# Fracture investigation on Al/NiTip composite manufactured by friction stir processing

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Fracture strength involves one of the key parameters in the design of metal-based structures in automobile and aerospace applications. Over the past few years, increased attention has been paid on metal matrix composites (MMCs) because of the flexibility of tailoring their mechanical properties. However, controlling damage remains a challenging issue in these composites due to the prevailing failure at the interface between matrix and reinforcement agents [1, 2]. Shape memory alloys (SMAs) are considered good candidates to overcome this problem since they permit to introduce local compressive residual stresses that may delay fracture initiation. This concept, which has been studied numerically [3], requires further experimental validation.

The present work investigates the fracture behavior in friction stir processed Al1050/NiTip composite. In order to trigger the shape memory effect (SME) of the integrated NiTi particles, cold rolling and heat treatment were consecutively performed following the composite manufacturing. *In-situ* tensile tests were performed in a scanning electron microscope to monitor the crack paths in both Al/NiTip and pure Al (also friction stir processed and cold rolled) samples. Fracture initiation and propagation were separately investigated in crack-free and pre-cracked samples. It is found that the Al/NiTip composite involves higher yield stress and ultimate tensile strength than the pure Al. The real time monitoring on the pre-cracked samples shows that the NiTi particles lead to fracture path deviation in the composite, while the crack growth is quite straight in the pure Al. Moreover, when looking at the fracture surface, a flat to slant transition is observed in Al/NiTip, in contrast to the fracture of pure Al in which only the so called “flip-flap” feature is involved. The strength improvement is found to be dependent of the volume fraction of NiTi particles. The largest increase of the fracture strength achieved in the present work is nearly 35%, which is much higher than that reported in previous works on Al/NiTip composites [4, 5]. The strengthening effect is proposed to stem from not only the shape memory effect of NiTi particles, but also some local stresses induced by the cold rolling in the heterogeneous Al/NiTip composite, according to finite element simulations.

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