Materials Design & Prototyping Laboratory

Self-Repair and Damage Mitigation of Metallic Structures

University of Florida

Goal: Development of lightweight high strength metal matrix self-healing composite

Motivation

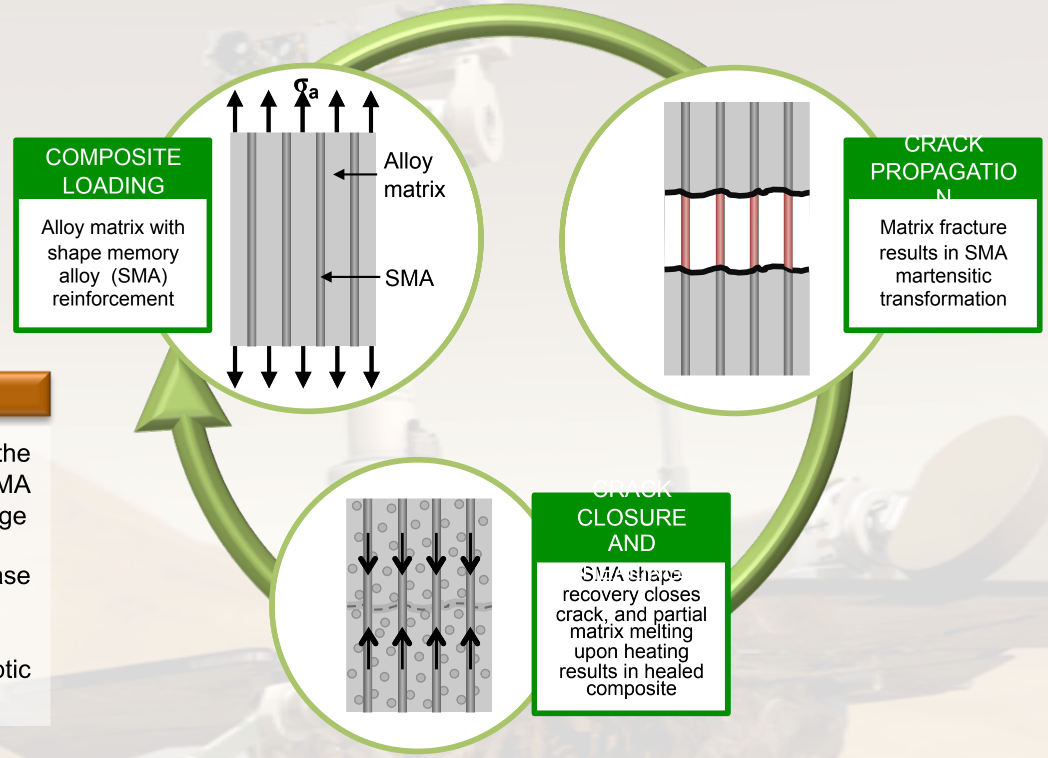
The need for material systems with improved reliability is especially necessary in weight - sensitive applications where neither redundancy or catastrophic failure is an acceptable outcome. Design of autonomous self-repairing multi-functional materials can lead to extended component lifetimes.

Outcomes

Provide fundamental understanding of the effect of microstructure and SMA properties on the ability to reverse damage

Demonstrate the ability to increase toughness through SMA integration

Analyze the efficacy of fiber optic waveguide integration for strain sensing



Objective 1

Explore and demonstrate the feasibility of a metallic material to self-repair.

Objective 2

Understand the correlation between shape memory alloys and macroscopic mechanical behavior of the metal-matrix composites (primarily strength and toughness).

Objective 3

Quantify the efficacy and precision of *in-situ* matrix fluxing and passive sensing.

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Iterative Design Approach

Matrix Alloy Characterization

Matrix alloy designed to retain similar mechanical properties after repeated healing cycles

High Strength SMA Study

Shape memory alloy (SMA) reinforcement designed to withstand plastic deformation upon matrix fracture, apply restoring force to facilitate crack closure

Composite Characterization and Analysis

Fracture toughness, strength, and healing efficiency of the SMA-matrix system used to model and improve the composite toughness

Sensor Integration

Systems design of the implementation of fiber optic strain gauges to detect fracture

Background image credit: NASA