

Supplementary material

**Insight into fast lithium diffusion and interface stability of
disordered rock-salt ω - $\text{Li}_3\text{V}_2\text{O}_5$ anodes in a wide
temperature range**

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1. Experimental

1.1 Materials Preparation

The ω -LVO anode was prepared via the electrochemical lithiation of V_2O_5 as previously reported.¹ Commercial V_2O_5 powders (Sigma-Aldrich, USA) were ball-milled for 2 h before used. The V_2O_5 electrodes were prepared by mixing the active material (80 wt%), carbon black (Super P, 10 wt%), PVDF (Sigma-Aldrich, 10 wt%). The mass loading of active materials is about 1 mg/cm^2 . The CR2032-type half-cells were assembled in an argon atmosphere in a glovebox. When the V_2O_5 electrode was discharged to 1.5 V at 0.1 A g^{-1} , a rock-salt ω -LVO material was obtained without further operation. The as-prepared ω -LVO electrode can be used to carry out the electrochemical test directly.

1.2 Characterizations

The morphology of the active materials was observed by scanning electron microscopy (SEM, Sirion 200, FEI, Netherlands). The crystal structure of the ω -LVO anode was investigated by transmission electron microscopy (TEM, JEM-2100, JEOL, Japan and TF20, FEI, Netherlands) and X-ray diffraction (XRD, Empyrean, PANalytical B. V., Netherlands).

1.3 Electrochemical Measurements

The ω -LVO electrode was composed of active material, Super P, and poly(vinylidene fluoride) with a weight ratio of 8:1:1, and the mass loading was $\sim 1.0 \text{ mg cm}^{-2}$. The electrolyte components were 1.2 M LiPF_6 in EC : EMC (3 : 7 in weight ratio) with

2%vol FEC and 1wt% LiPO₂F₂. CR2032 coin-type cells were assembled in an argon-filled glove box with the content of H₂O and O₂ less than 1 ppm. The ω-LVO||Li cells were cycled in the potential range of 0.01 – 2.0 V at the current density of 0.1 – 10 A g⁻¹ at room temperature (28 °C), which was operated in a battery test system (LAND CT2001A, Land Electronic Co. Ltd, China). Cyclic voltammetry (CV) with different scan rates was applied to obtain the Li-ion diffusion coefficient in the potential range of 0.01 – 2.0 V. EIS of the coin cells was tested in the frequency range of 10⁻¹ – 10⁶ Hz with a voltage amplitude of 10 mV. The CV and EIS tests were accomplished by using the electrochemical workstation (CHI600E, Chinstruments Co. Ltd, China).

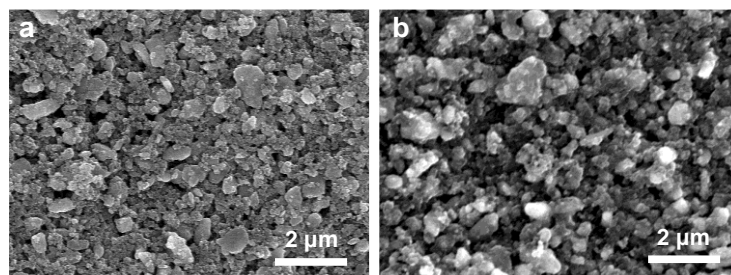


Fig. S1. SEM images of the electrodes: (a) Pristine V₂O₅. (b) ω-LVO anode.

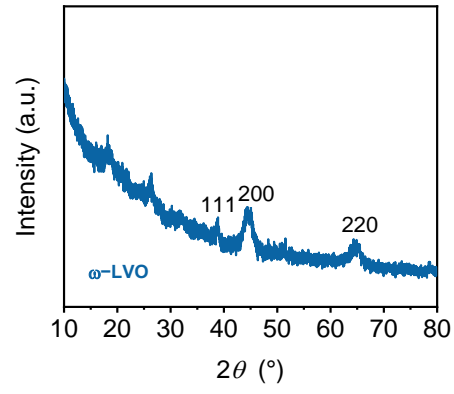


Fig. S2. XRD pattern of the as-prepared ω -LVO electrode

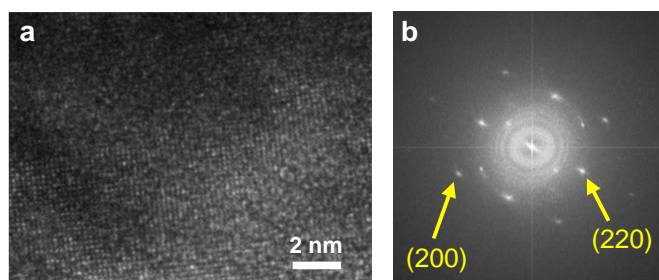


Fig. S3. (a) TEM image of the ω - $\text{Li}_3\text{V}_2\text{O}_5$ particles obtained by discharging the V_2O_5 to 1.5 V vs Li/Li^+ and (b) corresponding FFT pattern.

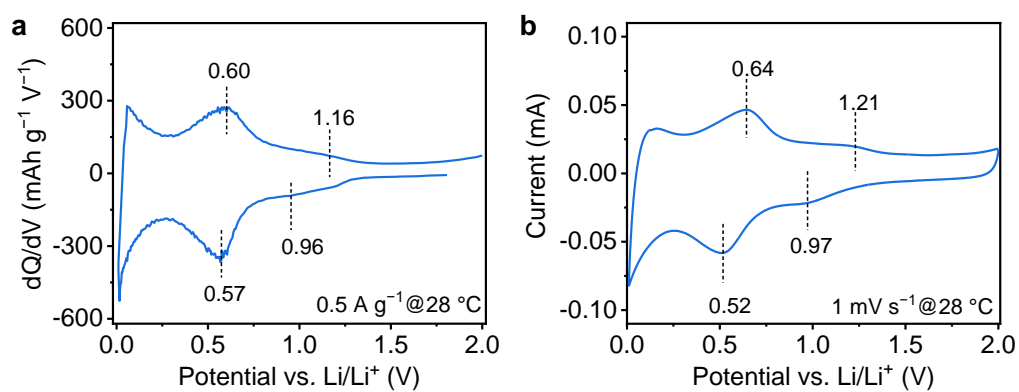


Fig. S4. (a) dQ/dV profiles. (b) CV curves at a scan rate of 1 mV s^{-1} .

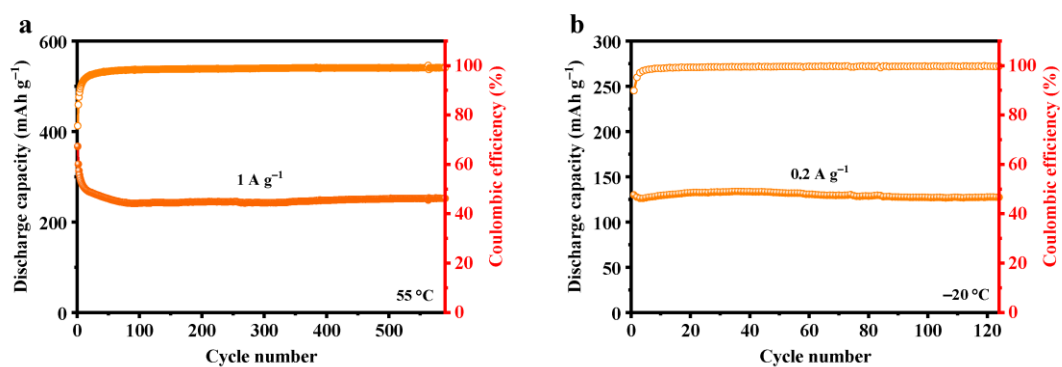


Fig. S5. Cycling performance at (a) 55 °C (1 A g⁻¹) and (b) -20 °C (0.2 A g⁻¹) of the ω -LVO||Li half cells.

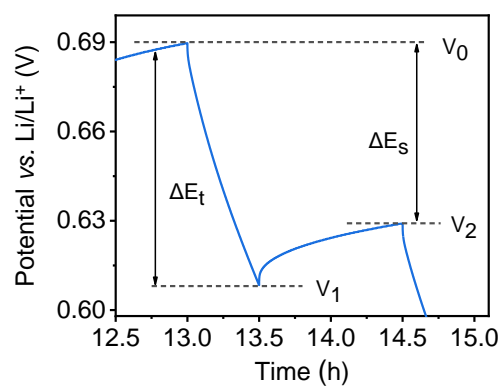


Fig. S6. Enlarged region of the GITT curve of the ω -LVO||Li half cell.

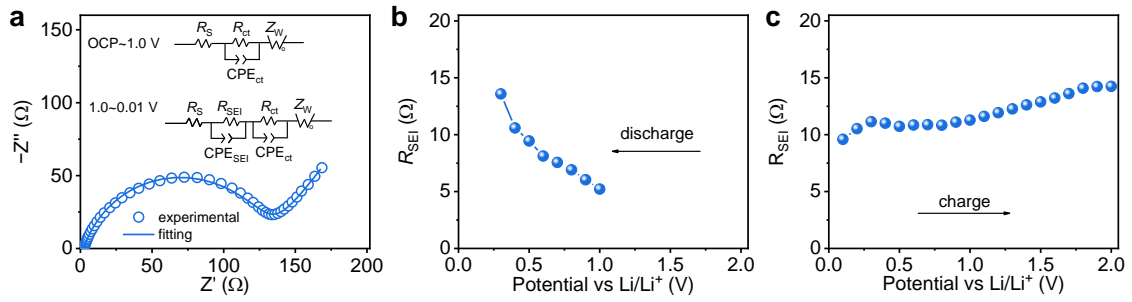


Fig. S7. (a) EIS curve and fitting result at OCP. Evolution of R_{SEI} during initial (b) discharging and (c) charging process.

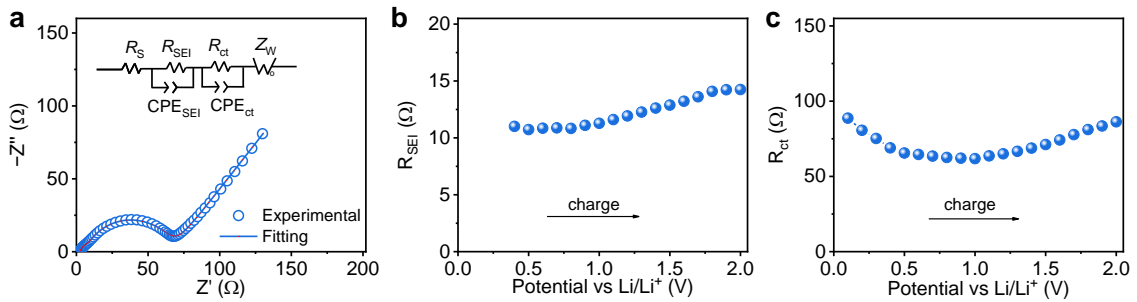


Fig. S8. (a) EIS curve and fitting result at 1.0 V. Evolution of R_{ct} during initial (b) discharging and (c) charging process.

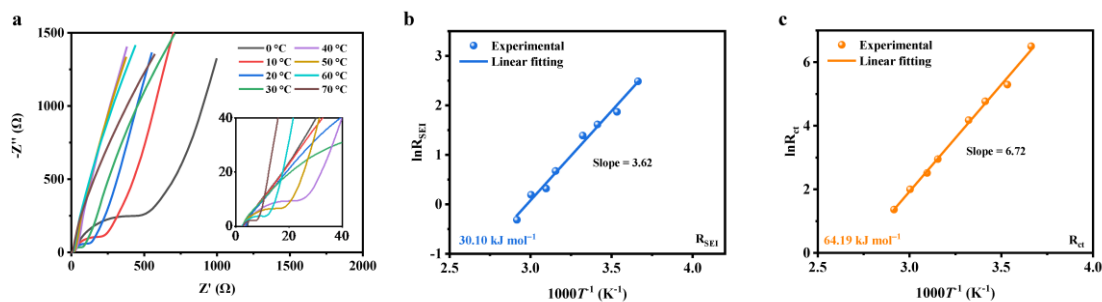


Fig. S9. Energy information of the graphite anode. Plots and linear fitting of (a) $\ln R_{SEI}$ vs. $1000T^{-1}$ and (b) $\ln R_{ct}$ vs. $1000T^{-1}$.

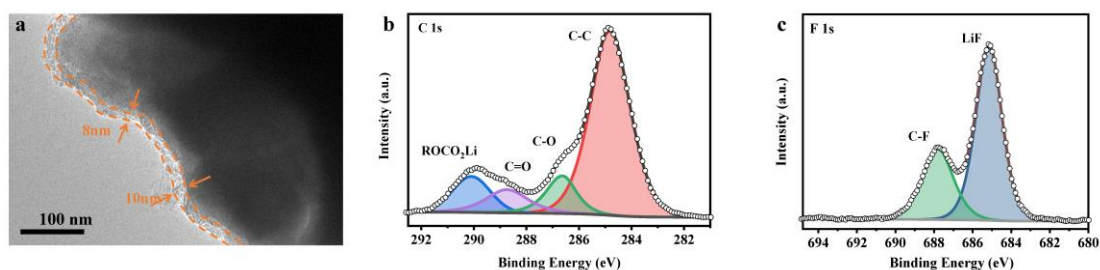


Fig. S10. (a) TEM images of the cyclized ω -LVO electrodes. XPS results of (b) C1s and (c) F1s of the cyclized ω -LVO electrodes.

References

- 1 H. Liu, Z. Zhu, Q. Yan, S. Yu, X. He, Y. Chen, R. Zhang, L. Ma, T. Liu, M. Li, R. Lin, Y. Chen, Y. Li, X. Xing, Y. Choi, L. Gao, H. S.-y. Cho, K. An, J. Feng, R. Kostecki, K. Amine, T. Wu, J. Lu, H. L. Xin, S. P. Ong and P. Liu, *Nature*, 2020, **585**, 63-67.