National Aeronautics and Space Administration

technology solution

Materials and Coatings

Shape Memory Alloy with Adjustable, Wide-Ranging Actuation Temperatures

A highly stable, heat-treatable, and tunable material

Innovators at NASA's Glenn Research Center have developed a new Nickel Titanium (NiTi) shape memory alloy (SMA) with additions of Hafnium (Hf) and Zirconium (Zr) that offers a broader transformation temperature range and greater dimensional stability than any other SMA on the market. In spite of their many unique properties, broad commercial success of SMAs has remained elusive due to limited phase transformation temperatures and dimensional instability in high cycle applications. Glenn's innovation solves these limitations by A) tailoring transformation temperatures through molecular composition, heat treatments, or microstructural refinements, and B) engineering inherent dimensional stability through composition control and processing methods. The result is an exceptionally strong SMA that is heat-treatable and can be tuned for high, ambient, or sub-zero transformation temperatures as needed, making it a game changer in the SMA industry with practical applications to a variety of industries including aerospace, automotive, biomedical, and more.

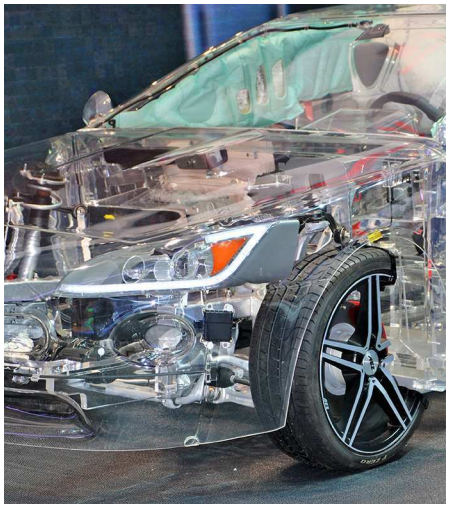
BENEFITS

- Adaptable: Performs at high, ambient, and sub-zero temperatures
- Tunable: Can be tailored to individual specifications because it is heat-treatable
- Strong: Provides inherent dimensional stability to the material through the inclusion of fine precipitates and other process control parameters
- Super-elastic: Exhibits high-force generation capability with excellent stress recovery
- Low-Cost: Uses affordable materials and enables faster production times by minimizing or negating the need for stabilization and training

THE TECHNOLOGY

SMAs are important multifunctional materials for the development of adaptive engineering structures. They exhibit a high work output that is competitive with, or superior to, conventional hydraulic, pneumatic, or electromagnetic actuators. While highly promising, SMAs are not always a practical alternative to conventional actuators because of their limited phase transformation temperatures and dimensional instability. Thanks to Glenn's innovative new SMA, that's about to change.

Unlike traditional binary NiTi SMAs, Glenn's Ni-Ti-Hf-Zr SMA includes secondary, nanoscale precipitate phases that offer inherent dimensional stability to the material. Consequently, there is minimal to no need for training, resulting in much faster production times, lower processing costs, and a finished product with superior work outputs and better operational life. These Ni-rich alloys can be produced by Vacuum Induction Melting, Vacuum Arc Melting, Vacuum Arc Remelting, and Induction Skull Melting. Perhaps the most exciting characteristic of Glenn's SMA, however, is its ability to achieve a broad range of transformation temperatures suitable for high temperature (100 to 300°C), ambient, and sub-ambient temperature applications nearing -100°C. Furthermore, these temperatures can be tailored and fine-tuned though heat treatment to fit the needed parameters for the application of interest. In contrast, traditional NiTi SMAs exhibit fixed phase transformation at temperatures from slightly below room temperature to around 100°C. Glenn's Ni-Ti-Hf-Zr SMA opens the door to countless applications that can benefit from the unique properties of SMAs but require high durability and extreme temperature capability.



Glenn's SMA could be used to create efficient window louvers, safer locking mechanisms, quieter actuators, and countless other automotive parts

SMAs can be used in orthopedic implants, stents, surgical tools, and countless other medical applications

APPLICATIONS

The technology has several potential applications:

- Aerospace
- Marine
- Automotive
- Medical
- Oil and gas

PUBLICATIONS

Patent Pending

More Information

National Aeronautics and Space Administration

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