National Aeronautics and
Space Administration

Materials and Coatings

Shape Adaptive Multilayered Polymer Composite

Variable stiffness shape memory polymer triggered by both Joule heating and dielectric loss

NASA's Langley Research Center has developed a novel shape memory polymer (SMP) made from composite materials for use in morphing structures. In response to an external stimulus such as a temperature change or an electric field, the thermosetting material changes shape, but then returns to its original form once conditions return to normal. Through a precise combination of monomers, conductive fillers, and elastic layers, the NASA polymer matrix can be triggered by two effects--Joule heating and dielectric loss--to increase the response. The new material remedies the limitations of other SMPs currently on the market--namely the slow stimulant response times, the strength inconsistencies, and the use of toxic epoxies that may complicate manufacturing. NASA has developed prototypes and now seeks a partner to license the technology for commercial applications.

BENEFITS

- Quickened response time (~1.5-2 times faster than Joule heating alone)
- Recovery force of approximately 220 MPa (~75-100 times greater than current commercial SMPs)
- Less toxic system than epoxy-based polymer matrices, allowing for conventional open extrusion manufacturing
- Increased reliability due to dual heating

APPLICATIONS

- Health - intelligent medical devices
- Military - smart armor and self-deployable structures
- Energy - turbine blade stabilization
- Aerospace - aircraft wing stabilization and noise reduction

technology solution

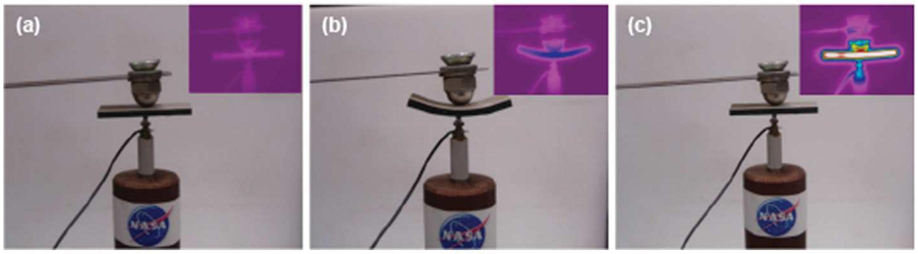
THE TECHNOLOGY

The NASA Langley SMP was originally designed for smart active structures in morphing spacecraft and airfoils to provide noise reduction and increased stability. The technology may also have applications in self-deployable structures, smart armors, intelligent medical devices, and other various morphing structures.

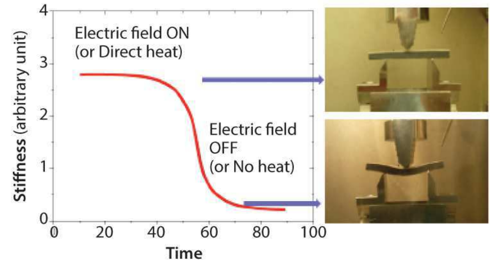
The incorporation of conductive fillers into the polymer matrix allows for a faster response time than that of typical SMPs due to a combined response from both Joule heating and dielectric loss. Joule heating is achieved by the application of a low-level current that is diffused uniformly across the polymer when an electric field is applied. The addition of an alternating field shortens the thermal response time due to dielectric loss. Voltage application is determined by the specific material dimensions. For a benchtop scale device, about 10-40V was required for activation of the material.

Furthermore, the technologys variable stiffness polymer composite (VSPc) is laminated with highly elastic layers to provide additional stored elastic energy, resulting in a higher recovery force than that of similar materials currently on the market.

The technology is being used in a laboratory setting at NASA and prototypes have been built, with durability and fatigue testing underway. The new polymer is patent pending, and NASA seeks companies to license the technology and develop it for commercial applications.



Electric field activated shape memory behavior of LaRC VSPc. (a) permanent shape, (b) programmed temporary shape, and (c) recovered permanent shape (inset: infrared images).



The LaRC VSPc shows hard and glassy behavior at room temperature or under NO electric field; however, when the electric field or direct heat is applied, the LaRC VSPc shows soft and elastic behavior.

PUBLICATIONS

Patent Pending

More Information

National Aeronautics and Space Administration

The Technology Gateway

Langley Research Center

Mail Stop 151
Hampton, VA 23681
757-864-1178
LARC-DL-technologygateway@mail.nasa.gov

http://technology.nasa.gov/

www.nasa.gov
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