

Enhancing resistance to fracture in light metals: From Al1050 fracture toughness to Al7075 fatigue crack growth rate

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Light metals, in particular aluminium alloys exhibit relatively low fracture toughness compared to steels presenting identical yield strength. In the framework of metal matrix composites (MMCs), shape memory alloys (SMAs), when serving as reinforcements, provide a possibility to tune damage mechanisms due to their shape memory effect (SME). The SME is used to introduce local internal stresses in the vicinity of the reinforcements, attracting or repelling the propagating crack, therefore leading to fracture path deviation. In the present work, particulate Al1050/NiTi composites have been manufactured via friction stir processing (FSP) to prove the aforementioned concept. FSP imparts a homogeneous reinforcement distribution and a minimal interfacial product in this low strength Al1050 matrix. The SME induced internal strain has been evidenced by digital image correlation. The analysis of fracture surface roughness confirms the enhancement of crack deviation in the presence of internal stresses. The fostering of crack deviation correlates well with the increase in fracture toughness of the composites. The concept SMA reinforced composites is then extended to high strength Al7075 alloys. An innovative strategy has been proposed to homogeneously distribute the NiTi particles via FSP, because conventional MMCs manufacturing by FSP involves severe particle clustering when using 7xxx Al as matrix. According to preliminary fatigue tests, the Al7075/NiTi composites present a lower fatigue crack growth rate compared to the FSPed Al7075 reference material as well as the Al7075/NiTi composites excluding internal stresses. Further investigations will be addressed in the near future to quantify the improvement of the resistance to fatigue crack propagation.

Keywords: damage mechanisms, metal matrix composites, friction stir processing, shape memory alloys