Supporting Information

ZIF-L derived carbon flower with in-situ grown CNTs accelerates the reaction kinetics of Li-Se batteries

Jia-Le He[a,†], Liang Wu[b,†], Qian-Yu Gao[a], Mei-Tong Wei[a, c], Yi-Xun Liu[a], Zhi-Yi Hu[a, c], Jing Liu[a], Yu Li[a,*], Bao-Lian Su[a, d,*]

[a] State Key Laboratory of Advanced Technology for Materials Synthesis and Processing, Wuhan University of Technology, 122 Luoshi Road, 430070 Wuhan, Hubei, China.

[b] School of Automotive Engineering, Xiangyang Polytechnic, 18 Longzhong Road, 441050, Xiangyang, Hubei, China.

[c] Nanostructure Research Centre (NRC), Wuhan University of Technology, 122 Luoshi Road, 430070 Wuhan, Hubei, China.

[d] Laboratory of Inorganic Materials Chemistry (CMI), University of Namur, Namur B-5000, Belgium.

[†] These authors contributed equally to this work.

[*] Corresponding authors. Email: yu.li@whut.edu.cn (Y. Li), bao-lian.su@unamur.be (B.-L. Su)

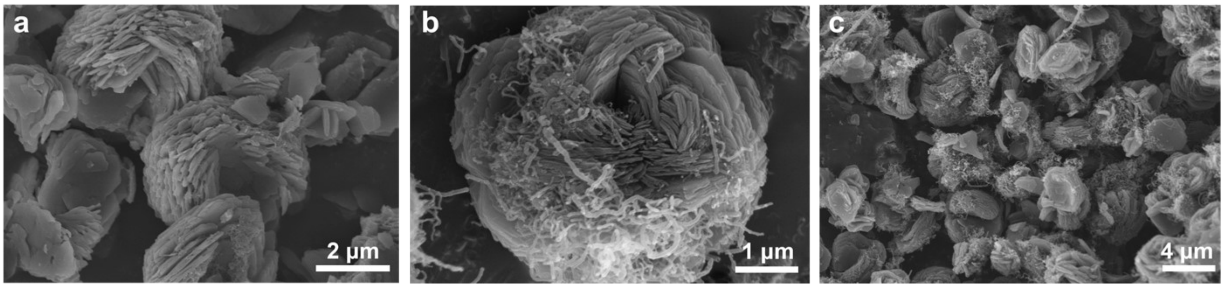

Fig. S1 SEM images of (a) Fe-ZIF-L-10, (b) CNTs@HPC-10 and (c) Se/CNTs@HPC-10.

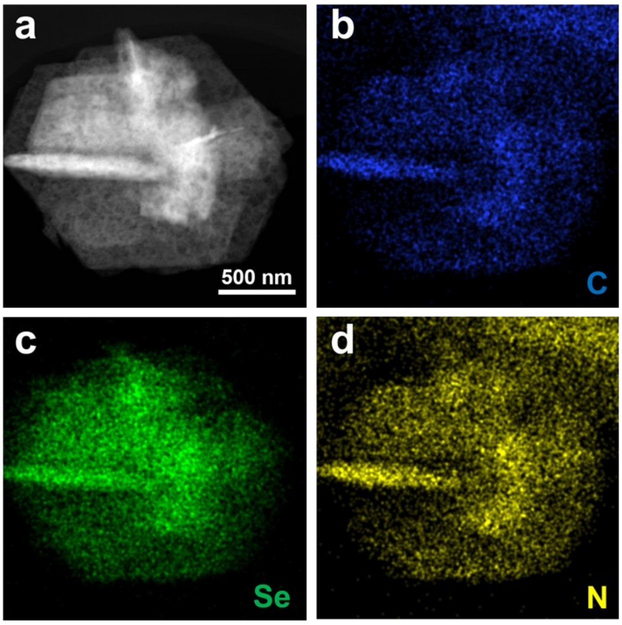

Fig. S2 (a-d) HAADF-STEM image and element distributions of C, Se and N in Se/HPC.

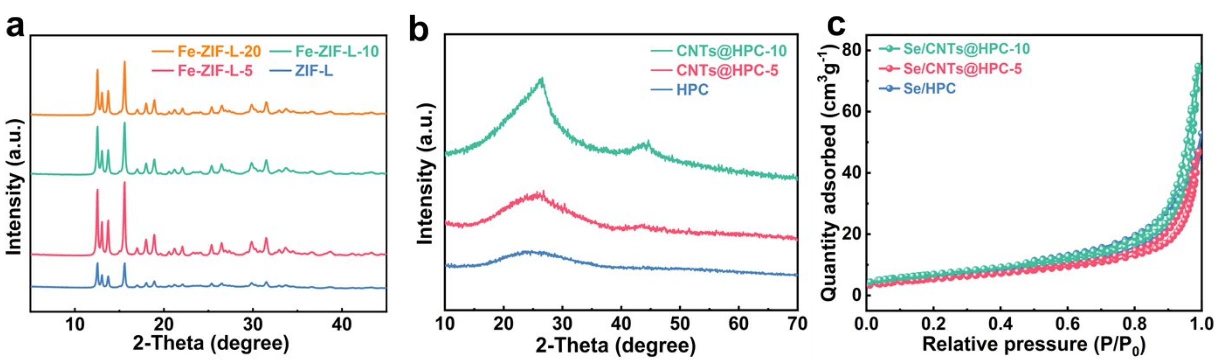

Fig. S3 (a) XRD patterns of the precursors. (b) XRD patterns after carbonization. (c) N_2 adsorption-desorption isotherms after Se encapsulation.

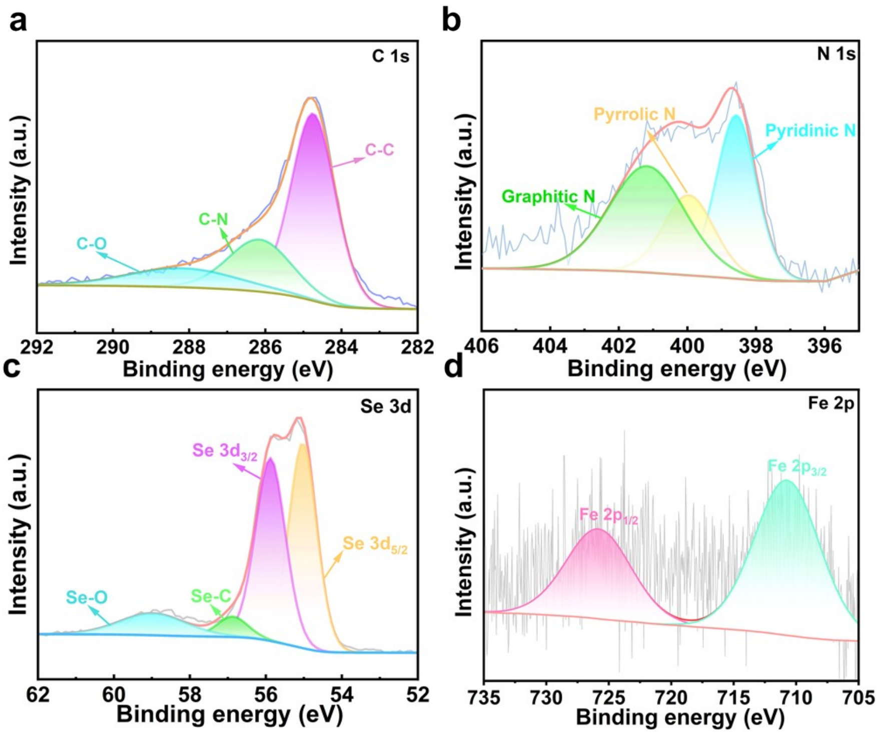

Fig. S4 (a) C 1s, (b) N 1s and (c) Se 3d XPS spectra of Se/HPC. (d) Fe2p XPS spectrum of Se/CNTs@HPC-5.

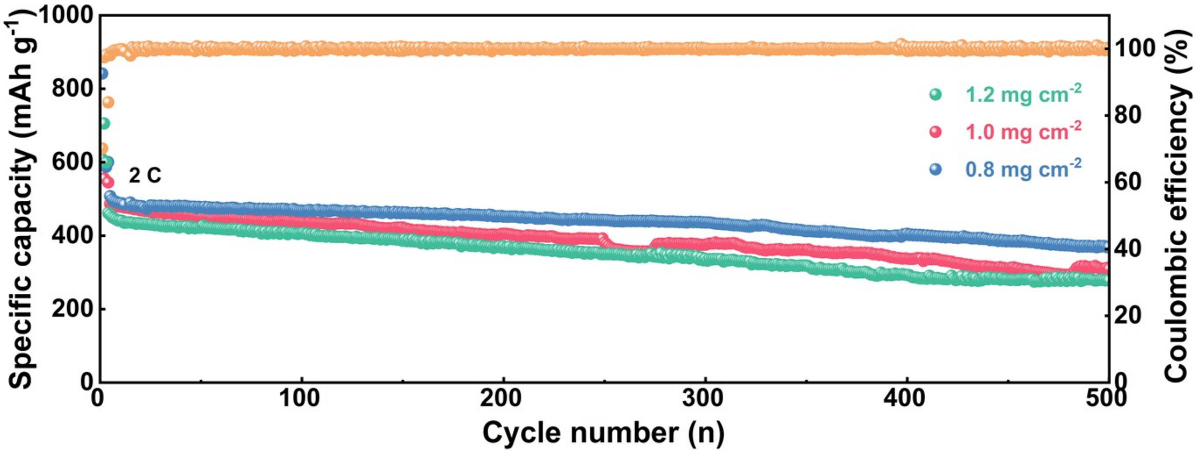

Fig. S5 Cycling performance of Se/CNTs@HPC-5 cathodes with different areal mass loading of Se.

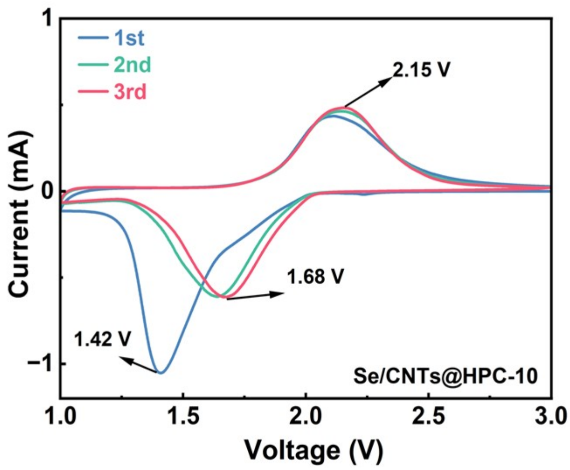

Fig. S6 CV curves of Se/CNTs@HPC-10 cathode at the scan rate of 0.2 mV s^{-1}.

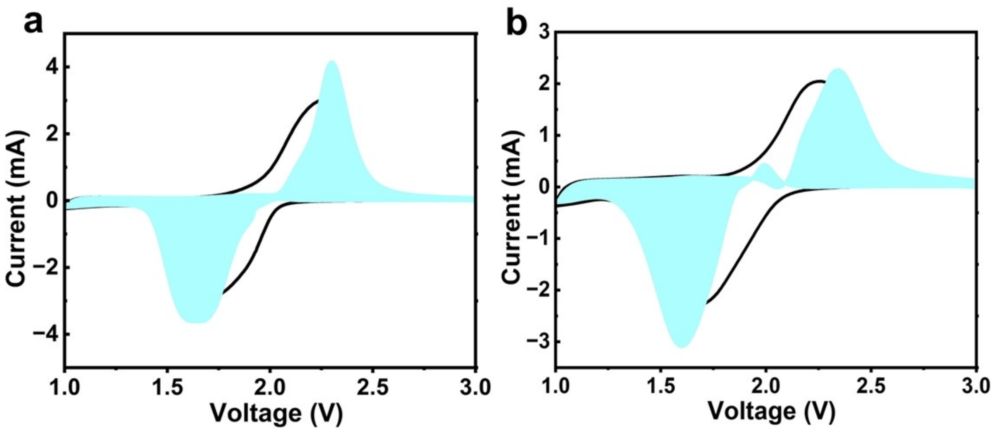

Fig. S7 Capacitive contribution at the scan rate of 0.5 mV s^{-1} for (a) Se/HPC-5 and (b) Se/HPC, respectively.

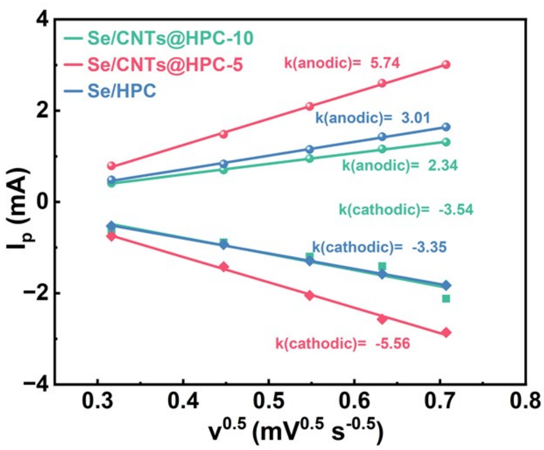

Fig. S8 Linear fitting of peak currents versus square root of the scan rates.

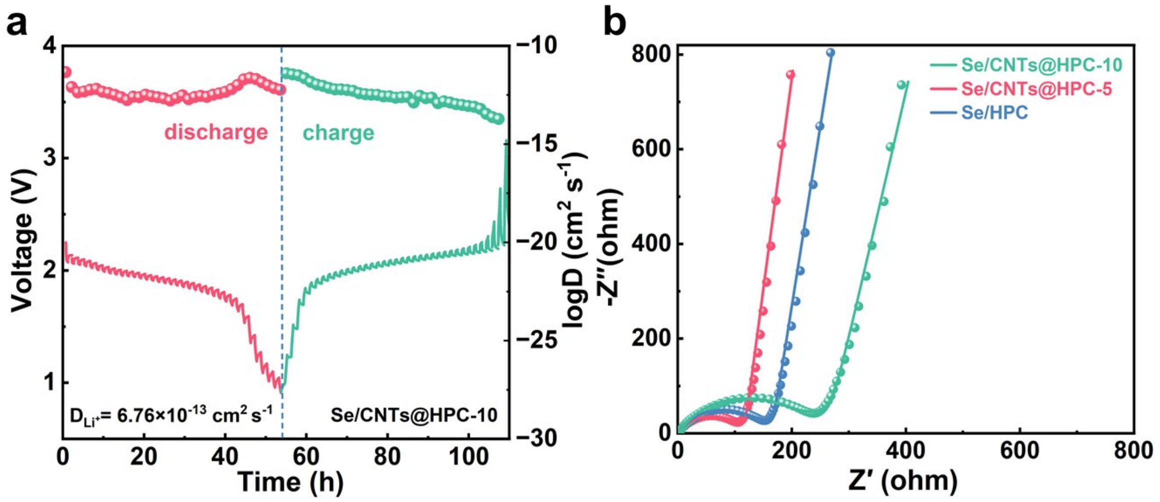

Fig. S9 (a) GITT curves and Li^+ diffusion coefficient of Se/CNTs@HPC-10. (b) EIS spectra of different cathodes after cycling 10 cycles at 1 C.

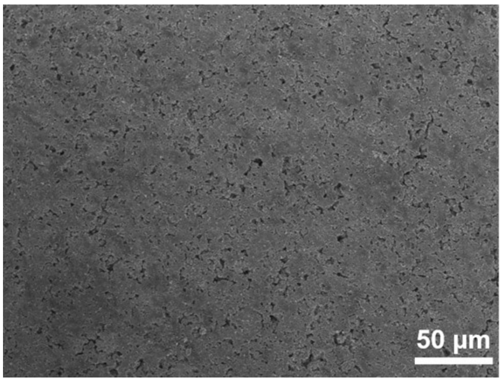

Fig. S10 SEM image of Se/CNTs@HPC-5 electrode after 100 cycles at 1 C.

Table S1 Electrochemical performances of the reported Se/C composites

Materials	Current rate (C)	Cycle number (n)	Reversible capacity (mAh g^{-1})	Areal loading (mg cm^{-2})	Reference
Se/CNTs@HPC-5	**0.5** **5**	**350** **400**	**606** **355**	**1.0**	**This work**
Se/C	0.15	250	430	1.2	[1]
Se/HPNC	1	500	410	-	[2]
Se@NPC-NS	0.5	225	585	0.72	[3]
Se@NHCS	0.5	1000	443	1.0	[4]
Se@CNTs@MPC	0.1	100	596	-	[5]
Se/CNTs microsphere	1	500	440	-	[6]
APPC/Se@PDA	5	1400	500	0.8-4.0	[7]
Se/Co-NC	1	200	480	1.0	[8]
Se@LHPC	0.5	450	500	0.47	[9]
CSe@HNCNFs	0.2	100	699	27.12	[10]

Table S2 EDX elemental analysis of Se/CNTs@HPC-5

Z	Element	Family	Atomic Fraction (%)	Atomic Error (%)	Mass Fraction (%)	Mass Error (%)
6	C	K	47.12	6.78	15.48	1.48
7	**N**	**K**	**9.85**	**2.43**	**3.77**	**0.84**
8	O	K	6.49	1.60	2.84	0.63
30	Zn	K	2.72	0.53	4.86	0.80
34	Se	K	33.83	6.55	73.05	11.75

Notes and Reference

1 C. Luo, J. J. Wang, L. M. Suo, J. F. Mao, X. L. Fan and C. S. Wang, *J. Mater. Chem. A*, 2015, **3**, 555-561.

2 W. N. Deng, Y. H. Li, D. F. Xu, W. Zhou, K. X. Xiang and H. Chen, *Rare Metals*, 2022, **41**, 3432-3445.

3 X. W. Luo, M. R. Zhou, M. J. Ran, D. X. Xun, J. L. He, Z. Y. Hu, H. S. H. Mohamed, J. Liu, L. H. Chen, Y. Li and B. L. Su, *Chem. Eng. J.*, 2024, **488**, 150885.

4 B. Kalimuthu and K. Nallathamby, *ACS Appl. Mater. Interfaces*, 2017, **9**, 26756-26770.

5 S. Xin, L. Yu, Y. You, H. P. Cong, Y. X. Yin, X. L. Du, Y. G. Guo, S. H. Yu, Y. Cui and J. B. Goodenough, *Nano Lett.*, 2016, **16**, 4560-4568.

6 N. X. Feng, K. X. Xiang, L. Xiao, W. H. Chen, Y. R. Zhu, H. Y. Liao and H. Chen, *J. Alloy. Compd.*, 2019, **786**, 537-543.

7 Y. Q. Cao, F. F. Lei, Y. L. Li, S. L. Qiu, Y. Wang, W. Zhang and Z. T. Zhang, *J. Mater. Chem. A*, 2021, **9**, 16196-16207.

8 F. Gao, X. A. Yue, X. Y. Xu, P. Xu, F. Zhang, H. S. Fan, Z. L. Wang, Y. T. Wu, X. Liu and Y. Zhang, *Rare Metals*, 2023, **42**, 2670-2678.

9 P. F. Lu, F. Y. Liu, F. Zhou, J. Q. Qin, H. D. Shi and Z. S. Wu, *J. Energy Chem.*, 2021, **55**, 476-483.

10 J. Zhou, M. X. Chen, T. Wang, S. Y. Li, Q. S. Zhang, M. Zhang, H. J. Xu, J. L. Liu, J. F. Liang, J. Zhu and X. F. Duan, *Iscience*, 2020, **23**, 20.