Designing Stable 5 V Cathode Compositions for Safe Solid-State Lithium Metal Batteries

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OBJECTIVE

- Cathode optimization to achieve:
  - High energy density (active material: Lithium Nickel Manganese Oxide (**LNMO**).
  - **Solid-state battery** (ion conductive binder → PVDF needs to be replaced).

CATHOLYTE REQUIREMENTS

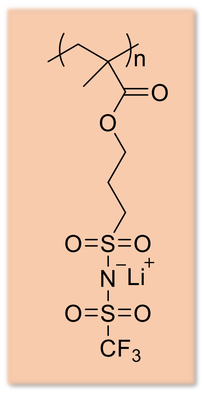
- Stability at high voltages (e.g. 5 V).
- Ionic conductivity.
- Binding properties.
- Low polarization.

PREVIOUS WORK

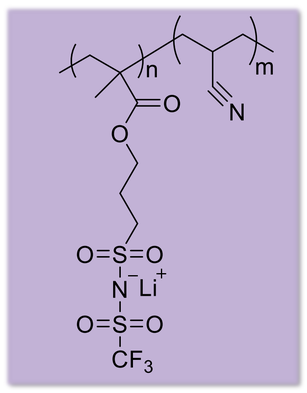
- **Processing parameters:** Speed mixer at 2700 rpm for 5 minutes.
- **Component ratio:** LNMO/carbon additive/polymer/plasticizer: 80/5/5/10 wt.%.
- **Porosity:** 45 % of thickness reduction.
- **Plasticizer selection:** sulfolane.

PROCEDURE

POLYMER CHEMISTRY

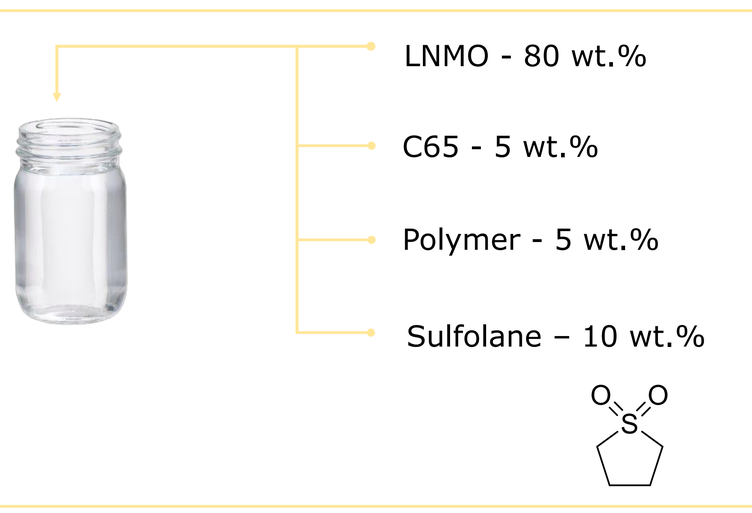


PolyMTFSILi



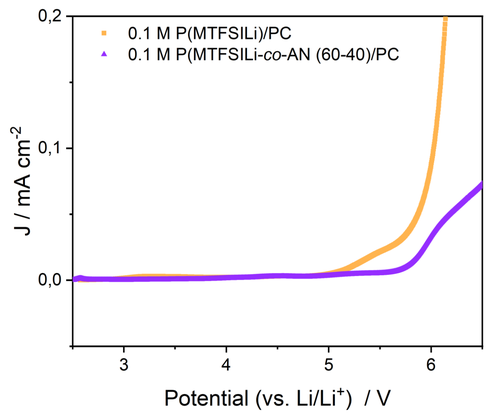
Poly(MTFSILi-*co*-AN)
60-40 mol%

CATHODE PREPARATION IN ETHANOL



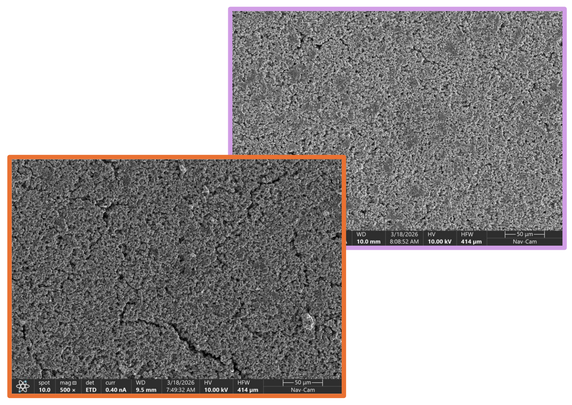
RESULTS

1. LINEAR SWEEP VOLTAMMETRY



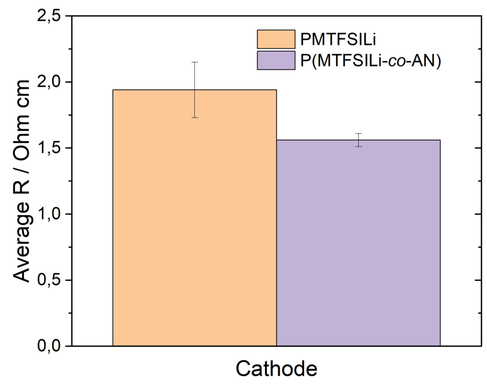
- Nitrile nature increases the voltage stability: PMTFSILi < P(MTFSILi-*co*-AN).

2. TOP VIEW OF CALENDERED CATHODES



- PMTFSILi-based cathode: cracked top-morphology.

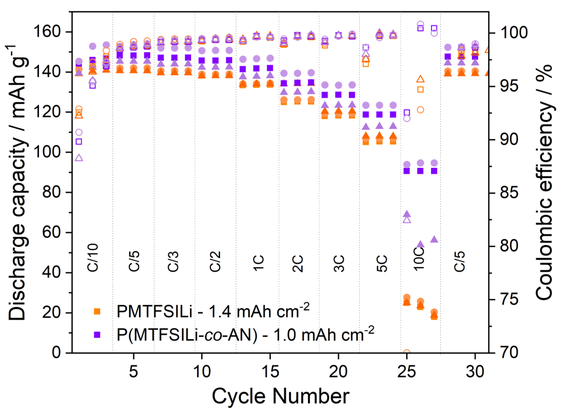
3. RESISTIVITIES OF CALENDERED SAMPLES



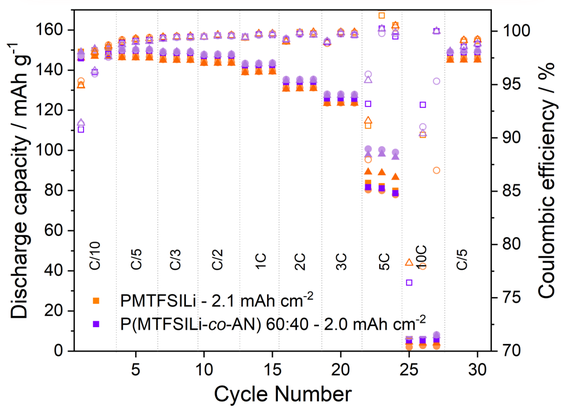
- P(MTFSLi-*co*-AN)-based cathode showed slightly lower resistivity.

4. C-RATE TEST OF LNMO|LP30|Li CELLS (CYCLED at 25 °C, between 5.0 V and 3.5 V)

Areal loading: 1 mAh cm^{-2}

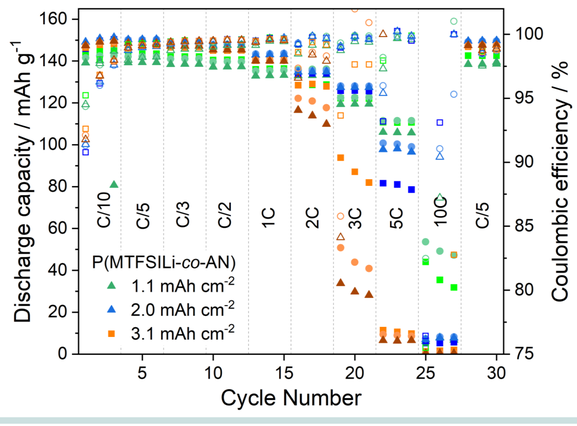


Areal loading: 2 mAh cm^{-2}



- PMTFSILi < P(MTFSILi-*co*-AN)
  - Binding properties.
  - Cathode morphology.

Areal loading up to 3 mAh cm^{-2}



- Up to 2C: high discharge capacities.
- At 3 mAh cm^{-2}: specific capacity drops. It might not only be related to the electrode by itself but also to the lithium metal anode, where plating high amount of lithium at high current might be restricted.
- High reversibility is delivered by all the electrodes being able to recover the initial discharge capacity values when going back to C/5.
- When using EtOH: challenging to target high loading cathodes due to its high volatility.

CONCLUSIONS

P(MTFSILi-*co*-AN)
- Voltage stability.
- Binding properties.
- Low resistivity.
- High discharge capacity:
  - 3 mAh cm^{-2} at 2C: 120 mAh g^{-1}.

NEXT STEPS

- Replace the solvent.
- Asses the cell performance with the solid electrolyte developed within the consortium.

ACKNOWLEDGEMENTS

The authors acknowledge the financial support provided by Horizon Europe through the HyLiST project (grant agreement No 101147688).

Funded by the European Union