Effect of reverse material flow on the microstructure and performance of friction stir welded T-joints of an Al-Mg alloy

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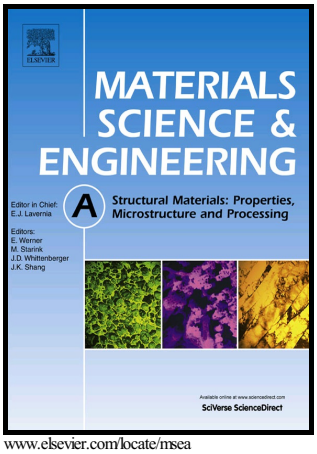

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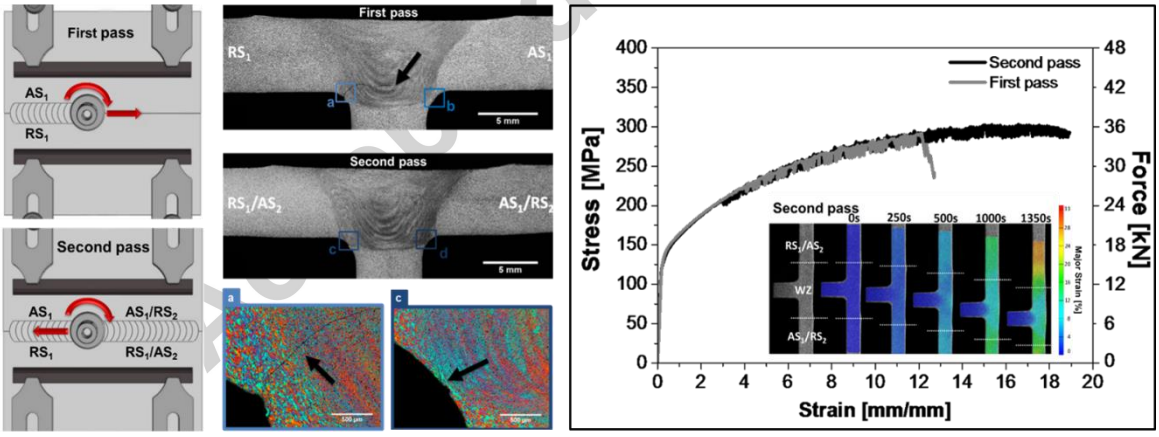
Abstract

Friction stir welding (FSW) has been developed and commercially applied with success to connect large and complex structures. However, process optimization is still required to improve the mechanical performance of the T assemblies. Therefore, a second welding pass was applied in this work and was performed backwards, while maintaining the same tool rotation direction. Thus, due to the creation of a reverse material flow, a second advance side over the previously retreating side of the joint was formed, which significantly reduced the defects typically found in FSWed T-joints. The joints were manufactured with dissimilar Al–Mg alloys (AA5083), which is of particular interest to the shipbuilding sector. The microstructural analysis revealed that the second pass significantly reduced the kissing bonding defect on the joints retreating side. As a result, the mechanical properties were improved under quasi-static loading, reaching performance levels comparable to those of the base material. A digital image correlation system (DIC) linked to a tensile test system was used to investigate the local strain fields of the T-joints under two different loading conditions. The fatigue strength was also evaluated and the FSWed T-joints reached the fatigue keen with a nominal load range of 88.4 MPa under skin loading.

Graphical abstract



Keywords: T-joints, friction stir welding, joint mechanical properties, digital image correlation system.

1. Introduction

The transportation sector is faced with demands to systemically reduce the weight of its structures, to decrease greenhouse gas emissions and to provide more fuel-efficient vehicles. Furthermore, all stages of manufacturing must consider and comply with strict environmental requirements. Recent