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Microstructural Variation through Weld Thickness and Mechanical Properties of Peened Friction Stir Welded 6061 Aluminum Alloy Joints

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Abstract

The current study examined the effect of microstructure variation on the development of mechanical properties in friction stir welded joints of 6061-T6 aluminum alloy, which were subsequently processed by shot peening (SP). Following to FSW, fatigue specimens were extracted perpendicularly to the welding direction. Surface Skimming to 0.5 mm from crown and root sides of the joint was made and SP was later applied on the two sides using ceramic shots of two different Almen intensities of 0.18 mmA and 0.24 mmA. Microstructural examination by electron back scattered diffraction (EBSD) indicated variation in the grain refinement of the weld zone, with coarsest grains (5 μm) at the crown side and finest grains (2 μm) at the root side. Reduction of microhardness to 60 Hv occurred in the weld zone for samples in FSW condition. Application of SP promoted significant strain hardening at the crown side, with Almen intensities of 0.24 mmA providing maximum increase in microhardness to 120 Hv. On the contrary, only a maximum microhardness of 75 HV was obtained at the root side. The difference in strain hardening capability at the two sides was strongly dependent on grain size. The two Almen intensities produced similar distribution of compressive residual stresses in the subsurface regions that led to enhance the fatigue strength to the level of base metal for $N \geq 10^5$ cycles. Yet, the increase in fatigue strength was more pronounced with increasing Almen intensity to 0.24 mmA, demonstrating further enhancement by strain hardening.

Keywords: Aluminum alloys, friction stir welding, shot peening, fatigue, microstructure

Abstract