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Surface Morphology Refinement and Laves Phase Control of Inconel 718 during Plasma Arc Additive Manufacturing by Alternating Magnetic Field

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Abstract : Improving formability and mechanical properties have always been one of the challenges in the field of additive manufacturing (AM) of nickel-based superalloys. In this work, the effect of a coaxially coupled alternating magnetic field (AMF) on surface morphology and mechanical properties of plasma arc-based additive manufactured Inconel 718 deposit were investigated. Results show that the Lorentz force induced by AMF strongly alters the flow behavior of the plasma jet and the molten pool, suppressing the tendency of the liquid metal in the molten pool to flow down on the two sides face of the deposit, which in turn remarkably improved the surface accuracy of the thin-walled deposit. Furthermore, the electromagnetic stirring induced by AMF can effectively enhance the convection between the dendrites, which could not only contribute to the formation of finer dendrites but also alleviate the enrichment of the elements (i.e., Nb and Mo) at the solid-liquid interface and inhibits the precipitation of Laves phase. The smallest primary dendritic arm spacing (~13 μm) and lowest Laves phases area fraction (3.12%) were witnessed in the bottom region of the AMF-assisted deposit. The mechanical test confirmed that the deposit's micro-hardness and tensile properties were moderately improved compared with the counterpart without AMF.

Keywords : additive manufacturing, inconel 718, alternating magnetic field, laves phase
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