



Materials and Coatings

## How to Train Shape Memory Alloys

Low cost, time-saving technique to prepare shape  
memory alloys for use

Shape memory alloys (SMAs), sometimes known as "smart metals," provide a lightweight, solid-state alternative to conventional actuators and switches, such as hydraulic, pneumatic, or motor-based systems. To function properly, SMAs must be "trained" to return to a previous form when heated, and innovators at NASA's Glenn Research Center have developed a remarkable new method of completing this training at a fraction of the time and cost of conventional training techniques. Glenn's technique uses mechanical cycling, rather than more complicated and time-consuming thermal cycling, to train SMAs before implementation. In addition, this new approach to training allows SMAs to be applied to complex geometric components, so that they may be used in a broader number of applications.

### BENEFITS

- Fast: Stabilizes SMAs in just minutes rather than days or weeks
- Simple: Achieves dimensional stability without the need for time-consuming and tedious processing
- Adaptable: Works for complex geometry components, not just simple geometries like wires or rods
- Reliable: Operates under a wide variety of environmental conditions

technology solution

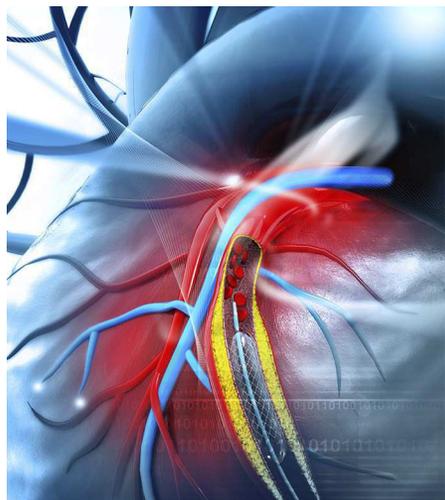


# NASA Technology Transfer Program

Bringing NASA Technology Down to Earth

## THE TECHNOLOGY

Glenn researchers have optimized how shape memory alloys (SMAs) are trained by reconceptualizing the entire stabilization process. Whereas prior techniques stabilize SMAs during thermal cycling, under conditions of fixed stress (known as the isobaric response), what Glenn's innovators have done instead is to use mechanical cycling under conditions of fixed temperature (the isothermal response) to achieve stabilization rapidly and efficiently. This novel method uses the isobaric response to establish the stabilization point under conditions identical to those that will be used during service. Once the stabilization point is known, a set of isothermal mechanical cycling experiments is then performed using different levels of applied stress. Each of these mechanical cycling experiments is left to run until the strain response has stabilized. When the stress levels required to achieve stabilization under isothermal conditions are known, they can be used to train the material in a fraction of the time that would be required to train the material using only thermal cycling. As the strain state has been achieved isothermally, the material can be switched back under isobaric conditions, and will remain stabilized during service. In short, Glenn's method of training can be completed in a matter of minutes rather than in days or even weeks, and so SMAs become much more practical to use in a wide range of applications.



A stent made using SMA is placed inside a narrow blood vessel to improve blood flow during an angioplasty procedure



A microstructure image of a shape memory alloy

## APPLICATIONS

The technology has several potential applications:

- Aerospace
- Aviation
- Automotive (actuators, engine mounts and suspension, car frames)
- Medical (e.g., stents/angioplasty, bone repair clamps, robotics actuators and micromanipulators that simulate human movement)
- Household appliances (fasteners, seals, connectors, and clamps)

## PUBLICATIONS

Patent No: 8,409,372; 9,273,369; 9,476,113

Patent Pending

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