Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.
This journal is © The Royal Society of Chemistry 2017

Electronic Supporting Information

Green synthesis of Se/HPCF-rGO composite towards Li - Se batteries with excellent long-term cycling performance

Lingxing Zeng,[a] Xi Chen,[a] Renpin Liu,[a] Liangxu Lin,[d] Cheng Zheng,[b] Lihong Xu, [a] Fenqiang Luo,[a] Qingrong Qian,[*a, c] Qinghua Chen,[a, c] and Mingdeng Wei [*b]

[a] Engineering Research Center of Polymer Green Recycling of Ministry of Education, Fujian Normal University, Fuzhou, Fujian 350007, China.

[b] Institute of Advanced Energy Materials, Fuzhou University, Fuzhou, Fujian 350002, China.

[c] Fujian Key Laboratory of Pollution Control & Resource Reuse, Fuzhou, Fujian 350007, China.

[d] The State Key Laboratory of Refractories and Metallurgy, Wuhan University of Science and Technology, Wuhan 430081, China.

E-mail: qrqian@fjnu.edu.cn, Tel: +86-591-83465156; wei-mingdeng@fzu.edu.cn, Tel: +86-591-83753180.

Table S1 The BET specific surface area and pore volume of LN-PAN composite fibers after different synthesis process.

LN:PAN sample	S_{BET} (m^2/g)	V_{total} (cm^3/g)
6:4 before immersion	3.1	0.009
6:4 after immersion	12.8	0.113
6:4 after carbonization	266.5	0.26
6:4 after activation	1058	0.55

Table S2 The BET specific surface area and pore volume of porous carbon fibers obtained from different LN : PAN (mass ratio) precursor.

LN:PAN sample	S_{BET} (m^2/g)	V_{total} (cm^3/g)
5:5 after activation	947	0.53
6:4 after activation	1058	0.55
7:3 after activation	1007	0.52
0:10 after activation	65	0.11

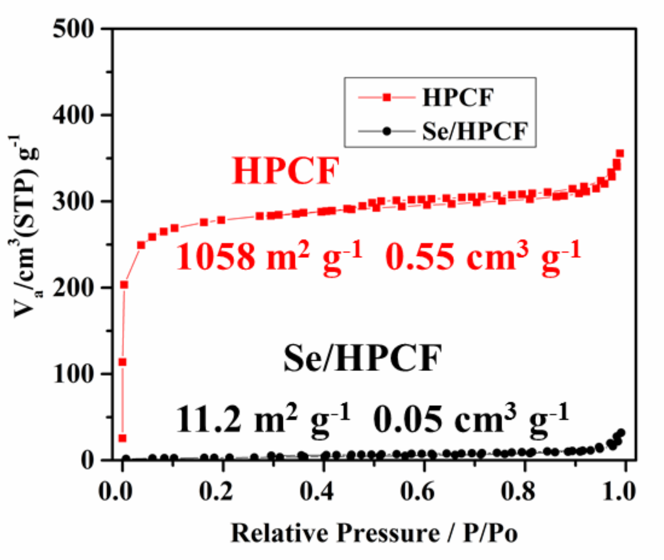

Fig. S1 N_2 adsorption-desorption isotherms for Se/HPCF and HPCF.

Table S3 A comparison of cycling and rate performance of Se-C composites reported in the literatures with present work.

Electrode Description	Se content (wt%)	Cycling performance			Rate performance		Ref.
		Current density	Final discharge Capacity (mAh $g^{-1}{}_{Se}$)	Cycle numbers	Current density	Capacity retention (mAh $g^{-1}{}_{Se}$)	
Se/mesoporous carbon spheres	30	0.25 C	480	1000	0.1 C 5 C	500 229	S1
Se/CMK-3	49	0.1C	600	50	0.1 C 1 C	670 432	S2
Se/microporous carbon spheres	70.5	1 C	780	1200	0.5 C 20 C	605 386	S3
Se/MPCS	60	0.25 C	320	500	0.25 C 5 C	640 430	S4
Se/N-containing hierarchical porous carbon	56.2	2 C	305	60	0.2 C 5 C	500 261	S5
Se-confined microporous carbon	51	1 C	249	3000	0.1 C 5 C	500 241	S6
Se/PHCBs	~50	0.1 C	606	120	0.1 C 1 C	691 432	S7
Se/HPCA	56	0.5 C	309	100	1 C 5 C	400 301	S8
Se/MCN-RGO	62	1 C	385	1300	0.1 C 3 C	650 274	S9
Selenium–metal complex-derived porous carbon	72	5 C	417	1000	0.1 C 20 C	641 510	S10
Se/porous carbon nanofibers	52.3	0.74 C	516	900	0.147 C 5.9 C	637 306	S11
Se-CDC	62	0.2 c	420	150	0.1C 2C	460 310	S12
Se@N-doped MPCS	~50	0.93 C	510	1000	0.09 C 4.7 C	635 440	S13
Se/PAN-CNT	35	0.74 C	517	500	1.47 C	485	S14
Se/carbon-rich core-shell	43.2	0.5 C	181	80	0.5 C 3 C	558 155	S15
Se/PTCDA-derived carbon	54	0.147 C	430	250	1.77 C	280	S16
MWCNT/Se	56.17	0.5 C	356	100	0.5 C 4 C	646 358	S17
Se/N-doped carbon sponges	50	0.5C	443	200	5 C	287	S18
3DG-CNT@Se	51	0.2 C	504	150	0.2 C 1 C 10 C	609 558 193	S19

Se/microporous carbon	51.4	5 C	511	1000	20 C	569	S20
Se/CNSs	60	0.5C	376	1000	0.1C 10C	700 ~390	S21
Se-NCSs	56	0.1C 1C	480 301	100 500	0.2C 2C	475 275	S22
Se/CMCs	~50	0.2C	425.2	100	0.2C 5C	420 218	S23
Se@CNx nanobelts	62.5	1.2 C	453	400	2.36 C	474	S24
Se/hollow carbon	59.5	0.74 C	525	1000	2.9 C	496	S25
Se/HPCF-rGO	57	2 C 5 C 10 C	418 287 208	1000 3000 5000	0.2 C 5 C	584 408	This work

Refs

[S1] C. Luo, Y. H. Xu, Y. J. Zhu, Y. H. Liu, S. Y. Zheng, Y. Liu, A. Langrock and C. S. Wang, *ACS Nano*, 2013, **7**, 8003−8010.
[S2] C. P. Yang, S. Xin, Y. X. Yin, H. Ye, J. Zhang and Y. G. Guo, *Angew. Chem. In. Ed.*, 2013, **52**, 8363−8367.
[S3] Z. Li, L. X. Yuan, Z. Q. Yi, Y. Liu and Y. H. Huang, *Nano Energy*, 2014, **9**, 229−236.
[S4] H. Ye, Y. X. Yin, S. F. Zhang and Y. G. Guo, *J. Mater. Chem. A*, 2014, **2**, 13293−13298.
[S5] Y. H. Qu, Z. A. Zhang, S. F. Jiang, X. W. Wang, Y. Q. Lai, Y. X. Liu and J. Li, *J. Mater. Chem. A*, 2014, **2**, 12255–12261.
[S6] Y. X. Liu, L. Si, X. S. Zhou, X. Liu, Y. Xu, J. C. Bao and Z. H. Dai, *J. Mater. Chem. A*, 2014, **2**, 17735-17739.
[S7] J. J. Zhang, L. Fan, Y. C. Zhu, Y. H. Xu, J. W. Liang, D. H. Wei and Y. T. Qian, *Nanoscale*, 2014, **6**, 12952−12957.
[S8] S. F. Jiang, Z. A. Zhang, Y. Q. Lai, Y. Q. Qu, X. W. Wang and J. Li, *J. Power Sources*, 2014, **267**, 394–404.
[S9] K. Han, Z. Liu, J. Shen, Y. Lin, F. Dai and H. Ye, *Adv. Funct. Mater.*, 2015, **25**, 455−463.
[S10] X. N. Li, J. W. Liang, Z. G. Hou, W. Q. Zhang, Y. Wang, Y. C. Zhu and Y. T. Qian, *Adv. Funct. Mater.*, 2015, **25**, 5229−5238.
[S11] L. C. Zeng, W. C. Zeng, Y. Jiang, X. Wei, W. H. Li, C. L. Yang, Y. W. Zhu and Y. Yu, *Adv. Energy Mater.*, 2015, **5**, 1401377.
[S12] J. T. Lee, H. Kim, M. Oschatz, D. C. Lee, F. Wu, H. T. Lin, B. Zdyrko, W. I. Cho, S. Kaskel and G. Yushin, *Adv. Energy Mater.*, 2015, **5**, 1400981.
[S13] Y. Jiang, X. J. Ma, J. K. Feng and S. L. Xiong, *J. Mater. Chem. A*, 2015, **3**, 4539-4546.
[S14] L. C. Zeng, X. Wei, J. Q. Wang, Y. Jiang, W. H. Li and Y. Yu, *J. Power Sources*, 2015, **281**, 461−469.
[S15] Z. A. Zhang, X. Yang, Z. P. Guo, Y. H. Qu, J. Li and Y. Q. Lai, *J. Power Sources*, 2015, **279**, 88−93.
[S16] 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.
[S17] X. W. Wang, Z. A. Zhang, Y. H. Qu, G. C. Wang, Y. Q. Lai and J. Li, *J. Power Sources*, 2015, **287**, 247−252.
[S18] Z. Li and L. Yin, *Nanoscale*, 2015, **7**, 9597-9606.
[S19] J. R. He, Y. F. Chen, W. Q. Lv, K. C. Wen, P. J. Li, Z. G. Wang, W. L. Zhang, W. Qin and W. D. He, *ACS Energy Lett.*, 2016, **1**, 16−20.
[S20] J. J. Zhou, J. Yang, Z. X. Xu, T. Zhang, Z. Y. Chen and J. L. Wang, *J. Mater. Chem. A*, 2017, **5**, 9350−9357.
[S21] S. F. Zhang, W. P. Wang, S. Xin, H. Ye, Y. X. Yin and Y. G. Guo, *ACS Appl. Mater. Interfaces*, 2017, **9**, 8759−8765.
[S22] H. L. Lv, R. P. Chen, X. Q. Wang, Y. Hu, Y. R. Wang, T. Chen, L. B. Ma, G. Y. Zhu, J. Liang, Z. X. Tie, J. Liu and Z. Jin, *ACS Appl. Mater. Interfaces*, 2017, **9**, 25232-25238.
[S23] T. Liu, M. Jia, Y. Zhang, J. Han, Y. Li, S. J. Bao, D. Y. Liu, J. Jiang and M. W. Xu, *J. Power Sources*, 2017, **341**, 53−59.
[S24] Q. F. Cai, Y. Y. Li, L. wang, Q. W. Li, J. Xu, B. Gao, X. M. Zhang, K. F. Huo and P. K. Chu, *Nano Energy*, 2017, **32**, 1–9.
[S25] Y. J. Hong and Y. C. Kang, *Carbon*, 2016, **111**, 198−206.

Table S4 Impedance parameters calculated from an equivalent circuit model.

Sample	R_s/Ω	R_f/Ω	R_{ct}/Ω
Se/HPCF-rGO	7.2	17.3	21.2
Se/MPCF-rGO	4.5	48.2	96.3
Se/HPCF	3.1	28.7	51.1

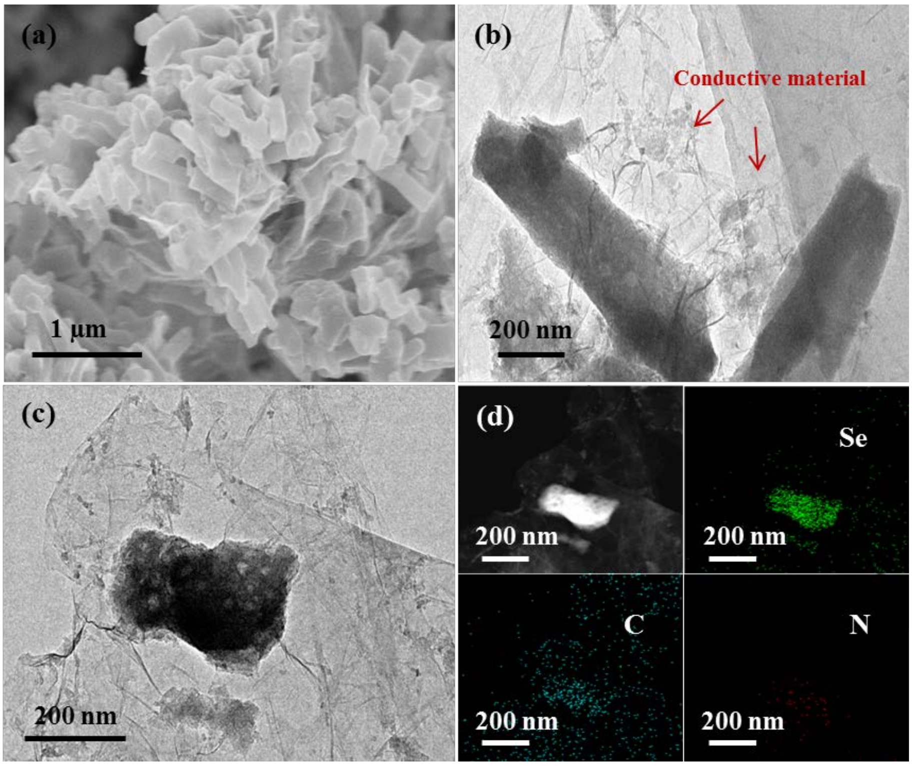

Fig. S2 (a) SEM and (b-c) TEM images of Se/HPCF-rGO composite after 200 cycles test at 0.5 C and (d) the corresponding elemental mapping results for Se, C and N.