Powering Wearable Technology with MXene Textile Supercapactior 'Patch'

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Researchers at Drexel University are one step closer to making wearable textile technology a reality.

Recently published in the Royal Society of Chemistry's Journal of Material's Chemistry A, materials scientists from Drexel's College of Engineering, in partnership with a team at Accenture Labs, have reported a new design of a flexible wearable supercapacitor patch. It uses MXene, a material discovered at Drexel University in 2011, to create a textile-based supercapacitor that can charge in minutes and power an Arduino microcontroller temperature sensor and radio communication of data for almost two hours.

"This is a significant development for wearable technology," said Yury Gogotsi, PhD, Distinguished University and Bach professor in Drexel's College of Engineering, who co-authored the study. "To fully integrate technology into fabric, we must also be able to seamlessly integrate its power source — our invention shows the path forward for textile energy storage devices."

A flexible textile supercapacitor patch, created by Drexel University researchers, can power a microcontroller and wirelessly transmit temperature data for nearly two hours without a recharge.

Co-authored along with Gogotsi's undergraduate and postdoctoral students; Genevieve Dion, professor and director of the Center for Functional Fabrics and researchers from Accenture Labs in California, the study builds on previous research that looked at durability, electric conductivity and energy storage capacity of MXene-functionalized textiles that did not push to optimize the textile for powering electronics beyond passive devices such as LED lights.

The latest work shows that not only can it withstand the rigors of being a textile, but it can also store and deliver enough power to run programmable electronics collecting and transmitting environmental data for hours – progress that could position it for use in health care technology.

“While there are many materials out there that can be integrated into textiles, MXene has a distinct advantage over other materials because of its natural conductivity and ability to disperse in water as a stable colloidal solution. This means textiles can easily be coated with MXene without using chemical additives — and additional production steps — to get the MXene to adhere to the fabric,” said Tetiana Hryhorchuk, a doctoral researcher in the College, and co-author. “As a result, our supercapacitor showed a high energy density and enabled functional applications such as powering programmable electronics, which is needed for implementing textile-based energy storage into the real-life applications.”

Drexel researchers have been exploring the possibility of adapting MXene, a conductive two-dimensional nanomaterial, as a coating that can imbue a wide range of materials with exceptional properties of conductivity, durability, impermeability to electromagnetic radiation, and energy storage.

Recently, the team has looked at ways of using conductive MXene yarn to create textiles that sense and respond to temperature, movement and pressure. But to fully integrate these fabric devices as “wearables” the researchers also needed to find a way to weave a power source into the mix.

“Flexible, stretchable and truly textile-grade energy storing platforms have so far remained missing from most e-textile systems due to the insufficient performance metrics of current available materials and technologies,” the research team wrote. “Previous studies reported sufficient mechanical strength to withstand industrial knitting. However, the demonstrated application only included simple devices.”

The team set out to design its MXene textile supercapacitor patch with the goal of maximizing energy storage capacity while using a minimal amount of active material and taking up the smallest amount of space — to reduce the overall cost of production and preserve flexibility and wearability of the garment.

To create the supercapacitor, the team simply dipped small swatches of woven cotton textile into a MXene solution then layered on a lithium chloride electrolyte gel. Each supercapacitor cell consists of two layers of MXene-coated textile with an electrolyte separator also made of cotton textile. To make a patch with enough power to run some useful devices — Arduino programmable microcontrollers, in this case – the team stacked five cells to create a power pack capable of charging to 6 volts, the same amount as the larger rectangular batteries often used to power golf carts, electric lanterns, or for jump-starting vehicles.

“We came to the optimized configuration of a dip-coated, five-cell stack with an area of 25 square centimeters to produce the electrical loading necessary to power programmable devices,” said Alex Inman, a doctoral researcher in the College of Engineering, and co-author of the paper. “We also vacuum-sealed the cells to prevent degradation in performance. This packaging approach could be applicable to commercial products.”

The best-performing textile supercapacitor powered an Arduino Pro Mini 3.3V microcontroller that was able to wirelessly transmit temperature every 30 seconds for 96 minutes. And it maintained this level of performance consistently for more than 20 days.

“The initial report of a MXene textile supercapacitor powering a practical peripheral electronics system demonstrates the potential of this family of two-dimensional materials to support a wide range of devices such as motion trackers and biomedical monitors in a flexible textile form,” Gogotsi said.

The research team notes that this is one of the highest total power outputs on record for a textile energy device, but it can still improve. As they continue to develop the technology, they will test different electrolytes and textile electrode configurations to boost voltage, as well as designing it in a variety of wearable forms.

“Power for existing e-textile devices still largely relies on traditional form factors like Lithium-polymer and coin cell Lithium batteries,” the researchers wrote. “As such, most e-textile systems do not use a flexible e-textile architecture that includes flexible energy storage. The MXene supercapacitor developed in this study fills the void, providing a textile-based energy storage solution that can power flexible electronics.”

Read the original article on Drexel University.