Regan Ding
Swinburne University of Technology

Challenges in Laser-Directed Energy Deposition on thin-substrates

Abstract
Laser directed energy deposition (L-DED) has emerged as a technology suitable for repairing various metallic components, including rocketry nozzles. Repairing rocket nozzles necessitates working on intricate parts with thin-walled regions, which present challenges related to heat sink and distortions during the repair process. This understanding paves the way for optimizing the L-DED process through a combination of modelling and experiments to identify the optimal processing windows and strategies for thin-walled components. This study focuses on the potential for using L-DED to repair high-temperature nickel super-alloy IN718 components produced using laser powder bed fusion. The research reveals that lowering substrate thickness caused an exponential reduction in cooling rates. Thinner substrates require reduced powers to achieve similar dilutions and heat-affected zones as thicker substrates. Faster scanning is also required to achieve similar microstructures and mechanical performance. Additionally, the scanning strategy and initial residual stress conditions were paramount in determining the final distortions from L-DED. These findings provide insight into optimal parameters and strategies to obtain ideal deposits on thin substrates with minimal substrate distortions.

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