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Advanced Materials and Additive Manufacturing for Demanding Industrial Applications: Nickel-Based Alloys for High-Performance Forging Tools

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With the increasing demands of industry for materials capable of withstanding extreme conditions such as high temperatures, mechanical stress, and aggressive environments, nickel-based alloys are being increasingly employed. These materials play a key role in the production and maintenance of forging tools, offering an optimal combination of strength, durability, and stability due to their unique properties.
The aim of this research is to analyse the potential use of nickel-based alloys, particularly Nimonic 80A and Inconel 718, for functional layers in forging tools. Although nickel alloys exhibit excellent thermomechanical properties, their high cost makes the production of an entire tool using additive manufacturing financially demanding, limiting their widespread application in industrial practice.
Traditional manufacturing methods often face limitations due to complex geometries, material characteristics, and production speed. Additive manufacturing, particularly using powder and wire feedstocks, opens new possibilities to overcome these barriers and enables the production of intricate structures. A highly effective approach involves the selective application of these materials through additive manufacturing, specifically the Directed Energy Deposition (DED-LB) method, which allows the creation of functional surfaces with optimized properties.
The research focuses on the comprehensive characterization of these alloys in terms of microstructure, mechanical and physical properties, and the impact of additive manufacturing techniques on the final properties of forging tools. The results demonstrate that utilizing these alloys as functional surface layers enhances wear resistance and thermal durability, thereby increasing the service life of forging tools. This research opens new opportunities in materials engineering and highlights the benefits of combining advanced alloys with additive manufacturing in industrial practice. By improving the production and repair of forging tools, this study contributes to greater sustainability and competitiveness in the industrial sector.

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