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High Cycle Fatigue Response of Dissimilar Aluminum Alloy Refill Friction Stir Spot Welds

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Light-weight automobile manufacturing can be designed to utilize a variety of light-weight materials that ultimately need to be joined in the final structure. Current aluminum intensive vehicles join different alloys by riveting since traditional welding of aluminum is difficult. The current work investigates the fatigue response of dissimilar aluminum alloy lap joints made by refill friction stir spot welding (RFSSW) of four stack-ups consisting of high and medium strength age-hardenable and non-age-hardenable alloys: AA7xxx-AA7xxx, 6xxx-7xxx, 5xxx-7xxx and 7xxx-6xxx. Friction stir spot welding produces heterogeneous microstructures with refill capable of minimizing defects that impact shear strength [1]. While there have been some studies on linear friction stir weld fatigue of dissimilar aluminum alloy joints [2], there are few published works on RFSSW in general [3], and none on dissimilar aluminum alloys. The high cycle fatigue response of spot-welded stack-ups was characterized at loads, L_{max}, less than observed for yield at a load ratio, R=0.1 and frequency of 5 Hz. The number of cycles to failure, N, followed a power law relationship, $L_{max}=A(\log N)^b$, where the Basquin-like slope [4], b ranged from -0.199±0.023 to -0.301±0.027 depending on the alloy stack-up order. Microscopy reveals material and geometrical dependent phenomenology for the origin, growth and propagation of cracks leading to failure.

Keywords: Basquin's law, crack, fatigue, fracture, heat affected zone, hook

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