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Show us your (carbon nanotube artificial) muscles!

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Abstract

The idea of doctors deploying miniscule robots in your body to diagnose and treat medical conditions is closer to reality today with the development of artificial muscles small and strong enough to push such tiny "nano-bots" along.

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Show us your (carbon nanotube artificial) muscles!

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Is that a nano-bot in your guns, or are you just pleased to see me? jcoterhals

The idea of doctors deploying miniscule robots in your body to diagnose and treat medical conditions is closer to reality today with the development of artificial muscles small and strong enough to push such tiny “nano-bots” along.

I know – it seems the stuff of science fiction. The image of nano-bots zipping through arteries in pursuit of nasty pathogens is an oft-used trope of the future courtesy of nanotechnology.

But in this this week’s edition of Science Express, my colleagues and I from the University of Wollongong – with colleagues from the University of Texas, the University of British Columbia and Hanyang University – report on a new type of “artificial muscle” – the name used for materials that can change their shape in response to stimulus.

Such muscles are currently being developed as motors for all types of micro-machines with applications emerging in portable electronic devices.

How hard can it be?

Creating small machines that can propel themselves through fluids is a monumental challenge; indeed, producing mechanical movements of any kind is difficult in confined spaces.

Muscles are the most prominent “motor” in nature and can operate very successfully at the

micro-scale: insects fly; fleas leap tall obstacles; ants carry heavy loads.

Our new type of artificial muscle produces a rotating action 1,000 times larger than previously known systems. The new type of torsional muscle is generated from a thin thread of twisted carbon nanotubes produced by our collaborators at the University of Texas.

To put this in perspective, the thread is ten times smaller in diameter than a human hair. When immersed in a liquid electrolyte and with a voltage applied, the carbon nanotube thread absorbs some of the surrounding liquid. As it swells, the untethered end of the twisted yarn starts to turn.

Our research team discovered the amount of rotation was about 2,500 degrees for each centimetre of thread length. On a per-weight basis, the carbon nanotube thread generates nearly as much power and torque as conventional electric motors. And by attaching a plastic paddle 1,000 times heavier than the thread, we demonstrated a simple mixer for fluids.

The twisted helical structure of the carbon nanotube yarn mimics the muscular structure that occurs in elephant trunks and octopus tentacles.

In these systems the helically-wound muscle fibres contract against an incompressible core (think of this as being like a balloon filled with water) and cause the trunk or tentacle to bend and rotate.

A world of gain

Our research team comprises labs from four countries. My colleague Gordon Wallace, also from the University of Wollongong, emphasises “the importance of international collaborative research in tackling complex multidiscipline problems”.

At Wollongong, we set about trying to understand the source of the rotation and test the performance limits. After a while we were able to generate very large and very fast rotations.

Meanwhile, other friends at the University of British Columbia in Vancouver discovered the carbon nanotube threads also shortened in length when a voltage was applied.

When the Canadian and Texan teams visited Wollongong, we put two and two together and realised the shortening and rotation were both a property of the helical twisted structure of the threads.

The mixer application was developed in collaboration with colleagues at Hanyang University in South Korea.

The upshot of this international effort? We believe that, with further improvements in performance, it may be possible to propel a micro or nano-bot with these fascinating materials.

Which means they could be coming to a vein near you some time soon.