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Development of metallic and composite consumables for WAAM applications

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ABSTRACT

Wire Arc Additive Manufacturing (WAAM) is a promising alternative to traditional manufacturing methods, during which the consumable wire is melted and deposited in a layer-by-layer technique to form 3D structures. The benefits of this method include low amounts of material waste, reduced running costs due to the inexpensive feedstock material, minimal constraints regarding part shape and size, as well as decreased energy usage due to the lack of machining required. The use of conventional welding materials for WAAM applications would allow for a wider spread industry utilization of WAAM with minimal start-up cost. However, the effects of consumable metallurgy on multi-bead 3D deposition characteristics are not yet fully understood.

This project investigates the WAAM deposition characteristics of conventional welding consumables, including how the alloy composition affects the microstructure, mechanical properties, and performance. Deposition trials using multiple consumables have been conducted, during which the welds were visually observed, and the welding parameters modified, to ensure the highest quality depositions with minimal void formation, spatter, and slumping. Each consumable was used to produce both single-bead and multi- bead deposits. Following this, metallographic analysis of the welded samples was undertaken to identify defects such as voids, cracking, and slag entrapment as well as to examine the formation of precipitates and other phases. Finally, the deposited materials underwent mechanical and performance testing to allow the consumables to be evaluated in terms of their wear performance. The suitability of the consumable alloy composition for WAAM applications is thus comprehensively assessed.