The International Journal of Advanced Manufacturing Technology

Volume 111, Issue 5, 2020, Pages 1553-1569

Weldability, microstructure, and residual stress in Al/Cu and Cu/Alfriction 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 thequality of Al/Cu (configuration #1) and Cu/Al (configuration #2) friction stir spot welds (FSSW) was investigated. The studyrevealed the close dependency of the weld joint quality on the pin length and Zn addition. The higher the pin plunge depth is, thegreater the obtained tensile shear strength. The Zn addition reduced sensibly the thickness of Al2Cu layer (from 10 to 2 ?m) andfavored the formation of the Al4.2Cu3.2Zn0.7 precipitate that hindered the formation of detrimental Al4Cu9compounds. Materialflow analysis revealed the presence of an intermixing zone containing thin continuous intermetallic layer (approximately 2.07 ?m) at the weld interface of configuration #1. Meanwhile, the Cu material was covered by the Zn layer, which resultedin 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 ? 118%). Conversely, in configuration #2, the Zn foil was squeezed out of the spotweld interface resulting in the absence of material intermixing, discontinuous intermetallic layer, low hardness level (140 HV),and weak improvement rate of the shear strength (? 53%). The Zn interlayer addition resulted in a quasi-symmetric distribution ofthe residual stresses and shifted their nature from tensile stresses (+ 60 MPa) to compressive ones (? 10 MPa).

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