

Scientists develop new technique for large-scale energy storage

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The sale of electric vehicles (EVs) has grown exponentially in the past few years as has the need for renewable energy sources to power them, such as solar and wind. There were nearly 1.8 million registered electric vehicles in the U.S. as of 2020, which is more than three times as many in 2016, according to the International Energy Agency (IEA).

Electric vehicles require power to be available anywhere and anytime, without delays in recharging, but solar and wind are intermittent energy sources that are not available on demand. And the electricity they do generate needs to be stored for later use and not go to waste. That's where Dr. Yu Zhu, a professor in UA's School of Polymer Science and Polymer Engineering, and his research team come in, by developing a more stable way to store this important energy.

Like the gas station today, electricity power stations need a storage system to keep the electricity for EV constantly charging. Low cost, scalable redox flow batteries (RFB) are among the most suitable technology for such a system; however, current RFBs use high-cost and environmentally hazardous active materials ([electrolytes](#)). Recently, water-soluble organic materials have been proposed as future electrolytes in the RFBs (namely aqueous organic RFBs, or AORFBs). Organic-based electrolytes can be obtained from renewable sources and manufactured with very low cost. However, the lack of stable water-soluble organic electrolyte materials, particularly the positive electrolyte (catholyte), is a major hurdle of AORFBs.

Zhu's research group, in collaboration with scientists in Pacific Northwestern National Laboratory led by Dr. Wei Wang, successfully developed the most stable catholyte (positive electrolyte) to date in AORFBs and demonstrated cells that kept more than 90 percent of capacity over 6,000 cycles, projecting more than 16 years of uninterrupted service at a pace of one cycle per day. Their research was recently published in *Nature Energy* and included contributions from Zhu's doctoral students Xiang Li and Yun-Yu Lai.

"Development of high-performance RFBs will enrich the category of electricity energy storage systems and complement the shortcoming of intermittent renewable energy sources, therefore largely improving the usability of electricity powered facilities, such as vehicles," says Zhu.

"To significantly improve the performance of aqueous organic RFBs, the urgency of developing new catholyte is crucial."

In the *Nature Energy* paper, the team not only demonstrated a state-of-the-art catholyte in AORFBs, but also provided a brand-new strategy to design water soluble catholyte to enhance their solubility (energy density) in water. Instead of attaching a hydrophilic functional group to improve the solubility of the molecules, the researchers change the symmetry of molecules, which results in a dramatic enhancement of solubility. With the new design strategy, the team plans to design new materials they can further mature the RFBs.

A patent application has been submitted based on the technology developed in this research. The scalability of the materials will be further studied in Akron PolyEnergy Inc., a spinout company from UA co-founded by Zhu that focuses on the development of materials in energy storage devices including lithium-ion batteries and flow batteries.

More information: Xiang Li et al, Symmetry-breaking design of an organic iron complex catholyte for a long cyclability aqueous organic redox flow battery, *Nature Energy* (2021). [DOI: 10.1038/s41560-021-00879-6](https://doi.org/10.1038/s41560-021-00879-6)

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