

Characterization of Wire Arc Additive Manufacturing: Geometrical Configurations, Mechanical Properties, and Process Parameter Analysis

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Abstract

This study focuses on the characterization and optimization of Wire Arc Additive Manufacturing (WAAM) process parameters for stainless steel specimens, evaluating their geometrical configurations, mechanical properties, and microstructure, where the WAAM process has been performed by manual arc welding. Results from experimental analysis reveal how surface roughness, hardness, and microstructures are affected by inclination angle, travel speed, and temperature. Such as the optimal inclination angle of 70° caused the lowest surface roughness ($R_a = 1.829 \mu\text{m}$), which indicates better deposition quality. However, due to microstructural defects such as pinholes, microcracks, and poor interfacial bonding, the hardness values varied significantly. The highest value of hardness was found at 25 Hardness Rockwell C scale (HRC). The microstructure analysis also highlighted residual stresses and thermal mismatch as primary contributors to reduced mechanical performance. The study emphasizes the importance of process parameter optimization for better WAAM-deposited parts featuring improved mechanical properties overall.

Keywords

Wire arc additive manufacturing, Manual arc welding, Surface roughness, Hardness, Microstructure.

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