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Advancements in Wire-Based Aluminum Additive Manufacturing: Molten Metal Deposition, Parameter Optimization, and Finite Element Analysis

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Molten Metal Deposition (MMD) represents an advanced wire-based aluminum additive manufacturing (AM) methodology wherein wire feedstock is directly liquified and extruded onto a heated substrate. This technique obviates the necessity for auxiliary energy sources such as lasers, as well as binders or additional support structures, thereby mitigating thermal stress implications and enhancing throughput. A distinctive attribute of MMD technology is its capacity to facilitate the automation and fabrication of high-strength aluminum alloys, specifically within the 6xxx and 7xxx series. To expedite the process of parameter optimization inherent to this method, a comprehensive finite element analysis (FEA) is undertaken. This involves the employment of an element-birth technique to accurately model the dynamic process conditions prevalent during deposition. Subsequent to the computational analysis, experimental validation is conducted to ascertain the thermal profiles of the manufactured component, ensuring congruence with the simulated outcomes. The paper elaborates on the resultant model's efficacy in enabling the fabrication of diverse geometrical configurations.

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