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Researchers engineer a material that can perform different tasks depending on temperature

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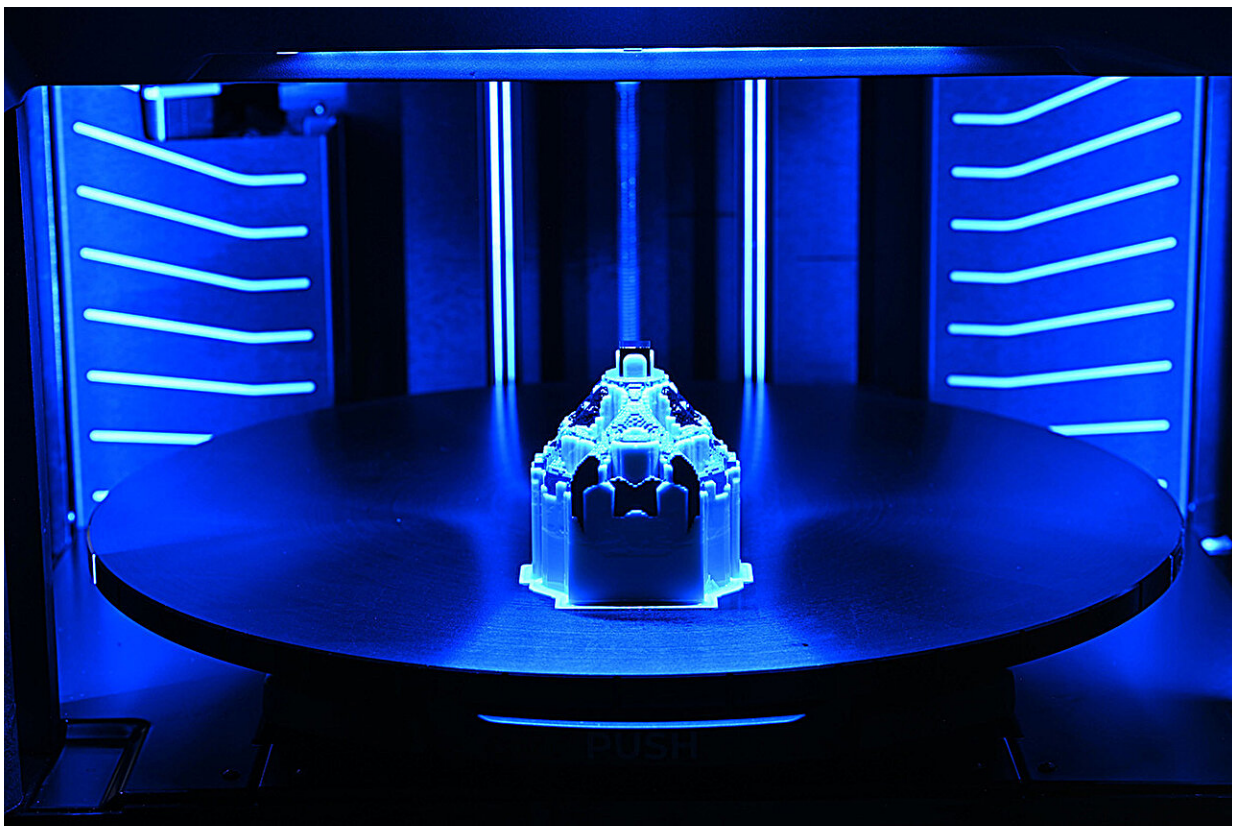

Research led by the University of Illinois Urbana-Champaign produced a new temperature dependent 3D-printed polymer composite that can react to its environment. Credit: *Science Advances* (2023). DOI: 10.1126/sciadv.adk0620

Researchers report that they have developed a new composite material designed to change behaviors depending on temperature in order to perform specific tasks. These materials are poised to be part of the next generation of autonomous robotics that will interact with the environment.

The new study conducted by University of Illinois Urbana-Champaign civil and environmental engineering professor Shelly Zhang and graduate student Weichen Li, in collaboration with professor Tian Chen and graduate student Yue Wang from the University of Houston, uses computer algorithms, two distinct polymers, and 3D printing to reverse engineer a material that expands and contracts in response to temperature change with or without human intervention.

The study findings are reported in the journal *Science Advances*.

"Creating a material or device that will respond in specific ways depending on its environment is very challenging to conceptualize using human intuition alone—there are just so many design possibilities out there," Zhang said. "So, instead, we decided to work with a computer algorithm to help us determine the best combination of materials and geometry."

The team first used computer modeling to conceptualize a two-polymer composite that can behave differently under various temperatures based on user input or autonomous sensing.

"For this study, we developed a material that can behave like soft rubber in low temperatures and as a stiff plastic in high temperatures," Zhang said.

Once fabricated into a tangible device, the team tested the new composite material's ability to respond to temperature changes to perform a simple task—switch on LED lights.

"Our study demonstrates that it is possible to engineer a material with intelligent temperature sensing capabilities, and we envision this being very useful in robotics," Zhang said. "For example, if a robot's carrying capacity needs to change when the temperature changes, the material will 'know' to adapt its physical behavior to stop or perform a different task."

Zhang said that one of the hallmarks of the study is the optimization process that helps the researchers interpolate the distribution and geometries of the two different polymer materials needed.

"Our next goal is to use this technique to add another level of complexity to a material's programmed or autonomous behavior, such as the ability to sense the velocity of some sort of impact from another object," she said. "This will be critical for robotics materials to know how to respond to various hazards in the field."

More information: Weichen Li et al, Algorithmic encoding of adaptive responses in temperature-sensing multimaterial architectures, *Science Advances* (2023). DOI: 10.1126/sciadv.adk0620

Provided by University of Illinois at Urbana-Champaign

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