

Microstructural Evolution and Mechanical Performance of Friction Stir Welded Dissimilar AA 6082-T6, AA 6061-T6, and AA 5052-H32 Joints

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Abstract

Experimental investigations are performed to characterize friction stir welded joints of dissimilar AA 6082 T6, AA 6061 T6, and AA 5052 H32 aluminum alloys, with emphasis on metallurgical phenomena. These joints are used in aerospace fuselage structures, ship hulls, and chemical storage vessels where joint strength, durability, and corrosion resistance are critical. A correlation is established between microstructural evolution and mechanical properties, including yield strength, tensile strength, percentage elongation, microhardness, modulus of toughness, and modulus of resilience. The weld formation mechanisms, namely dynamic recrystallization, phase transformation and grain refinement, are investigated in the stir zone, thermomechanically affected zone, and heat affected zone for all three dissimilar combinations. Tensile fractography of the three dissimilar weld combinations are examined by scanning electron microscopy, and elemental segregation leading to intermetallic compound formation is analyzed by energy dispersive spectroscopy. The findings are presented as insights into weld formation dynamics and the role of microstructural evolution in determining joint integrity of dissimilar aluminum alloy welds for industrial applications.

Keywords: Stir Zone, AA 6082-T6; AA 6061-T6; AA 5052-H32; SEM; EDS.