



Fundamentals and advances of wire arc additive manufacturing: materials, process parameters, potential applications, and future trends

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Abstract

The advancement of the wire arc additive manufacturing (WAAM) process has been significant due to the cost-effectiveness in producing large metal components with high deposition rates. With the growth in the understanding of WAAM, researchers have found that the microstructure and mechanical properties of the fabricated components are greatly improved. As a result, a diverse range of materials have been linked to the process, leading to a wider application of WAAM in various industries. Thus, this review paper provides a comprehensive analysis of the recent advancements in WAAM, a technology that combines arc welding with additive manufacturing. The focus is on the microstructure, mechanical properties, materials used, process-related defects, and post-process treatments. The paper aims to offer guidance on producing high-quality and defect-free components by aligning the material characteristics with the capabilities of various WAAM techniques. The results of the paper highlight the strengths and limitations of WAAM and provide insights into its future prospects. This information is valuable for academics, designers, and manufacturers in the field, serving as a milestone for future WAAM research and application.

Keywords Wire arc additive manufacturing · Additive manufacturing · Microstructure · Mechanical properties · Future trends

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1 Introduction

In recent years, additive manufacturing methods have improved significantly owing to their capacity to produce complex components without the constraints of traditional production techniques, resulting in reduced lead time, material waste, and prices. Nonetheless, there are substantial challenges in the manufacture of large volume components, notably in terms of process efficiency [1]. The constraint in component size and low build-up rate of frequently employed powder-based technologies is a key hurdle to the deployment of additive manufacturing at the industrial scale and its practicality within sustainable business cases [2]. Additive manufacturing is still not a one-size-fits-all solution. Researchers have worked hard to develop parts for additive manufacturing applications, which involves increasing the value of a product by lowering the number of parts, substances, and weight [3]. Metal additive manufacturing (AM) technologies are now mostly powder bed fusion procedures that employ a laser beam as the energy source and pricey metal powder as the material. Although laser-based powder

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