Electronic Supplementary Material (ESI) for Nanoscale.
This journal is © The Royal Society of Chemistry 2022

Supporting Information

Lignin-derived flexible porous carbon material for highly efficient polyselenides and sodium regulation

Linchao Zeng, [a] Jianhui Zhu, [a] Jiahong Wang, [a] Licong Huang, [a] Xiaowu liu, [b] Wei Lu [a] and Xuefeng Yu*[a]

[a] *Materials Interfaces Center, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen 518055, P. R. China*
[b] *Key Laboratory of Biomimetic Sensor and Detecting Technology of Anhui Province, School of Materials and Chemical Engineering, West Anhui University, Lu'an, Anhui 237012, China*

*Corresponding author
E-mail: xf.yu@siat.ac.cn

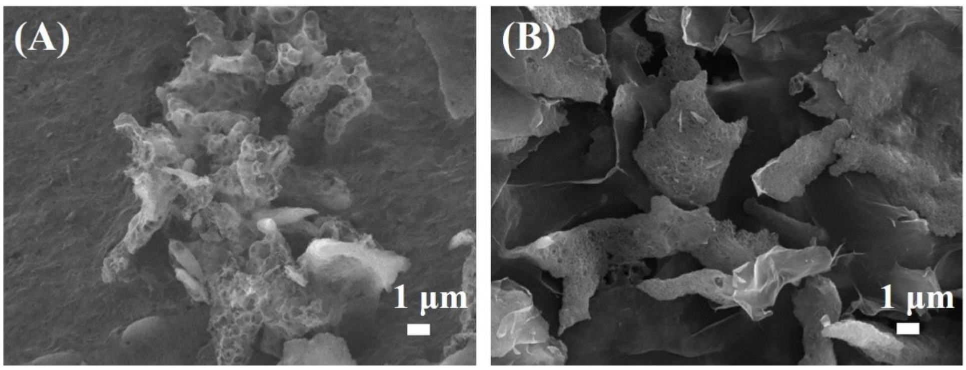

Figure S1. SEM images of the Fe-BC (A) and Fe-BC/rGO (B).

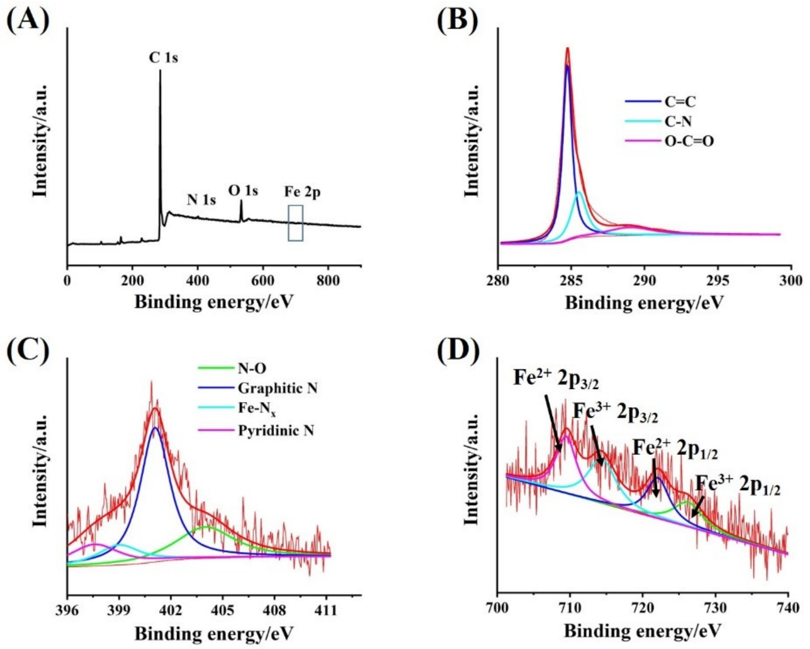

Figure S2. (A) Full range XPS spectra of the Fe-BC. High-resolution C 1s (B), N 1s (C) and Fe 2p (D) XPS spectrum of the Fe-BC.

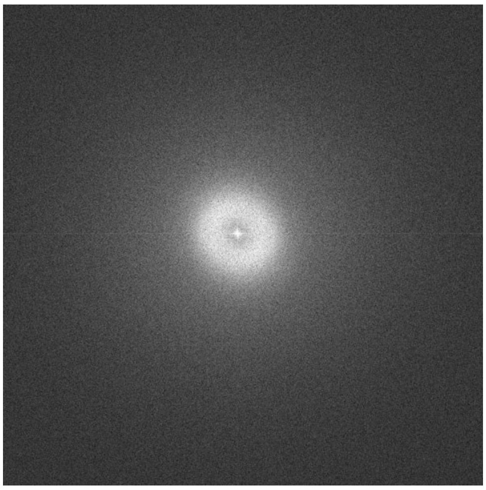

Figure S3. Corresponding fast Fourier transformation of Fe-BC/rGO.

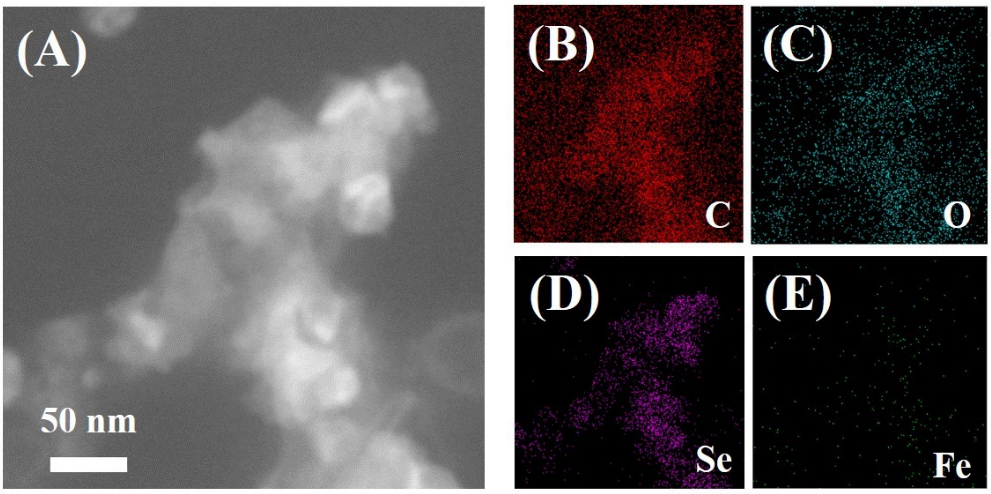

Figure S4. Dark-field TEM image (A) and corresponding element mapping distribution (B-E) of the Se@Fe-BC/rGO.

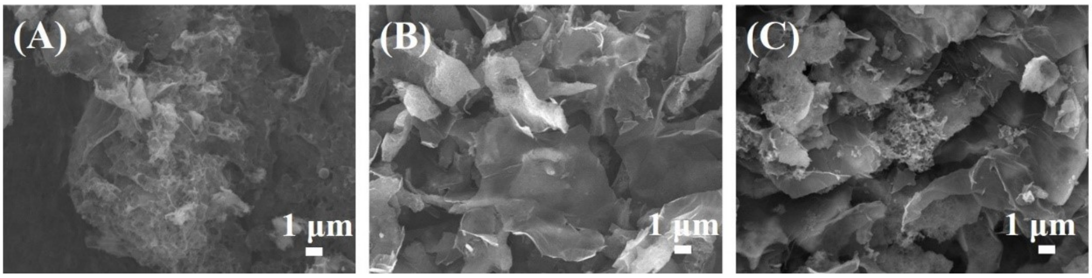

Figure S5. SEM images of the BC (A), BC/rGO (B) and Se@BC/rGO (C).

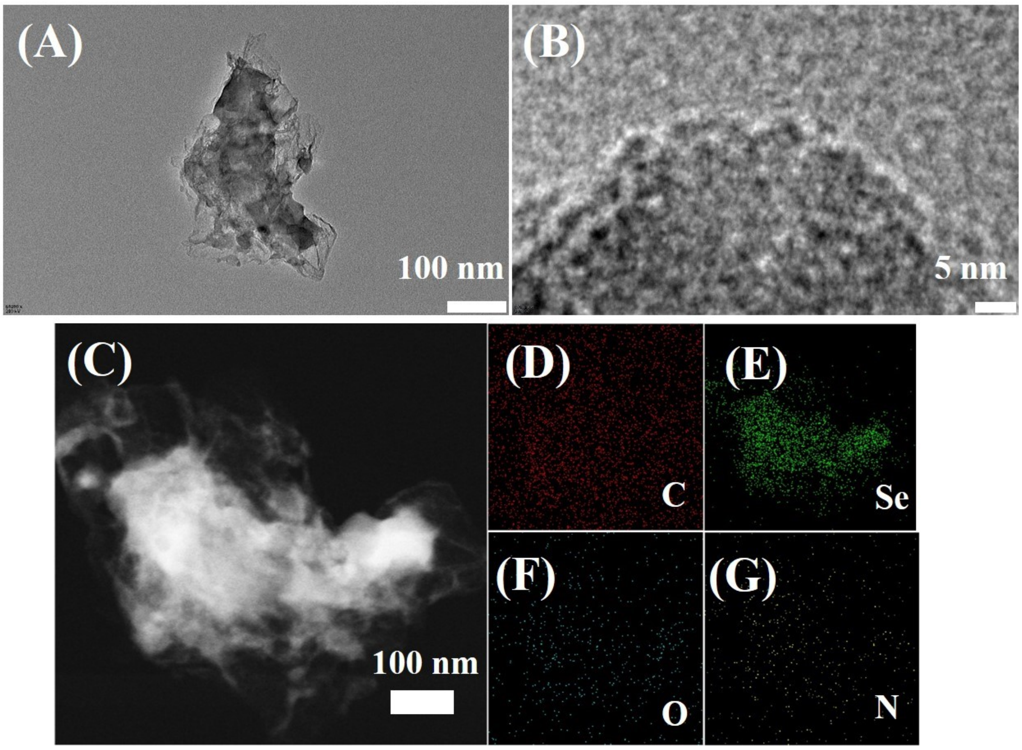

Figure S6. TEM (A) and HR-TEM (B) images of the Se@BC/rGO. Dark-field TEM image (F) and corresponding element mapping distribution (D-G) of the Se@BC/rGO.

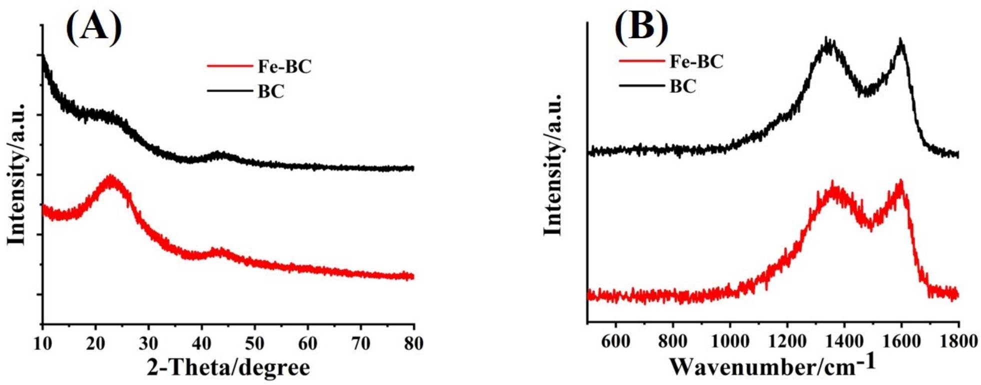

Figure S7. XRD (A) and Raman (B) spectrums of the Fe-BC and BC.

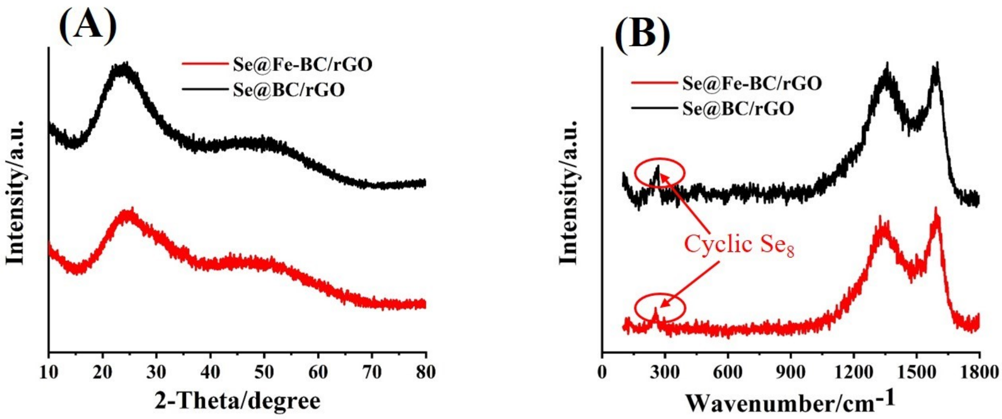

Figure S8. XRD (A) and Raman (B) spectrums of the Se@Fe-BC/rGO and Se@BC/rGO.

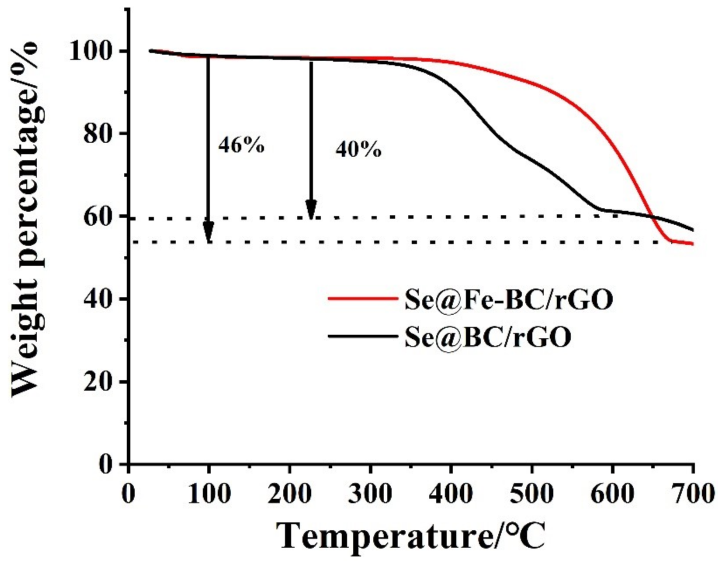

Figure S9. TG curves of the Se@Fe-BC/rGO and Se@BC/rGO in a pure N_2 atmosphere.

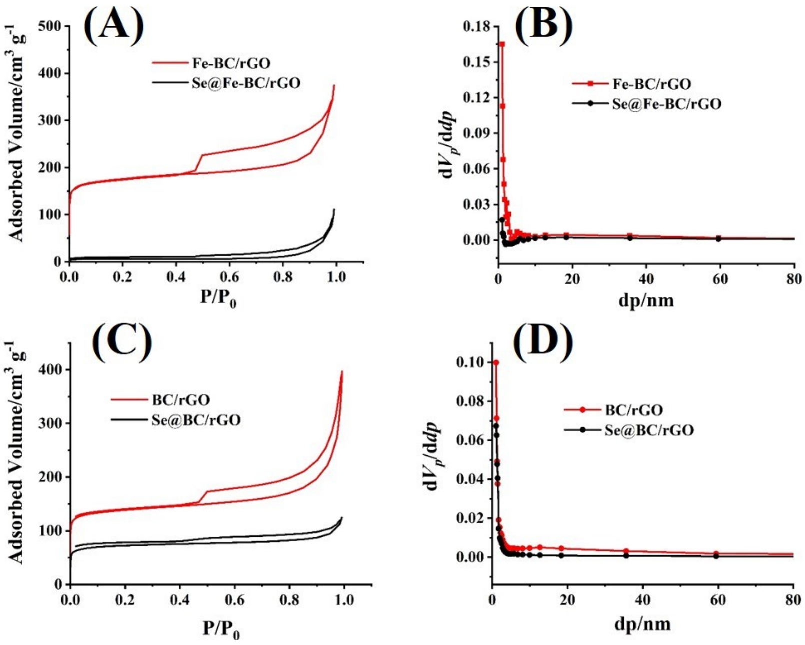

Figure S10. (A) N_2 adsorption/desorption isotherms and (B) pore-size distribution curves of the Fe-BC/rGO and Se@Fe-BC/rGO. (C) N_2 adsorption/desorption isotherms and (D) pore-size distribution curves of the BC/rGO and Se@BC/rGO.

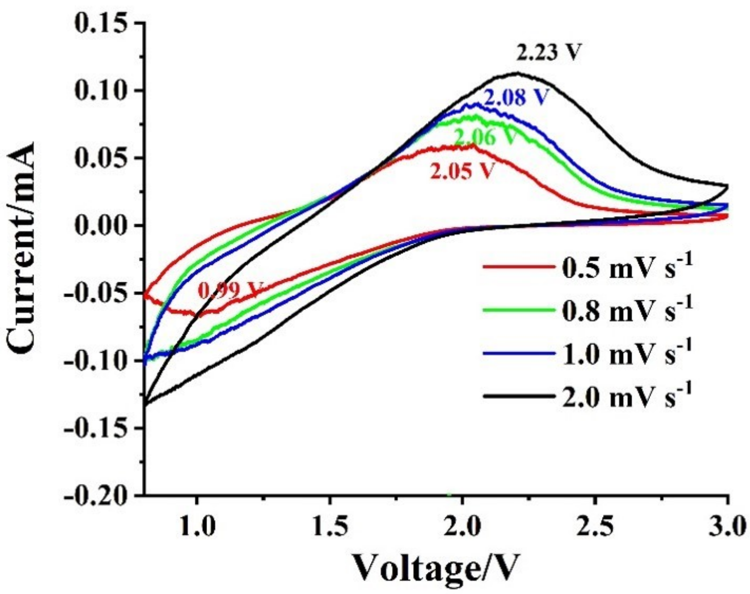

Figure S11. CV curves of the Se@BC/rGO at sweep rate from 0.5-2.0 mV s^{-1} at voltage range of 0.8-3.0V.

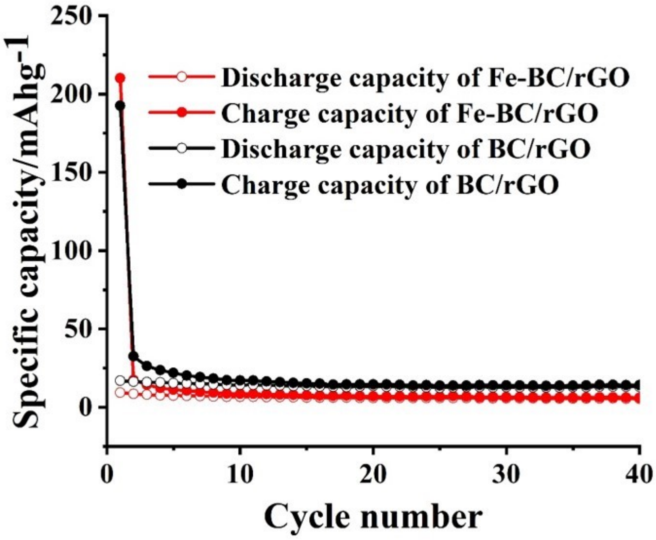

Figure S12. Electrochemical performance of the Fe-BC/rGO and BC/rGO at a current density of 0.1 A g^{-1}.

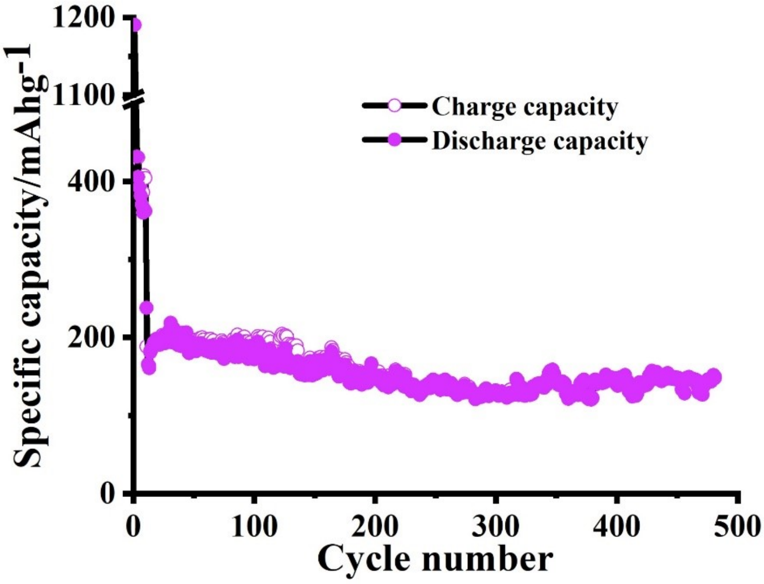

Figure S13. Long-term cycling performance of Se@Fe-BC/rGO.

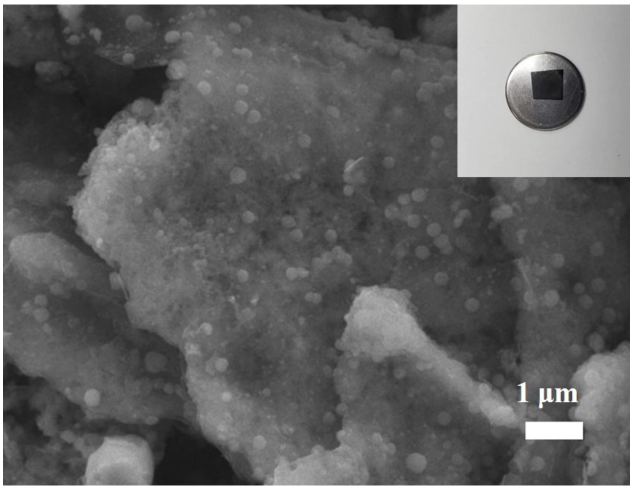

Figure S14. SEM images of the Se@Fe-BC/rGO after extending cycles (inset is the photograph of Se@Fe-BC/rGO electrode after extending cycles).

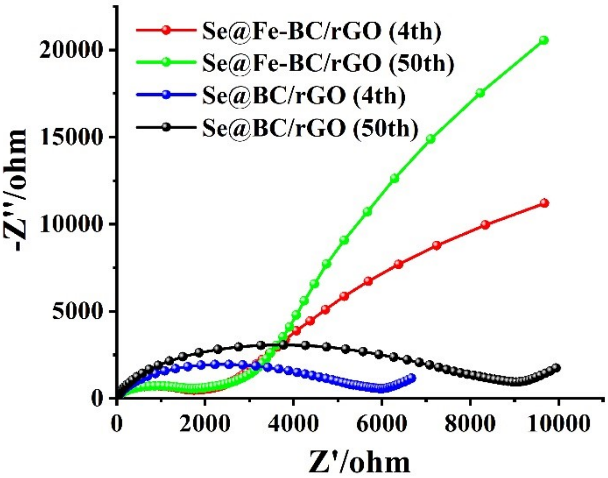

Figure S15. EIS of the Se@Fe-BC/rGO and Se@BC/rGO after 4 cycles and 50 cycles.

Table S1. Comparison between the as-prepared Se@Fe-BC/rGO electrode with the recent reported electrodes for Na-Se batteries.

Cathode	S loading	Current density	Retained capacity	Reference

	(mg cm^{-2})	(A g^{-1})	(mAh g^{-1})	
Se@Fe-BC/rGO	**~1.0**	**0.1**	**568 mAh g^{-1} after 300 cycles**	**This work**
SC@Se-25Al_2O_3	~1.2	0.05	548 mAh g^{-1} after 140 cycles	Nano Energy 43 (2018) 317-325
Se@NOPC-CNT	~1.5	0.1	582 mAh g^{-1} after 200 cycles	Adv. Mater. 30 (2018) 1805234
Se/N-HRMC	~1.0	0.27	611 mAh g^{-1} after 200 cycles	J. Mater. Chem. A 6 (2018) 22790-22797
Se@PCNFs	~0.8	0.1	520 mAh g^{-1} after 80 cycles	Adv. Energy Mater. 5 (2015) 1401377

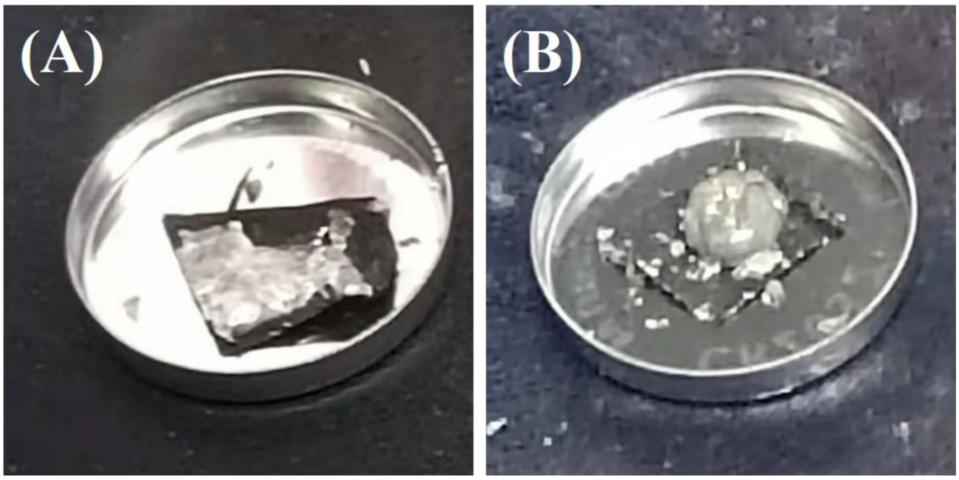

Figure S16. Molten Na test on the surfaces of Fe-BC/rGO film (A) and BC/rGO film (B), respectively. The molten Na metal can spread out on the surface of Fe-BC/rGO film, while retaining the sphere shape on the surface of BC/rGO film, indicating Fe-BC/rGO film has a much better wettability to Na metal than that of BC/rGO film.

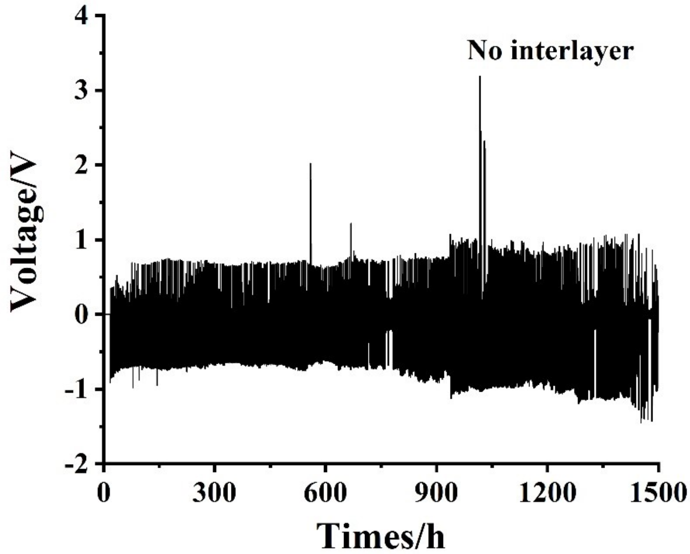

Figure S17. Cycling performance of Na symmetrical cells without any interlayer material cycled at 1 mA cm^{-2} with a fixed capacity of 1 mAh cm^{-2}.

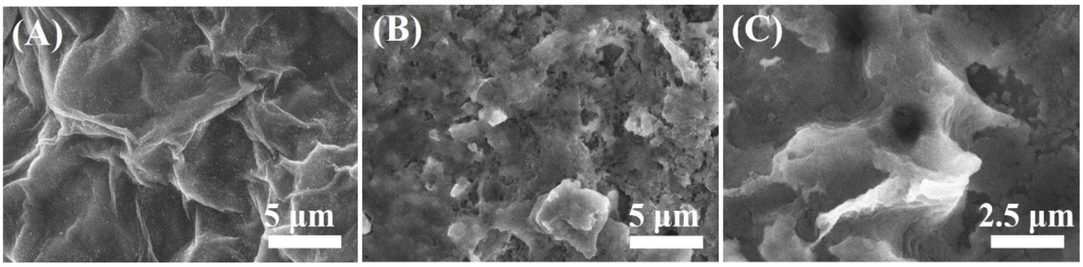

Figure S18. SEM images of the BC/rGO film before (A) and after the 100th cycles (B) at 1 mA cm^{-2} with a fixed capacity of 1 mAh cm^{-2}. (C) SEM images of Na electrodes with BC/rGO interlayer after 100 cycles at 1 mA cm^{-2} with a fixed stripping/plating capacity of 1 mAh cm^{-2}.

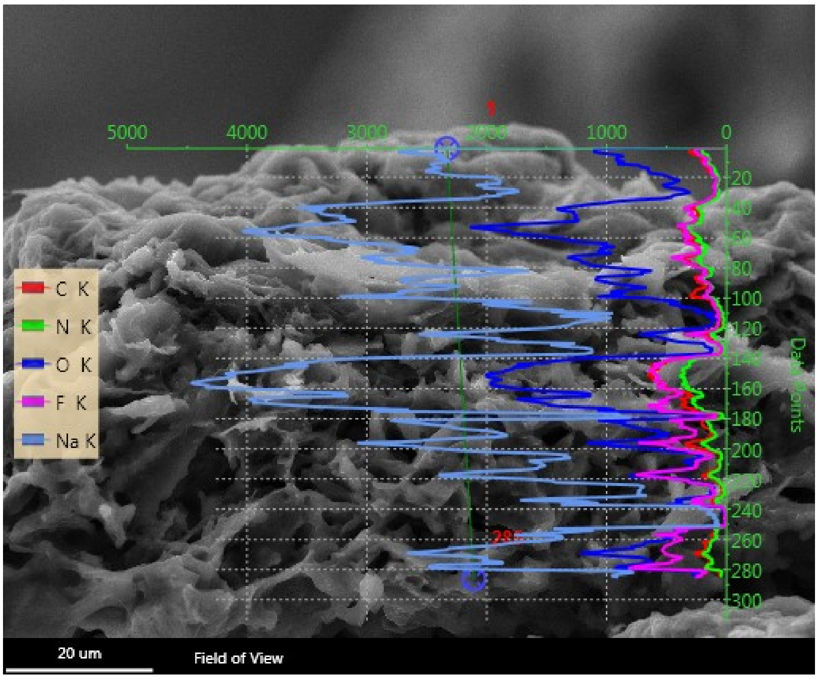

Figure S19. Elemental line sweep of the BC/rGO interlayer after the 100th discharge.

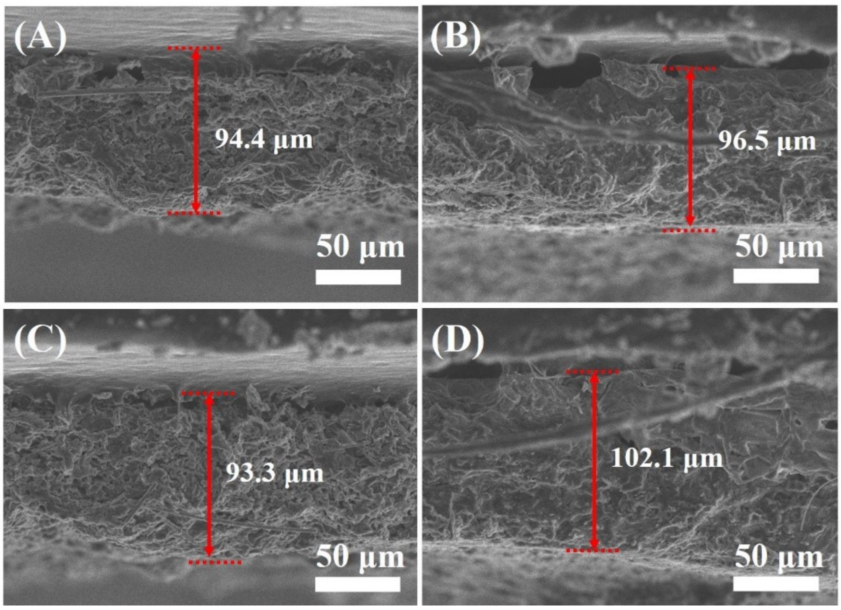

Figure S20. Cross-section SEM images of the Fe-BC/rGO film before (A) and after (B) 100 cycles at 1 mA cm^{-2} with a fixed capacity of 1 mAh cm^{-2}. Cross-section SEM images of the BC/rGO film before (C) and after (B) 100 cycles at 1 mA cm^{-2} with a fixed capacity of 1 mAh cm^{-2}.