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Nanostructured Fibers Can Impersonate Human Muscles

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Researchers at The University of Texas at Austin and Penn State University have created a new type of fiber that can perform like a muscle actuator, in many ways better than other options that exist today. And, most importantly, these muscle-like fibers are simple to make and recycle.

Mimicking the human body, specifically the actuators that control muscle movement, is of immense interest around the globe. In recent years, it has led to many innovations to improve robotics, prosthetic limbs and more, but creating these actuators typically involves complex processes, with expensive and hard-to-find materials.

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In a new paper published in Nature Nano, the researchers showed that these fibers, which they initially discovered while working on another project, are more efficient, flexible and able to handle increased strain compared to what's out there today. These fibers could be used in a variety of ways, including medicine and robotics.

“You can basically build a limb from these fibers in a robot that responds to stimuli and returns power, instead of using a mechanical motor to do this, and that’s good because then it will have a softer touch,” said Manish Kumar, an associate professor in the Cockrell School of Engineering’s Department of Civil, Architectural and Environmental Engineering and one of the lead authors of the paper.

This kind of robotic arm could be used in an assistive exoskeleton to help people with weak arms regain movement and strength. Another potential application, the researchers say, could be a sort of "self-closing bandage" that could be used in surgical procedures and naturally degrade inside the body once the wound heals.

“Actuators are any material that will change or deform under any external stimuli, like parts of a machine that will contract, bend, or expand,” said Robert Hickey, assistant professor of materials science and engineering at Penn State and corresponding author on the paper. “And for technologies like robotics, we need to develop soft, lightweight versions of these materials that can basically act as artificial muscles. Our work is really about finding a new way to do this.”

The fiber material is known as a block co-polymer. Creating it only requires putting the polymer in a solvent and then adding water. One part of the polymer is hydrophilic (attracted to water), while the other part is hydrophobic (resistant to water). The hydrophobic parts of the polymer group together to shield themselves from the water, creating the structure of the fiber.

Similar existing fibers require an electric current to stimulate the reactions that bond parts together. This chemical cross-linking is harder to make happen, compared to the researchers' new fiber, which is a mechanical reaction, meaning the parts take care of most of the work themselves. Another added bonus is it is simple to reverse the process and return the pieces of the fiber to their original states.

"The ease of making these fibers from the polymer and their recyclability are very important, and it's an aspect that much of the other complicated artificial muscle research doesn't cover," Kumar said.

The researchers found their fibers were 75% more efficient in terms of converting energy to movement, able to handle 80% more strain and could rotate with more speed and force than current actuators. And it can stretch to more than 900% of its length before it breaks.

The discovery came while the researchers were working on something else. They were trying to use these polymers to make membranes for water filtration. However, the structures they made were too long for membranes. They stretched out to five times their original length and held that length. The researchers noticed that these characteristics were similar to muscle tissue, so they decided to shift the focus.

The researchers are early on in the project, and they next plan to learn more about the structural changes of the polymer and improve some of the actuation properties, including energy density and speed. They also may use this same design technique to create actuators that respond to different stimuli, such as light.

Read the original article on University of Texas at Austin.