Microstructural and Electrochemical Characterization of Friction Stir Welded Aluminum Alloys

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Aluminum alloys of 2000 and 7000 series are extensively used in aircraft structures. However, these classes of aluminum alloys are difficult to join by conventional fusion welding techniques because the dendritic structure formed in the fusion zone can seriously compromise the mechanical and corrosion resistance properties of the joint. Friction Stir Welding (FSW) is attractive for joining high strength aluminum alloys since there is far lower heat input during the process compared with conventional welding methods. Frictional heat causes the metal to soften and allows the tool to traverse along the joint line. The FSW process generates three distinct microstructural zones: the nugget, the thermomechanically affected zone and the heat-affected zone. These microstructural modifications generally interfere in the performance of the corrosion resistance of welded alloys. In the present study, FSW was used to join two dissimilar aluminum alloys, AA2024-T3 and AA7475-T651 and the effect of this process on the corrosion resistance of the welded joints and on the microstructure of the alloys was evaluated. Microstructural characterization was carried out by optical microscopy, scanning electron microscopy and atomic force microscopy. The weld zone regions showed significant microstructural changes. Electrochemical impedance spectroscopy and Electrochemical noise measurements were used to evaluate the corrosion resistance of the different zones of the weld in NaCl solution. The electrochemical results showed that the corrosion behavior of the aluminum alloy is dominated by the electrochemical activity within the intermetallics (IMs). The weld zone regions containing copper IMs have a more noble character than the regions containing Zn and Mg IMs. Therefore, the results showed an increased susceptibility of welded joints to these forms of corrosion in comparison to the unaffected base metal by a more severe attack related to AA7475 alloy

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