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# Single sulfur resolution polysulfide sensing: first steps in nanopores as battery sensors

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Batteries, as one of the most versatile energy storage technologies, play a central role in the ongoing transition from fossil fuels to renewable energy[1]. One of the challenges is to monitor inside the cell battery the electrolyte stability, responsible of capacity stability, during charge and discharge cycles[2]. Research on battery technologies mostly focuses on electrodes and electrolytes while few activities are devoted to separator membranes whose porosity enables ions transport. However, they could be used as a toolbox for injecting chemical curing functionalities in case of battery malfunctioning events. Here, we report the use of biological membranes hosting a nanopore sensor for electrical single molecule detection and use aqueous sodium polysulfides encountered in sulfur-based batteries for proof of concept[3]. By investigating the host-guest interaction between polysulfides of different chain-lengths and cyclodextrins, via combined chemical approaches and molecular docking simulations, and using a selective nanopore sensor inserted into a lipid membrane, we demonstrate that supramolecular polysulfide/cyclodextrin complexes only differing by one sulfur can be discriminated at the single molecule level. The findings offer innovative perspectives to the nanopore detection to be used as a powerful probe to sense species migrating through a membrane such as characterizing red-ox shuttle effects.

1. Larcher, D. & Tarascon, J. M. Towards greener and more sustainable batteries for electrical energy storage. *Nature Chemistry* **7,** 19–29 (2015).
2. Grey, C. P. & Tarascon, J. M. Sustainability and in situ monitoring in battery development. *Nat Mater* **16,** 45–56 (2016).
3. Bétermier, F. *et al.* Single-sulfur atom discrimination of polysulfides with a protein nanopore for improved batteries. *Communications Materials* **1,** 59 (2020).

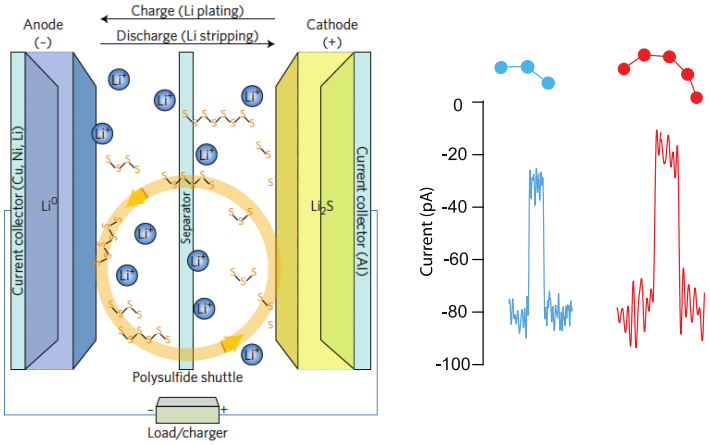


Figure 1: Polysulfide shuttle in LiS batteries and polysulfide detection using a nanopore.