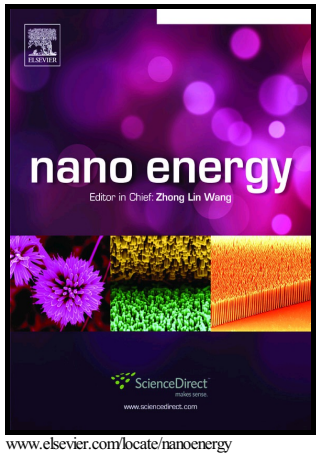

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PII: S2211-2855(17)30636-5
DOI: https://doi.org/10.1016/j.nanoen.2017.10.032
Reference: NANOEN2266

To appear in: *Nano Energy*

Received date: 21 June 2017
Revised date: 1 August 2017
Accepted date: 12 October 2017

Cite this article as: Xuejun Liu, Na Xu, Tao Qian, Jie Liu, Xiaowei Shen and Chenglin Yan, High Coulombic Efficiency and High-Rate Capability Lithium Sulfur Batteries with Low-Solubility Lithium Polysulfides by Using Alkylene Radicals to Covalently Connect Sulfur, *Nano Energy,* https://doi.org/10.1016/j.nanoen.2017.10.032

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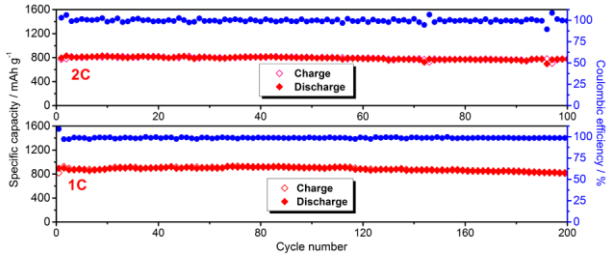
Abstract: The long-chain lithium polysulfides that are soluble in ether-based electrolyte for lithium sulfur battery are regarded as one of reason for their low Coulumbic efficiency and low rate capability. In this work, we reported a new strategy to stabilize sulfur cathodes with alkylene radicals to covalently connect sulfur through the formation of low-solubility lithium polysulfides, which enables high Coulombic efficiencies of 99.9% at 0.2 C, 99.9% at 0.5 C, 100% at 1 C, 100% at 2 C, 100% at 4 C, 100% at 6 C as well as outstanding rate capability with a high capacity of 702 mAh g^{-1} at 6 C. The proposed mechanism was clearly revealed by *in-situ* UV/Vis spectroscopy, demonstrating that short chain polysulfides as discharge products with low solubility are mainly produced during charging and discharging process. Moreover, DFT calculations confirmed that the bond breakage of the linear sulfur chains preferentially takes place in the center of the linear polysulfane, resulting in the formation of short-chain polysulfides, which could effectively avoid the production of soluble long-chain polysulfide and suppress the shuttling effect for high Coulumbic efficiency and high-rate capability lithium sulfur batteries.

Graphical abstract



A new strategy is reported to stabilize sulfur cathodes with alkylene radicals through the formation of weakly soluble lithium polysulfides, which enables nearly 100% Columbic