Breakthrough boosts performance of sodium-sulfur batteries

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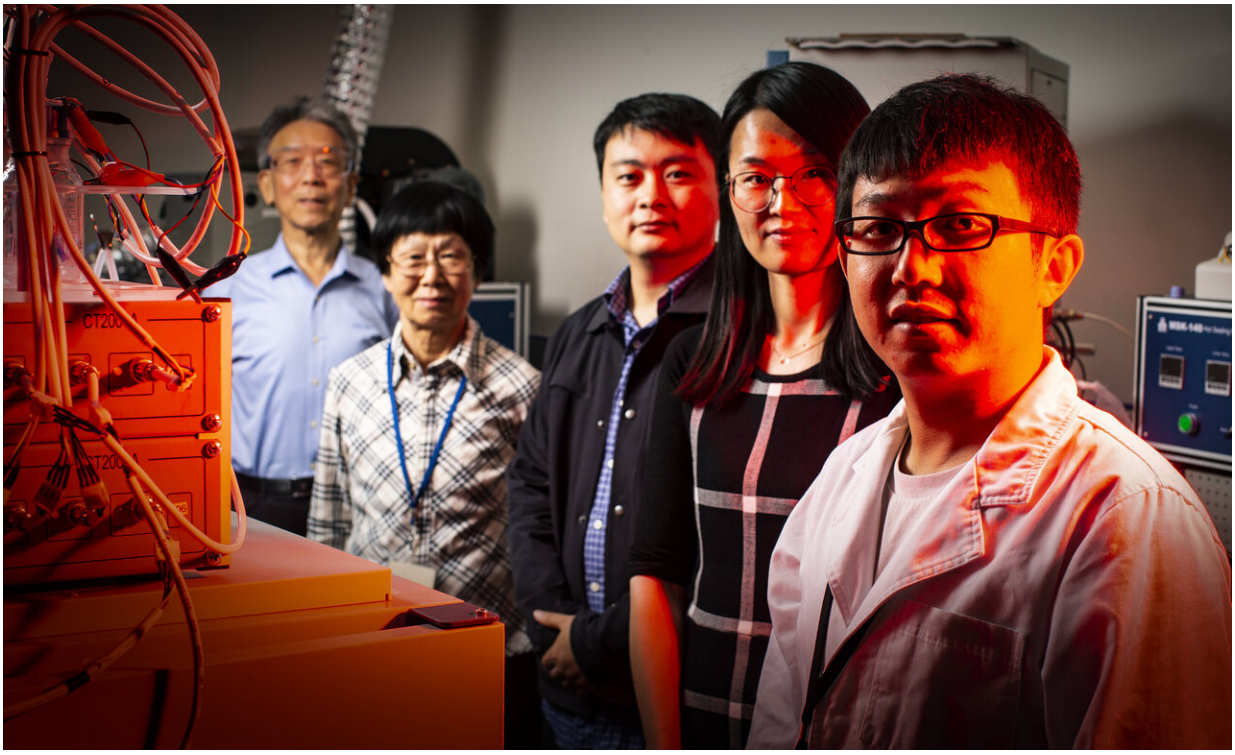

Left to right: Distinguished Professor Shi Xue-Dou, Distinguished Professor Huakun Liu, Associate Professor Shu-Lei Chou, Dr Yunxiao Wang and Mr Zichao Yan from the Institute for Superconducting and Electronic Materials, University of Wollongong. Credit: Paul Jones, University of Wollongong

Researchers from the University of Wollongong have manufactured a nanomaterial that acts as a superior cathode for room-temperature

sodium-sulfur batteries, making them a more attractive option for large-scale energy storage.

Their research results are published in *Nature Communications*, where they were featured in the editors' highlights webpage.

Room-temperature sodium-sulfur batteries are an attractive proposition for next generation energy storage, which will be required to meet increasing demands. A superior room-temperature sodium-sulfur battery with high energy density and long cycling life would provide a low-cost and competitive technology for large-scale stationary storage, thus promoting the shift towards renewable energy.

However, room-temperature sodium-sulfur batteries currently suffer from rapid capacity fading and low reversible capacity.

The researchers overcame this problem by creating a nanomaterial—nickel sulphide nanocrystals implanted in nitrogen-doped porous carbon nanotubes—which exhibited excellent performance when used as cathodes.

Chief investigators Dr. Yunxiao Wang and Associate Professor Shulei Chou, from UOW's Institute for Superconducting and Electronic Materials, said their research group had been working on room-temperature sodium-sulfur batteries since 2016.

"For now, the actual energy densities of sodium-sulfur batteries are a far cry from the theoretical values," Dr. Wang said.

"Their practical applications are mainly impeded by the problematic sulfur cathode due to its insulating nature and the slow redox kinetics, as well as the dissolution and migration of the reaction intermediates."

The research team experimented with a number of different materials before their breakthrough. The new nanomaterial not only delivers superior performance, but is also suited to large-scale production and therefore commercialisation.

Ph.D. candidate Mr Zichao Yan devoted himself to conducting the intricate experiments needed for this work.

"We tried many carbon hosts, and finally found the nickel sulfide nanocrystals implanted nitrogen-doped porous carbon nanotubes as a multifunctional sulfur host," Mr Yan said.

"We found that the continuous carbon backbone inside the host can provide short ion diffusion paths and a fast transfer rate. And the nitrogen-doping sites and the nickel sulfide polar surface are capable of enhancing the adsorption energy of polysulfides, leading to strong catalytic activity towards polysulfide oxidation.

"This indicates that sodium-sulfur batteries with this sulfur host could potentially offer a longer cycle life and high performance in fast charging and discharging."

The next step, Professor Chou said, was to scale up production of the material.

"All our previous papers, including this one, were focused on how to find an efficient host for lab-scale research. The next step for our group is to bring sodium-sulfur batteries from lab-scale to industry-scale, and make a real application for this battery system."

More information: Zichao Yan et al. Nickel sulfide nanocrystals on nitrogen-doped porous carbon nanotubes with high-efficiency electrocatalysis for room-temperature sodium-sulfur batteries, *Nature*

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