TOUGHENING OF SHAPE MEMORY ALLOY EMBEDDED COMPOSITES

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Keywords: NiTi, J-integral, Multifunctional composites, Transformation toughening, Fracture toughness

ABSTRACT

Shape memory alloys (SMAs) are a class of materials that are being increasingly used within self-healing research and have been successfully implemented in self-healing polymers and metals. The SMAs are specifically used for their inherent ability to recover their shape after deformation due to reversible thermo-elastic martensitic phase transformations. While the addition of SMAs as reinforcements to a matrix primarily serves to facilitate crack closure, a subsequent result is increased fracture toughness of self-healing metal and polymer matrix composite systems. Self-healing systems with increased fracture toughness can be used longer in their intended application prior to failure and healing. The motivation of this study is SMA reinforced metal matrix systems. Manuel et al. developed a self-healing SnBi matrix that was embedded with uni-directional SMA wires. Research has continued utilizing more structurally relevant metal matrices. Because the constituent composite materials were capable of inelastic deformation, J-integral fracture toughness experiments were performed on composites embedded with nickel-titanium SMAs. The SMA reinforcements were in the austenite and martensite phases to evaluate the effect of the martensitic phase transformation and detwinning processes during the composite deformation. The fracture toughness results will be presented. Relevant toughening mechanisms will be discussed yielding a better understanding of the SMA contribution to composite toughness and what this means for SMA reinforced self-healing materials. This project was supported by a NASA Office of the Chief Technologist's Space Technology Research Opportunity – Early Career Faculty grant number NNX12AQ42G and the University of Florida NASA Florida Space Grant Consortium.