Heat, light stimulate self-assembly: Researchers develop shape-changing 'smart' material

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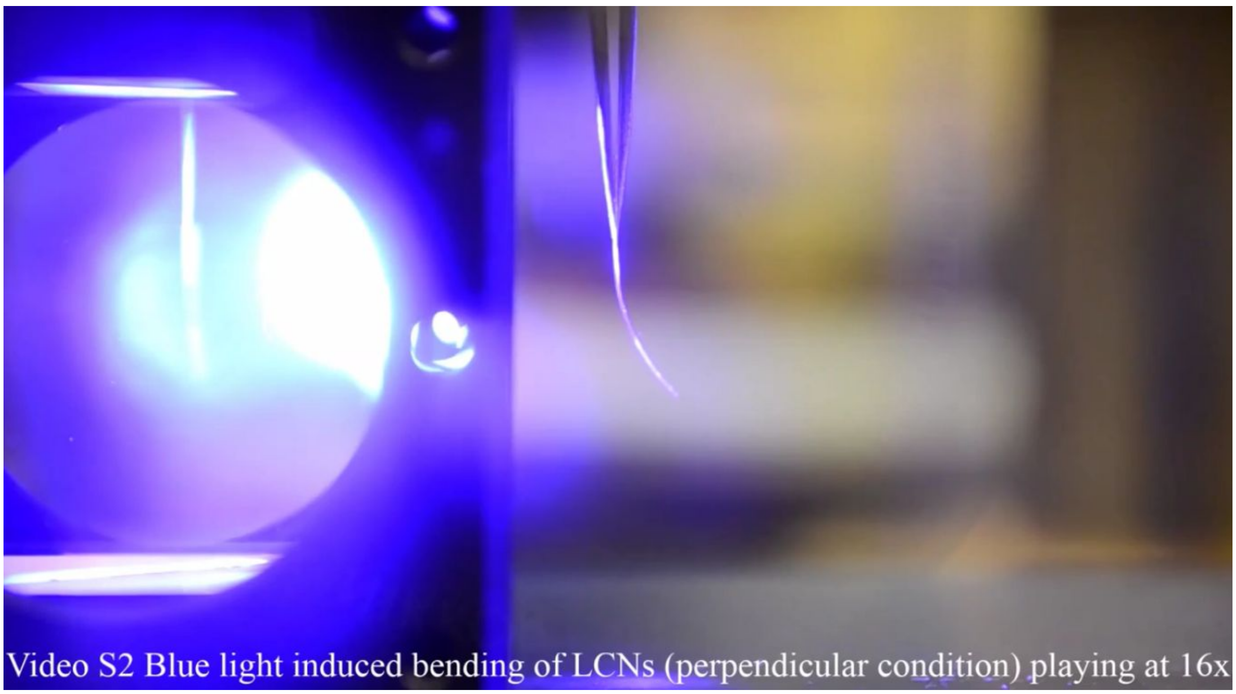

Washington State University researchers have developed a unique, multifunctional smart material that can change shape from heat or light and assemble and disassemble itself. They have filed a provisional patent on the work.

This is the first time researchers have been able to combine several smart abilities, including shape memory behavior, light-activated movement and self-healing behavior, into one material. They have published their work in *ACS Applied Materials & Interfaces*.

The work is led by Michael Kessler, professor and Berry Family director and in the WSU School of Mechanical and Materials Engineering (MME), and Yuzhan Li, MME staff scientist, in collaboration with Orlando Rio, a researcher at Oak Ridge National Laboratory.

Adding functional versatility

Smart materials that can react to external stimuli, like light or heat, have been an interesting novelty and look almost magical as they mysteriously fold and unfold themselves. They have a variety of potential applications, such as for actuators, drug delivery systems and self-assembling devices. For instance, smart materials could change shape to unfold a solar panel on a space satellite without need of a battery-powered mechanical device.

But smart materials haven't come into widespread use because they are difficult to make and often can only perform one function at a time. Researchers also have struggled to reprocess the material so its special properties can continually repeat themselves.

The WSU research team developed a material that allows multiple functions at once with potential to add more.

Fold and unfold, remember and heal

The team worked with a class of long-chain molecules, called liquid crystalline networks (LCNs), which provide order in one direction and give material unique properties. The researchers took advantage of the way the material changes in response to heat to induce a unique three-way shape shifting behavior. They added groups of atoms that react to polarized light and used dynamic chemical bonds to improve the material's reprocessing abilities.

"We knew these different technologies worked independently and tried to combine them in a way that would be compatible," said Kessler.

The resulting material reacts to light, can remember its shape as it folds and unfolds and can heal itself when damaged. For instance, a razor blade scratch in the material can be fixed by applying ultraviolet light. The material's movements can be preprogrammed and its properties tailored.

The Oak Ridge National Laboratory researchers used facilities at their Center for Nanophase Materials Sciences to study the mechanisms responsible for the material's unique abilities.

The research is in keeping with WSU's Grand Challenges, a suite of research initiatives aimed at large societal issues. It is particularly relevant to the challenge of smart systems and its theme of foundational and emergent materials.

More information: Yuzhan Li et al, Photoresponsive Liquid Crystalline Epoxy Networks with Shape Memory Behavior and Dynamic Ester Bonds, *ACS Applied Materials & Interfaces* (2016). DOI: 10.1021/acsami.6b04374

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