part while using a single feedstock. Microstructural evolution, specifically grain size, during LPBF is influenced by post melt cooling rate, with faster cooling resulting in finer grains. In this study, cooling rate of a material point within the part was modified through local double melt strategy. Samples were fabricated with single Ti-6Al-4V feedstock, using a predefined local double melting strategy within each layer, to achieve localized reinforcement. Sample testing and analysis primarily focused on evaluating microstructural aspects, defects, and grain size, along with the mechanical properties, specifically the Vickers hardness at various positions within the samples. Additionally, the crack propagation resistance of the material, influenced by the specialized processing, was examined to assess its impact on fracture toughness. The findings indicated that the integration of the predefined locally double melting scan in each layer had a significant influence on the microstructure, resulting in variations in grain size across different locations, as well as hardness values with variations of up to 10% across different areas. Subsequent improvement in elongation by about 40% and the crack arresting behavior by more than 5% has also been observed. Moreover, these discoveries underscore the potential of employing the predefined locally double melting strategy in each layer to create fabricated components with distinctive behaviors, like composites, which could find applications in the aerospace industry.