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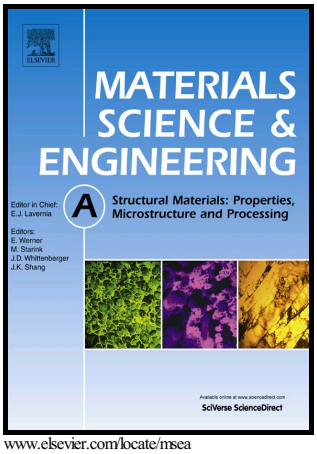

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Abstract

Small-scale shear punch testing has been applied to a butt joint created by friction stir welding of two adjoining AA2139-T8 plates. Advantages of this technique include the ability to perform a large number of independent tests on a given volume of material and the ability to measure site-specific differences and variations in local material properties. As such, combined with a simultaneous evaluation of the weld morphology, a series of 144 shear punch tests were carried out in a 12×12 grid pattern on the retreating half of the weld. The overlay of the grid pattern onto the etched surface allowed a correlation of the microstructure and mechanical properties measured across the weld at each shear punch site. Two-dimensional color enhanced property maps were generated to provide a powerful site specific visualization of the unique or distinctive microstructural features and how they correlate with the local mechanical response across the weld. One of the more insightful discoveries was the weld nugget region undergoing 2.5 times more strain-hardening than the base plate material, while simultaneously experiencing the Portevin-LeChatelier effect. Aspects of the technique and results of our experiments are described.

Keywords:

Friction Stir Weld, Shear Punch Testing, Property Mapping

1. Introduction

Friction stir welding (FSW) [1] is a solid state process for joining metals which are difficult to weld by conventional arc welding methods, e.g., high strength aluminum alloys that are currently replacing steels in automotive applications at an ever increasing rate. FSW uses a mechanical stirring process to join together two adjoining metal plates; the joint or weld is created by first plunging, and then traversing a rotating tool along the interface. Weld quality