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Process Optimization for 2205 Duplex Stainless Steel by Laser Metal Deposition

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Abstract : This work aims to establish a reliable approach for optimizing a Laser Metal Deposition (LMD) process for a critical maritime component, based on the material properties and structural performance required by the maritime industry. The component of interest is a water jet impeller, for which specific requirements for material properties are defined. The developed approach is based on the assessment of the effects of LMD process parameters on microstructure and material performance of standard AM 2205 duplex stainless steel powder. Duplex stainless steel offers attractive properties for maritime applications, combining high strength, enhanced ductility and excellent corrosion resistance due to the specific amounts of ferrite and austenite. These properties are strongly affected by the microstructural characteristics in addition to microstructural defects such as porosity and welding defects, all strongly influenced by the chosen LMD process parameters. In this study, the influence of deposition speed and heat input was evaluated. First, the influences of deposition speed and heat input on the microstructure characteristics, including ferrite/austenite fraction, amount of porosity and welding defects, were evaluated. Then, the achieved mechanical properties were evaluated by standard testing methods, measuring the hardness, tensile strength and elongation, bending force and impact energy. The measured properties were compared to the requirements of the water jet impeller. The results show that the required amounts of ferrite and austenite can be achieved directly by the LMD process without post-weld heat treatments. No intermetallic phases were observed in the material produced by the investigated process parameters. A high deposition speed was found to reduce the ductility due to the formation of welding defects. An increased heat input was associated with reduced strength due to the coarsening of the ferrite/austenite microstructure. The microstructure characterizations and measured mechanical performance demonstrate the great potential of the LMD process and generate a valuable database for the optimization of the LMD process for duplex stainless steels.

Keywords : duplex stainless steel, laser metal deposition, process optimization, microstructure, mechanical properties
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