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SCHOOL OF MECHANICAL,
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Effectiveness of Laser Shock Peening in Post-processing Additive Manufactured Ti-6Al-4V

MECN8000 - MSc Dissertation

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Abstract

The purpose of this work was to set the groundwork for post-processing Additive Manufactured (AM) Ti-6Al-4V manufactured by Laser Powder Bed Fusion (L-PBF) using the Laser Shock Peening (LSP) surface treatment process. Samples of varying thicknesses were manufactured on a wrought substrate plate, and one half of the samples were processed using LSP. Residual stresses were measured using Laboratory X-Ray Diffraction and Incremental Hole Drilling techniques. These measurements showed that LSP is capable of successfully inducing compressive residual stress to a good depth and magnitude in as-built AM Ti-6Al-4V samples. Surface roughness was measured and showed a decrease in surface roughness after LSP treatment. This was attributed to the peaks being affected more than the valleys by the peening action of the expanding plasma. Microhardness was investigated along the depth of an LSP treated sample and its measurements compared to as-built AM Ti-6Al-4V as well as wrought Ti-6Al-4V plate. The microhardness of AM Ti-6Al-4V was more than double that of the wrought Ti-6Al-4V plate. LSP treatment increased the microhardness slightly. Optical microscopy and SEM were used to inspect the grain structure and surface morphology of the samples before and after LSP treatment. No difference in microstructure was observed between as-built and LSP treated material. Atypical oxidation was found on the LSP treated samples, characteristic of the extreme temperatures, pressures and presence of oxygen during the LSP process. This research forms the groundwork of knowledge in the combined capability of AM and LSP technologies to potentially produce highly complex components for specialised industries such as aerospace.