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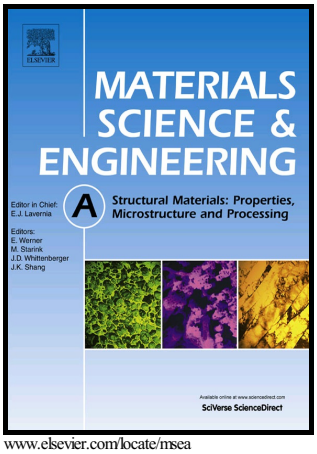

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The Effect of Tensile Pre-Straining on Fatigue Crack Initiation Mechanisms and Mechanical Behavior of AA7050 Friction Stir Welds

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ABSTRACT

This work examines the plastic strain gradients developed by pre-straining AA7050 friction stir welds (FSW), the damage to intermetallic particles caused by this strain, and the effect of these fractured particles on the subsequent fatigue performance of the weld. After pre-straining FSW samples to 1% and 3%, the local plastic strain distribution was measured along the crown (top) and root (bottom) of the weld, and the maximum local plastic strain was found to be 3.34 and 1.83 times higher than the average plastic strain. Metallography conducted on pre-strained welds showed cracked intermetallic particles in both the 1% and 3% levels which may have influenced fatigue crack initiation. Pre-straining was found to decrease the fatigue life at high cycles for the 1% pre-strain; however the 3% pre-strain level showed essentially the same fatigue life as the 0% pre-strained welds. Fractography showed that increasing pre-strain was correlated with increasing prevalence of Fe-rich particles at the fatigue crack initiation sites. When corrected for maximum local strain, the fatigue results for non-pre-strained AA7050 FSWs were shown to match the base material, AA7050-T7451.

Keywords: Friction stir welding, Pre-strain, Fatigue, Strength gradient, AA7050

I. INTRODUCTION

Aluminum alloys are becoming increasingly popular in the automotive industry as it seeks to increase vehicle efficiency. However, unlike the steel components they replace, many high strength aluminum alloys, specifically the 2xxx and 7xxx series, cannot be easily welded because of solidification cracking that occurs in the fusion zone [1]. Friction stir welding (FSW) is an attractive alternative since