Smart memory foam made smarter

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Researchers from Northwestern University and Boise State University have figured out how to produce a less expensive shape-shifting "memory" foam, which could lead to more widespread applications of the material, such as in surgical positioning tools and valve mechanisms.

David Dunand, the James N. and Margie M. Krebs Professor of Materials Science and Engineering at Northwestern, has been collaborating with Peter Müllner, professor of materials science and engineering at Boise State, on a project focused on a nickel-manganese-gallium alloy that changes shape when exposed to a magnetic field.

The alloy retains its new shape when the field is turned off but returns to its original shape if the field is rotated 90 degrees, demonstrating "magnetic shape-memory." The alloy can be activated millions of times, and it deforms reliably and reproducibly as a result. This property could be used to advantage in fast-operating actuators (mechanical devices for moving or controlling a mechanism or system) in inkjet printers, car engines and surgical tools.

To date, the magnetic shape-memory effect has occurred only in nickel-manganese-gallium single crystals, which are much more difficult and expensive to create than the more common polycrystals.

Now, Dunand, Müllner and their colleagues have created easily processable polycrystalline foams with shape-changing properties resembling those of the much more expensive single crystals. They did this by introducing small pores into the "nodes" of their original metallic foam, which, much like a sponge, consisted of struts connected by relatively large nodes. Adding a second level of porosity allowed for deformation and retention in the polycrystalline foam of some of the shape-memory properties.

The results are published online by the journal Nature Materials.

"One key aspect of this new 'smart' foam is that, together with a simple coil to produce a magnetic field, it creates a linear actuator of extreme simplicity -- and thus high reliability and miniaturization potential -- replacing a much more complex electro-mechanical system with many moving parts," Dunand said.

Potential applications range from replacing materials currently being used in sonar devices, precision actuators and magneto-mechanical sensors to enabling new devices in biomedicine and microrobotics.

"This was such a huge improvement that the foam was tested over and over again to make sure that no experimental mistakes were made," Müllner said. "Our new results may pave the way for magnetic shape-memory alloys for use in research labs and commercial applications."

Northwestern and Boise State have jointly filed a patent application.

More information: The title of the *Nature Materials* paper is "Giant Magnetic-field-induced Strains in Polycrystalline Ni-Mn-Ga Foams."

Source: Northwestern University (news : web)