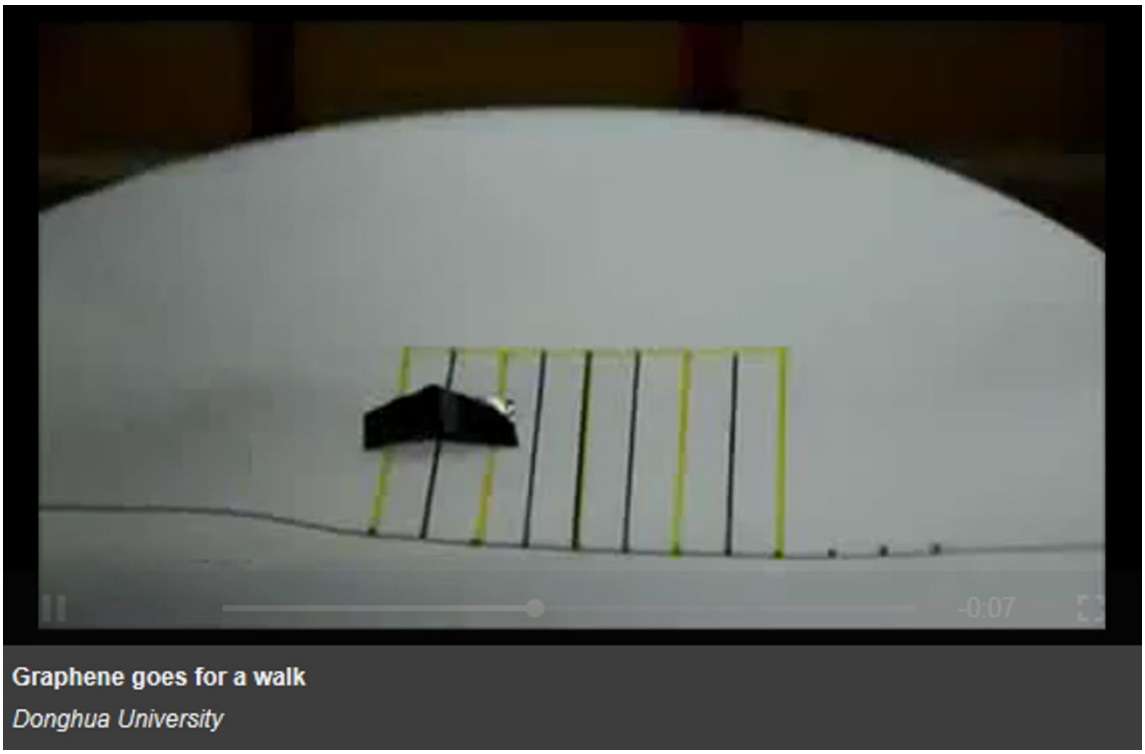
Light and heat propel bendy graphene crawlers

Layers of water-absorbing material fold into origami-inspired shapes.

Chris Cesare

06 November 2015



Graphene goes for a walk
Donghua University

Motivated by a centuries-old art, researchers have created self-folding remote-controlled materials from paper-thin stacks of graphene. The results are reported on 6 November in *Science Advances*[1].

Designing materials that draw inspiration from origami — the Japanese art of paper folding — is a field that “is on fire at the moment”, says Itai Cohen, a physicist at Cornell University in Ithaca, New York.

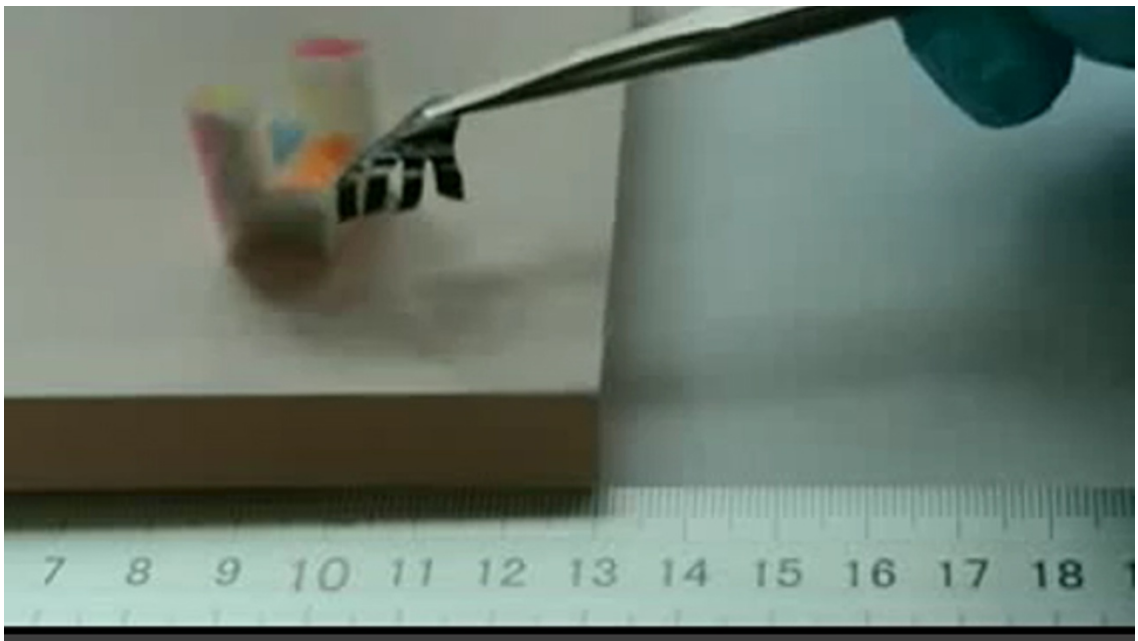
The paper describes one such material. Its base is formed of layers of graphene oxide, a one-atom-thick sheet of carbon peppered with compounds made up of hydrogen and oxygen. Atop this backbone sit layered strips of modified graphene oxide that are porous to water molecules.

Just add light

The strips act like sponges, absorbing water from the air and swelling in humid conditions. When exposed to heat or near-infrared light, they release the water. As that water leaves, the strips wither and tug on the material underneath them, causing it to bend.

The speed of this effect was surprising, says Hongzhi Wang, a materials researcher at Donghua University in Shanghai, China, and a co-author of the paper. “Water comes in very fast and goes out very fast,” he says. One experiment demonstrated that a ribbon of the material with a single strip of modified graphene oxide could fold and unfold in about 5 seconds.

Wang and his colleagues used their layered material to create a walking robot powered by pulsed light (see 'Graphene goes for a walk'); a design that folds up into a box; and a hand that can grab and lift items that are five times heavier than itself (see 'Light, camera, action!'). By hitting one side of the walking robot with infrared light, they could contract just that side and cause the device to turn.



“This paper is an important milestone on the path towards folding a single sheet of atoms,” Cohen says. If engineers achieve that goal, they will be able to use the existing infrastructure and expertise in fabricating 2D materials to create a variety of 2D patterns that pop up on their own into 3D designs.

Wang says that he and his colleagues will be looking to both scale up their technology — potentially for use as substrates for folded solar cells in space — and shrink it further. But the 1.8% efficiency rate at which the material converts light and heat into mechanical energy is still a limiting factor, Wang says. “If we want to do some practical applications, we have to improve this kind of efficiency,” he says.

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References

1. Mu, J. *et al. Sci. Adv.* http://dx.doi.org/10.1126/sciadv.1500533 (2015).

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"peppered with compounds made up of hydrogen and oxygen" is inaccurate. The hydrogen and oxygen in graphene oxide are not in 'compunds', but rather bonded directly as functional groups. See, e.g., Wikipedia (https://en.wikipedia.org/wiki/Graphite_oxide).