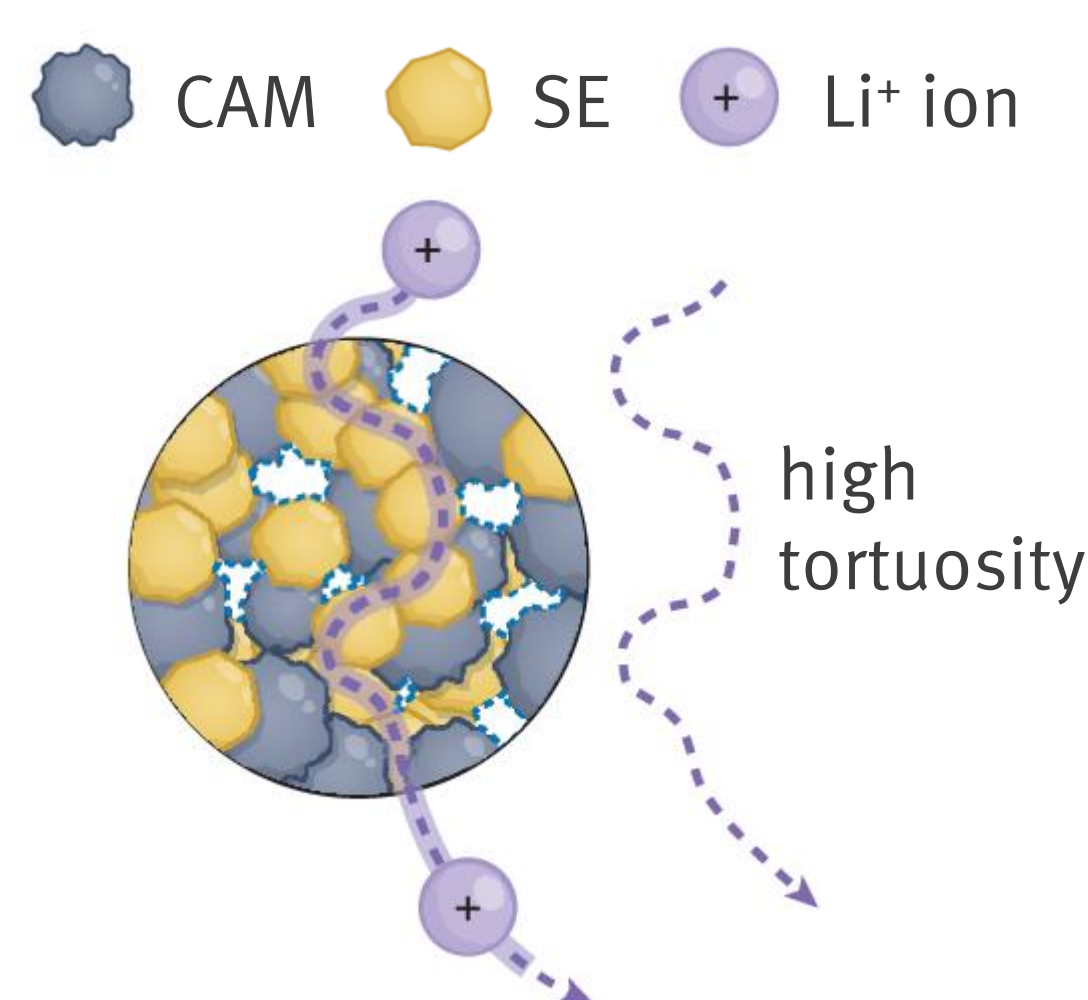


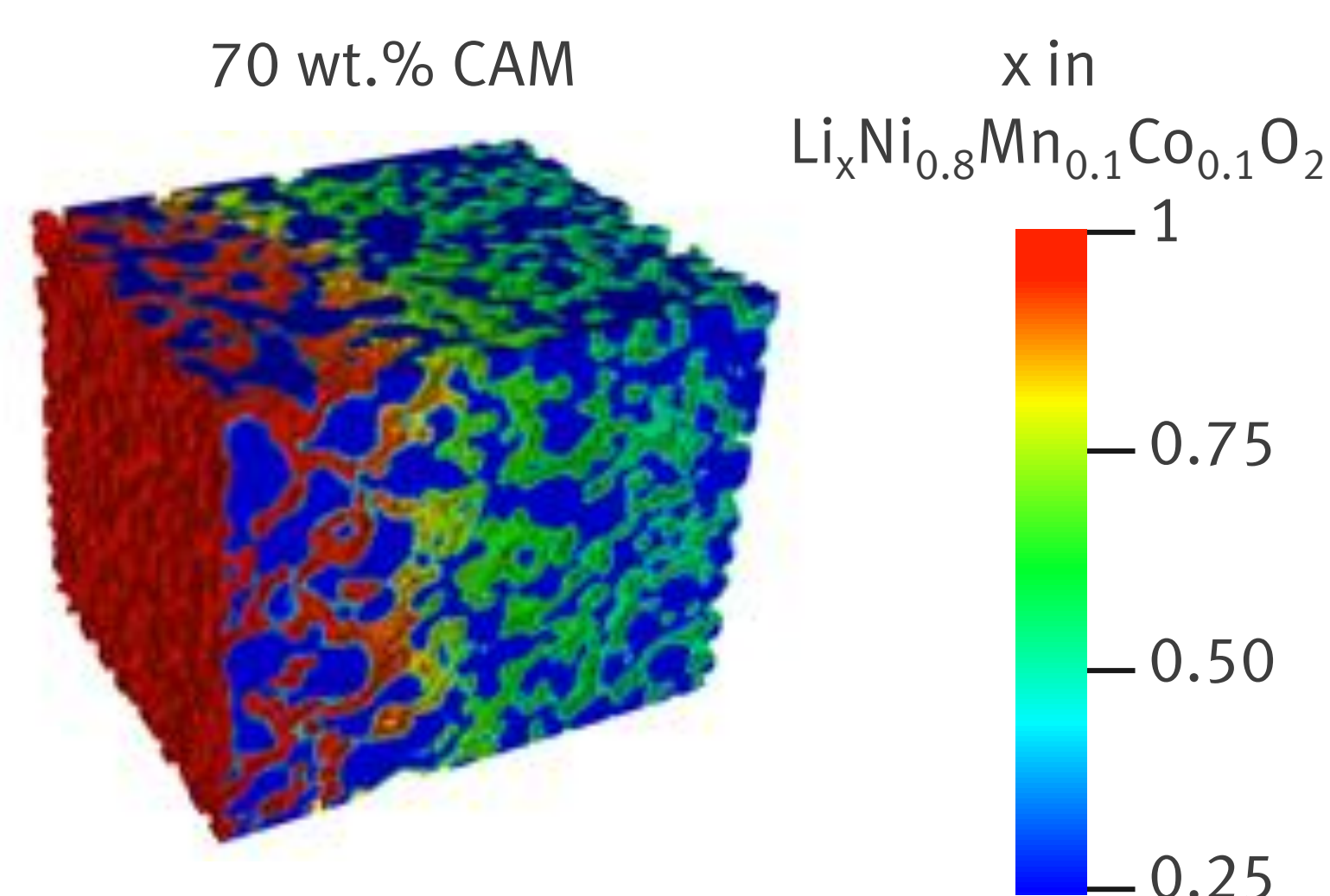


Transport in solid-state batteries

Charge transport in SSB



Lithiation at discharge state

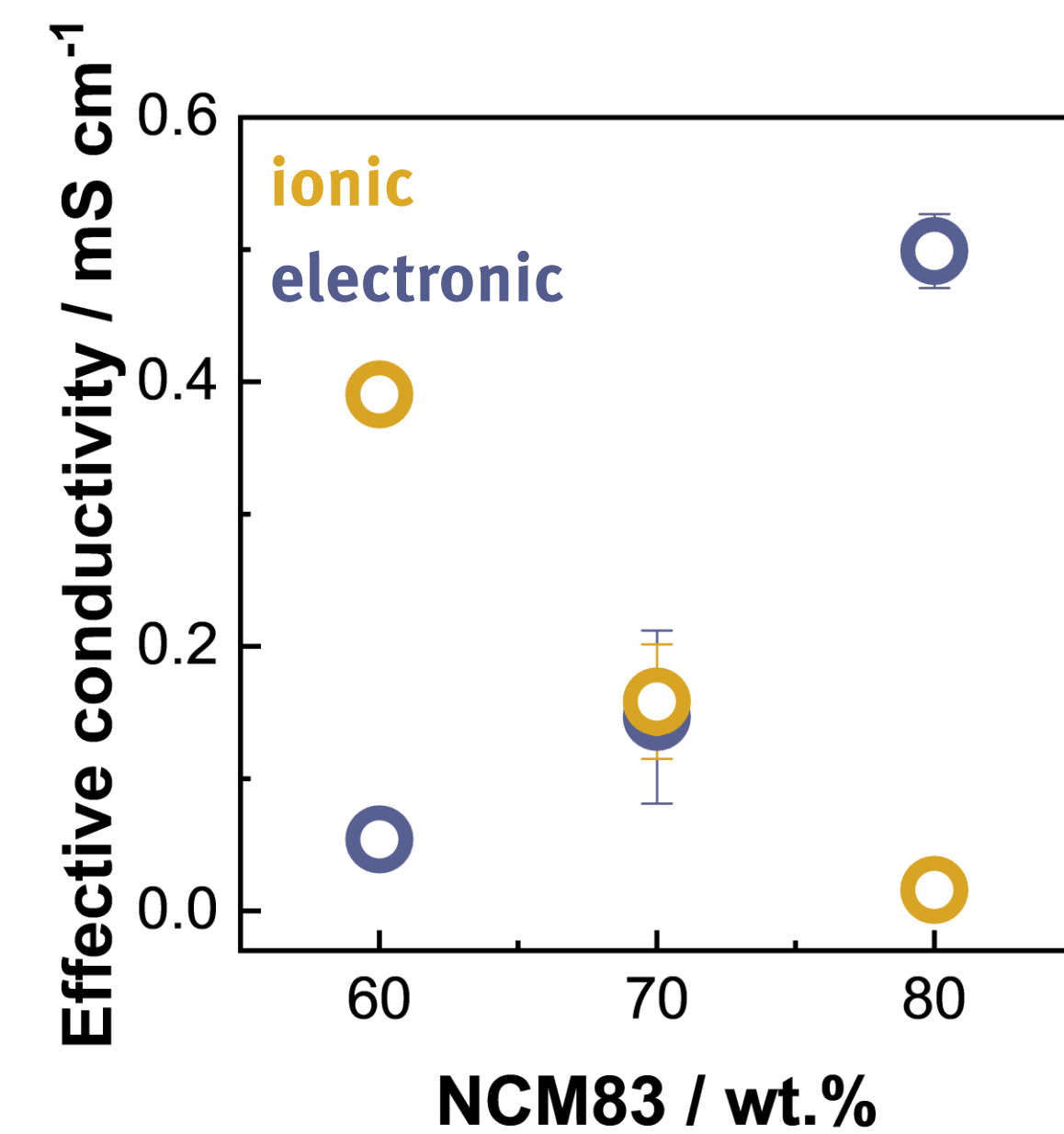


High fractions of CAM essential for high areal capacity cathodes.

Low fraction of SE hinders percolation of Li⁺ ions in composite cathode.

Unbalanced charge transport result in non-uniform reaction distribution and incomplete CAM utilization.

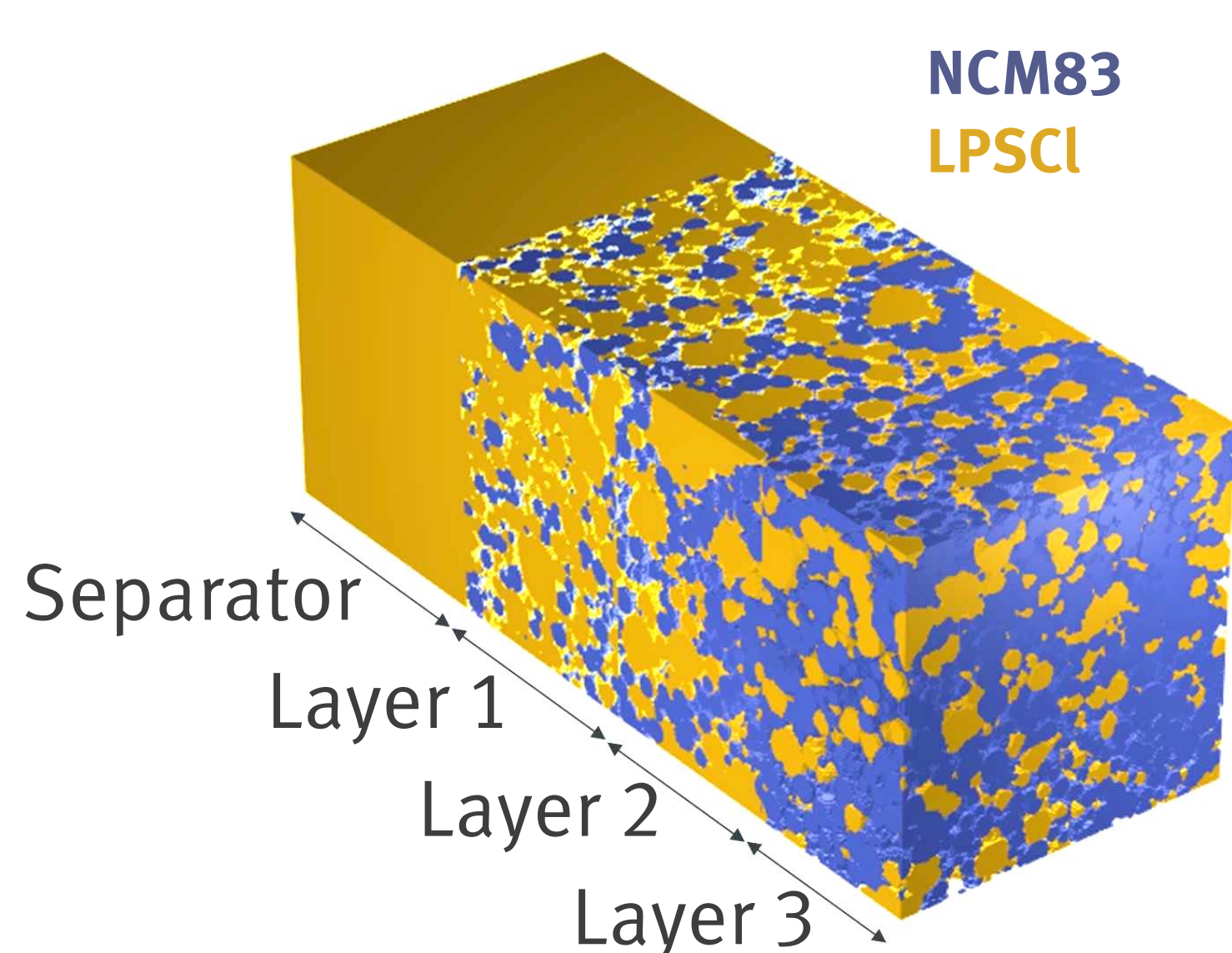
Cathode composite
 $\text{LiNi}_{0.83}\text{Co}_{0.11}\text{Mn}_{0.06}\text{O}_2 : \text{Li}_6\text{PS}_5\text{Cl}$



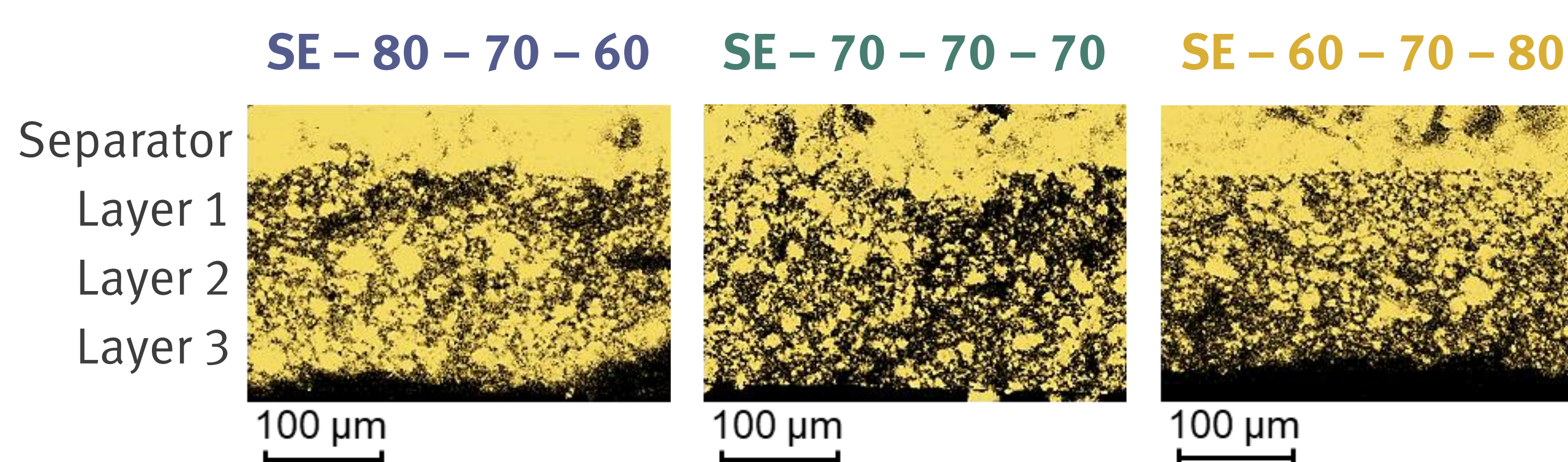
Janecek and Zeier, Nature Energy, **2023**, 8, 230–240. Clausnitzer et al., Battery & Supercaps **2024**, 7, 4.

Graded cathode

3-layer design

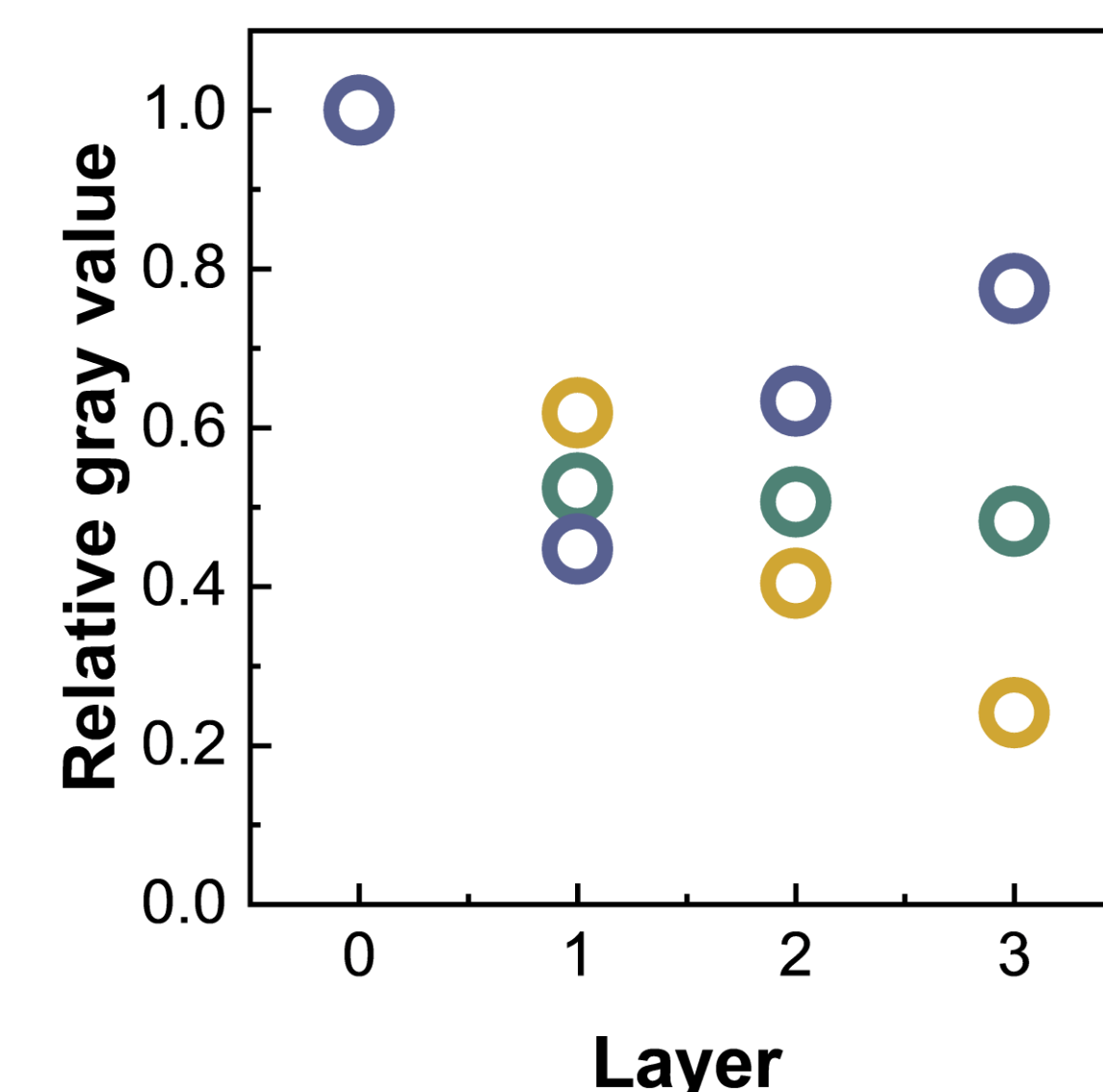


EDS-mapping of sulfur



EDS-mapping of sulfur with gray value determination confirms graded cathode design.

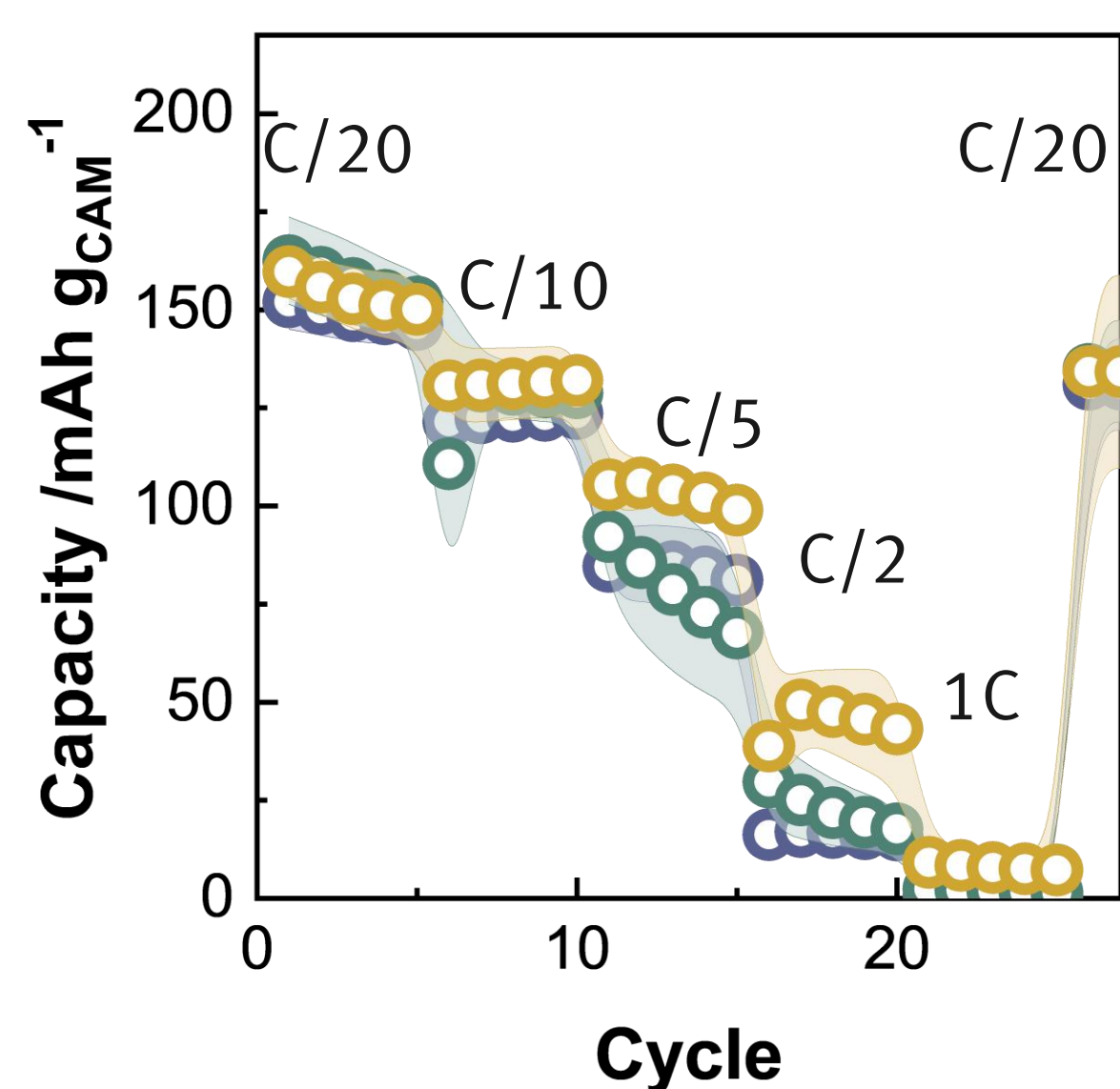
Gray values of EDS-mapping



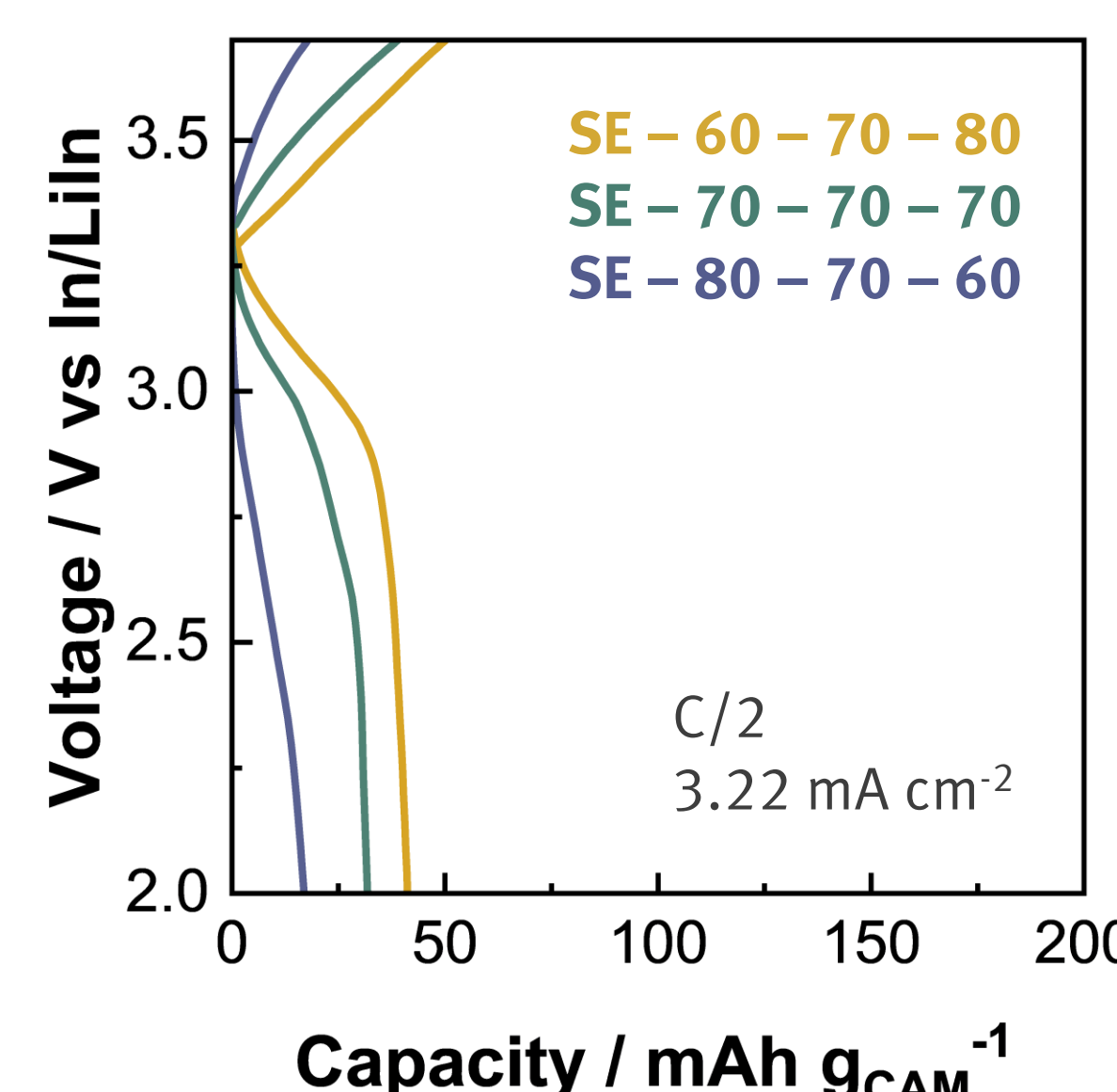
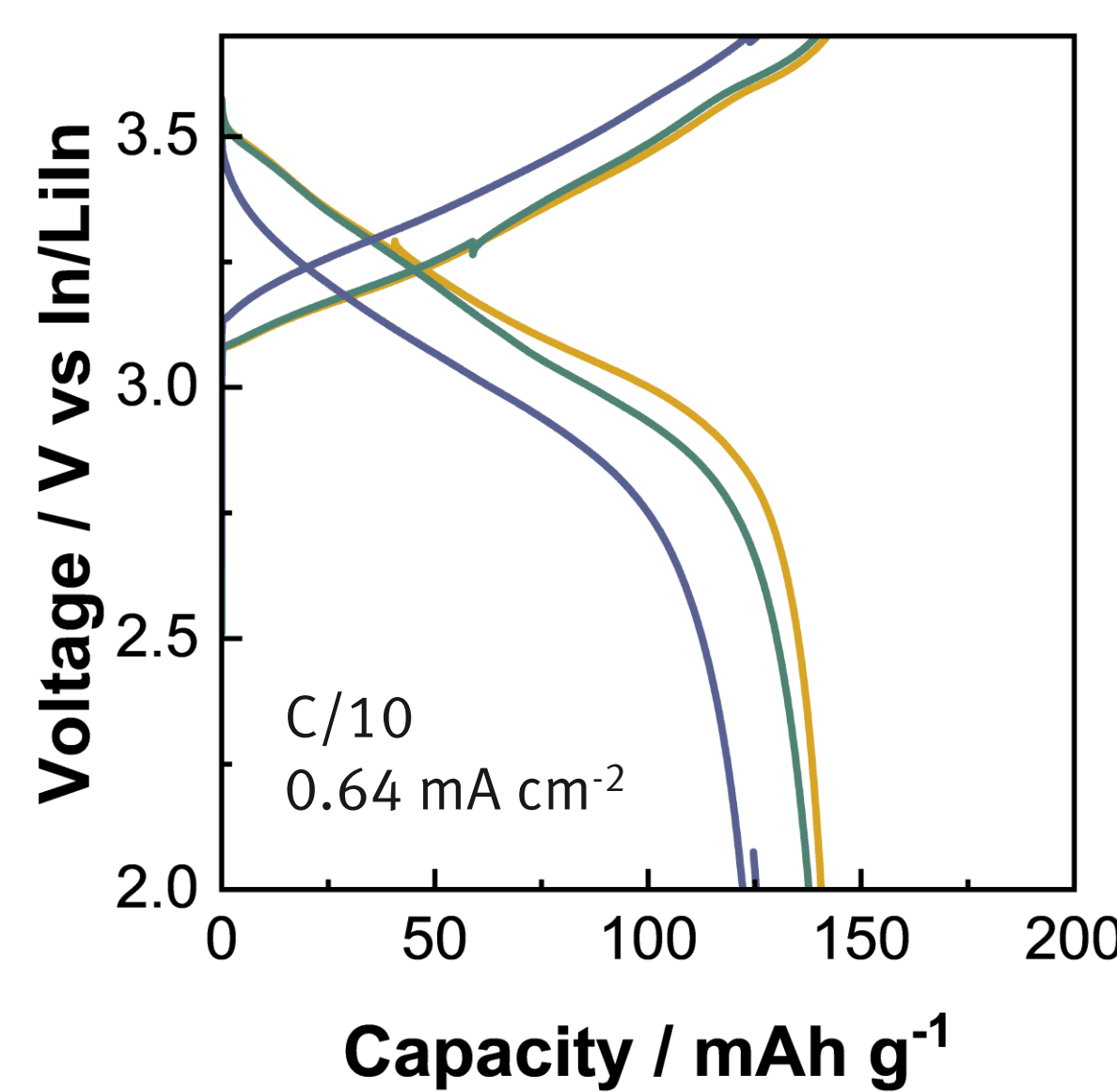
Electrochemical cell performance

In/LiIn
 $\text{Li}_{5.5}\text{PS}_{4.5}\text{Cl}_{1.5}$
 $\text{NCM83}:\text{Li}_6\text{PS}_5\text{Cl}$
 Temperature 25 °C
 Pressure 50 MPa
 Loading 6.4 mAh cm⁻²

Rate performance



Charge & discharge curves



High rate behavior indicate less transport limitation for cathode with less NCM at separator side.

Higher overpotential for SE-80-70-60 already at low current density (C/10).

Less overpotential for SE-60-70-80 at high current density (C/2).

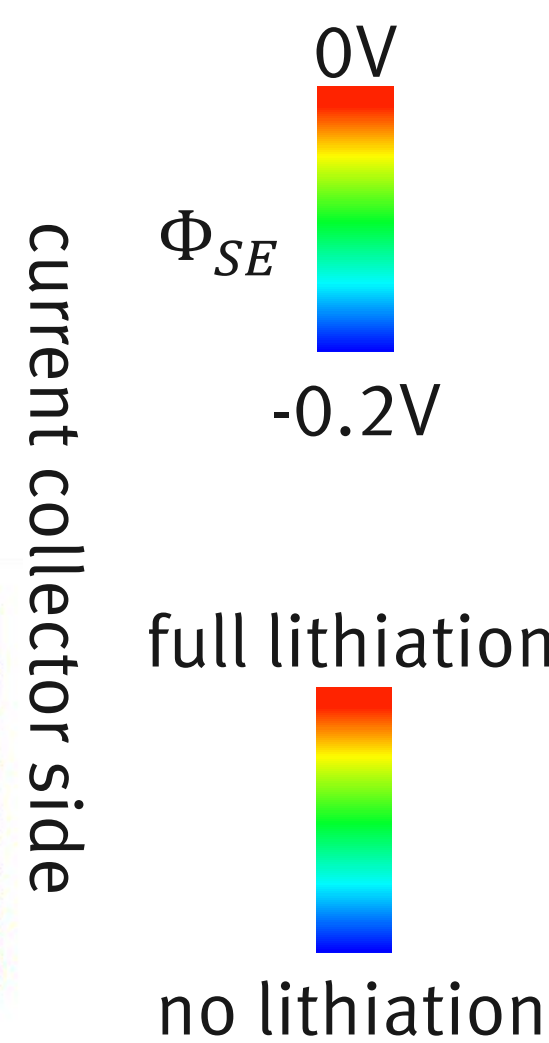
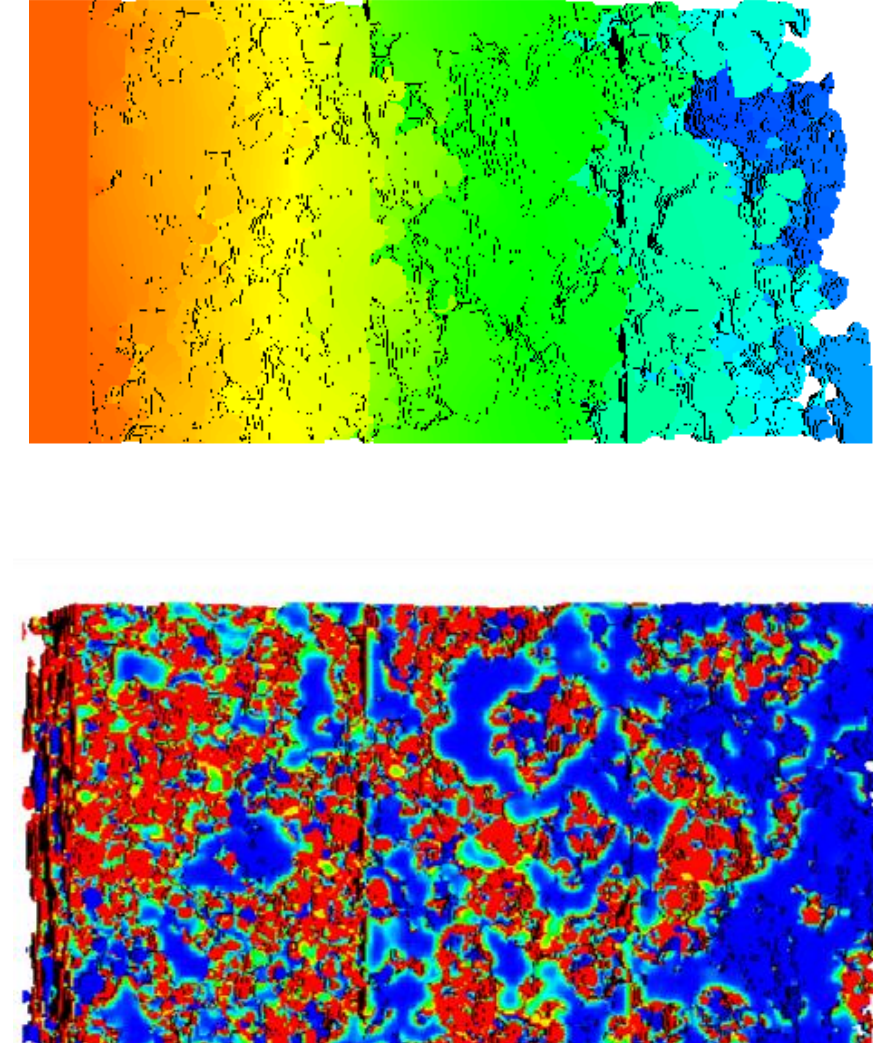
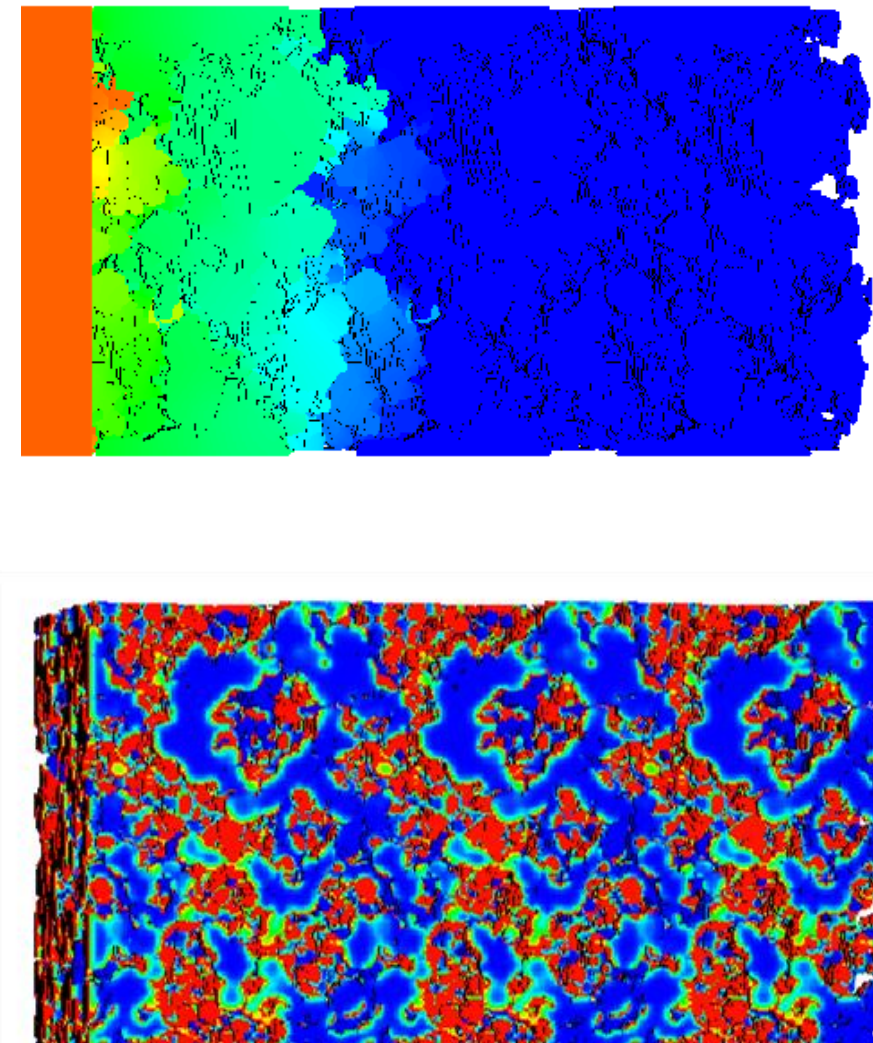
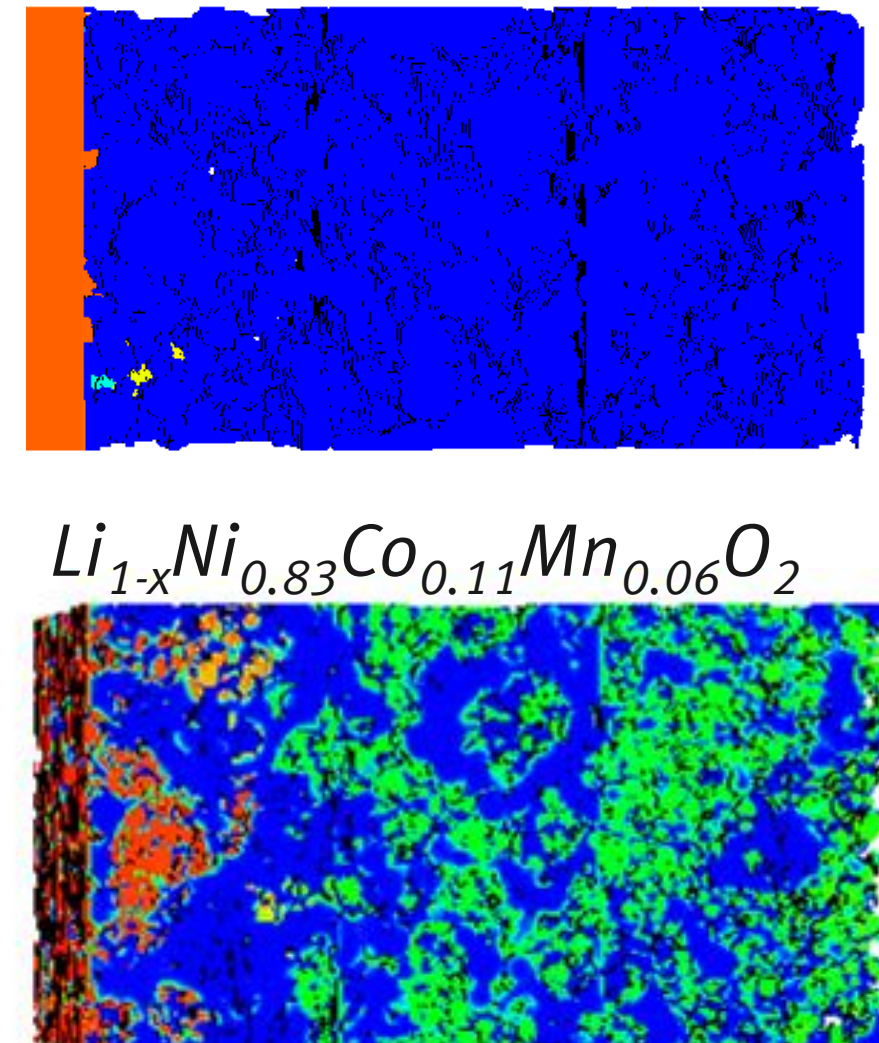
Continuum simulations

SE-80-70-60

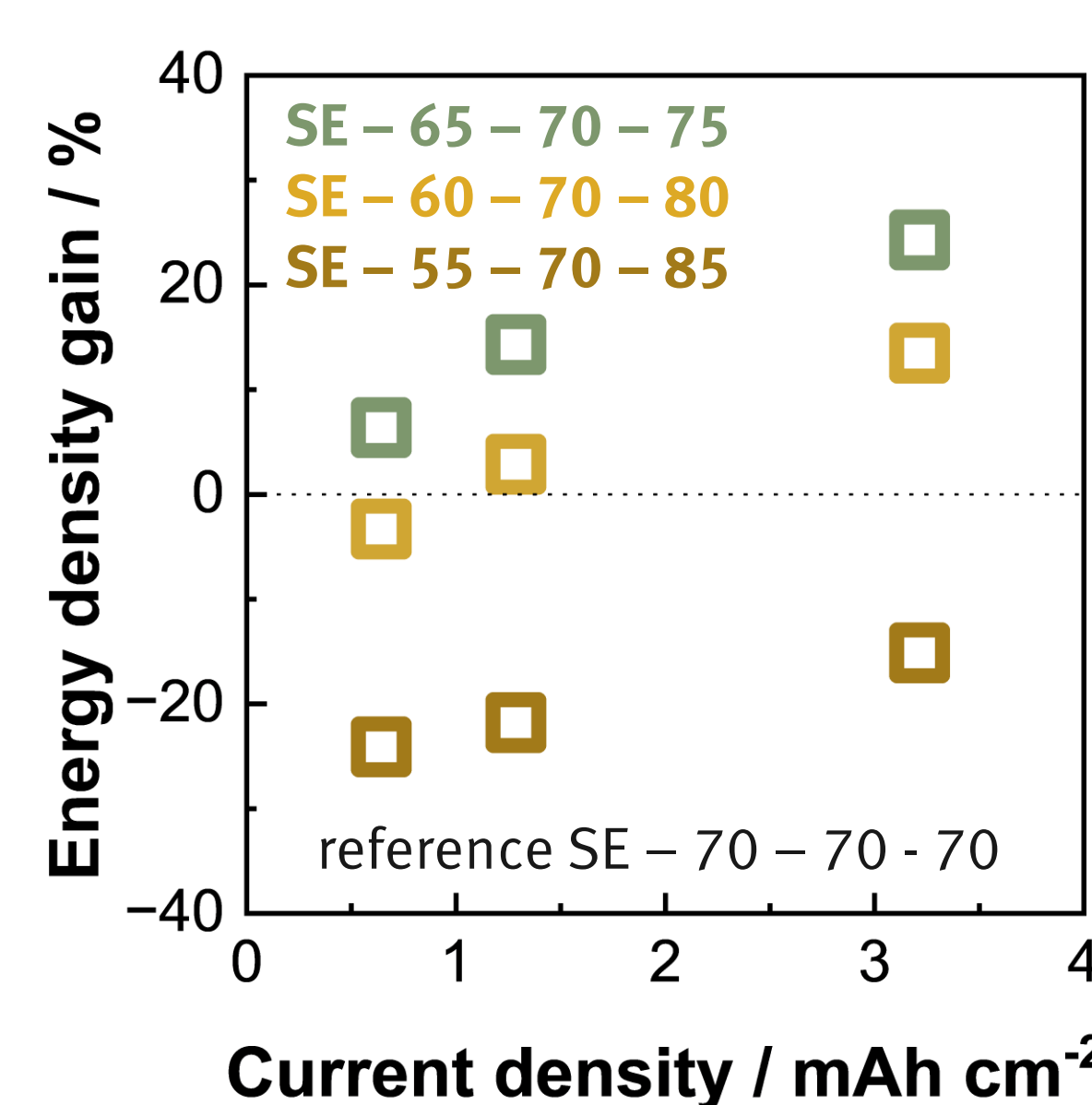
SE-70-70-70

SE-60-70-80

Electron-transfer overpotential $\eta = \Phi_{AM} - \Phi_{SE} - U_0$



Simulated energy density gain



Less contribution of Φ_{SE} to overpotential and higher lithiation for SE-60-70-80.

Layer with 80 wt% NCM shows Li⁺ ion blocking behavior due to unconnected LPSCL.

Gain in energy density with less NCM at separator side especially for SE-65-70-75.

Conclusion

ACS Energy Lett. **2025**, 10, 4, 1664–1670



Graded cathode with less NCM at separator results in better electrochemical cell performance through improved charge transport.

Especially at high current is the overpotential decreased and higher lithiation is achieved.

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