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SKPFM and portable electrochemical minicell for development of welding procedure specification to asset stainless steel

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Passivity determines corrosion resistance and stability of highly alloyed stainless steels, and passivity breakdown is a continuous degradation process of the passive film over a potential range, associated with an enhanced Fe dissolution before rapid Cr dissolution and oxide removal. In this work, a portable electrochemical minicell and Scanning Kelvin Probe Force Microscopy (SKPFM) were used in conjunction as a surface analytical method to engineer the welding procedure specification (WPS) for aseptic or corrosive applications and quality control of the passivation properties of the welded regions. An optimized WPS to the corrosion performance was designed using lean duplex stainless steel grade 2101 welded by TIG process and ER 2209 weld consumable. The SKPFM was used to exam the weld microstructural evolution and identify the susceptibility of the weld regions to the localized corrosion, such as fusion line in heat-affected zone. Then, the welding procedure specification was changed to adjust the welding parameters in order to eliminate or minimize the non-conformity of the weld microstructure, as Cr and Mo depleted zones. The electrochemical minicell was applied to measure the degree of sensitization and the passive region of the weld zones using the techniques such as the double loop electrochemical potentiokinetic reactivation test and cyclic potentiodynamic polarization, respectively. The welding speed, arc length (voltage) and current density were changed to achieve an optimized WPS; it was acquired to a heat input of 1.6-1.9 kJ/mm and using a low current density. The minicell corroborated the SKPFM results, which demonstrated that the fusion line in weld root pass represents the most susceptibility weld region to localized corrosion. The corrosion performance of weld face and root was improved through the change of the welding parameters, obtaining a reduction of the Cr and Mo depleted zones, which resulted in a lower degree of sensitization. Therefore, it is concluded that the surface analytical method composed by SKPFM and electrochemical minicell is a powerful technique to develop WPS to the high corrosion resistance performance of the asset stainless steel.