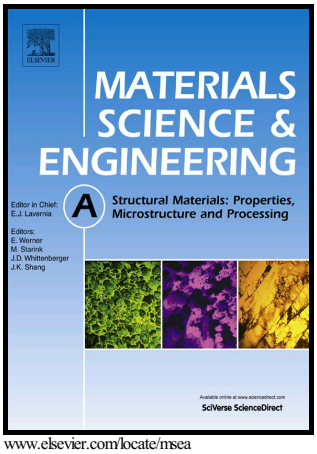
Microstructure reaction control of dissimilar automotive aluminium to galvanized steel sheets ultrasonic spot welding

Farid Haddadi



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Farid Haddadi

farid.haddadi@gmail.com

+1-647-939-7472

Global Research & Development, Light Alloys Solutions
#305, 45 Cummer Ave. Toronto, ON Canada M2M0A1

Abstract

Ultrasonic spot welding (USW) is an energy efficient thermomechanical technology causing effective bond in less than a second for difficult dissimilar materials combination such as aluminium to steel sheet welding. The interfacial reaction between aluminium 6111-T4 and two different zinc coated steels of hot dipped DX56-Z and galvannealed DX53-ZF has been investigated under controlled process parameters of clamping forces and welding times. Formation of melt at the weld interface was seen to be accelerated and the cause for this discrepancy will be discussed. In aluminium to both coated steel joints, formation of a eutectic structure occurred between aluminium and the zinc coats in short period of time, which changed to a dendritic structure due to an increase in aluminium concentration with longer welding times. In aluminium to DX56-Z steel joints, the failure mainly occurred through the $Fe_2Al_{(5-x)}Zn_x$ ($<0x<1$) which thickened close to the steel substrate. However, in the aluminium to DX53-ZF steel welds fracture took place mainly due to the brittleness of the Fe_3Zn_{10} and Fe_5Zn_{21} (Γ and Γ_1) phases and grain boundary embrittlement of the steel. The behavior of these two zinc coatings during ultrasonic spot welding will be discussed further in detail.

Keywords: Ultrasonic Spot Welding; Galvanized steel; Aluminium 6111; Interface reaction; Failure analysis