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Wire Arc Additive Manufacturing (WAAM) of Metallic 316L Parts

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The latest advances in additive manufacturing (AM) technologies have led to significant transformations in the production and engineering domains, where metal additive manufacturing will soon replace some materials produced by conventional manufacturing methods. These advances enable the creation of three-dimensional parts by a layer-by-layer deposition method. Among the AM technologies, we have WAAM, which represents a variation in the field of metal additive manufacturing, based on the principles of arc welding. One of the metals most used as raw material in AM are austenitic stainless steels, especially 316L. Its wide use is attributed to its exceptional characteristics, including corrosion resistance, weldability, ease of machining, good mechanical properties in various temperature ranges and superior toughness. These characteristics make this material suitable for various applications in industries such as nuclear, chemical, and petrochemical, for example. 316L stainless steel has a microstructure composed of austenite and ferrite when produced by casting, welding, or AM technologies. However, it is possible for some intermetallic inclusions to form, oxides, sulfides, carbides, and sigma phase, for example, which even in small quantities lead to a decline in mechanical properties and corrosion. The microstructure and properties of metals fabricated by WAAM is defined for your thermal history. The thermal cycles during the WAAM deposition result in complex non-equilibrium microstructures that differ from the conventional wrought counterparts typically used for structural applications. This study involved the production of 316L stainless steel cubes via WAAM, employing varied deposition strategies and overlap angles to employ different thermal cycles. The objective was to explore the impact of these process variables on the microstructural characteristics, mechanical properties, and corrosion behavior of these components, intending to offer a comprehensive analysis of their relationships and optimize the process. By optimizing parameters, the study achieves successful component fabrication, highlighting the pivotal role of deposition parameters in determining surface quality. Examination of XRD peaks unveils post-weld crystallographic texture development, corroborated by EBSD analyses indicating notable texture presence. SEM analyses distinguish varied ferrite phase morphologies across different component regions. Mechanical assessments suggest a tendency towards anisotropic behavior in WAAM materials, with samples featuring a 45° overlap angle displaying marginally superior mechanical properties. Consistent microhardness along the build direction underscores the reliability of the deposition strategy.