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PROCEEDINGS

Investigation on Microstructural Evolution and Corrosion Resistance Improvement of E690 Steel via Underwater Laser Directed Energy Deposition

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ABSTRACT

Marine environments pose severe corrosion challenges to underwater equipment, thereby leading to significant risks and demanding immediate in-situ restoration. Here we developed an underwater laser directed energy deposition (UDMD) technique to repair the E690 steel and enhance its corrosion resistance. Systematic investigations about the underwater pressure (P) and 316L stainless steel (SS316L) coatings on the microstructure, mechanical properties, and corrosion resistance of the repaired E690 steel were conducted. Results show that water cooling can refine grain, promote the formation of lath martensite, and increase dislocation density. No obvious relationship between the pressure and microstructure evolution and mechanical properties was observed when $P \leq 0.25$ MPa. However, when $P \geq 0.35$ MPa, underwater high pressure can induce the nitriding of the molten pool, promoting the precipitation of highly thermostable (Ti, V)N particles, thereby improving the mechanical properties. Furthermore, SS316L coating can improve the corrosion resistance of the repaired E690. Monolayer SS316L coating suffers from the dilution effect and macro-segregations (peninsula, island, and banded zone), leading to preferential dissolution and crevice-shaped corrosion. These issues were alleviated on bilayer SS316L by forming a dense and continuous passive film, thereby enhancing the corrosion resistance. This research demonstrates the feasibility and benefits of DMD in underwater applications and highlights the importance of tailored multilayer coatings for optimal corrosion resistance.

KEYWORDS

Underwater laser directed energy deposition; microstructure; mechanical properties; nitriding; macro-segregation; corrosion resisitance

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