

Thin Solid Electrolyte Separators for Solid-State Lithium–Sulfur Batteries



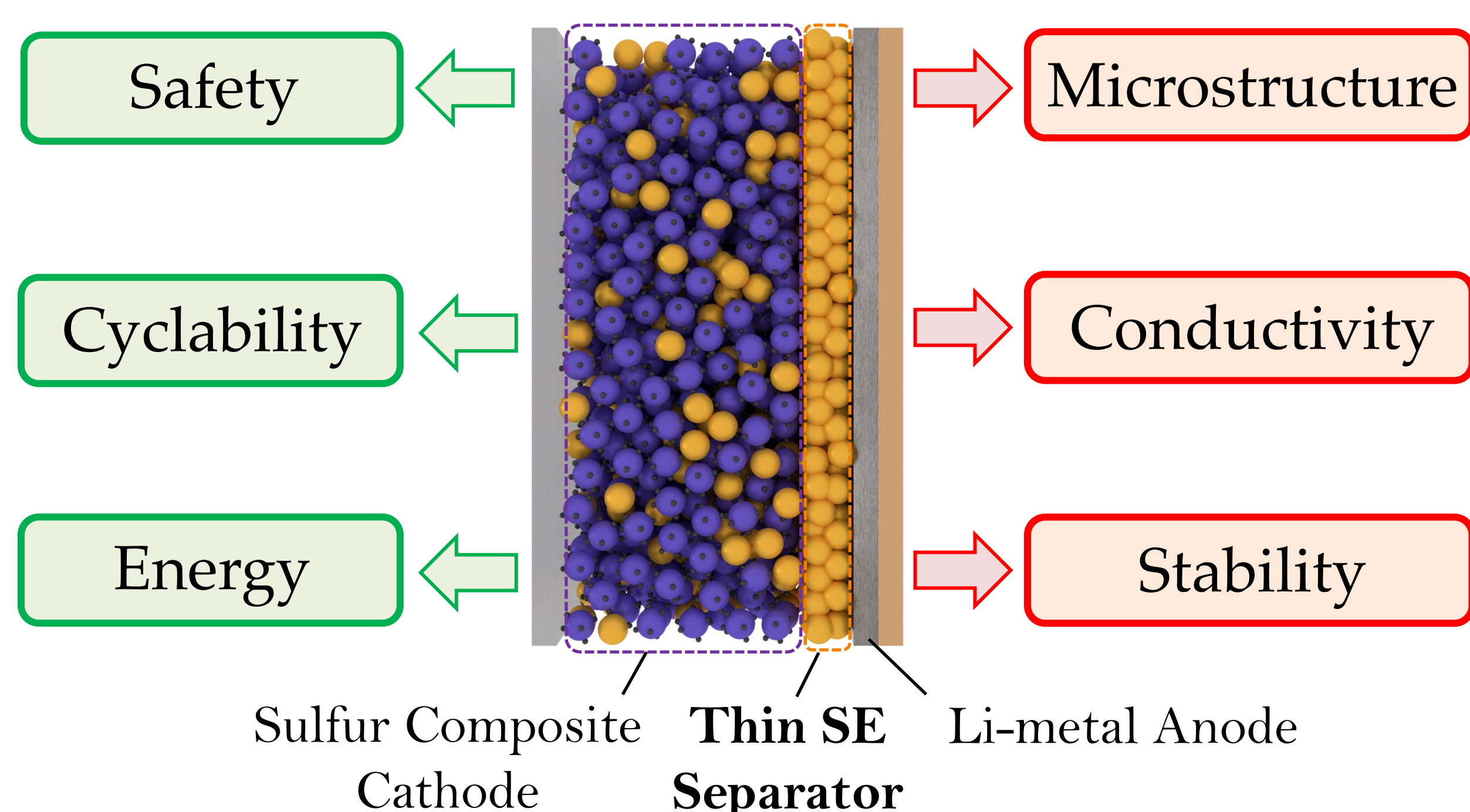
UNIVERSITY OF
OXFORD

Liwei Dai, Junhao Li, Soochan Kim, Lorenzo Mezzomo, Yvonne Chart, Jack Aspinall, Riccardo Ruffo, Sudarshan Narayanan and Mauro Pasta
Department of Materials, University of Oxford

Email: liwei.dai@materials.ox.ac.uk

Website: www.pastagroup.org

INTRODUCTION

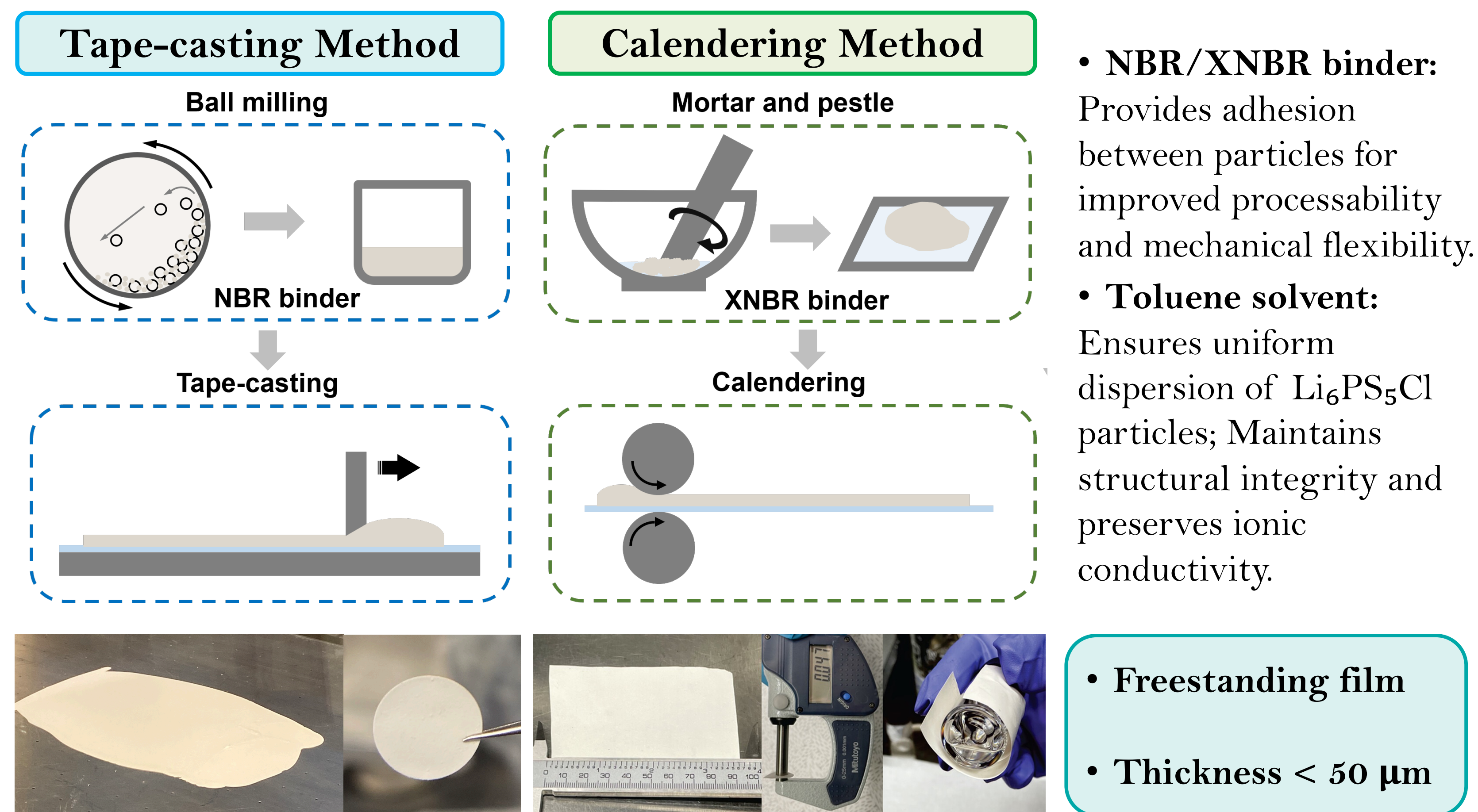


Solid-state lithium–sulfur (Li–S) batteries are promising next-generation systems, as polysulfide shuttle and Li dendrite growth can be effectively suppressed by replacing liquid electrolytes with solid electrolytes (SEs), boosting the both cyclability and energy density.^{1–2}

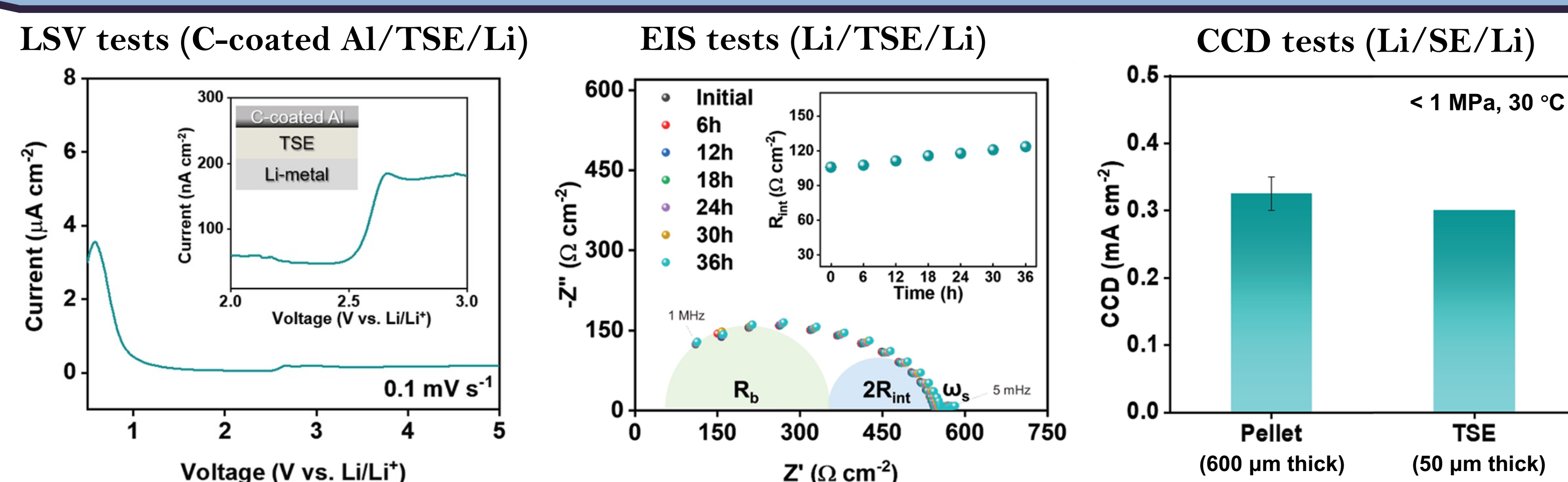
However, their commercialization is limited by the lack of thin, robust, and scalable SEs that combine strong microstructure, high ionic conductivity, and stable interfaces with Li metal.^{3–4}

This work presents scalable fabrication of $\text{Li}_6\text{PS}_5\text{Cl}$ -based thin solid electrolyte (TSE) separators, revealing how processing governs mechanical and electrochemical properties essential for practical solid-state batteries.

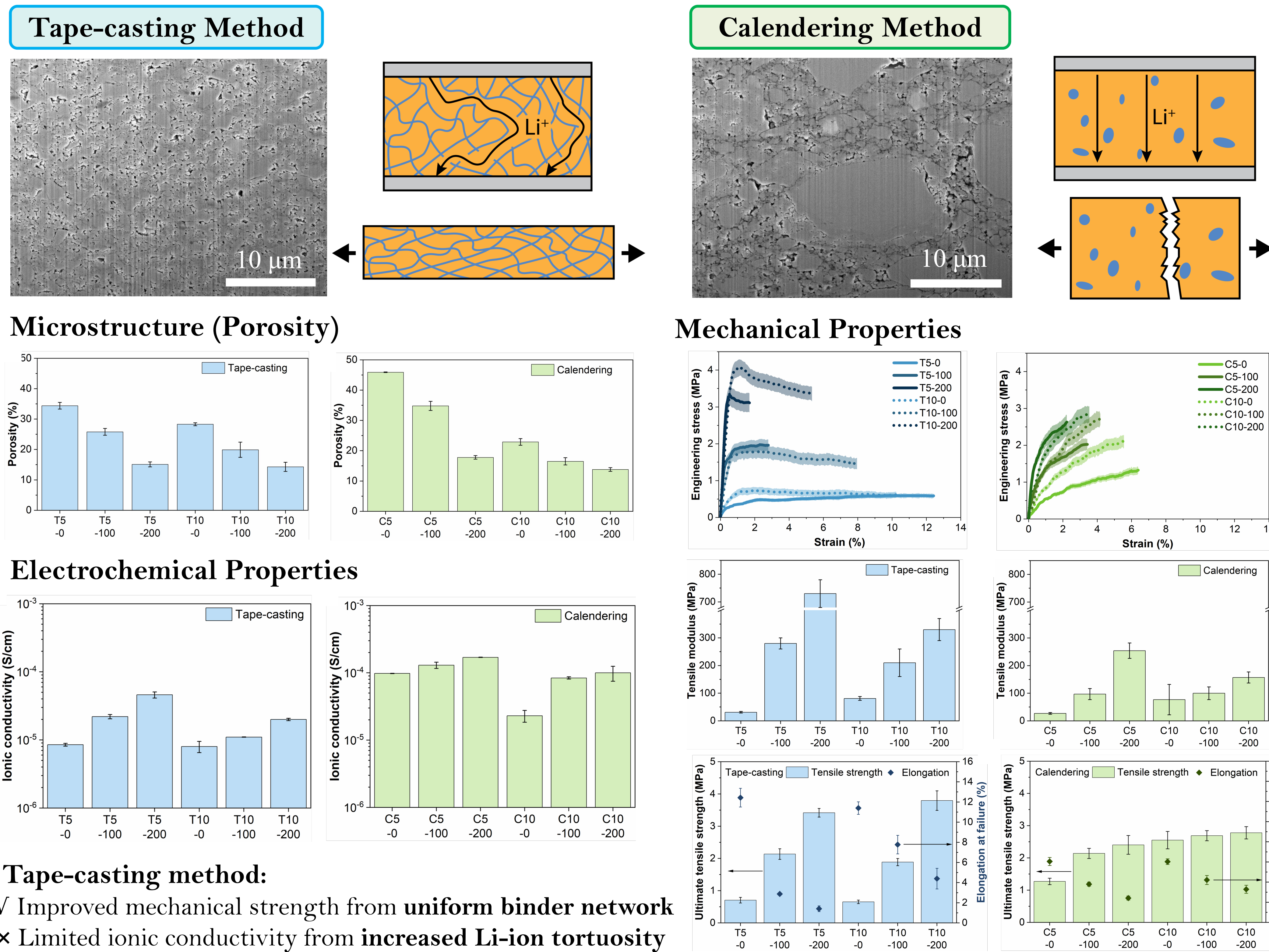
SCALABLE PROCESSING STRATEGIES



ELECTROCHEMICAL TESTS



MICROSTRUCTURE-PROPERTY RELATIONSHIP



SUMMARY

- This work:**
- Developed scalable processing methods for thin $\text{Li}_6\text{PS}_5\text{Cl}$ separators ($< 50 \mu\text{m}$).
 - Demonstrated compatibility with Li-metal anode through the formation of a stable solid electrolyte interphase (SEI).
 - Processing–property trade-off: mechanically stronger films exhibit lower ionic conductivity.
- Future work:**
- Binder and slurry optimisation for balanced mechanical and electrochemical properties.
 - Further densification required to enhance critical current densities (CCD).

References

- S. Kim, Y. Chart, S. Narayanan, and M. Pasta, "Thin Solid Electrolyte Separators for Solid-State Lithium–Sulfur Batteries." *Nano Letters* 22 (24), 10176–10183, 2022.
- J. Li, S. Kim, L. Mezzomo, Y. Chart, J. Aspinall, R. Ruffo and M. Pasta, "Processing-structure-property relationships in practical thin solid-electrolyte separators for all-solid-state batteries." *J. Phys. Energy* 6 025023, 2024.
- B. Ding, J. Wang, Z. Fan, S. Chen, Q. Lin, X. Lu, H. Dou, A. K. Nanjundan, G. Yushin, X. Zhang, Y. Yamauchi, "Solid-state lithium–sulfur batteries: Advances, challenges and perspectives." *Mater. Today*, Volume 40, 114–131, 2020.
- S. Ohno and W.G. Zeier, "Toward Practical Solid-State Lithium–Sulfur Batteries: Challenges and Perspectives." *Accounts of Materials Research* 2 (10), 869–880, 2021.