



Operando Neutron Imaging of Electrolyte Dynamics in Lean-Electrolyte Li-S Pouch Cells

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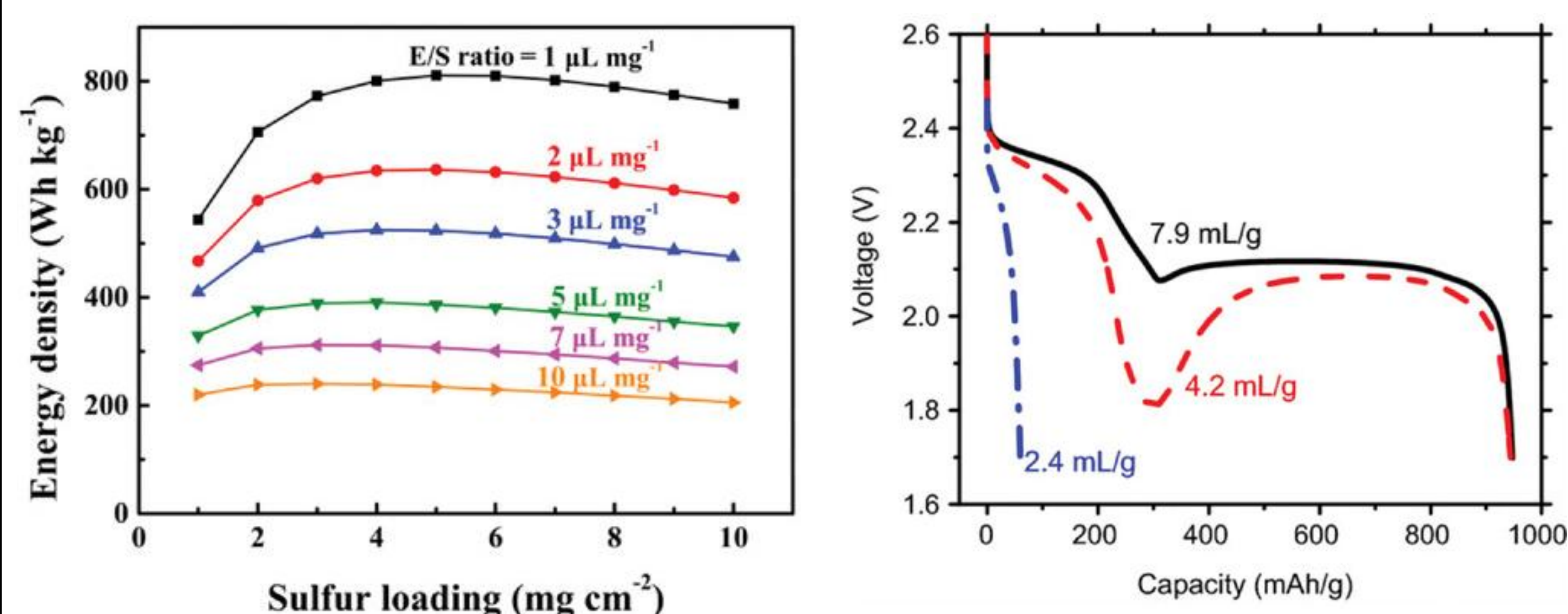
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ABSTRACT

In lithium-sulfur (Li-S) batteries, lean electrolyte often causes inhomogeneous wetting and uneven electrochemical reactions, leading to performance loss. Here, *operando* neutron tomography is used to non-destructively visualize electrolyte distribution in lean-electrolyte Li-S pouch cells. Rest and cycling influence electrolyte redistribution, with slow cycling enhancing wetting and sulfur activation. Periodic “breath-in/out” behavior is linked to polysulfide dynamics. These insights guide electrolyte management and cell design in Li-S and other metal-sulfur batteries.

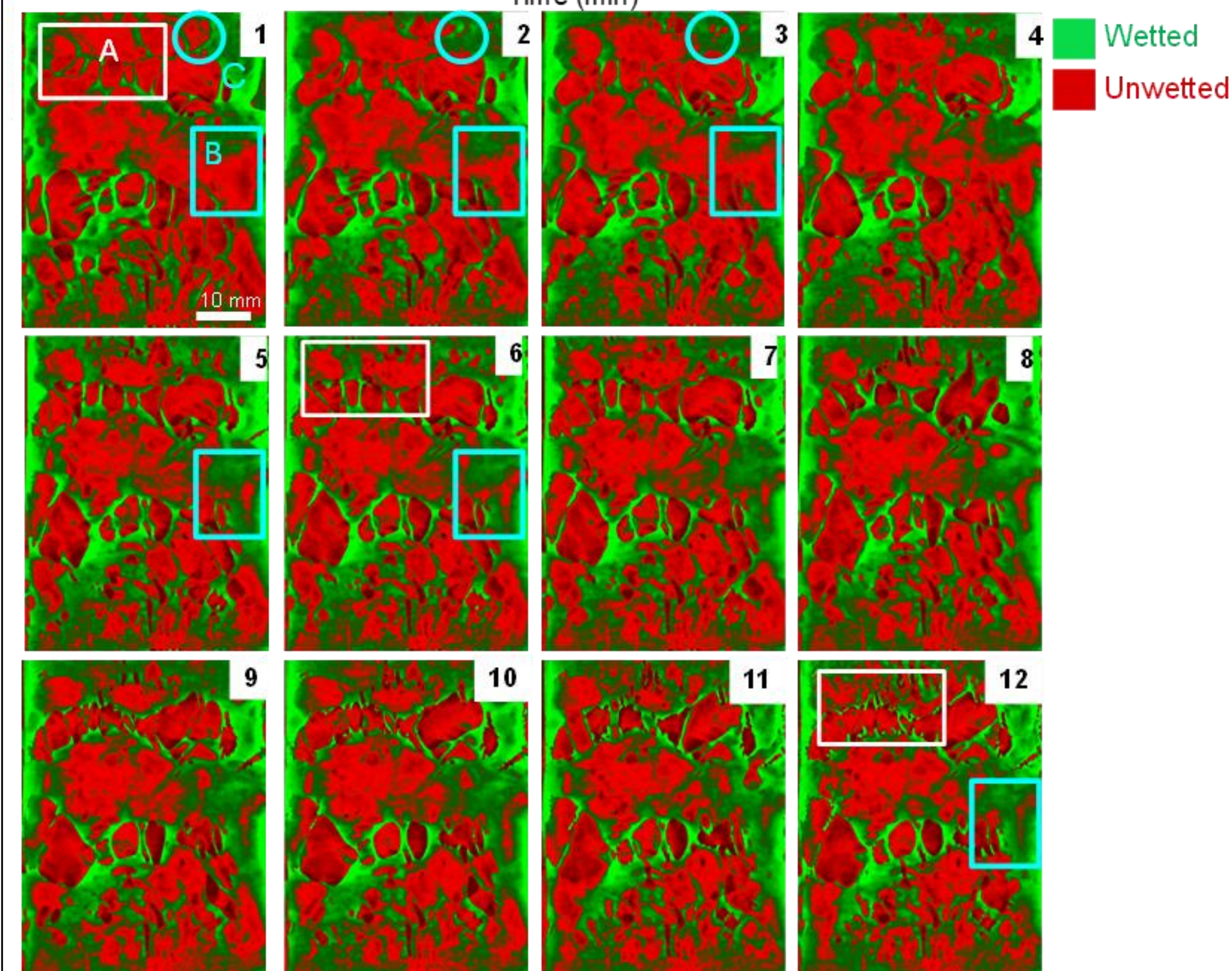
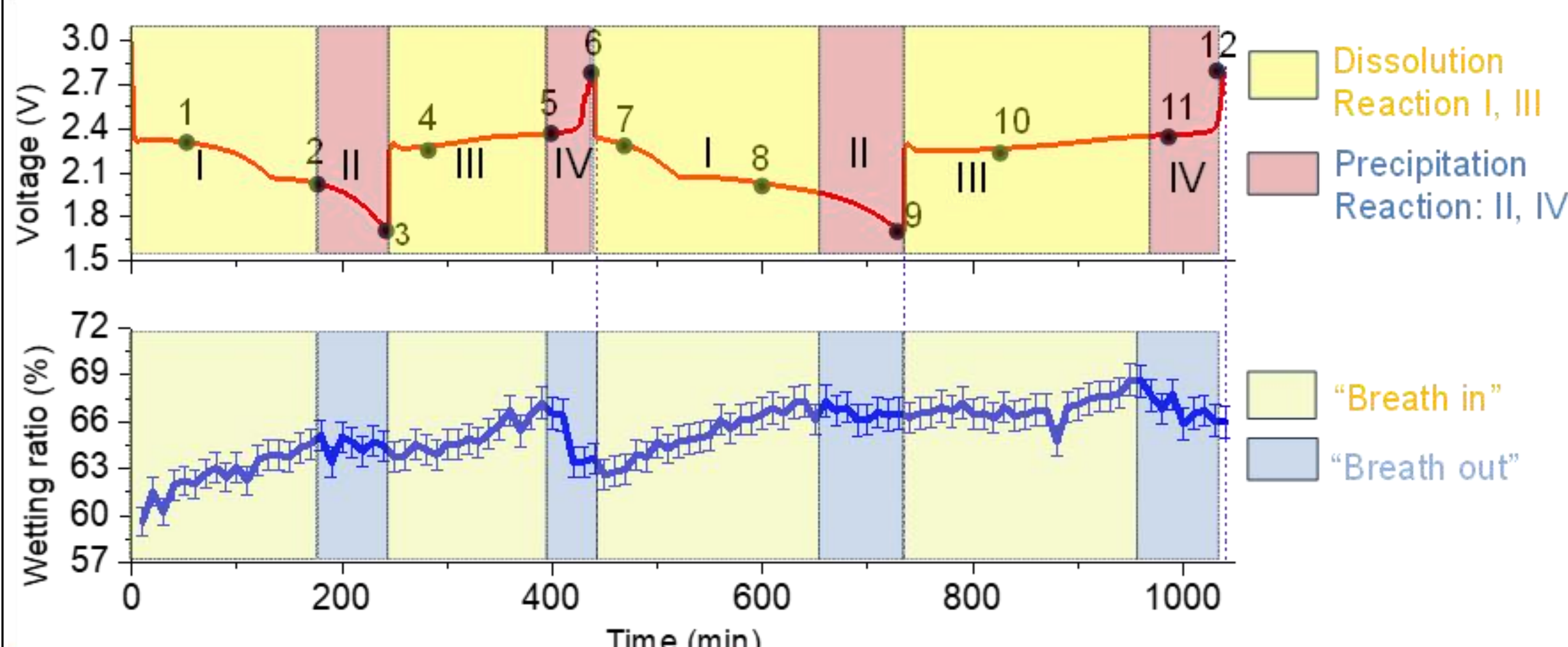
BACKGROUND



- ▲ To reach the energy density of 500 Wh kg⁻¹, the electrolyte of Li-S batteries is suggested to be reduced to less than 3 $\mu\text{L mg}^{-1}$. [1]
- ▲ Lean electrolyte conditions in Li-S batteries lead to increased polarization and rapid capacity deterioration by poor electrolyte wetting. [1]
- ▲ Non-destructive *operando/in-situ* methods that can visualize electrolyte wetting and dynamics in liquid metal-sulfur batteries have not been reported.

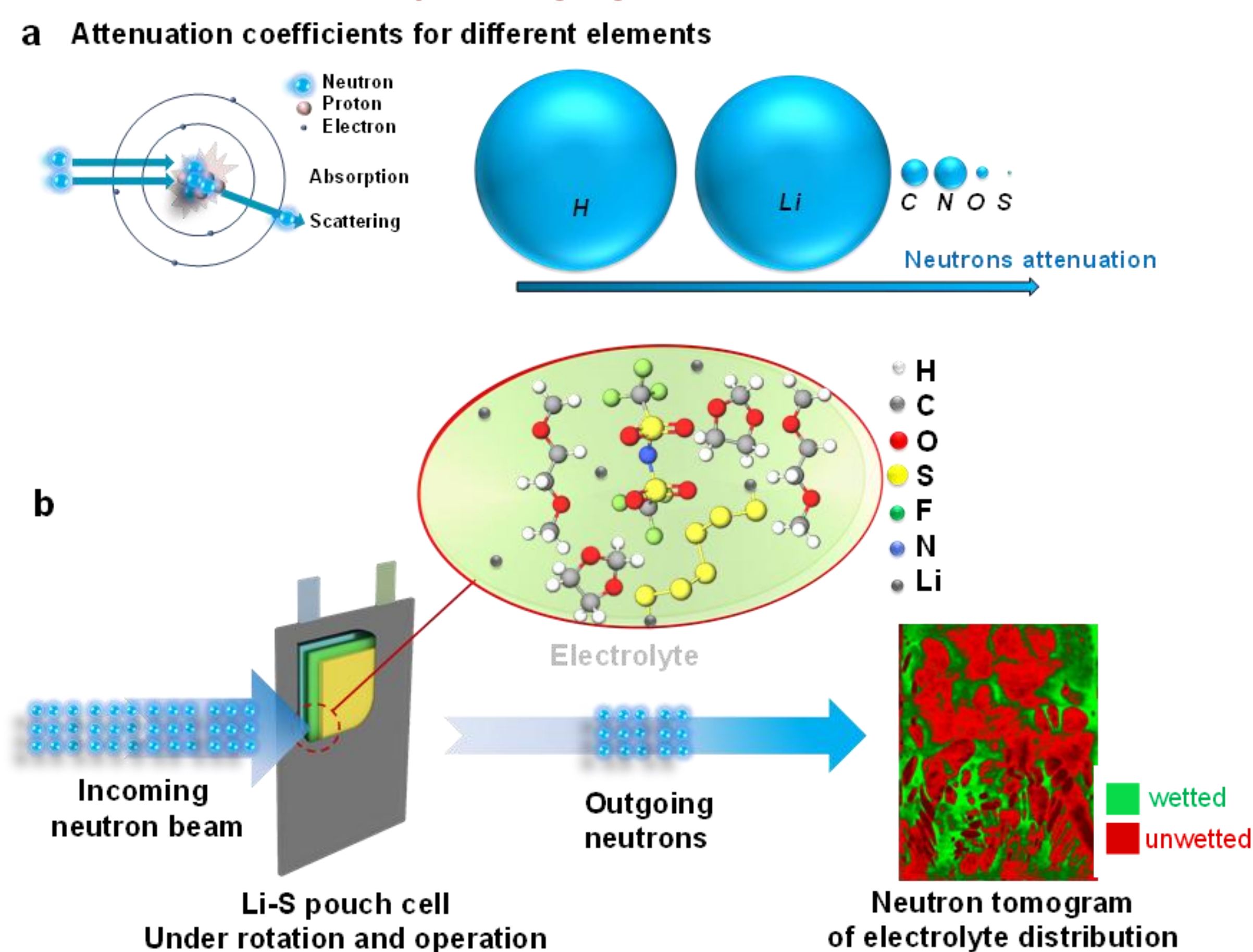
DYNAMIC ELECTROLYTE WETTING DURING CYCLING

Dynamic evolution of electrolyte distribution during GCD (0.06C)

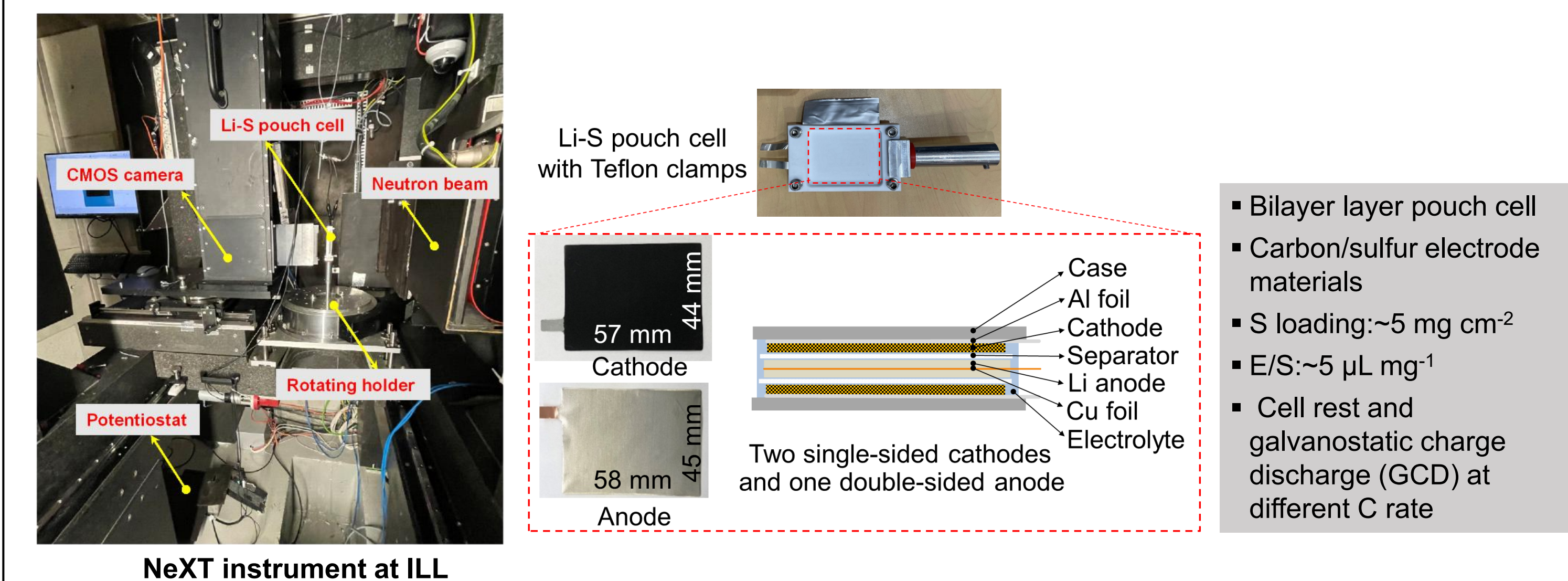


OPERANDO NEUTRON IMAGING AND SETUP

Illustration of the electrolyte imaging

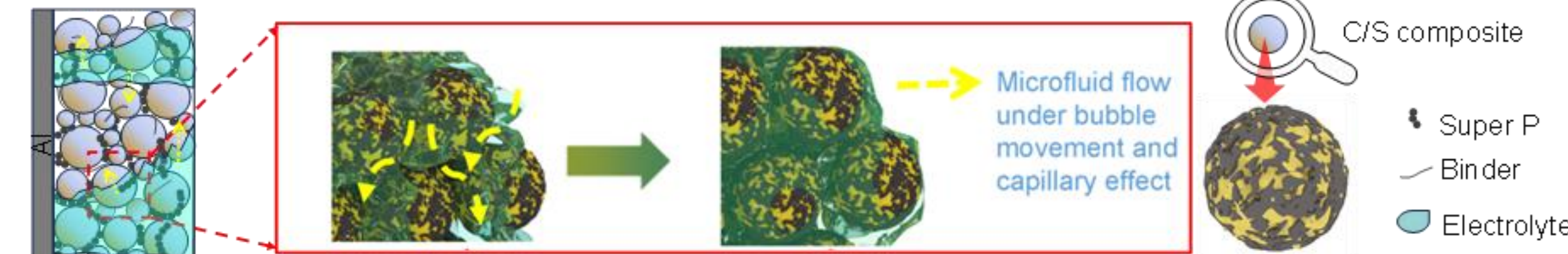


Experimental setup and measurements

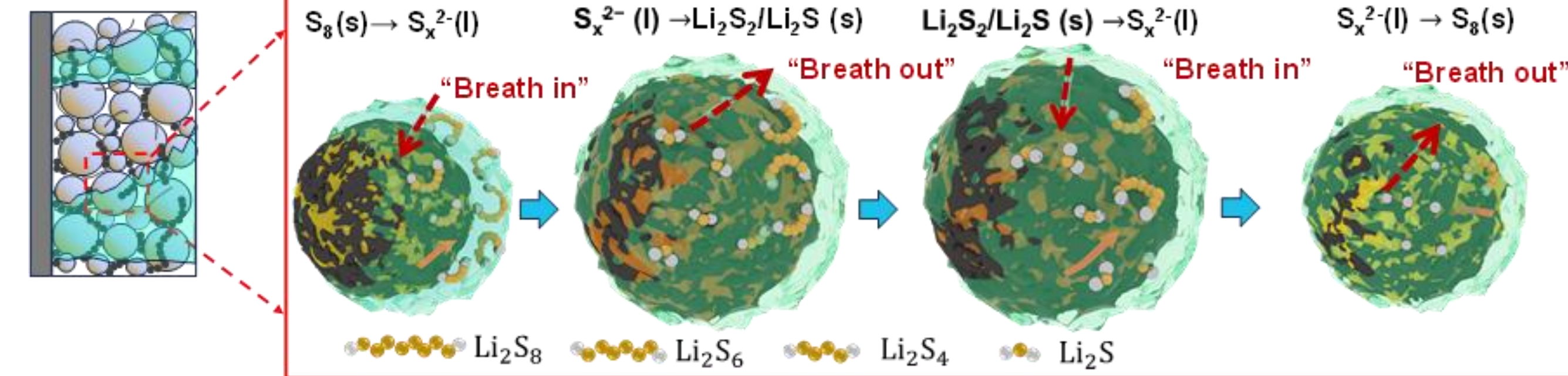


ELECTROLYTE WETTING MECHANISMS

Cell rest



GCD



CONCLUSION

The results confirm that electrolyte distribution in lean-electrolyte Li-S pouch cells is inhomogeneous and highly dynamic, which closely tied to the electrochemical behavior of sulfur species. The observed inhomogeneity and its evolution during rest and cycling—especially the reversible “breath-in” and “breath-out” wetting behavior—underscore the critical role of electrolyte management in achieving uniform reactions and stable performance.

REFERENCES

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- [3] Q. Wu et al. *ACS nano* **2024**, 18, 13468.
- [4] L. Lu et al. *Adv. Energy Mater.* **2025**, 15, e01324.



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MORE INFORMATION

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