Sulfur-Rich Covalent Polymer for Enhanced Cycling in Li-S Batteries

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Lithium-sulfur (Li-S) batteries are promising for next-generation energy storage due to their high theoretical energy density (2600 Wh kg^{-1}) and specific capacity (1675 mAh g^{-1}), far exceeding conventional lithium-ion technologies. However, their commercialization is limited by the shuttle effect, where soluble lithium polysulfides (LiPS) migrate between electrodes, causing rapid capacity degradation [1]. To address this, organosulfur polymer cathodes have emerged, enabling covalent sulfur immobilization [2]. In this context, we synthesized a sulfur-rich polymer, designated S-TAIC ($C_{36}H_{48}N_{12}O_{12}S_{15}$, supported by elemental analysis), through a straightforward one-step synthesis (Fig. 1a). In this polymer, sulfur is covalently bound to the structure, effectively minimizing the shuttle effect. Preliminary tests indicate that disulfide bonds significantly influence the reduction mechanism, reforming the behavior typically seen in conventional sulfur electrodes (e.g., Carbon Black:S_8). This modification appears to suppress the generation of long-chain polysulfides, suggesting improved electrochemical stability, as shown in the charge-discharge curves (Fig. 1b).

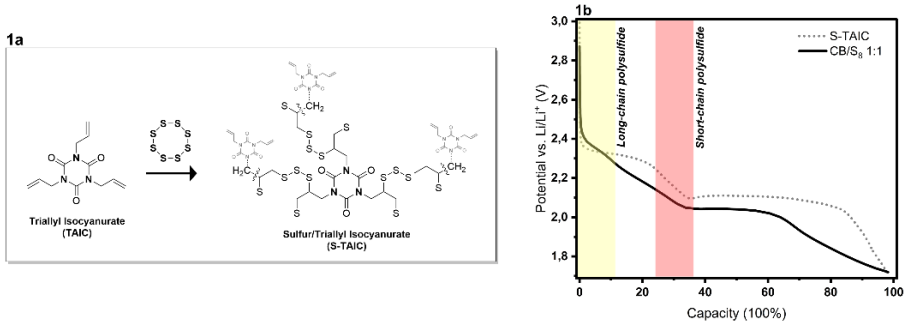

Fig. 1. a) Reaction scheme for the vulcanization of triallyl isocyanurate (TAIC) with elemental sulfur, forming S-TAIC. b) Discharge cycles of S-TAIC (solid black line) and CB/S_8 1:1 (dashed gray line).

Acknowledgments:
This work was supported by FAPESP (2022/10235-4); IQ-USP.

References:

[1] S. Chauque, B. L. Souza, H M. Sintaku, R. A. Ando, R. M. Torresi. Unveiling the polysulfide-PPY interaction for enhanced lithium–sulfur battery performance. *Electrochimica Acta*, 2024, V. 475, 0013-4686. **[2]** S. Haldar, P. *et al.* Sulfide-Bridged Covalent Quinoxaline Frameworks for Lithium–Organosulfide Batteries. *Adv. Mater*, 2023, 35, 2210-151.