

Revealing thermal runaway routes in lithiumsulfur batteries

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Top: thermal runaway behavior of all-solid-state electrolyte Li-S batteries under abused conditions. Bottom: the decisive role of cross reaction between electrodes on triggering the thermal runaway of Li-S batteries. Credit: Huang Lang

Lithium-sulfur (Li-S) batteries offer great potential for use in energy storage systems because of their large energy capacity. However, safety problems related to their thermal behavior continue to be a concern for scientists.

Now, a research team led by researchers from the Qingdao Institute of Bioenergy and Bioprocess Technology (QIBEBT), Chinese Academy of Sciences (CAS), have revealed the thermal runaway routes of Li-S batteries, which may help to address the safety issues of next-generation batteries.

This study was published on Mar. 14 in Joule.

"One of these safety concerns with Li-S batteries is thermal runaway, a phenomenon where the battery begins to overheat uncontrollably. As the temperature in the battery rises, the <u>electrolyte</u> can be ignited, possibly leading to a fire," said Huang Lang, assistant professor at QIBEBT and lead author of the study.

The research team set out to investigate the safety characteristics of largeformat pouch-cell Li-S batteries. In particular, they examined inorganic all-solid-state electrolytes because of their <u>high thermal stability</u>, which may provide a strategy for overcoming the safety problems. They then analyzed the thermal runaway behaviors of the pouch-cell batteries.

The results showed that even all-solid-state electrolytes cannot stop the thermal runaway that occurs in Li-S batteries at high temperatures. This



understanding will benefit scientists looking at ways to build safer nextgeneration Li-S batteries.

The team examined the thermal features of Li-S batteries from the aspect of the material. They started at the whole pouch cell and worked down to the electrode level.

They discovered that the exothermic chain reactions of Li-S batteries were initially triggered by sulfur cathode derivatives that reacted with the electrolyte. This reaction then accelerated as the <u>lithium metal anode</u> reacted with the electrolyte or cathode active species. As the sulfur cathode and Li metal anode melted, they immigrated and cross-reacted at high temperatures, playing a decisive role in the battery's thermal runaway behavior.

The study reveals that as-assembled Li-S batteries using electrolytes with different thermal stabilities, including inorganic all-<u>solid-state</u> <u>electrolytes</u>, all undergo rapid thermal runaway because of the unavoidable short circuiting that occurs when the sulfur cathode and Li anode melt.

"The in-depth depicted thermal runaway routes will shed fresh light on the way forward for building next-generation Li-S batteries with enhanced safety performance," said Cui Guanglei, professor at the QIBEBT.

More information: Guanglei Cui, Thermal runaway routes of largeformat lithium-sulfur pouch cell batteries, *Joule* (2022). <u>DOI:</u> <u>10.1016/j.joule.2022.02.015</u>. <u>www.cell.com/joule/fulltext/S2542-4351(22)00096-4</u>



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