

Weldability, microstructure, and residual stress in Al/Cu and Cu/Al friction stir spot weld joints with Zn interlayer

Adel Boucherit, Said ABDI, Mouloud Aissani, Brahim MEHDI, Khadidja Abib, Riad BADJI

Abstract: In this work, the effect of lap joint configuration and Zn interlayer addition on the microstructure, the residual stress state, and the quality of Al/Cu (configuration #1) and Cu/Al (configuration #2) friction stir spot welds (FSSW) was investigated. The study revealed the close dependency of the weld joint quality on the pin length and Zn addition. The higher the pin plunge depth is, the greater the obtained tensile shear strength. The Zn addition reduced sensibly the thickness of Al₂Cu layer (from 10 to 2 μ m) and favored the formation of the Al₄.₂Cu₃.₂Zn_{0.7} precipitate that hindered the formation of detrimental Al₄Cu₉ compounds. Material flow analysis revealed the presence of an intermixing zone containing thin continuous intermetallic layer (approximately 2.07 μ m) at the weld interface of configuration #1. Meanwhile, the Cu material was covered by the Zn layer, which resulted in a hardness increase (228 HV) at the stirred zone. In addition, a significant increase of the tensile shear strength from 1650 to 3600 N was noticed (an improvement rate of \sim 118%). Conversely, in configuration #2, the Zn foil was squeezed out of the spot weld interface resulting in the absence of material intermixing, discontinuous intermetallic layer, low hardness level (140 HV), and weak improvement rate of the shear strength (\sim 53%). The Zn interlayer addition resulted in a quasi-symmetric distribution of the residual stresses and shifted their nature from tensile stresses (+ 60 MPa) to compressive ones (\sim 10 MPa).

Keywords : FSSW, aluminum, copper, Zinc interlayer, Tensile shear, microstructure, intermetallic Compounds, residual stress