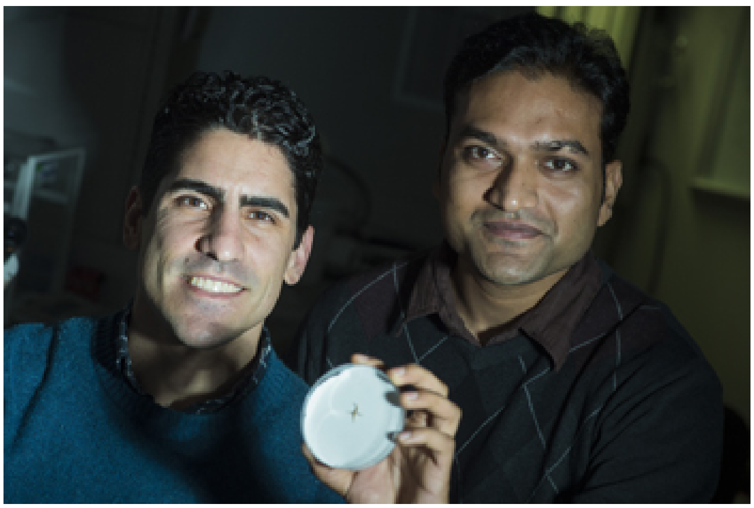
# Morphing composite material has mighty potential (w/ Video)

December 9 2013, by Mike Williams



Rice University polymer scientist Rafael Verduzco, left, and graduate student Aditya Agrawal show a sample of their morphing material, which changes shape in a predetermined pattern when heated. Credit: Jeff Fitlow

(Phys.org) —Heating a sheet of plastic may not bring it to life – but it sure looks like it does in new experiments at Rice University.

The materials created by Rice polymer scientist Rafael Verduzco and his colleagues start as flat slabs, but they morph into shapes that can be controlled by patterns written into their layers.

The research is the subject of a new paper in the Royal Society of Chemistry journal *Soft Matter*.

Materials that can change their shape based on environmental conditions are useful for optics, three-dimensional biological scaffolds and the controlled encapsulation and release of drugs, among other applications, the researchers wrote.

"We already know the materials are biocompatible, stable and inert," Verduzco said, "so they have great potential for biological applications."

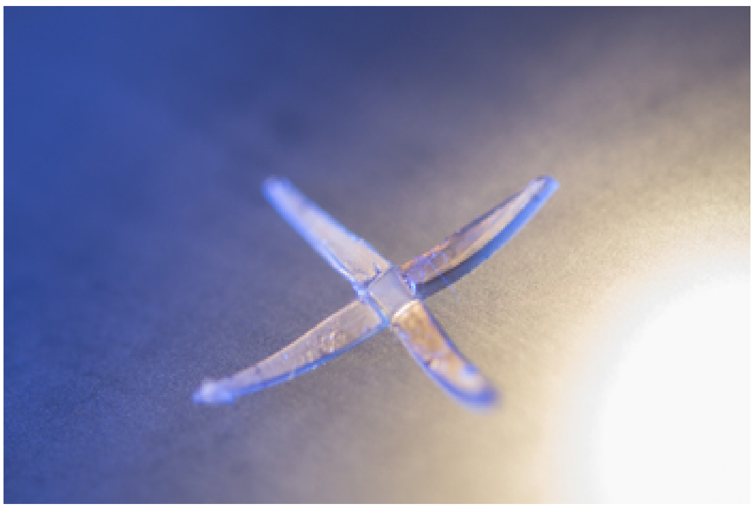
The material needs two layers to perform its magic, Verduzco said. One is a liquid crystal elastomer (LCE), a rubber-like material of cross-linked polymers that line up along a single axis, called the "nematic director." The other is a thin layer of simple polystyrene, placed either above or below the LCE.

Without the polystyrene layer bonded to it, an LCE would simply expand or contract along its nematic axis when heated. With changing temperature, the LCE tries to contract or expand, but the stiffer polystyrene layer prevents this and instead causes wrinkling, bending or folding of the entire material.

The lab discovered that the layers would react to heat in a predictable and repeatable way, allowing for configurations to be designed into the material depending on a number of parameters: the shape and aspect ratio of the LCE, the thickness and patterning of the polystyrene and even the temperature at which the polystyrene was applied.

The lab made spiraling, curling and X-shaped materials that alternately closed in or stood up on four legs. Placing polystyrene on top of one half of a strip of LCE and on the bottom of the other half produced an "S" shape. Verduzco suggested there's no limit to the complexity of the shapes that could be teased from the material with proper patterning.

The primary direction of folding or wrinkling of the material was set by the temperature at which the polystyrene layer was deposited. In experiments, the researchers found that when the polystyrene layer was applied at 5-6 degrees Celsius (about 42 degrees Fahrenheit), the material would wrinkle perpendicular to the LCE's nematic director. At 50 C (122 degrees F), the polystyrene wrinkled parallel to the director. The micrometer-scale wrinkles seemed smooth to the naked eye.



A composite material created by scientists at Rice changes shape in a predetermined pattern when heated and changes back when cooled. The morphing material may be useful for bioengineering, optical, pharmaceutical and other applications. Credit: Jeff Fitlow

As expected, however, if the polystyrene layer was too thick, it would not allow the composite material to bend. And if the temperature got too hot, the polystyrene would pass its glass transition temperature and allow the composite to relax back into its flat shape. When the material cooled to room temperature and the polystyrene became glassy again, it would deform in the opposite direction, but it could return to its initial flat-at-room-temperature state if annealed with a solvent, dicloromethane, that relaxed the layers once more.

"For any application, you would want to be able to change shape and then go back," Verduzco said. "LCEs are reversible, unlike shape-memory polymers that change shape only once and cannot go back to their initial shape.

"This is important for biomedical applications, such as dynamic substrates for cell cultures or implantable materials that contract and expand in response to stimulus. This is what we are targeting with these applications."

**More information:** Paper: pubs.rsc.org/en/content/articl … m51654g#!divAbstract

Provided by Rice University

Citation: Morphing composite material has mighty potential (w/ Video) (2013, December 9) retrieved 26 April 2024 from
https://phys.org/news/2013-12-morphing-composite-material-mighty-potential.html