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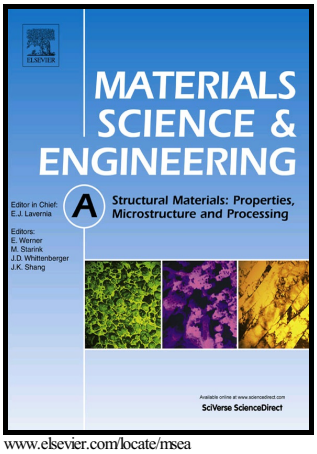

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Effect of scanning strategies on residual stress and mechanical properties of Selective Laser Melted Ti6Al4V

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Abstract

During the Selective Laser Melting (SLM) process large temperature gradients can form, generating a mismatch in elastic deformation that can lead to high levels of residual stress within the additively manufactured metallic structure. Rapid melt pool solidification causes SLM processed Ti6Al4V to form a martensitic microstructure with a ductility generally lower than a hot working equivalent. Currently post-process heat treatments can be applied to SLM components to remove in-built residual stress and improve ductility.

This study examined the effect of scanning strategy (scan vector lengths and scan vector rotation) and rescanning strategy on residual stress formation and mechanical properties of SLM Ti6Al4V parts. 90^{O} alternating scanning strategy resulted in the lowest residual stress build-up for SLM Ti6Al4V parts built on both the standard and modified Renishaw platforms using a modulated Nd-YAG fiber laser. Scanning strategy did not show any direct correlation with mechanical properties. Re-scanning with 150% energy density resulted in 33.6% reduction in residual stress but the effect on mechanical properties was detrimental and samples failed prematurely. The study was based on detailed experimental analysis along with Finite Element simulation of the process using ABAQUS to understand the underlying physics of the process.