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Strategies for Self-Repairing Shape Memory Alloy Actuators

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Abstract

Shape memory alloys (SMA) are thermally activated smart materials. Due to their ability to change into a previously imprinted actual shape through the means of thermal activation, they are suitable as actuators for microsystems and, within certain limitations, macroscopic systems. A commonly used shape memory actuator type is an alloy of Nickel and Titanium (NiTi), which starts to transform its inner phase from martensitic to austenitic structure at a certain austenite start temperature. Retransformation starts at martensitic start temperature after running a hysteresis cycle. Most frequently utilized SMA-systems use wire actuators because of their simple integration, the occurring cost reduction and the resulting miniaturization. Unfortunately, SMA-actuators are only seldom used by constructors and system developers. This is due to occurring functional fatigue effects which depend on boundary conditions like system loads, strains and number of cycles. The actuating stroke does not reduce essentially during the first thousand cycles. Striking is the displacement of the actuating start point which is caused by system elongation during cycling. In order to create a system which adjusts and repairs itself, different concepts to solve this problem are presented. They vary from smart control methods to constructive solutions with calibration systems. The systems are analyzed due to their effectively, life cycle and system costs showing outstanding advantages in comparison to commonly used SMA actuators.