



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

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Received: 5 December 2022 / Revised: 8 February 2023 / Accepted: 26 February 2023
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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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Table of Contents Fundamentals And Advances

1. Understanding the eBook Fundamentals And Advances
 - The Rise of Digital Reading Fundamentals And Advances
 - Advantages of eBooks Over Traditional Books
2. Identifying Fundamentals And Advances
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Fundamentals And Advances
 - User-Friendly Interface
4. Exploring eBook Recommendations from Fundamentals And Advances
 - Personalized Recommendations
 - Fundamentals And Advances User Reviews and Ratings
 - Fundamentals And Advances and Bestseller Lists
5. Accessing Fundamentals And Advances Free and Paid eBooks

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- Fundamentals And Advances eBook Subscription Services
- Fundamentals And Advances Budget-Friendly Options
- 6. Navigating Fundamentals And Advances eBook Formats
 - ePub, PDF, MOBI, and More
 - Fundamentals And Advances Compatibility with Devices
 - Fundamentals And Advances Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Fundamentals And Advances
 - Highlighting and Note-Taking Fundamentals And Advances
 - Interactive Elements Fundamentals And Advances
- 8. Staying Engaged with Fundamentals And Advances
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Fundamentals And Advances
- 9. Balancing eBooks and Physical Books Fundamentals And Advances
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Fundamentals And Advances
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Fundamentals And Advances
 - Setting Reading Goals Fundamentals And Advances
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Fundamentals And Advances
 - Fact-Checking eBook Content of Fundamentals And Advances
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development

- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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