

## Supporting information

# Fast Li<sup>+</sup> transfer scaffold enables stable high-rate all-solid-state Li metal batteries

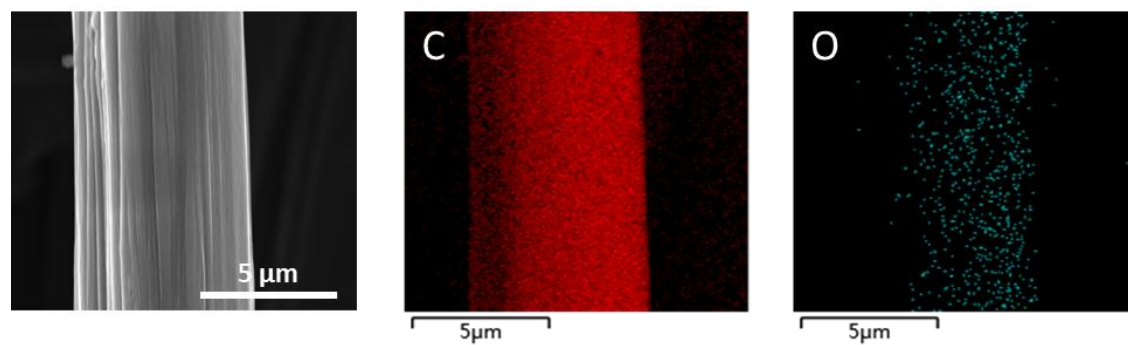
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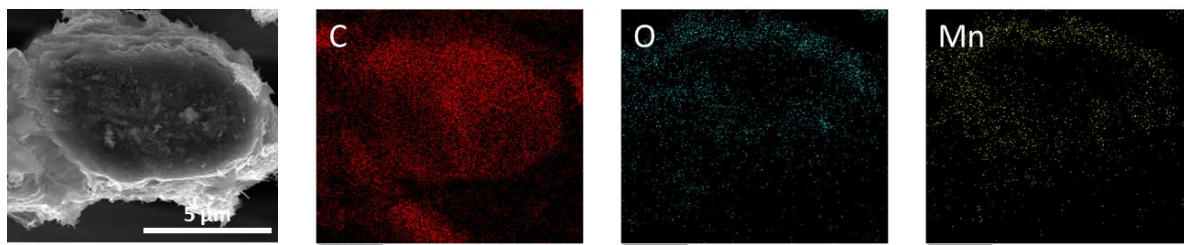
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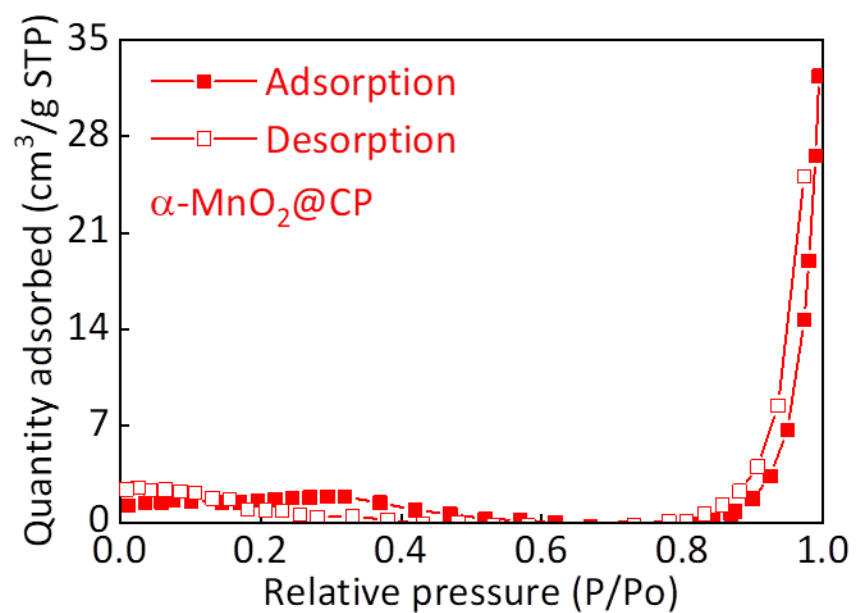
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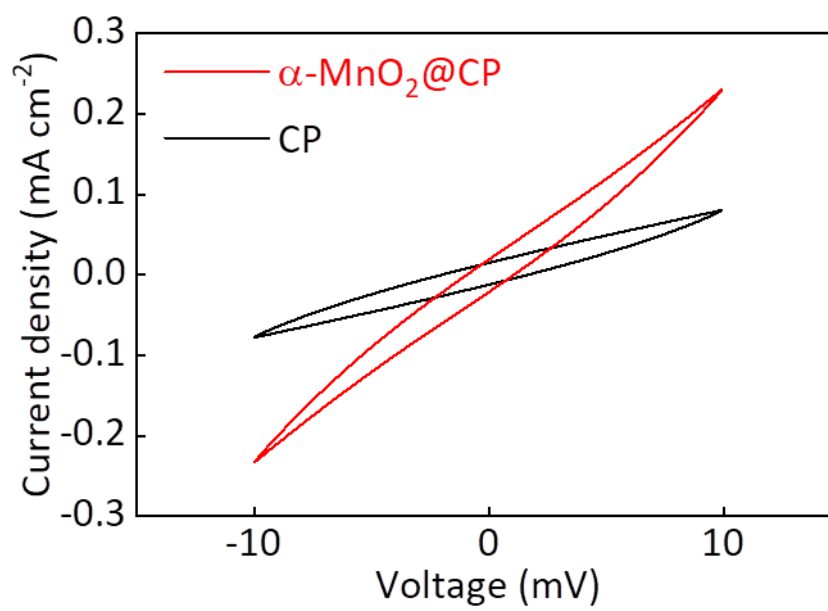
**Figure S1.** SEM and EDS images of CP.



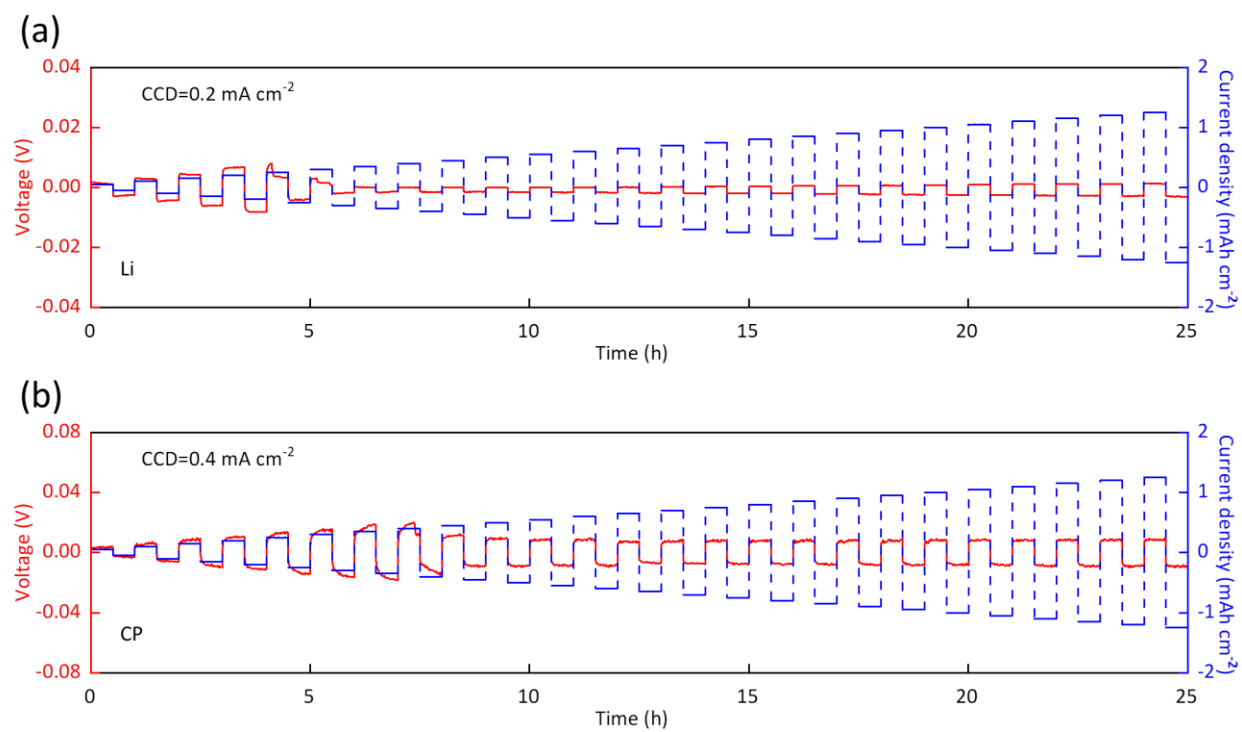
**Figure S2.** Cross-sectional SEM and EDS images of  $\alpha$ -MnO<sub>2</sub>@CP.



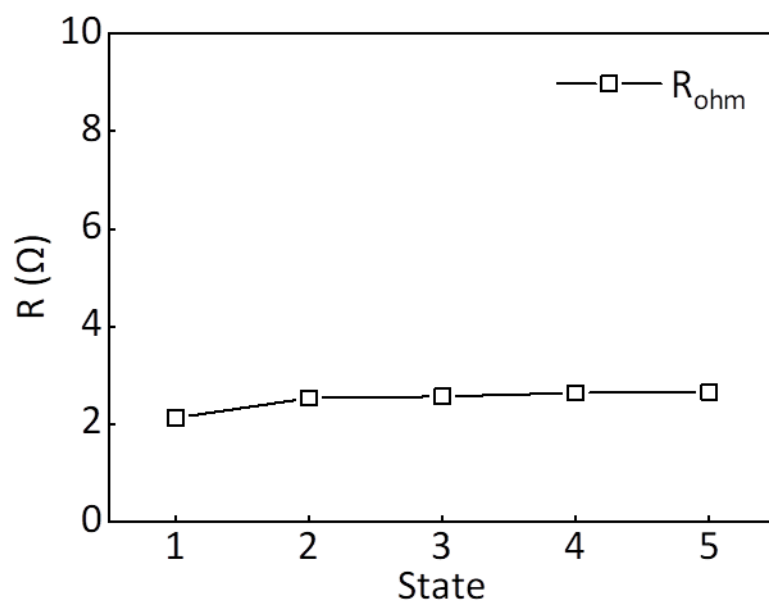
**Figure S3.** BET measurement of  $\alpha$ -MnO<sub>2</sub>@CP with adsorption-desorption curves.



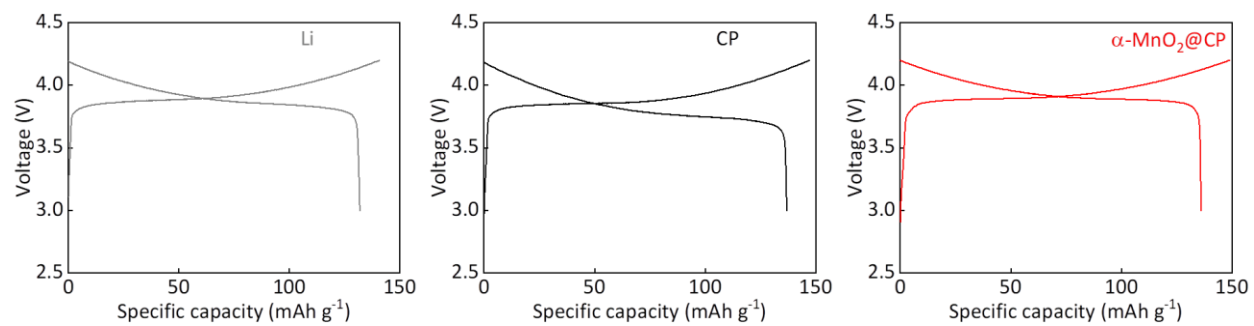
**Figure S4.** CV curve of all-solid-state Li || Li symmetrical cells using CP or  $\alpha\text{-MnO}_2\text{@CP}$  interlayers at a scan rate of  $0.5 \text{ mV s}^{-1}$ .



**Figure S5.** Voltage profile of CCD measurement for all-solid-state Li || Li symmetrical cells using (a) bare Li without interlayer and (b) CP interlayer between Li and SE.



**Figure S6.**  $R_{ohm}$  evolution of  $\alpha$ - $MnO_2$ @CP at different states during lithiation/delithiation processes.



**Figure S7.** Pre-cycling charge/discharge curves of ASSLMs at 0.1C/0.1C.

Table S1. Survey of CCD obtained in recent studies.

Method	Electrolyte	CCD (mA cm <sup>-2</sup> )	Reference
Co/Li <sub>2</sub> O interlayer	Li <sub>6.4</sub> La <sub>3</sub> Zr <sub>1.4</sub> Ta <sub>0.6</sub> O <sub>12</sub>	1.1	Science Bulletin 66 (2021) 1746–1753
Dual-layer multifunctional interface consisting of an upper layer enriched with organic LiBASF <sub>3</sub> compounds and an LiF-rich lower layer	Li <sub>6</sub> PS <sub>5</sub> Cl	1.9	Nano Energy 120 (2024) 109150
Ag/LiF multi-layer	Ta-doped Li <sub>6.4</sub> La <sub>3</sub> Zr <sub>1.4</sub> Ta <sub>0.6</sub> O <sub>12</sub>	3.1	Science Advances 8 (2022) eabq0153
Li-SnF <sub>2</sub> composite anode	Li <sub>5.5</sub> PS <sub>4.5</sub> Cl <sub>1.5</sub>	3.5	Advanced Functional Materials 34 (2024) 2314306
α-MnO <sub>2</sub> @CP interlayer	Li <sub>6</sub> PS <sub>5</sub> Cl	3.95	This work