Effects of energy density distribution on Ti-6Al-4V during hybrid laser-arc wire-direct energy deposition

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This research investigates a novel hybrid laser-arc multi-energy source system, aimed at investigating the flow behaviour of molten material produced by a plasma-transferred arc and continuous wave laser through a galvo scanner. Through independent control of thermal input and bead geometry, this study explores new dimensions in the interaction between different energy sources for use with welding engineering and directed-energy deposition[1]. The focus to understand how the cumulative use of two energy sources interacts and effects the deposited feedstock and substrate material.

Different energy profiles are used to explore and assess the influence on the spread of molten material and provide validation for computational fluid dynamics simulations. These simulations are used to examine the critical parameters between the laser and arc energy sources, identifying the roles of each energy source interaction in the shaping of the melt pool and optimising its deposition in terms of bead geometry.

By investigating the potential for precise control of the bead shape independently of thermal input, this work contributes to advancing the applicability of multi-energy source systems in fields where traditional single-energy systems fall short. The multi-energy source approach could significantly improve the welding of complex geometries and the manufacturing of near-net shape high-value components during directed-energy deposition.

This research emphasizes the deposition of Ti-6Al-4V, a widely used titanium alloy in aerospace applications that presents challenges due to its innate characteristics during the molten phase. The study emphasizes the need for ongoing research in this field, as the potential for multi-energy systems to improve manufacturing techniques is still under development.

[1] G. Chen and J. Ding (2023) Efficient reduced-order thermal modelling of scanning laser melting for additive manufacturing, Journal of Materials Processing Technology, vol. 321, article 118143