Docket #: S18-008

Rational design of redox mediator for fast and energy-efficient charging of sulfur cathodes

Stanford researchers in Zhenan Bao and Yi Cui's labs have developed an organic redox mediator that could make Lithium Sulfur batteries charge faster with less energy. An energy efficient Li_2S electrode design is crucial for industrial manufacturing of Li-S batteries, a lightweight and high performance alternative to Li-ion batteries. The redox mediator (RM) acts as a charge shuttle (see figure 1). It 'patrols' the cathode to react with Li_2S particles that are not in contact with current collectors, facilitates electron transport, and improves efficiency.

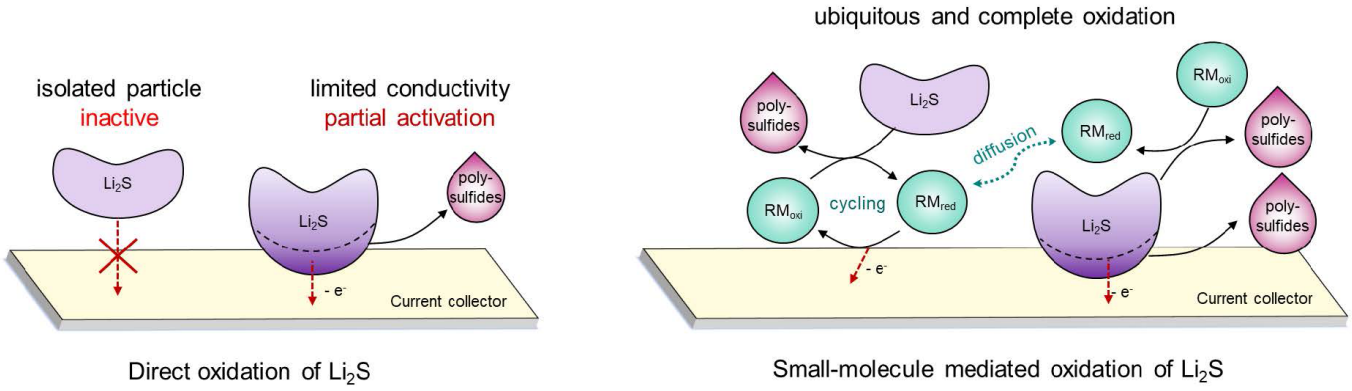


Figure 1 Direct oxidation of Li_2S vs. mediated oxidation

This specially designed RM is compatible and soluble with the electrolyte, making it easy to integrate into the conventional cell design.

Stage of Research

Stanford researchers designed and employed a small molecule in the electrolyte as a redox mediator. This RM molecule facilitates charge transport during oxidation of Li_2S, at a 20% lower first charge potential than state of the art approaches, at a

voltage that is only slightly above the oxidation potential of Li_2S.

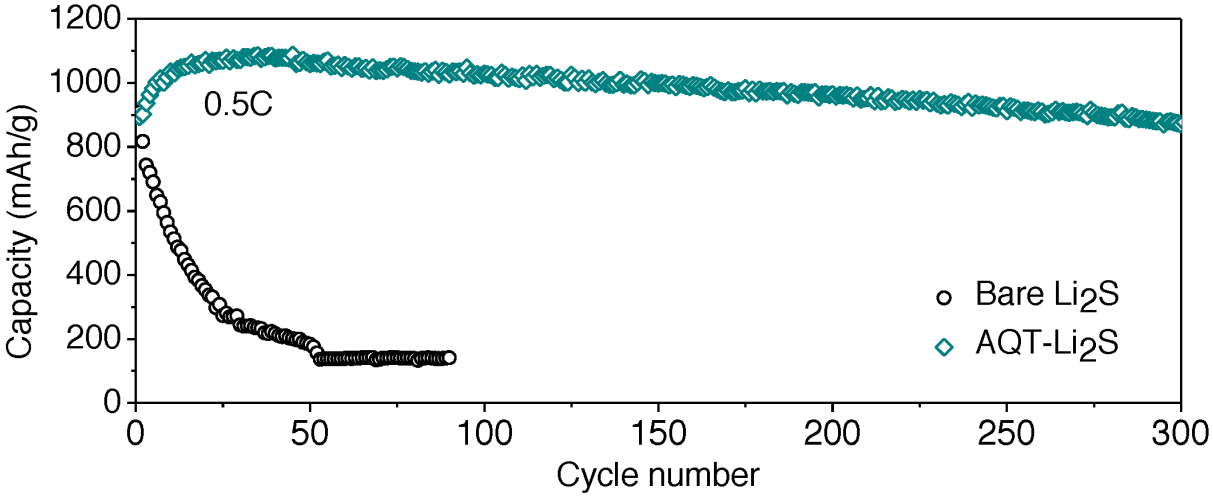


Figure 2 Cycle stability of bare Li_2S vs. AQT redox mediated Li_2S

The new RM demonstrated good compatibility and solubility with the electrolyte, and cycle stability retention improved from 60% to 81%, with 76% retention over 700 cycles at a decay rate of 0.034 % per cycle – outperforming other methods.

Applications

- Advanced battery design – In additional to Li_2S batteries, this redox mediator design concept is applicable to other non-conductive battery materials.

Advantages

- Scalable production and manufacturing– RM is easily blended into electrolyte.
- Simple process – RM is dissolved in electrolyte and requires no change in electrolyte nor battery electrode.
- Improved charge performance - 20% lower first charge potential than published state of art.
- Enhanced cycle stability – Retention improved from 60% to 81%, with 76% retention over 700 cycles.

Patents

- Published Application: 20210050624
- Issued: 11,804,620 (USA)

Innovators

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