Prize-winning technology for large-scale energy storage

November 18 2021

Professor Xavier Crispin and research engineers Ujwala Ail and Ziyauddin Khan, at the crimper that manufactures coin cell batteries to prove the concept, in the Laboratory of Organic Electronics. Credit: Thor Balkhed

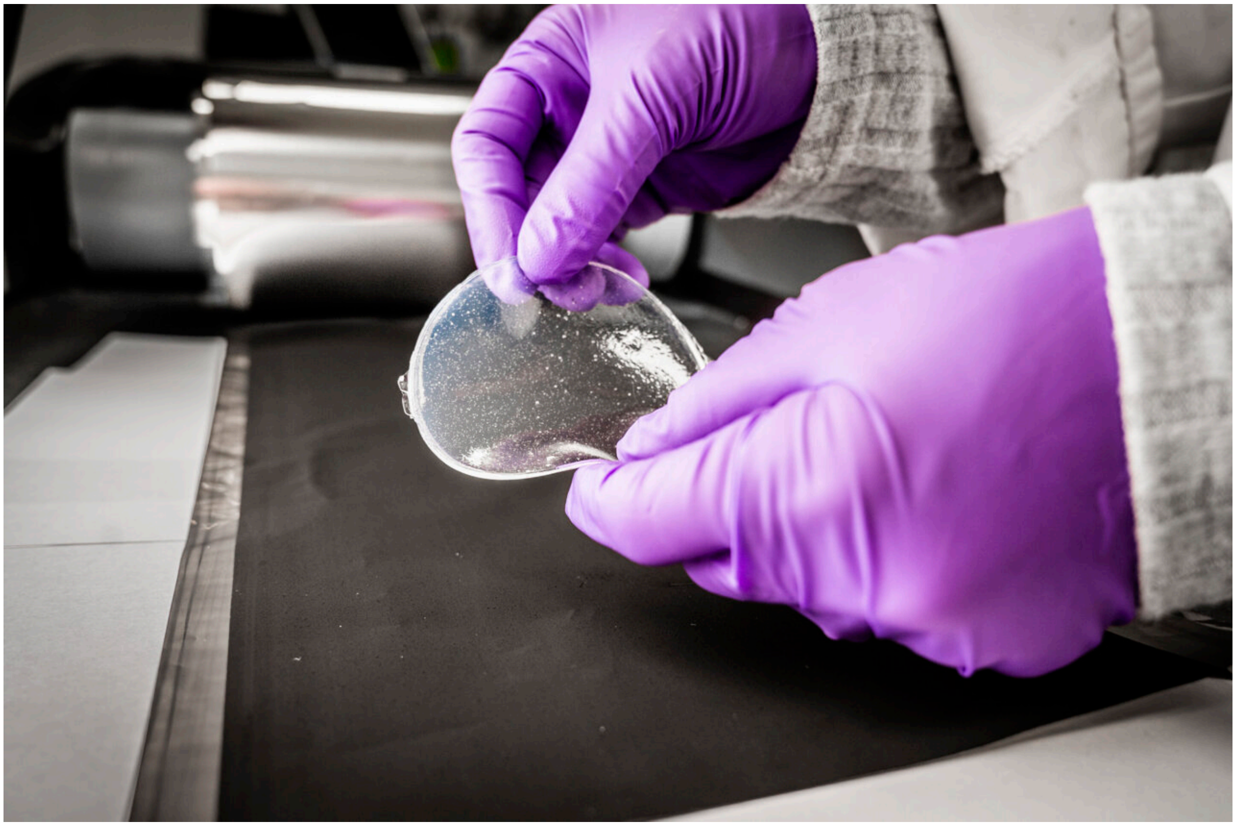
Safe, cheap and sustainable technology for energy storage has been developed at the Laboratory of Organic Electronics, Linköping

University. It is based on two major breakthroughs: the manufacture of wood-based electrodes in rolled form, and a new type of water-based electrolyte. The result has been published in the scientific journal Advanced Energy and Sustainability Research. The technology has been patented and is to be commercialized by Norrköping-based spin-off company Ligna Energy AB, which received the award for best "Startup for Climate", during the recent COP26 meeting in Glasgow.

An increasing share of renewable energy in the energy mix and increasing consumption of electricity in society are causing major challenges for balancing power supply networks. In principle, electricity is consumed at the instant of its production, and there are currently limited options for storing large amounts of electricity. The problem is particularly acute during cold periods, when the demand for electricity is highest. Imbalance in the grid can cause serious power outages.

Professor Xavier Crispin and his colleagues at the Laboratory of Organic Electronics, Linköping University, have developed a concept for large-scale energy storage that is safe, cheap and sustainable. The potential power output is sufficiently high for the technology to maintain power balance in the electricity supply.

"Our results allow for safe, environmentally sustainable organic energy storage with high power density, 5 kW/kg, where the electrodes are manufactured from wood-based material in a printing press. We must, however, increase the energy density: our organic batteries are better than normal supercapacitors, and have about the same performance as lead-acid batteries. But lithium-ion batteries are better", says Crispin.

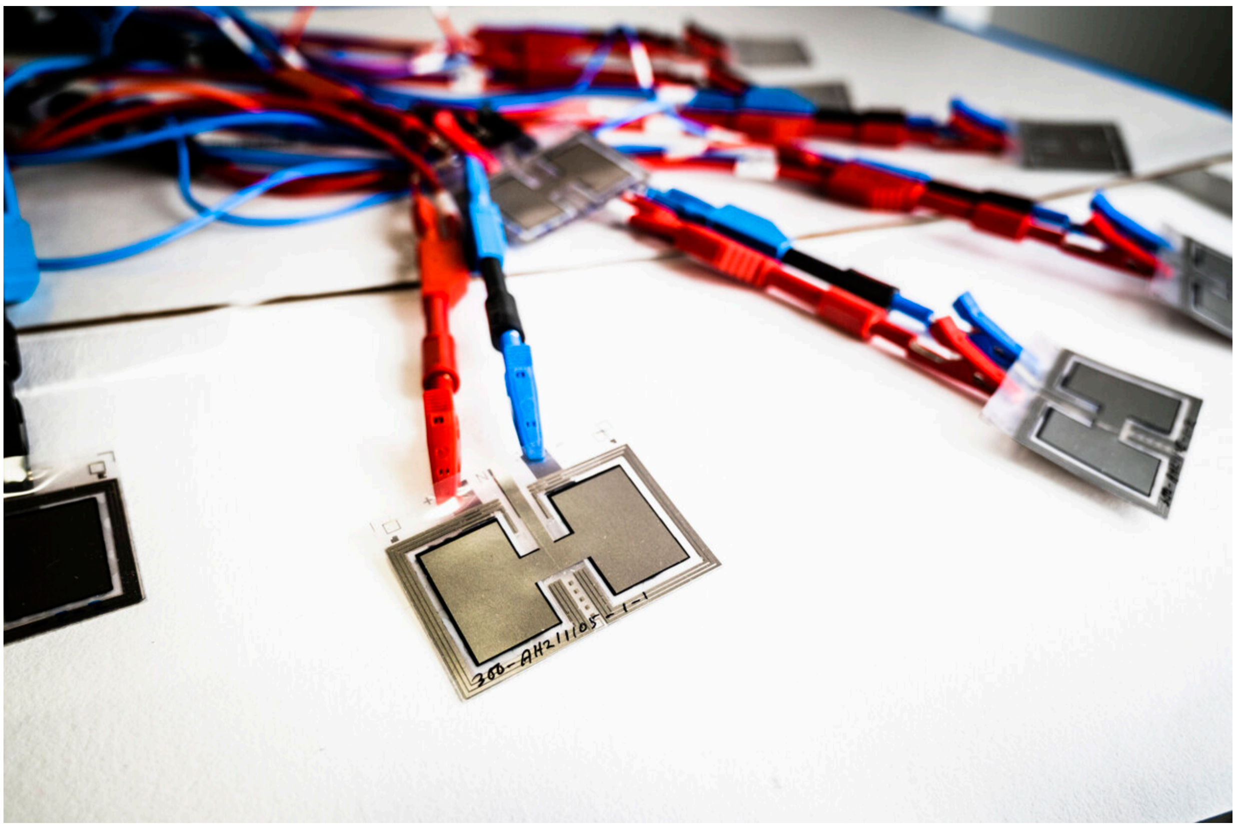


The electrolyte here is seen in the form of a gel, while the black base is a large-area lignin electrode coated on a metal collector. Credit: Thor Balkhed

Previous attempts to develop a sustainable system for energy storage based on cheap organic and water-based electrolytes with carbon-based electrodes have all had problems with rapid self-discharge: it has been difficult to achieve more than one day.

The excellent results presented in the article are based on two breakthroughs: a new type of water-based electrolyte, and electrodes made from lignin, which is a readily available, cheap by-product from the manufacture of paper. The researchers have developed a polyelectrolyte that consists of a highly concentrated water-based polymer, potassium polyacrylate, together with biopolymer lignin (as positive electrode) and polyimide mixed with conductive carbon (as negative electrode).

"The voltage drop, which measures the self-discharge, is less than 0.5 V in 100 hours, which is a world record for energy storage with organic electrodes in water-based electrolytes", says Crispin.



Printed battery with two cells, designed in collaboration with the Ligna Energy company. Credit: Thor Balkhed

The new technology uses cheap raw materials: neither lignin, carbon nor the polyelectrolyte cost more that 1 USD/kg. These are readily available and non-flammable materials, and the technology can be scaled up to large batteries. It is a sustainable solution for large-scale and safe energy storage.

The research appeared in *Advanced Energy and Sustainability Research*.

More information: Ziyauddin Khan et al, Water-in-Polymer Salt Electrolyte for Slow Self-Discharge in Organic Batteries, *Advanced Energy and Sustainability Research* (2021). DOI: 10.1002/aesr.202100165

Provided by Linköping University