Scientists develop high-performance lithium-sulfur batteries

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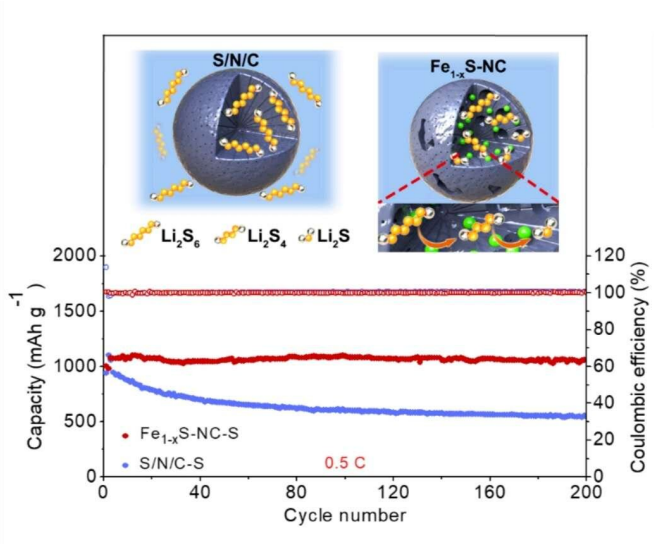

Schematic illustration for molecular-level design of pyrrhotite electrocatalyst decorated hierarchical porous carbon spheres as nanoreactors for lithium-sulfur batteries Credit: DICP

Recently, research groups led by Prof. Liu Jian and Prof. Wu Zhongshuai from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences have developed $Fe_{1-x}S$-decorated mesoporous carbon spheres as the nanoreactor for a lithium-sulfur battery cathode. The nanoreactor showed excellent polysulfide catalytic activity and cyclic stability. The study was published in *Advanced Energy Materials* on Apr. 16.

Lithium-sulfur batteries have a high theoretical energy density of 2600 Wh kg^{-1} and theoretical capacity of 1675 mAh g^{-1}. However, the slow conversion reaction dynamics of sulfur in the process of charging and discharging lead to low utilization rate of sulfur and a serious shuttle effect. This further reduces the capacity and stability of lithium-sulfur batteries.

Therefore, a reasonably designed electrocatalytic system would realize steady and efficient catalytic transformation of polysulfide under high sulfur loading, resulting in high cyclic stability. In the current study, the researchers designed a mesoporous carbon nanoreactor decorated with highly dispersed $Fe_{1-x}S$ electrocatalyst nanoparticles ($Fe_{1-x}S$-NC), and applied it as a lithium-sulfur battery cathode for high catalytic activity and high sulfur loading.

The nanoreactor has low mass density, high porosity, and a highly dispersed electrocatalyst, which significantly improves the adsorption and catalytic conversion capacity of polysulfides. The researchers found that there was virtually no decay in capacity of $Fe_{1-x}S$-NC from an initial value of 1070 mAh g^{-1} after 200 cycles and under a current density of 0.5 C.

"The nanoreactor design strategy provides a new protocol for building high-capacity and long-cycle rechargeable batteries," said Prof. Liu. "It will also open an avenue for design of safer and high-energy-density Li-metal batteries."

More information: Yash Boyjoo et al, Molecular?Level Design of Pyrrhotite Electrocatalyst Decorated Hierarchical Porous Carbon Spheres as Nanoreactors for Lithium–Sulfur Batteries, *Advanced Energy Materials* (2020). DOI: 10.1002/aenm.202000651

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