Researchers create shape-memory aerogels with rubber-like elasticity

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Time-lapse of an aerogel flexing back to its original shape. Credit: Sam O'Keefe, Missouri S&T

Polymeric aerogels are nanoporous structures that combine some of the most desirable characteristics of materials, such as flexibility and

mechanical strength. It is nearly impossible to improve on a substance considered the final frontier in lightweight materials. But chemists from Missouri University of Science and Technology have done just that by making aerogels that have rubber-like elasticity and can "remember" their original shapes.

Aerogels are created by replacing liquids with gases in a silica, metal oxide or polymer gel. They are used in a wide variety of products, from insulation of offshore oil pipelines to NASA space missions.

"The specific kind of polyurethane aerogels we have created are superelastic, meaning that they can be bent in any direction or be smashed flat and still return to their original shape," says Dr. Nicholas Leventis, lead researcher on the project and Curators' Distinguished Professor of chemistry at Missouri S&T. "Our superelastic aerogels are different from rubber in that they can on-command return to a specific form. That is, they also show a strong shape memory effect, meaning that they can be deformed and cooled and keep the deformed shape forever.

"However, when the temperature rises back to room temperature, they recover their original un-deformed shape," Leventis explains. "The shape memory effect is not new. Shape memory metallic alloys and polymers are known for many years, however, shape memory aerogels are the last frontier in lightweight."

Leventis and his group have demonstrated this unique property by shaping a "bionic hand" that is capable of mimicking coordinated muscle functions. The aerogel hand can clasp a pencil and, when stimulated, can clasp a pencil form its stretched open-palm shape.

"We believe this work has produced one of the 'holy grails' in the field of aerogels," says Leventis. "I see a lot of biomimetic applications for

these aerogels in the future. Their flexibility, combined with elasticity, greatly enhance the range of possible uses."

More information: Suraj Donthula et al. Shape Memory Superelastic Poly(isocyanurate-urethane) Aerogels (PIR-PUR) for Deployable Panels and Biomimetic Applications, *Chemistry of Materials* (2017). DOI: 10.1021/acs.chemmater.7b01020

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