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REVIEW

Weldability, machinability and surfacing of commercial duplex stainless steel AISI2205 for marine applications – A recent review

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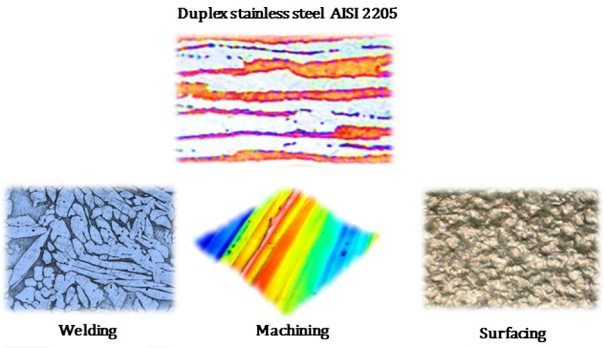
GRAPHICAL ABSTRACT



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ABSTRACT

In the present review, attempts have been made to analyze the metallurgical, mechanical, and corrosion properties of commercial marine alloy duplex stainless steel AISI 2205 with special reference to its weldability, machinability, and surfacing. In the first part, effects of various fusion and solid-state welding processes on joining DSS 2205 with similar and dissimilar metals are addressed. Microstructural changes during the weld cooling cycle such as austenite reformation, partitioning of alloying elements, HAZ transformations, and the intermetallic

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precipitations are analyzed and compared with the different welding techniques. In the second part, machinability of DSS 2205 is compared with the commercial ASS grades in order to justify the quality of machining. In the third part, the importance of surface quality in a marine exposure is emphasized and the enhancement of surface properties through peening techniques is highlighted. The research gaps and inferences highlighted in this review will be more useful for the fabrications involved in the marine applications.

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Introduction

The anticorrosive stainless environment in both onshore and offshore applications is being a needful objective for many countries around the world. Among the group of stainless steel family, Duplex Stainless Steel (DSS) grades are contributing an important role in fabricating thousands of tonnage marine structures and machinery successfully over the past few decades [1]. DSS grades are mainly used in the fabrication of offshore oil and gas pipelines, offshore concrete structures, offshore umbilicals, ocean mining machinery, chemical tankers in ships, fasteners used in marine machinery, construction of bridges in cold countries, paper, pulp industries, pipelines in desalination plants, etc. The alloying process of modern DSS was started in 1980s only after understanding the importance of nitrogen in the chemical composition. Today, it has become a popular material and satisfying the combined needs of Ferritic Stainless Steel (FSS) and Austenitic Stainless Steel (ASS) grades. They are dual phase Fe-Cr-Ni-N system of alloys consist of an equal amount of ferrite (α) and austenite (γ) phases in the microstructure [2–7]**.** During the alloying process of DSS, the parameters for solution annealing followed by water quenching are carefully monitored to control the duplex microstructure. Under equilibrium conditions, ferrite promoting elements (Cr, Mo, W, Nb, Si, Ti and V) are concentrated by diffusion into the ferritic structure. At the same time, austenite promoting elements (Ni, Mn, C, N, Co and Cu) are concentrated by diffusion into the austenitic structure. The combined lattice arrangement of Body Centered Cubic (BCC) and Face Centered Cubic (FCC) structure gives greater strength and offers excellent resistance against Stress Corrosion Cracking (SCC) [8]. Among the available DSS grades, AISI 2205 is more popular and contributing a predominant role in the marine fabrication industries for more than three decades. The yield strength and the ultimate tensile strength of DSS 2205 are 2–3 times greater than the commercial ASS grades such as 304L and 316L. To overcome the shortage of raw material resources, stainless steels for the future generation should be optimized with respect to the mechanical and corrosion properties. DSS 2205 is a better alternative for the ASS grades and offers economic benefits by reducing the thickness of the members in the fabrication thereby reducing the weight as well as the cost without sacrificing the strength.

Successful application of any material in service mainly depends on its ability to fabricate with minimum cost. Fusion welding plays a major role in the construction of various structures and machinery used in marine applications [9–11]. The Weldability of DSS 2205 is far superior to the FSS grades but lesser than the ASS grades. The welding metallurgy of