Origami inspires research into materials that self-assemble when exposed to light

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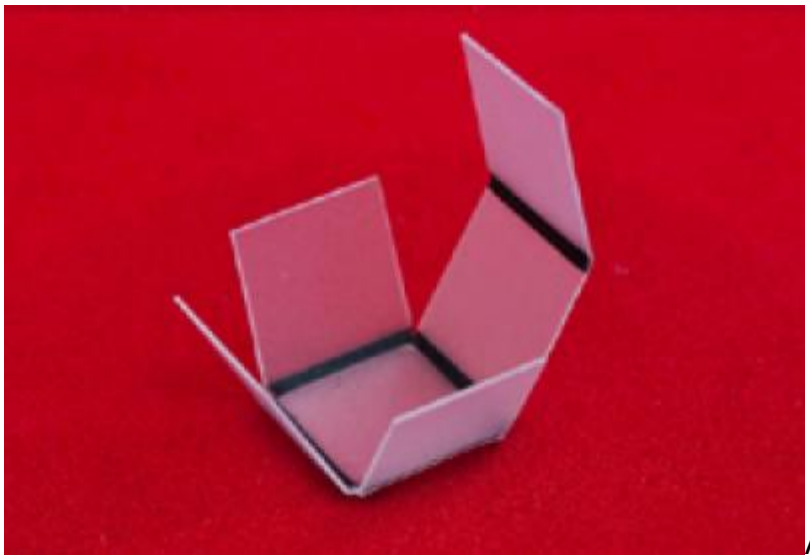

A multi-university research team led by North Carolina State University will be developing methods to create two-dimensional (2-D) materials capable of folding themselves into three-dimensional (3-D) objects when exposed to light. The effort, which is funded by a grant from the National Science Foundation (NSF), is inspired by origami and has a broad range of potential applications.

"We're pulling together a diverse team of designers, engineers and mathematicians to advance our understanding of how to manipulate photoresponsive materials," says Dr. Jan Genzer, Celanese Professor of Chemical and Biomolecular Engineering at NC State and the primary investigator under the NSF grant. "Ultimately, we hope to develop new techniques that have applications ranging from electronics to high-volume manufacturing to the delivery of humanitarian relief." The NSF grant is for approximately $1.76 million over four years.

Specifically, the researchers plan to use experiments and computational models to evaluate the folding process in order to develop new multi-functional 3-D structures that can form rapidly while retaining precise control over their shape. Because the patterns will be on 2-D materials, the process should be compatible with high-throughput patterning techniques, such as roll-to-roll patterning used in electronics manufacturing.

Potential applications include the development of unfoldable air foils that could be used for airdrops of humanitarian supplies with greater precision; hands-free assembly of electronics in a "clean" environment; or various packaging and manufacturing processes.

The research team includes Genzer; Dr. Michael Dickey, an assistant professor of

chemical and biomolecular engineering at NC State; Dr. Yong Zhu, an assistant professor of mechanical and aerospace engineering at NC State; Susan Brandeis, Distinguished Professor of Art and Design at NC State; Dr. Alan Russell, of Elon University, who has studied origami for more than 30 years; Emily Beck, of Meredith College; and Dr. Rich Vaia, of the Air Force Research Laboratory. The grant will also support four to five graduate students and post-doctoral research associates.

The research effort builds on earlier research from NC State, which detailed a simple way to convert 2-D patterns into 3-D objects using only light. In that work, the researcher ran pre-stressed plastic sheets through a conventional inkjet printer to print bold black lines on the material. The material was then cut into a desired pattern and placed under an infrared light, such as a heat lamp. Because the bold black lines absorbed more energy than the rest of the material, the plastic contracted – creating a hinge that folded the sheets into 3-D shapes. A video demonstration of the previous work can be seen here.

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