

# Lightweight green supercapacitors could quickly charge devices

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A prototype of the green supercapacitor made by Dr. Hong Liang's team. Credit: Texas A&M University College of Engineering

In a new study, researchers at Texas A&M University have described their novel plant-based energy storage device that could charge even electric cars within a few minutes in the near future. Furthermore, they said their devices are flexible, lightweight and cost-effective.

"Integrating biomaterials into [energy storage devices](#) has been tricky because it is difficult to control their resulting [electrical properties](#), which then gravely affects the devices' life cycle and performance. Also, the process of making biomaterials generally includes chemical treatments that are hazardous," said Dr. Hong Liang, Oscar S. Wyatt Jr. Professor in the J. Mike Walker '66 Department of Mechanical Engineering. "We have designed an environmentally friendly energy storage [device](#) that has superior electrical performance and can be manufactured easily, safely and at much lower cost."

Their research is outlined in the June issue of the journal *Energy Storage*.

Energy storage devices are generally in the form of either batteries or supercapacitors. Although both types of devices can deliver electrical currents when required, they have some fundamental differences. While batteries can store large amounts of charge per unit volume, supercapacitors are much more efficient at generating a large quantity of electric current within a short duration. This burst of electricity helps supercapacitors to quickly charge up devices, unlike batteries that can take much longer.

Supercapacitors have an internal architecture that is more in line with basic capacitors. Both these devices store charge on [metal plates](#) or electrodes. However, unlike basic capacitors, supercapacitors can be made in different sizes, shapes and designs, depending on the intended application. Furthermore, [supercapacitor](#) electrodes can also be built with different materials.

For their work, Liang and her team were attracted to manganese dioxide nanoparticles for designing one of the two supercapacitor electrodes.

"Manganese dioxide is cheaper, available in abundance and is safer compared to other [transition metal oxides](#), like ruthenium or zinc oxide,

that are popularly used for making electrodes," said Liang. "But a major drawback of manganese dioxide is that it suffers from lower electrical conductivity."

Past research has shown that lignin, a natural polymer that glues wood fibers together, used with metal oxides enhances the electrochemical properties of electrodes. However, Liang said there have been few studies looking into combining manganese dioxide and lignin to leverage both of their useful properties.

To create their [electrode](#), Liang and her team treated purified lignin with a commonly available disinfectant, called potassium permanganate. They then applied high heat and pressure to initiate an oxidation reaction that results in the breaking down of potassium permanganate and the deposition of manganese dioxide on lignin. Next, they coated the lignin and manganese dioxide mixture on an aluminum plate to form the green electrode. Finally, the researchers assembled the supercapacitor by sandwiching a gel electrolyte between the lignin-manganese dioxide-aluminum electrode and another electrode made of aluminum and activated charcoal.

Upon testing their newly designed green electrode, they found that their supercapacitor had very stable electrochemical properties. In particular, the specific capacitance, or the ability of the device to store an electrical charge, changed little, even after thousands of cycles of charging and discharging. Also, for an optimal lignin-[manganese dioxide](#) ratio, the specific capacitance was observed to be up to 900 times more than what has been reported for other supercapacitors.

Liang noted that these supercapacitors are also very light and flexible. These properties extend their use as structural energy storage elements in vehicles, for example.

"In this study, we have been able to make a plant-based supercapacitor with excellent electrochemical performance using a low-cost, sustainable method," said Liang. "In the near future, we'd like to make our supercapacitors 100% environmentally friendly by incorporating only green, sustainable ingredients."

**More information:** Swarn Jha et al, Design and synthesis of high performance flexible and green supercapacitors made of manganese-dioxide-decorated alkali lignin, *Energy Storage* (2020). [DOI: 10.1002/est2.184](https://doi.org/10.1002/est2.184)

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