

## Supporting Information

# Engineering the Solid Electrolyte Interphase for Enhancing High-Rate Cycling and Temperature Adaptability of Lithium-Ion Batteries

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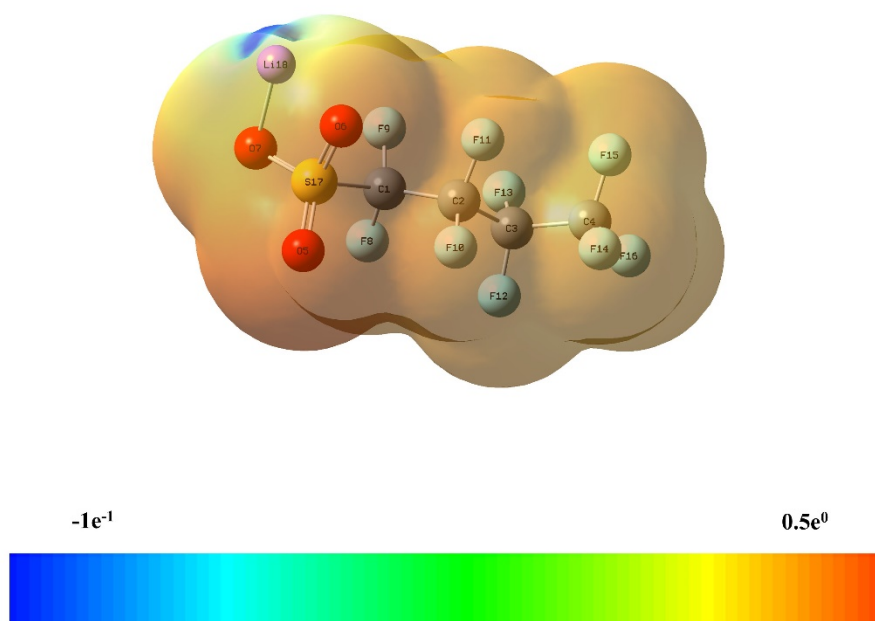
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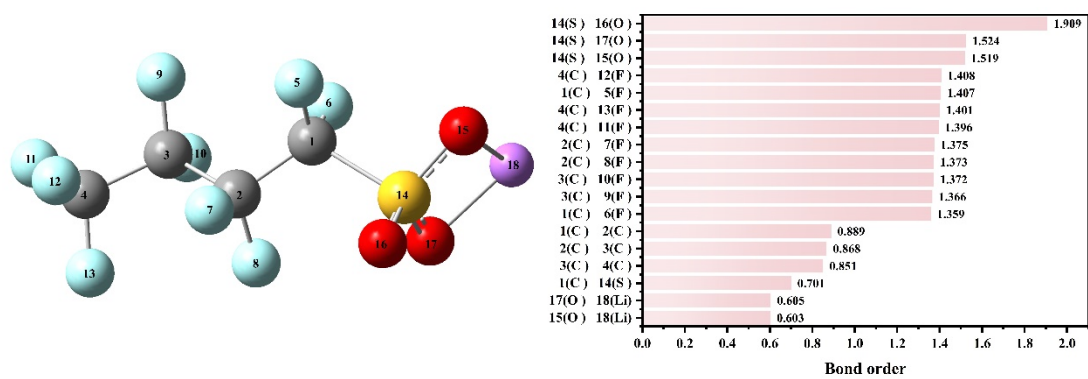
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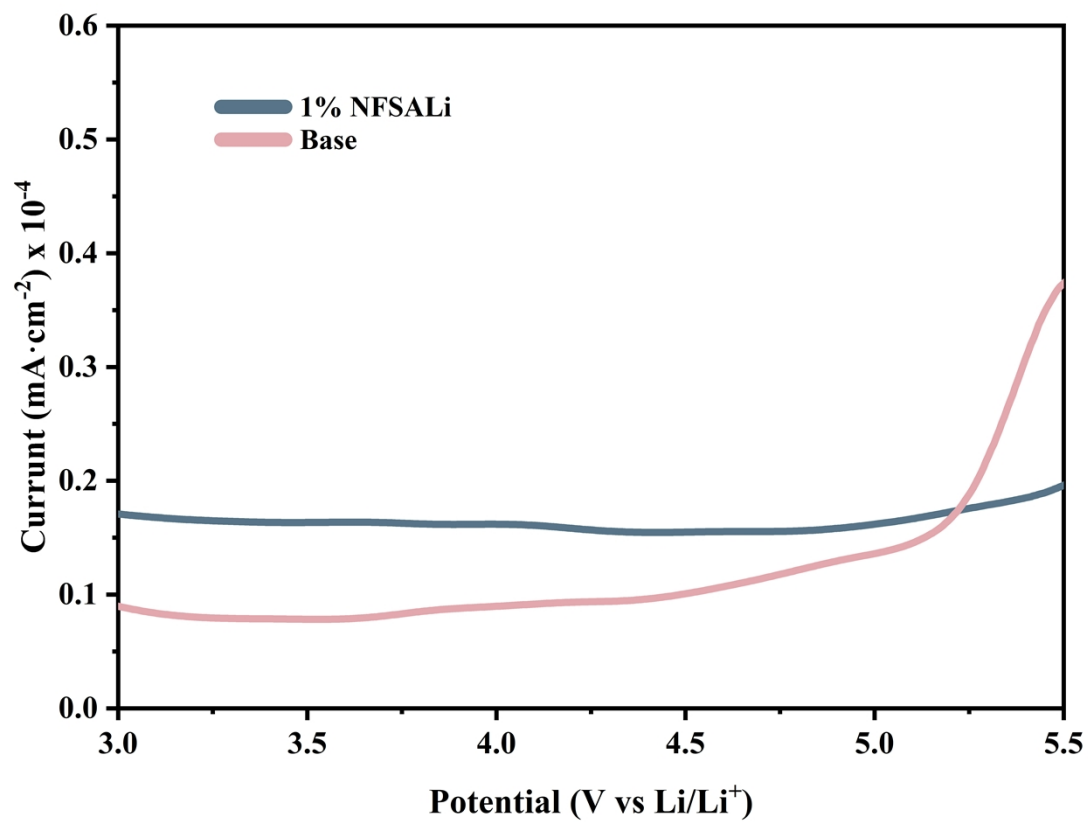
**Keywords:** Lithium-ion Battery; Electrolyte Additive; Lithium Nonfluoro-1-Butanesulfonate; Electrode/Electrolyte Interface.



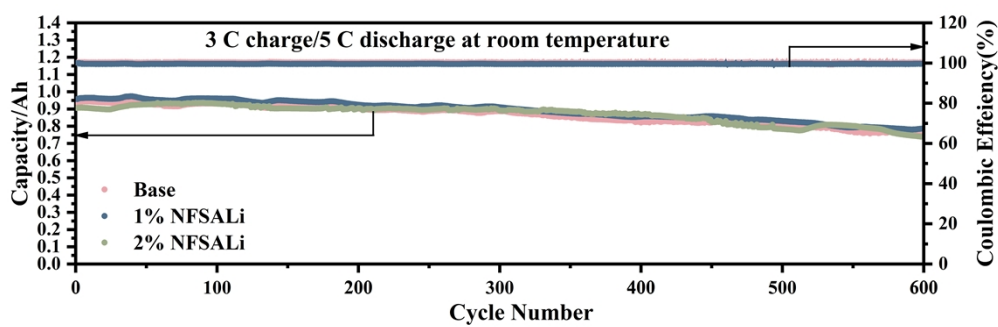
**Figure S1.** Electron cloud density distribution of NFSALi.



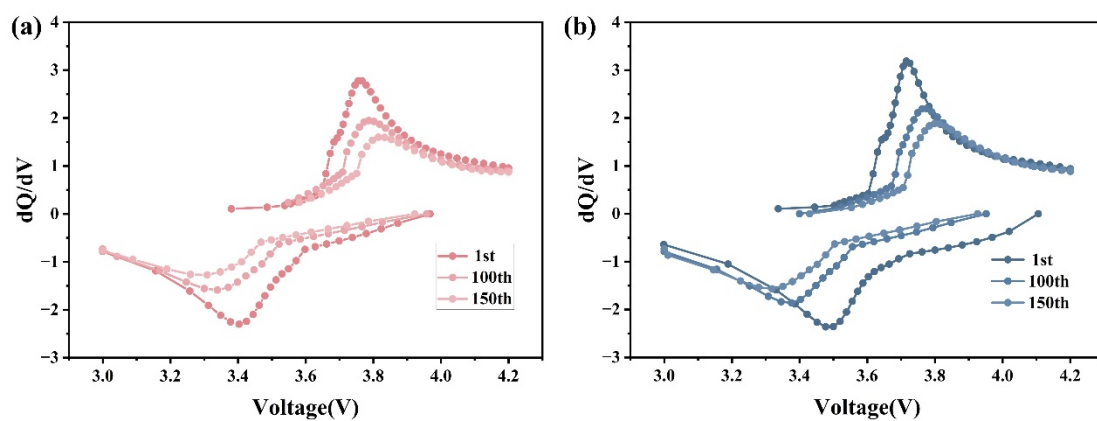
**Figure S2.** Bond order of NFSALi



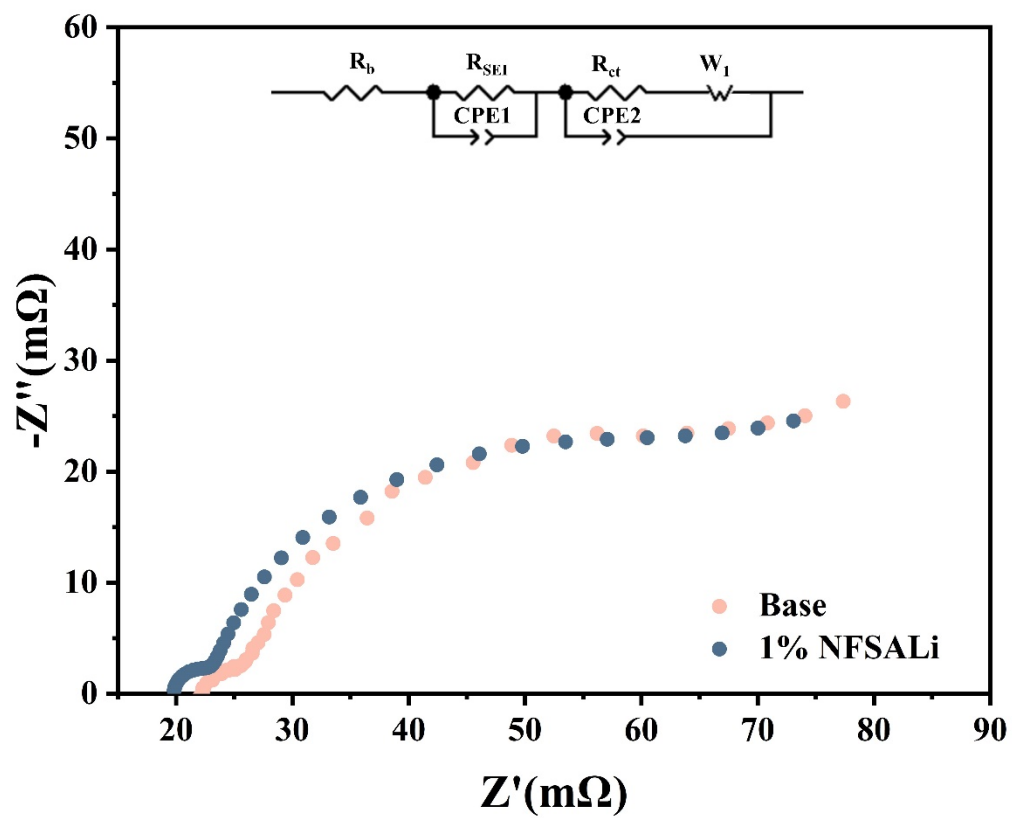
**Figure S3.** Oxidation potential by LSV with steel foil as work electrode, Li foil as counter- and reference electrodes at a scanning rate of 1 mV s<sup>-1</sup>.



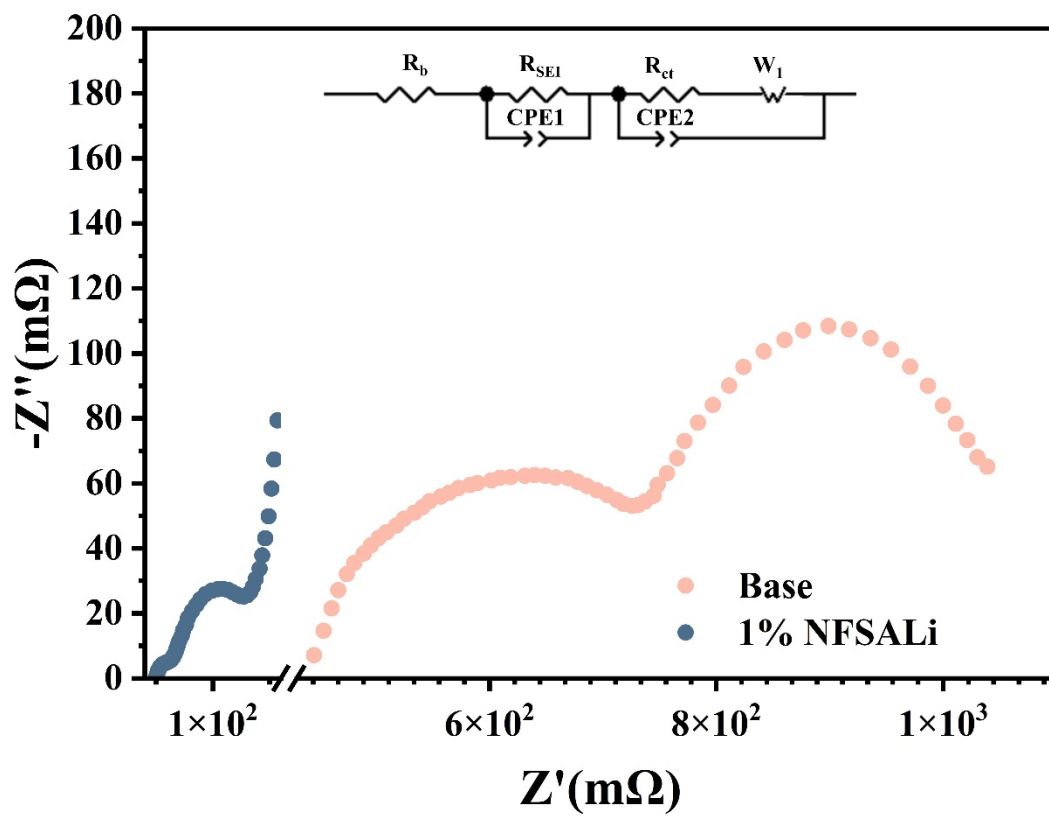
**Figure S4.** Cycling performance under 3 C charge/5 C discharge rate at room temperature.



**Figure S5.** The  $dQ/dV$  curves of various electrolytes with different cycles at 55 °C, (a) base electrolyte, (b) 1% NFSALi electrolyte.

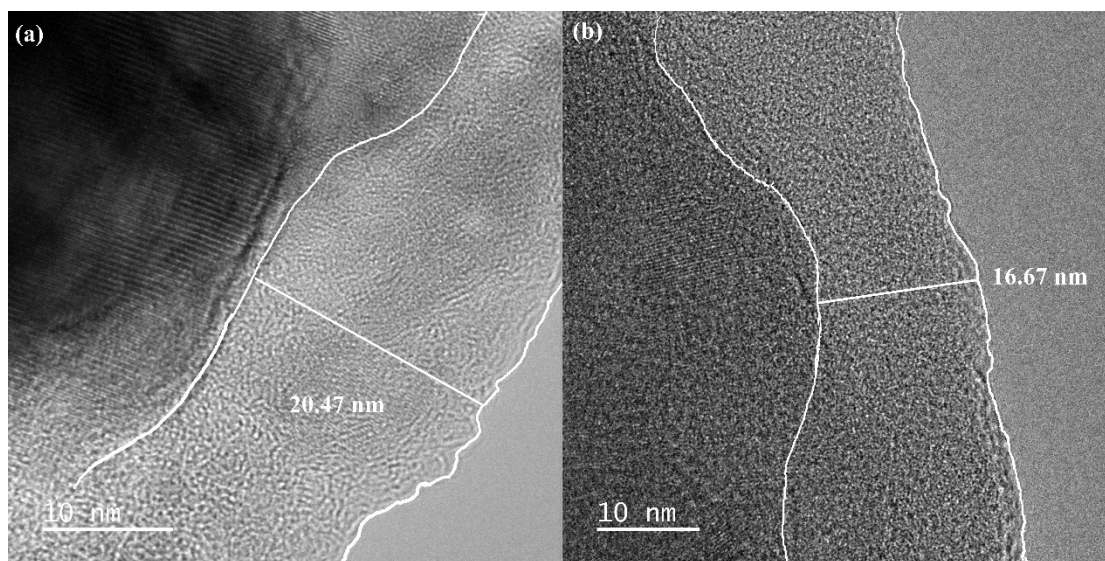


**Figure S6.** The electrochemical impedance spectroscopy (EIS) of each electrolyte before cycling.

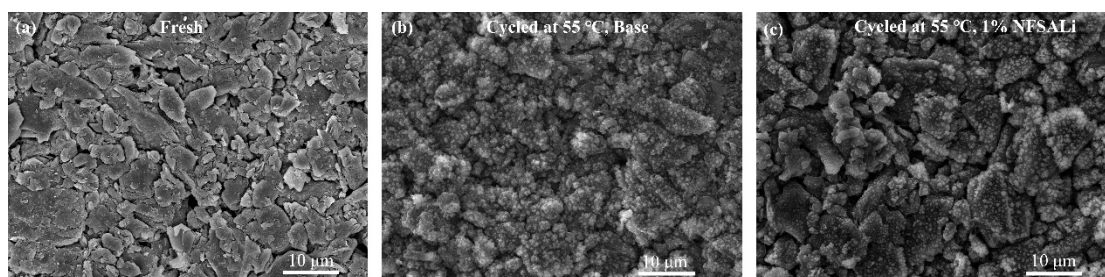


**Figure S7.** The electrochemical impedance spectroscopy (EIS) of each electrolyte after cycling at 55 °C.

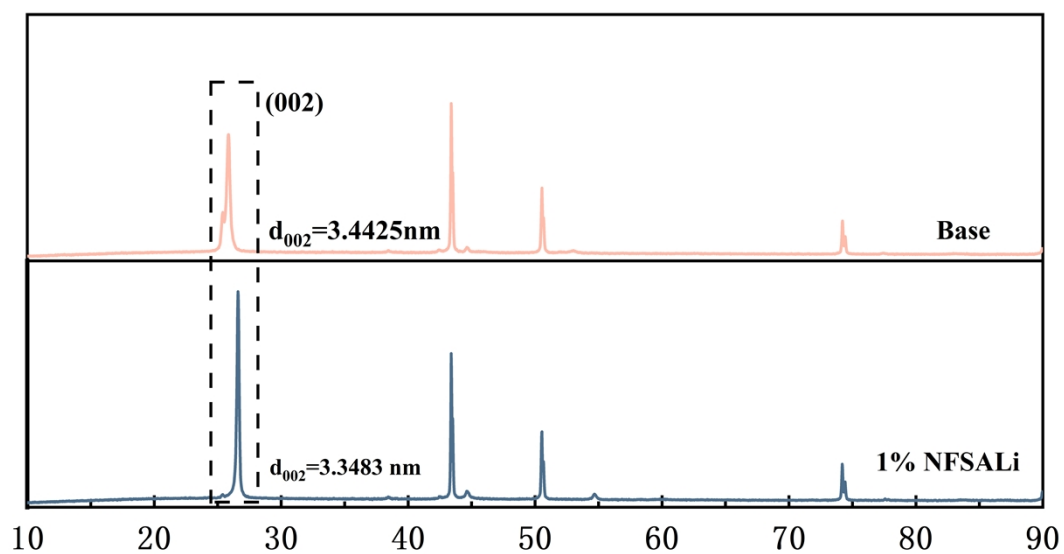




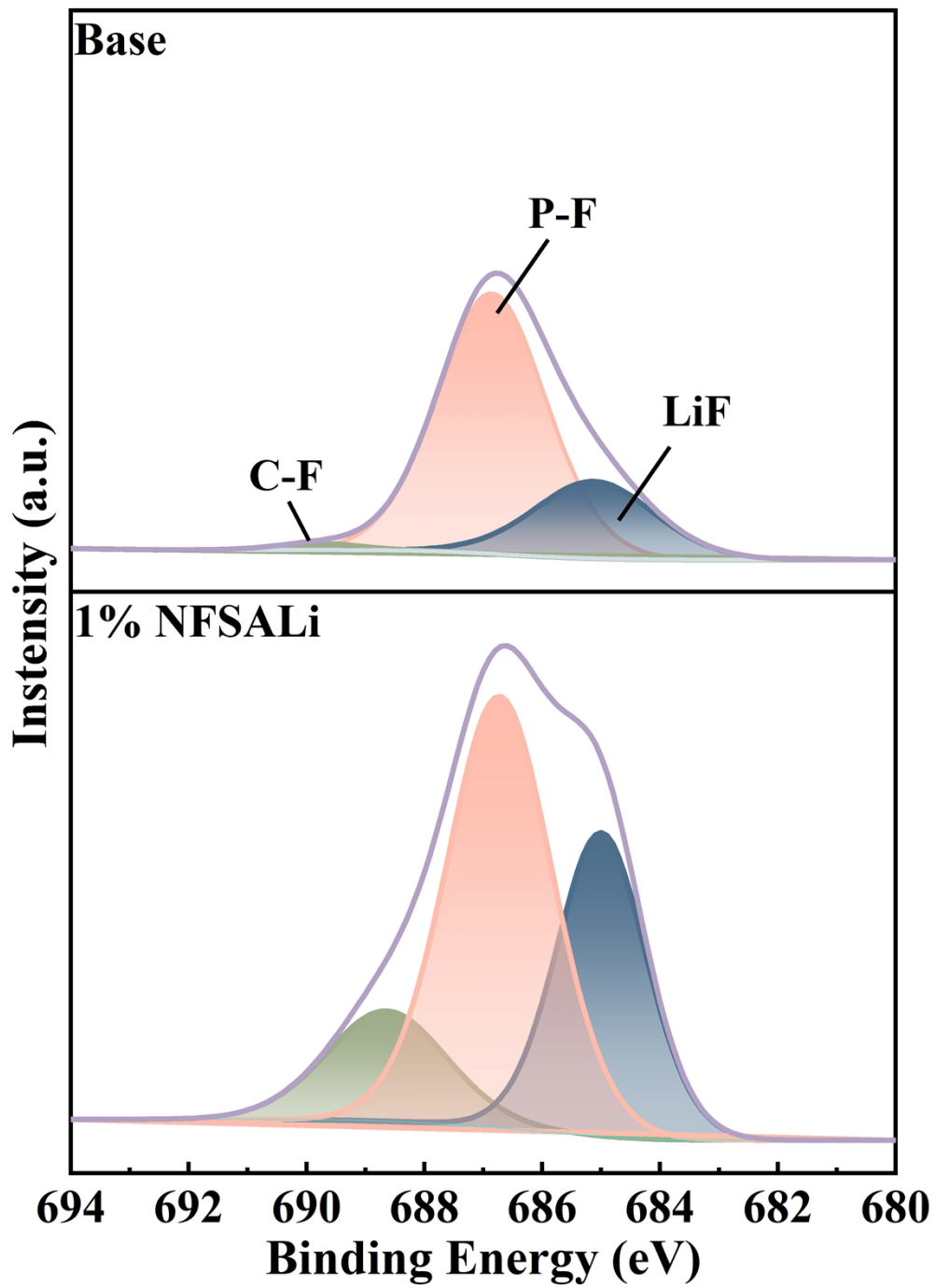
**Figure S8.** Transmission Electron Microscope (TEM) image of the NCM523 electrodes: (a) base electrolyte after 200 cycles at 55 °C, (b) 1% NFSALi electrolyte after 200 cycles at 55 °C.



**Figure S9.** Surficial SEM images of graphite electrodes: (a) fresh, (b) after 200 cycles at 55 °C with base electrolyte, (c) after 200 cycles at 55 °C with 1% NFSALi electrolyte.



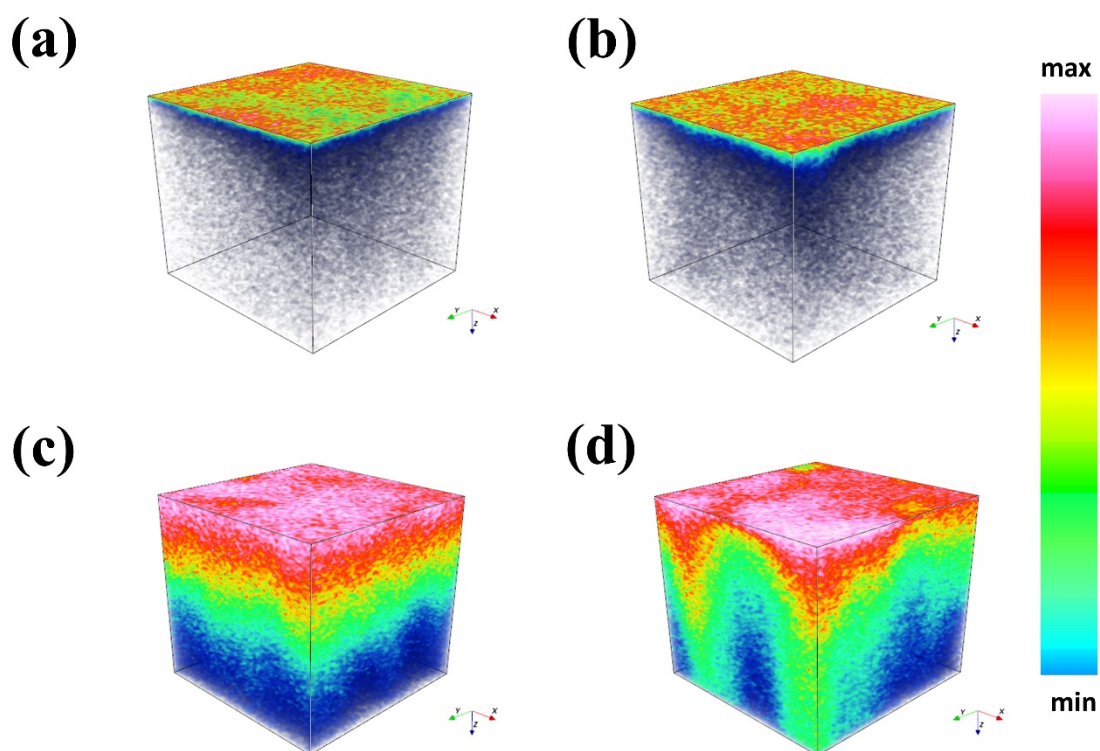
**Figure S10.** XRD patterns of graphite electrodes after cycling at 55 °C in base electrolyte and NFSALi containing electrolyte.



**Figure S11** The X-ray photoelectron spectroscopy (XPS) analysis of the NCM523 electrodes: F 1s spectra after cycling.

**Table S1** Atomic concentration (%) of NCM523 electrodes after 200 cycles.

Regions	Component	Base	1% NFSALi
F 1s	P-F	74.17	31.63
	C-F	1.47	15.41
	LiF	24.36	31.63



**Figure S12.** 3D render of  $\text{PO}_2^-$ :(a) base electrolyte, (b) 1% NFSALi electrolyte, (c) base electrolyte after 200 cycles at 55 °C, (d) 1% NFSALi electrolyte after 200 cycles at 55 °C.