Super-concentrated water-based electrolytes for lithium-ion batteries

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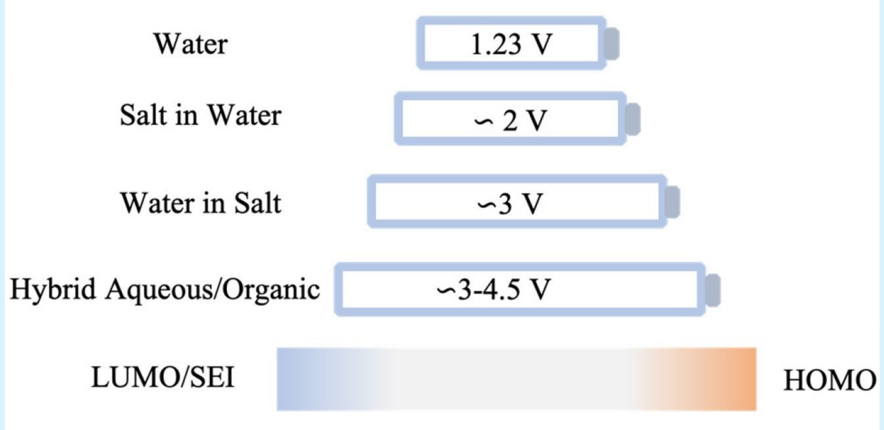
1. Introduction

Nowadays, lithium-ion batteries (LIBs) are more and more present in our daily life; just think about the portable devices, such as smartphones and computers, or the more recent electrical vehicles.

One of the most serious problems of LIBs is the flammability of the most used electrolytes [1], due to the organic solvent employed. Indeed, sometimes, combustion or explosion accidents related to these devices are reported.

The most currently studied alternatives include: ionic-liquids, solid-state electrolytes and water-based electrolytes. This last option is the one exhibited in this poster.



2. Aim of the work

Water-based electrolytes for LIBs present a significant limit: the narrow electrochemical stability window (ESW) of water (only 1.23 V), that restrict the maximum cell voltage achievable [2].

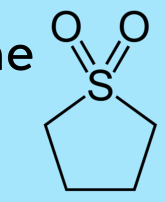
There are two main solution that help to overcome this problem [3]:

1. Increase the salt content until reaching a salt:water molar ratio near to 1 or even higher (Water-in-Salt Electrolyte) [4];
2. Introduce additives that promote the formation of a SEI (solid-electrolyte interphase) layer. This is a passivation layer that prevent electrode/electrolyte reactions.

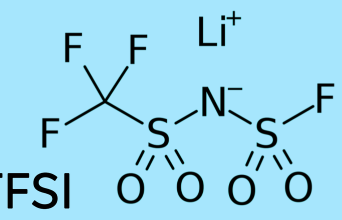
By mixing this two strategies, in this work new water-based electrolytes were designed, characterized and tested in a real battery.

3. Design

Solvents: water + sulfolane



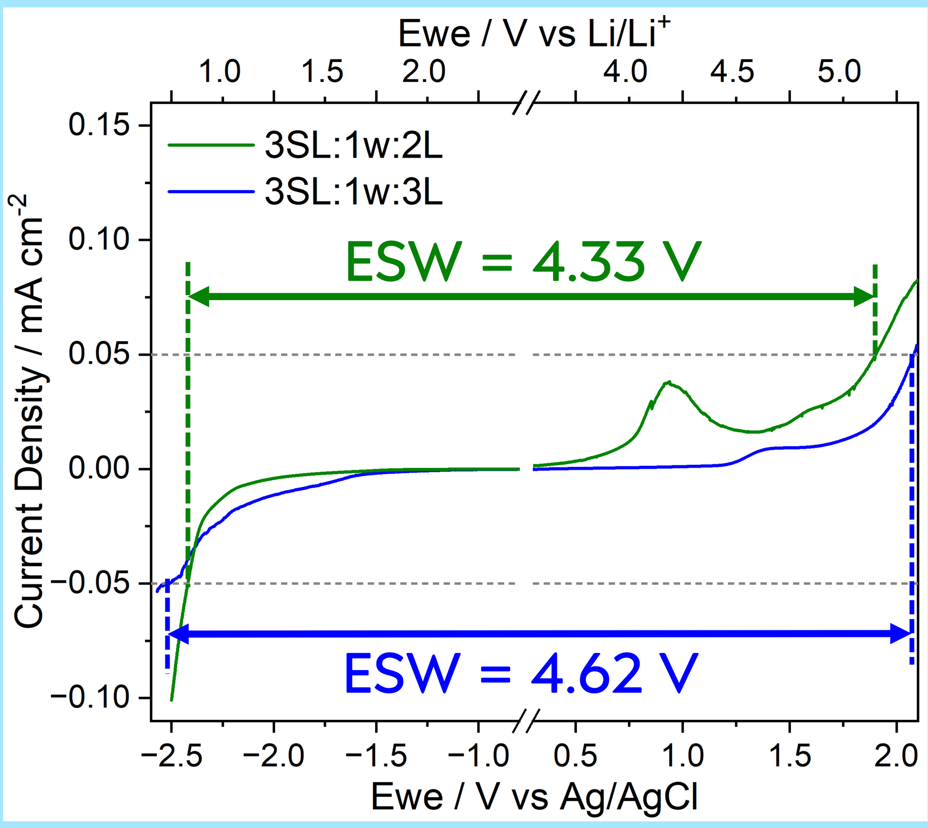
Salt: LiFTFSI



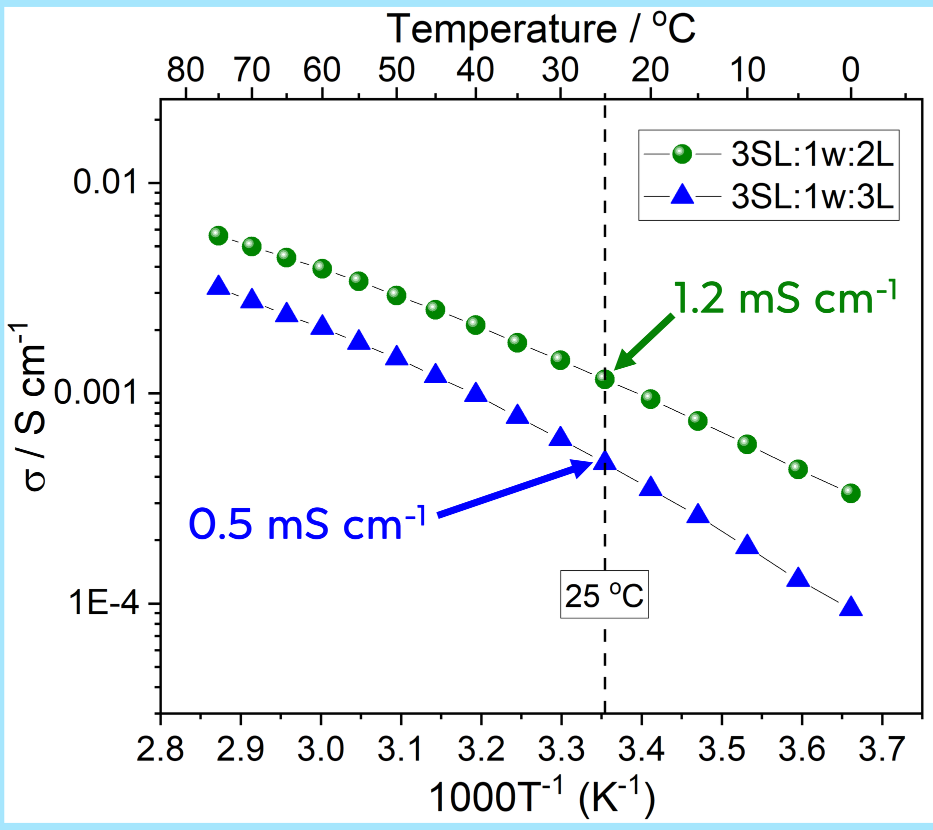
Two different molar ratios: sulfolane:water:LiFTFSI = 3:1:2 (called 3SL:1w:2L) and 3:1:3 (called 3S:1w:3L)

4. Characterizations

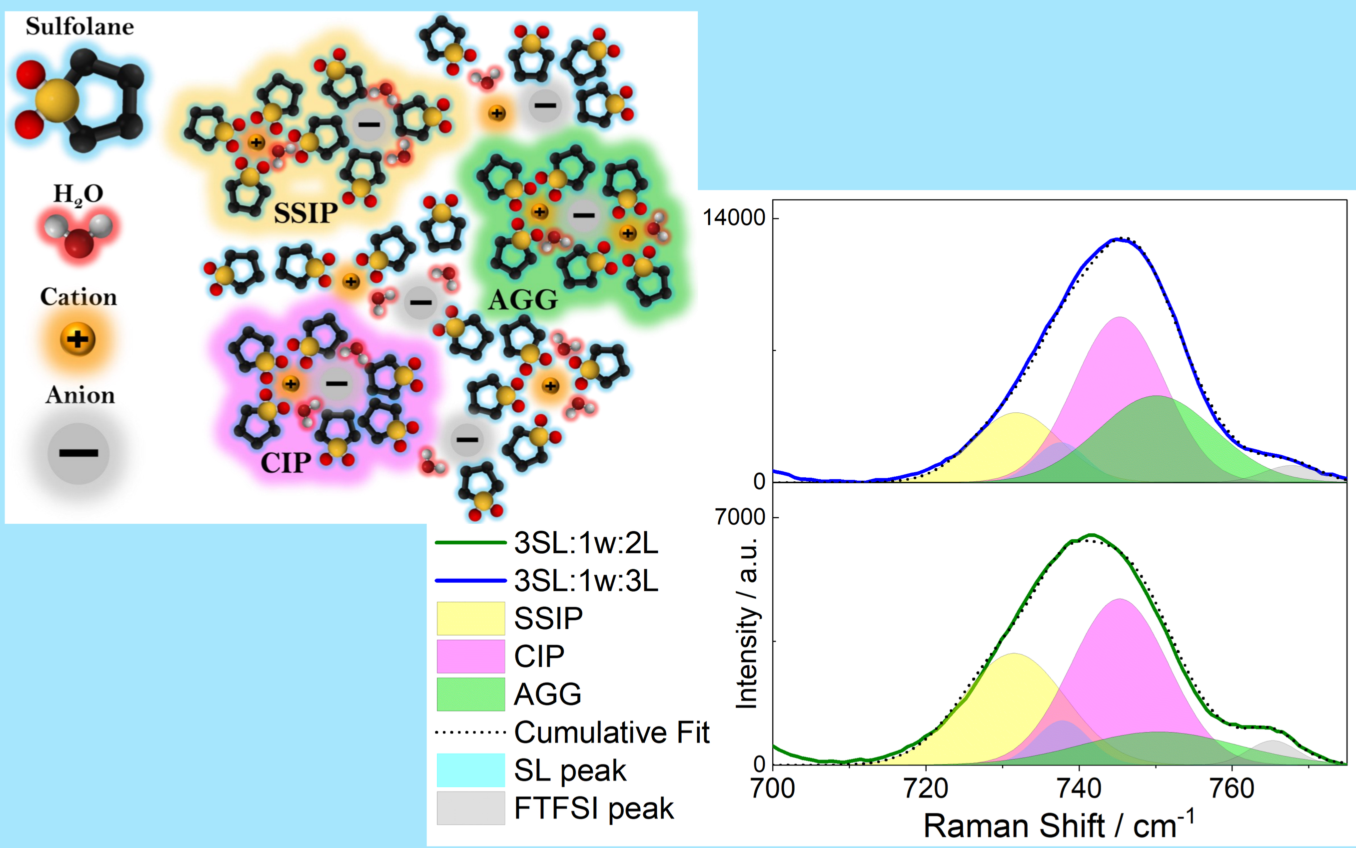
Electrochemical Stability Window



Conductivity

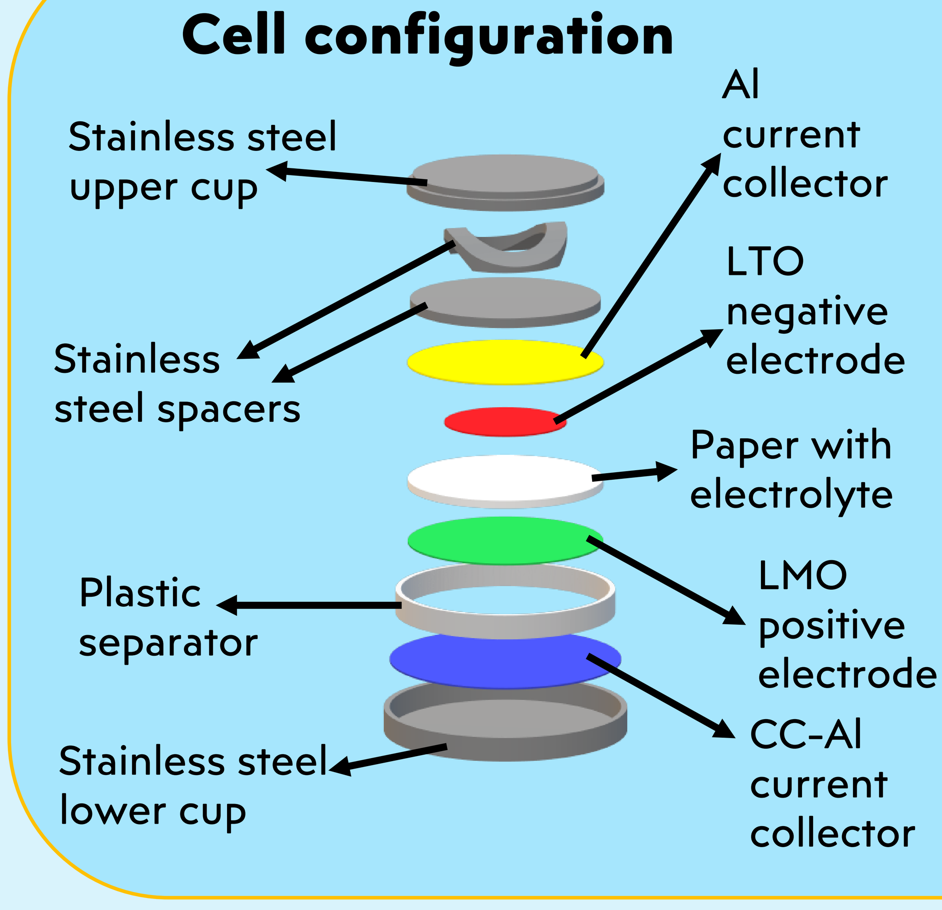


Solvation structure

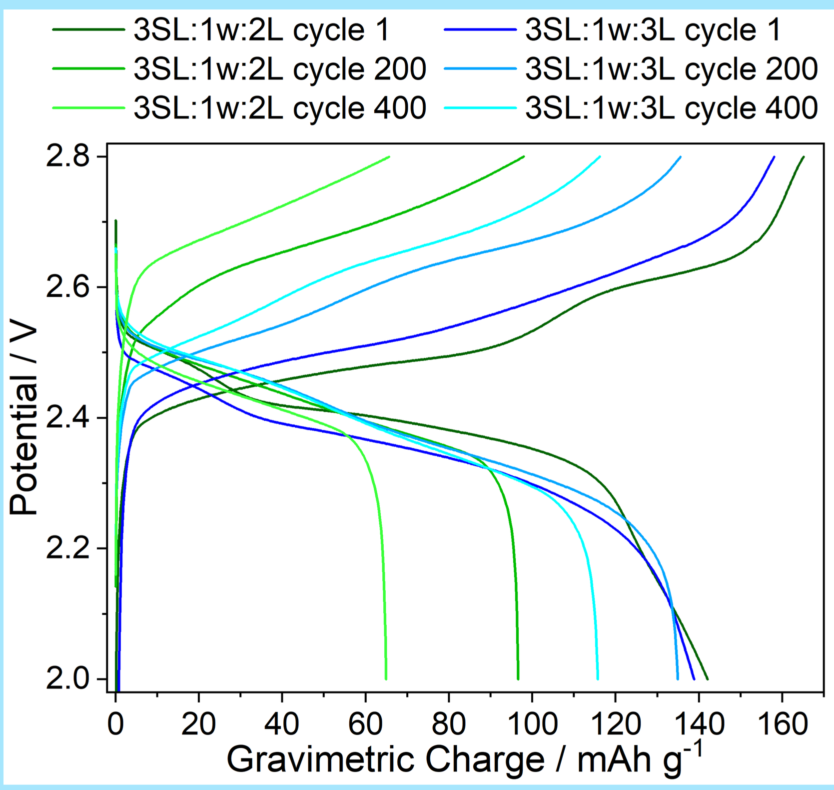


5. Cell performances

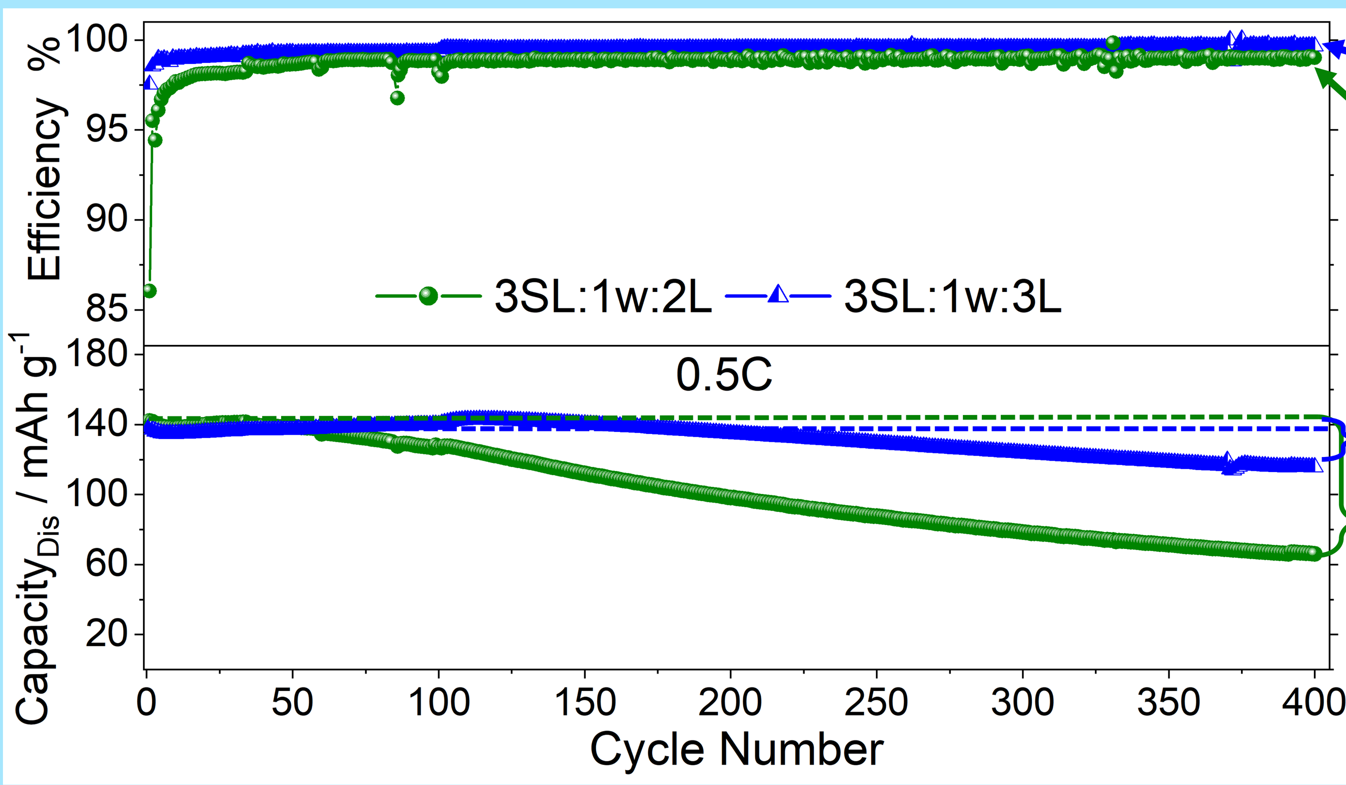
Cell configuration



GCPL curves



Long cycling performances



6. Conclusions

- The less concentrated sample (3SL:1w:2L) has a better conductivity, but a narrower ESW than the 3S:1w:3L sample. On a long cycling measurement, the 3S:1w:3L sample show better performances than the 3S:1w:2L one.
- A full cell with the configuration Al | LTO | 3S:1w:3L | LMO | CC-Al allow to obtain a battery with an excellent coulombic efficiency, able to last hundreds of cycles with only a little capacity fade.

7. Reference

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