Development of electrolyte for Na-ion batteries with enhanced cycling stability

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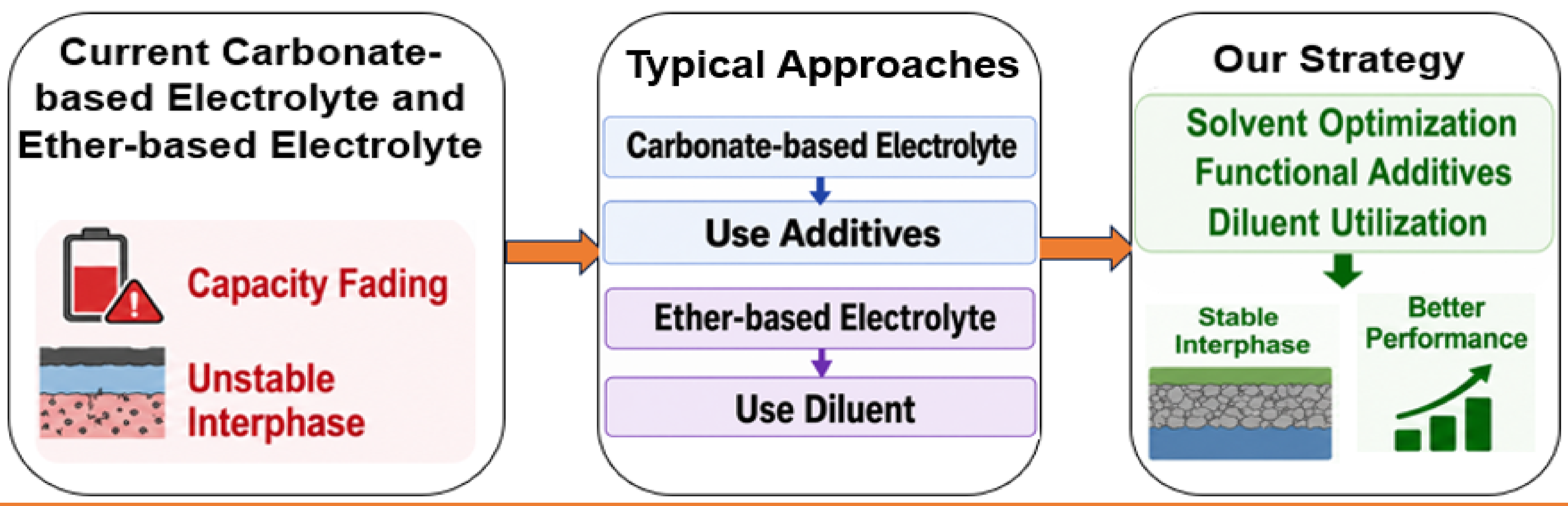
PROJECT PROFILE
Topic: Sodium Batteries | Vertical: Materials and Systems Innovation Strategic Pathway: Grow Project start and finish: FY24-FY25

PROBLEM

Conventional carbonate-based electrolytes in sodium-ion batteries (SIBs) often suffer from unstable SEI/CEI formation, leading to rapid capacity fading. Although ether-based electrolytes can improve interfacial stability, they typically exhibit poor oxidative stability and gas generation. In addition, electrolyte additives used to regulate interphase formation may undergo uncontrolled decomposition issues.

APPROACH

We propose a carbonate-based electrolyte incorporating a novel interphase-forming additive for sodium-ion batteries using $NaNi_{1/3}Fe_{1/3}Mn_{1/3}O_2$(NFM) cathodes and hard carbon (HC) anodes. The electrolyte composition is engineered to promote stable interphase formation, suppress continuous side reactions, and enabling enhanced cycling stability.



RESULTS

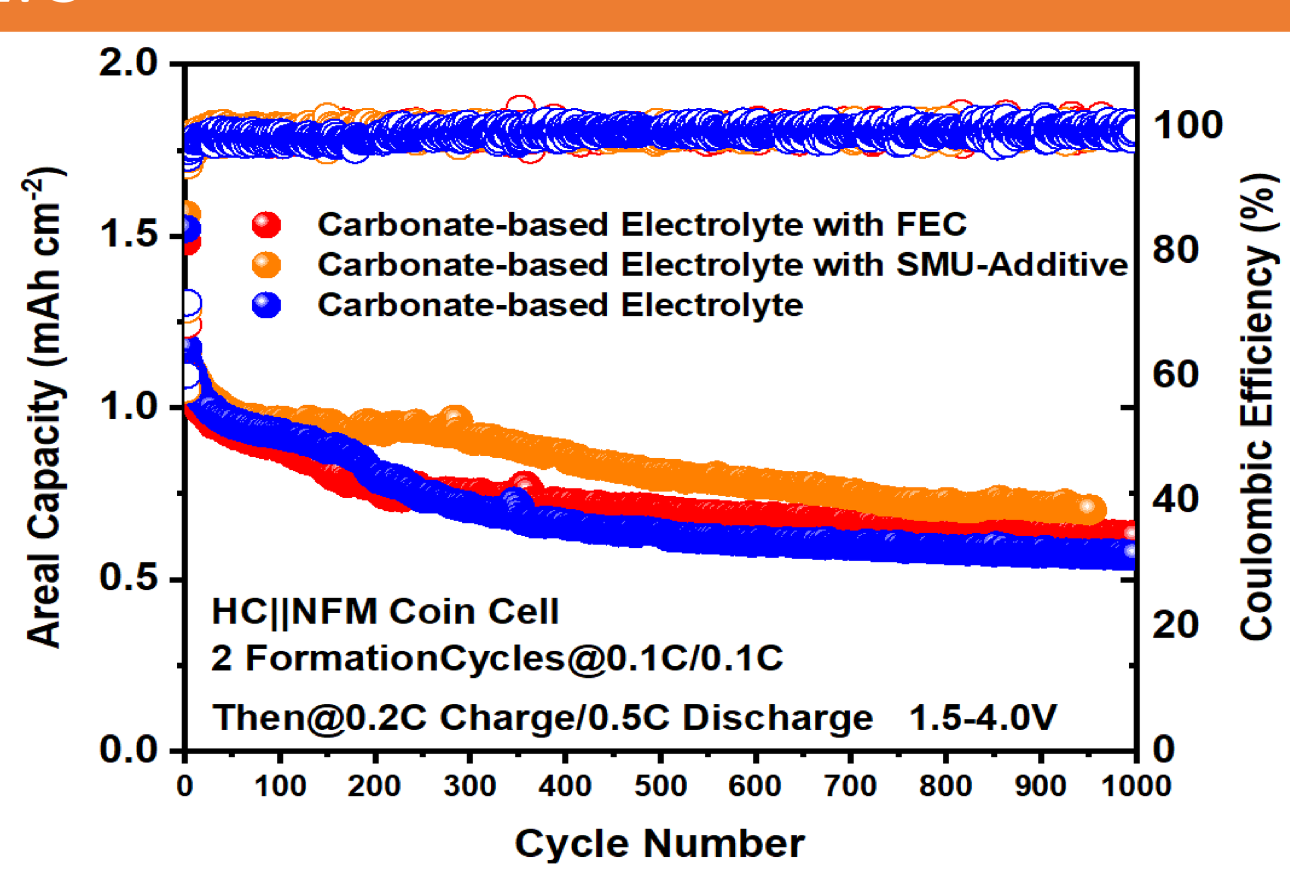


Fig. 1. Long-term cycling performance of HC||NFM SIB coin cells with carbonate-based electrolyte.

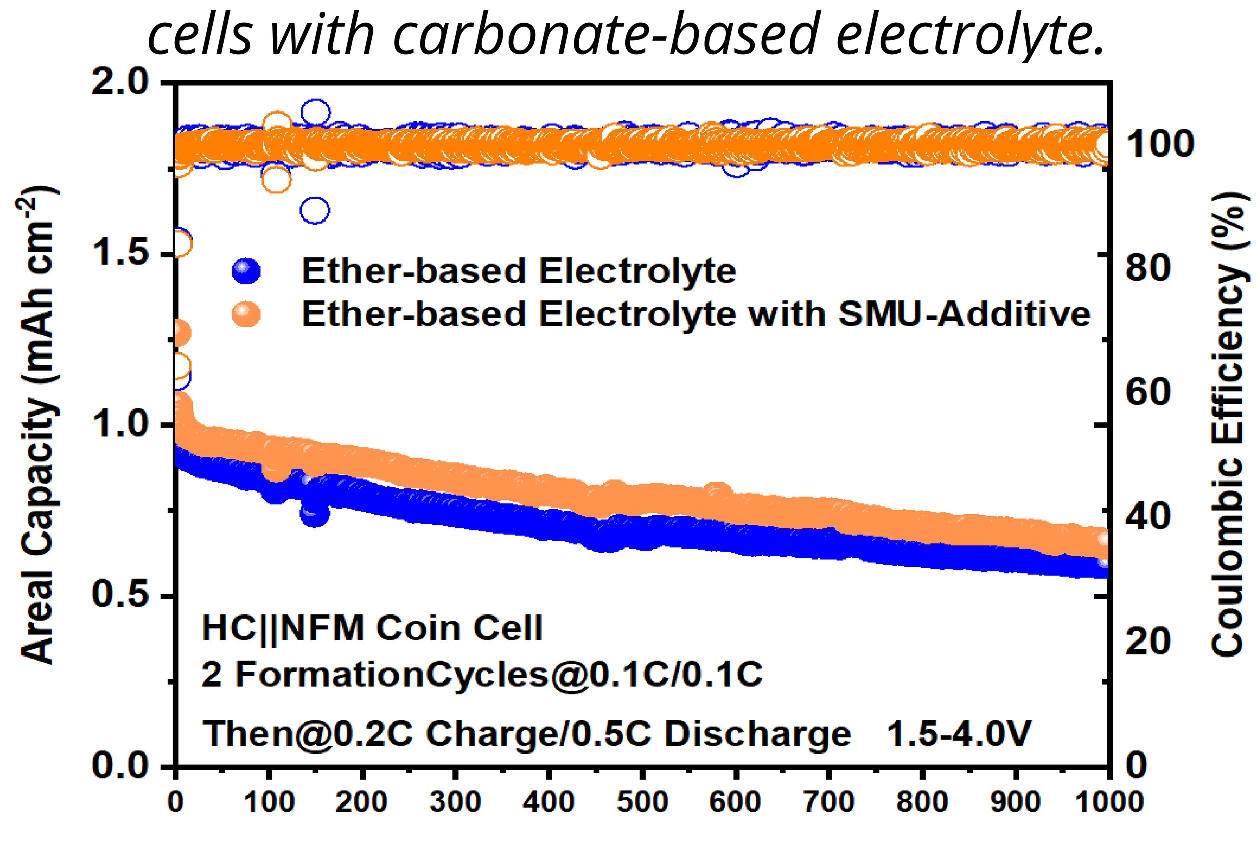


Fig. 2. Long-term cycling performance of HC||NFM SIB coin cells with ether-based electrolyte.

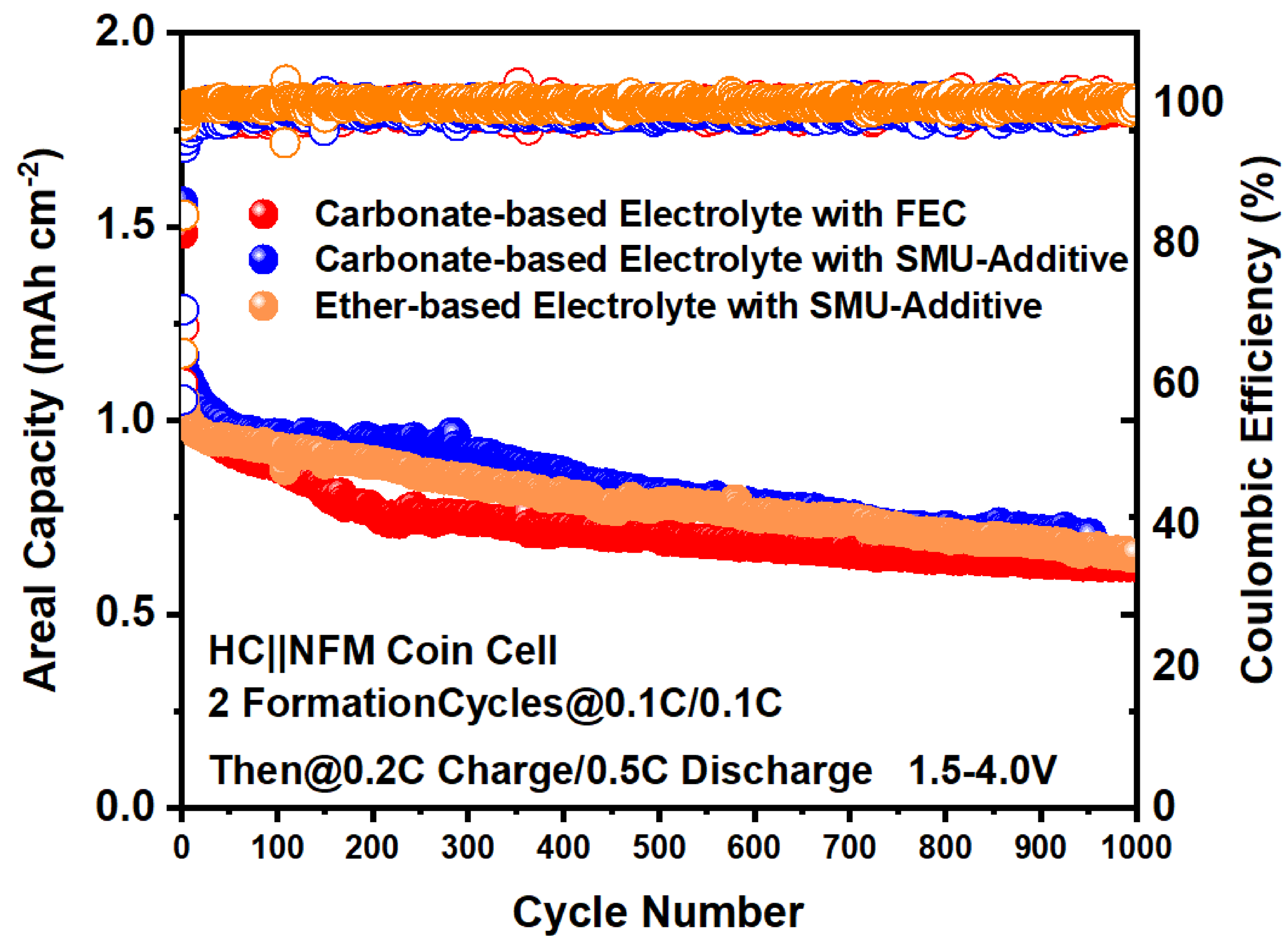


Fig. 3. Long-term cycling performance of HC||NFM SIB coin cells with carbonate-based electrolyte and ether-based electrolyte.

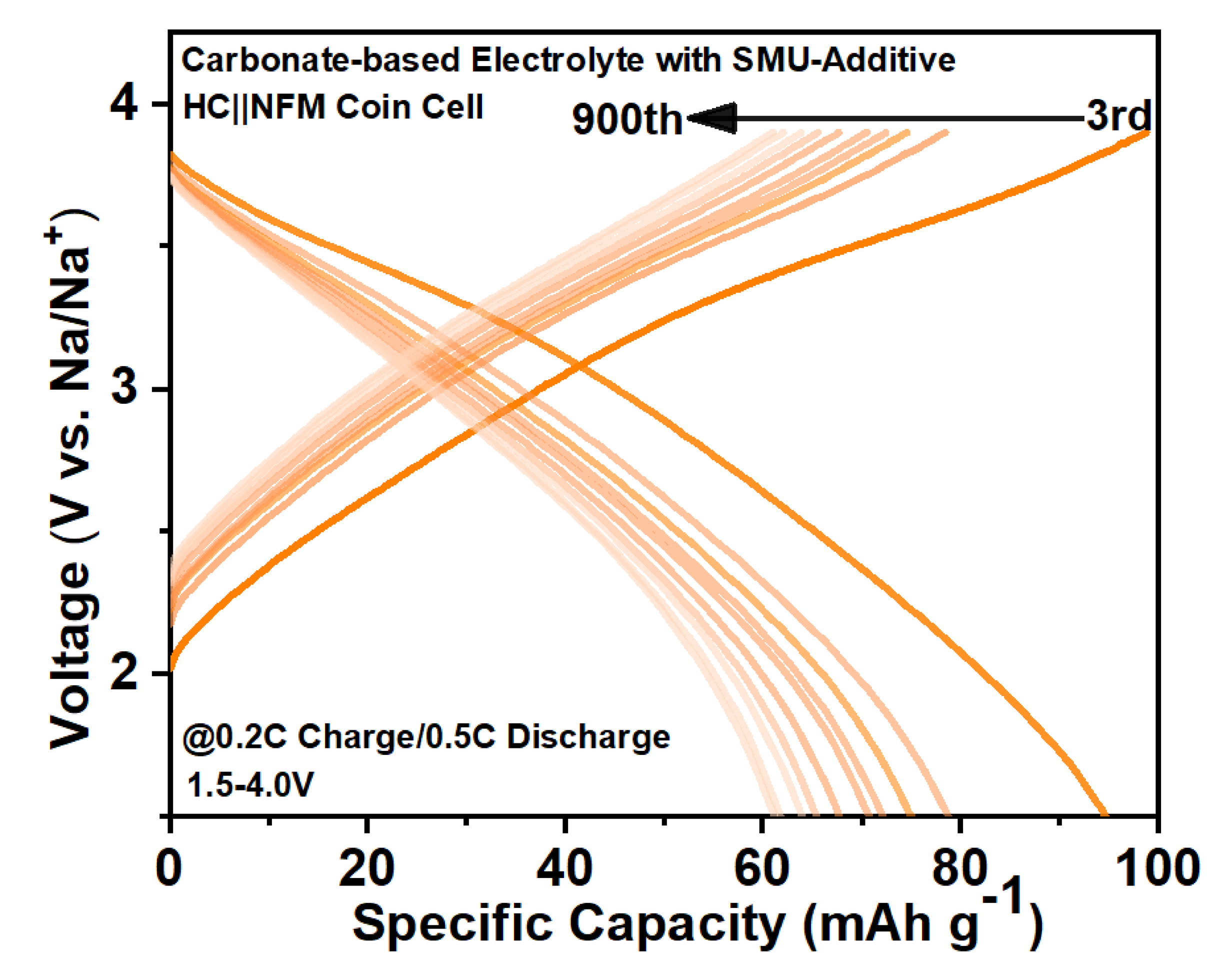


Fig. 4. Voltage profile of HC||NFM SIB coin cell with carbonate-based electrolyte with SMU-Additive.

CONCLUSIONS & IMPACT

We demonstrates a promising strategy to improve the cycling stability of SIBs by engineering carbonate-based electrolytes with a functional interphase-forming additive. Compared with conventional FEC-containing carbonate electrolytes, the proposed electrolyte delivers enhanced cycling stability. This approach enables long-cycle-life SIBs by utilizing conventional low-cost carbonate solvents.

FUTURE DIRECTIONS

Future work will focus on characterizing the interphase composition, evaluating gas generation during cycling, and elucidating the underlying mechanisms by which the proposed electrolyte and additive suppress gas evolution and stabilize the interphase compared with conventional FEC-based electrolytes.

References

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[2] Pandey, A.K., Jhang, L.-J., Wang, D., Li, X., and Wang, D. Development of Materials for All Solid-State Sodium-Sulfur Batteries: Review and Prospects. *Adv. Energy Mater.* (2025): e05400. https://doi.org/10.1002/aenm.202505400

This material is based upon work supported by the U.S. Department of Energy, Office of Electricity (OE), Energy Storage Division.

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