Catapult showcases ultra-strong artificial muscles

Carbon nanotubes soaked in paraffin wax flex and twist.

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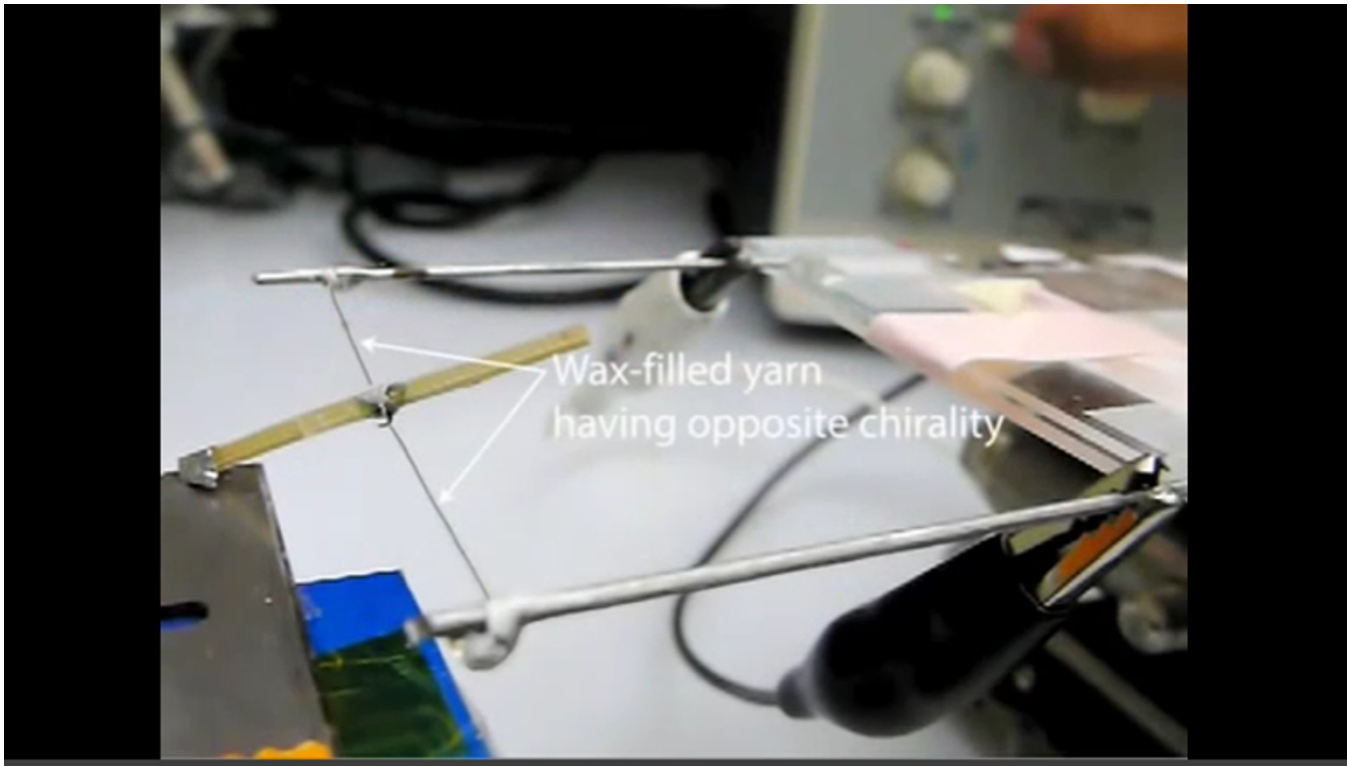

Miniature catapult

Video courtesy of The Alan G. MacDiarmid NanoTech Institute, The University of Texas at Dallas.

When your lab develops ultra-strong artificial muscles, you can be forgiven for wanting to show them off. To provide a memorable demonstration, Ray Baughman at the University of Texas at Dallas and his colleagues decided to build a catapult.

The device contains muscle 'yarns' similar in diameter to a human hair,spun from carbon nanotubes and then soaked in paraffin wax. When a current is passed through a yarn, the wax heats up and expands. As the yarn swells, its peculiar helical weave, like several parallel springs, causes it to shorten, and the 'muscle' contracts. Then, as it cools, the yarn relaxes and returns to its original length[1]. When coiled tightly and heated to high enough temperatures, wax-free or ‘neat’ yarns behave in the same way.

The torque produced by the twisting and untwisting of muscle yarns’ as the electric current is turned on and off is sufficient to power the miniature catapult and launch pieces of foil across a lab bench.

The muscle yarns can haul 200 times the weight that natural muscles of the same size can handle, and generate more torque than a large electric motor if compared by weight. But the yarns can’t quite haul a piano up the side of the building yet, or even beat you at the bench press, because the manufacturing techniques currently available limit the weight of yarn that can be made. “We can lift 50 grams,” Baughman says. “If you’re talking 50 tonnes, that’s a different ball game.”

But the yarns are not short of applications. They could be put to work as actuators in microfluidic systems or as components in optical cameras within just two years, Baughman estimates, and could one day be used as intelligent sensors. “Right now, we’re playing around with venetian blinds,” Baughman says. “If the room temperature gets too hot, the wax melts, the yarn contracts, and the blinds close.”

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References

1. Lima, D. M. *et al*. *Science* **338**, 928–932 (2012).