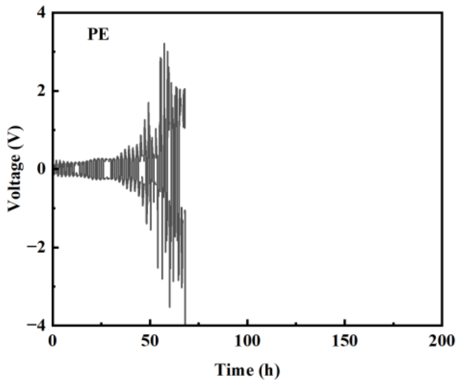
Supplementary Materials

Synergistic electrolyte engineering to enhance cycle stability of sodium ion batteries at high rates and elevated temperatures

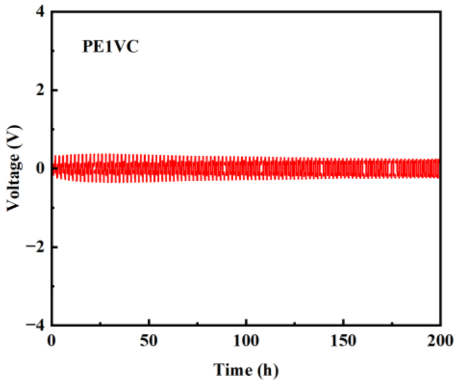
Zhenyun Zhao[1,2,#], Tengda Wang[1,#], Zixiang Yang[2,#], Xu Wang[2], Yujia Cai[2], Wei Chen[1,*], Jianguo Lu[2,*]

[1]National Engineering Lab for Textile Fiber Materials and Processing Technology, School of Materials Science and Engineering, Zhejiang Sci-Tech University, Hangzhou 310018, Zhejiang, China.
[2]State Key Laboratory of Silicon and Advanced Semiconductor Materials, School of Materials Science and Engineering, Zhejiang University, Hangzhou 310058, Zhejiang, China.
[#]Authors contributed equally.

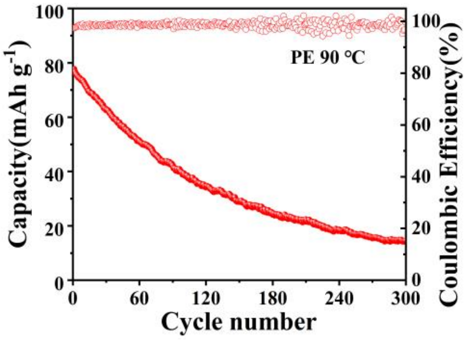
Correspondence to: Dr. Wei Chen, National Engineering Lab for Textile Fiber Materials and Processing Technology, School of Materials Science and Engineering, Zhejiang Sci-Tech University, Hangzhou 310018, Zhejiang, China. E-mail: wchen@zstu.edu.cn; Dr. Jianguo Lu, State Key Laboratory of Silicon and Advanced Semiconductor Materials, School of Materials Science and Engineering, Zhejiang University, Hangzhou 310058, Zhejiang, China. E-mail: lujianguo@zju.edu.cn



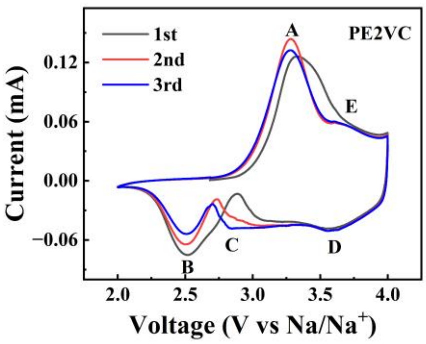
Supplementary Figure 1. Voltage-time curve of the Na||Na cell with the PE electrolyte.



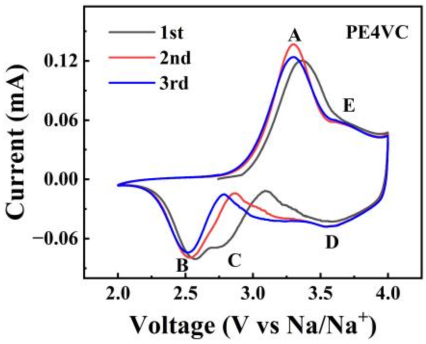
Supplementary Figure 2. Voltage-time curve of the Na||Na cell with the PE1VC electrolyte.



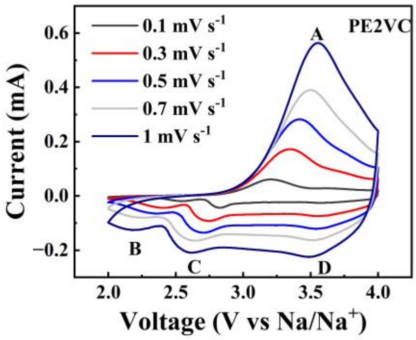
Supplementary Figure 3. Cycling performance of the half-cell with the PE electrolyte at 90 ℃.



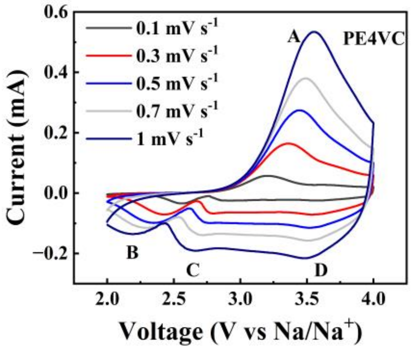
Supplementary Figure 4. CV profiles of the first three cycles of the half-cell with the PE2VC electrolyte at 0.2 mV s^{-1}.



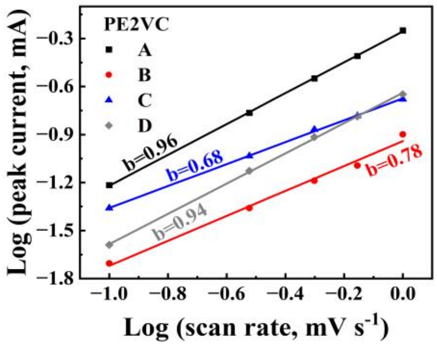
Supplementary Figure 5. CV profiles of the first three cycles of the half-cell with the PE4VC electrolyte at 0.2 mV s^{-1}.



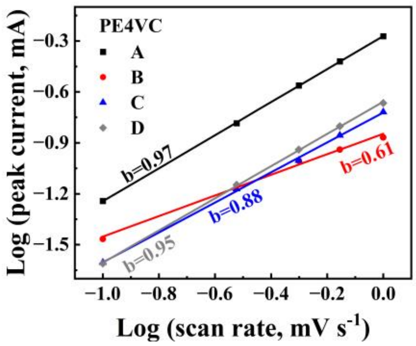
Supplementary Figure 6. CV curves of the half-cell with the PE2VC electrolyte at different scanning rates from 0.1 to 1 mV s^{-1}.



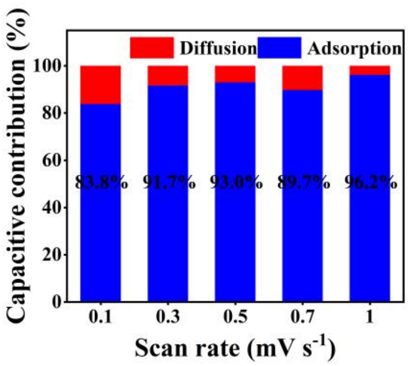
Supplementary Figure 7. CV curves of the half-cell with the PE4VC electrolyte at different scanning rates from 0.1 to 1 mV s^{-1}.



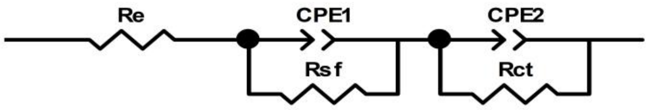
Supplementary Figure 8. Plots of log (i) vs. log (v) for the half-cell with the PE2VC electrolyte.



Supplementary Figure 9. Plots of log (i) vs. log (v) for the half-cell with the PE4VC electrolyte.

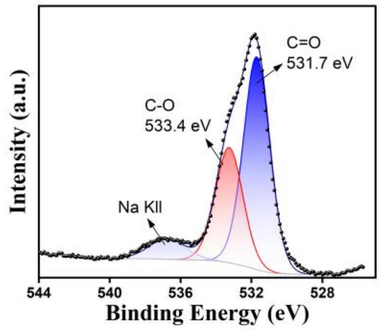


Supplementary Figure 10. Adsorption and diffusion contributions of the half-cell with PE.

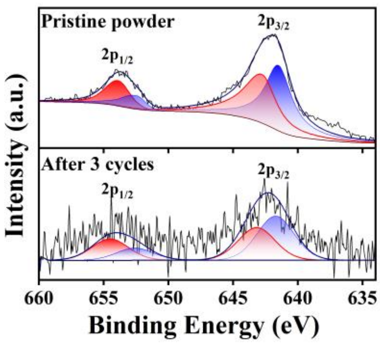


Supplementary Figure 11. The EIS equivalent circuit.

The EIS data were fitted using equivalent circuit R_e $(R_{sf}CPE_1)$ $(R_{ct}CPE_2)$. Where R_e is the solution resistance, R_{sf} and CPE_1 are the resistance and constant-phase element (CPE) of the surface film, and R_{ct} and CPE_2 correspond to the charge transfer resistance and double-layer CPE, respectively.



Supplementary Figure 12. XPS high-resolution spectrum of O 1s of the NFM@CTA-4 cathode in PEIVC cycled for 3 cycles at 1 C.



Supplementary Figure 13. XPS high-resolution spectra of Mn 2p of the NFM@CTA-4 pristine powder (as reported in our previous work) and the NFM@CTA-4 cathode in PE1VC after 3 cycles at 1 C.

Supplementary Table 1. Surface elemental contents of the NFM@CTA-4 cathode in PE1VC cycled for 300 cycles at 10 C.

Element	Weight%	Atomic%
O	22.50	38.98
Na	32.26	38.89
Mn	13.47	6.79
Fe	13.91	6.91
Ni	17.86	8.43
Total	100	100

Supplementary Table 2. Surface elemental contents of the NFM@CTA-4 cathode in PE cycled for 300 cycles at 10 C.

Element	Weight%	Atomic%
O	22.14	31.24
Na	64.65	63.48
Mn	4.41	1.81
Fe	4.55	1.84
Ni	4.25	1.64
Total	100	100