Supplementary Information

Graphene-encapsulated selenium@polyaniline nanowires with three-dimensional hierarchical architecture for high-capacity aluminum-selenium batteries

Haiping Lei,[a] Jiguo Tu,[*b] Suqin Li,[a] Zheng Huang,[b] Yiwa Luo,[a] Zhijing Yu,[a] Shuqiang Jiao[*a,b]

[a] School of Metallurgical and Ecological Engineering, University of Science and Technology Beijing, Beijing 100083, PR China.

[b] State Key Laboratory of Advanced Metallurgy, University of Science and Technology Beijing, Beijing 100083, PR China.

Corresponding authors:

*E-mail addresses: sjiao@ustb.edu.cn (S. Jiao) guo15@126.com (J. Tu).

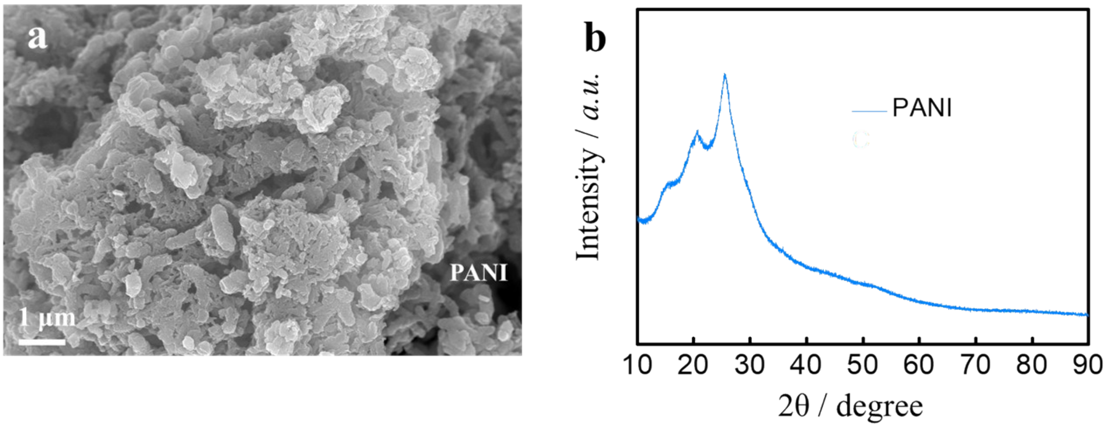

Fig. S1 (a) SEM image of PANI. (b) XRD pattern of PANI.

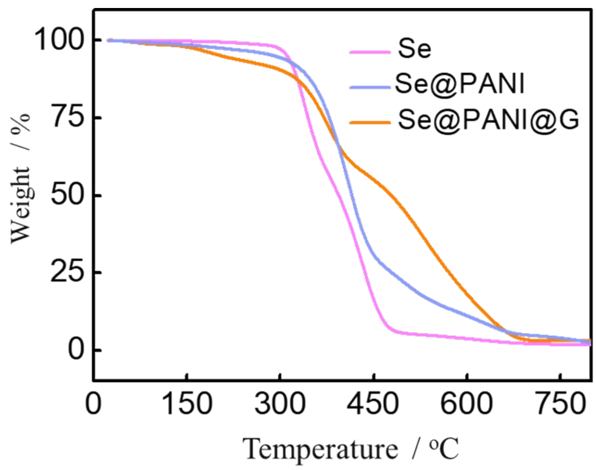

Fig. S2 TG curves of the as-prepared Se nanowires, Se@PANI, and Se@PANI@G.

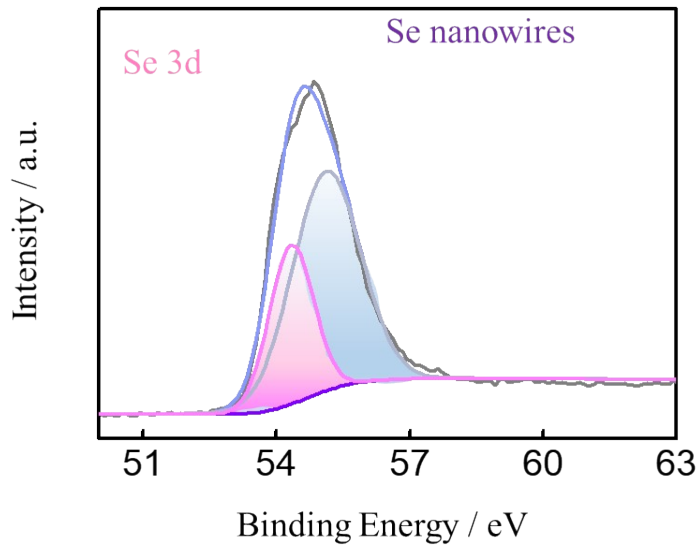

Fig. S3 Se 3d XPS spectra of as-prepared Se nanowires.

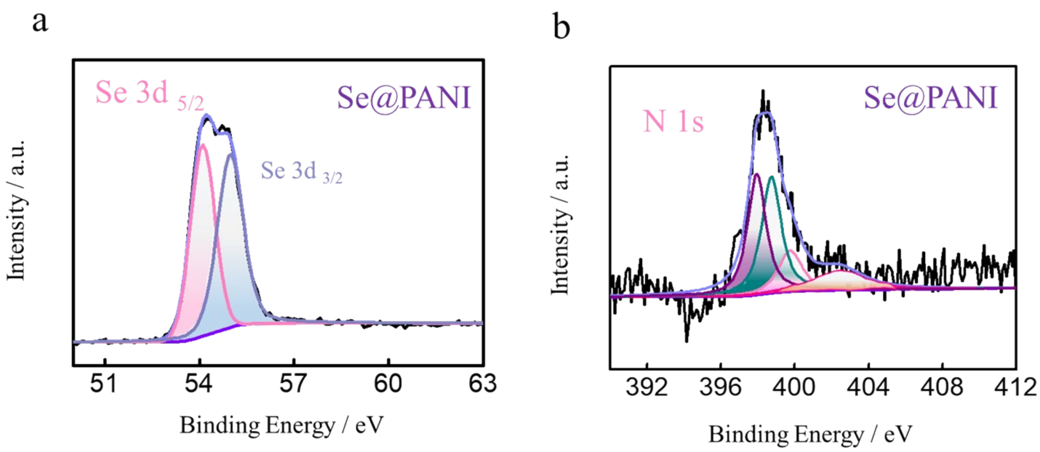

Fig. S4 (a) Se 3d XPS spectra of as-prepared Se@PANI. (b) N 1s XPS spectra of as-prepared Se@PANI.

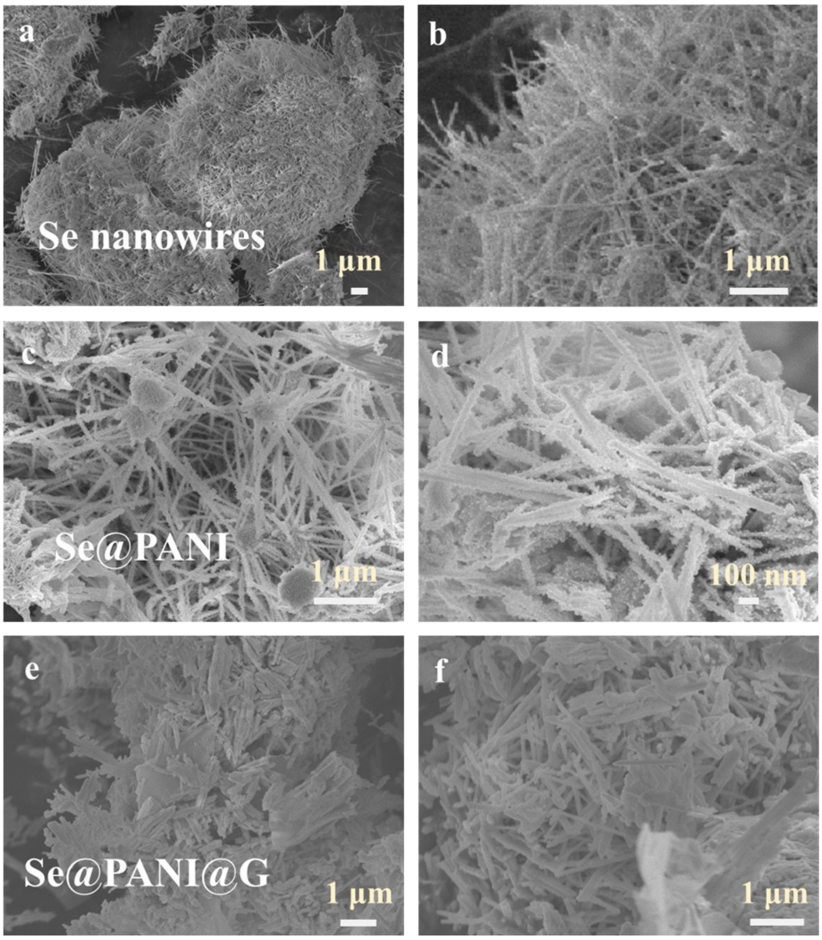

Fig. S5 (a,b) SEM images of as-prepared Se nanowires. (c,d) SEM images of as-prepared Se@PANI. (e,f) SEM images of as-prepared Se@PANI@G.

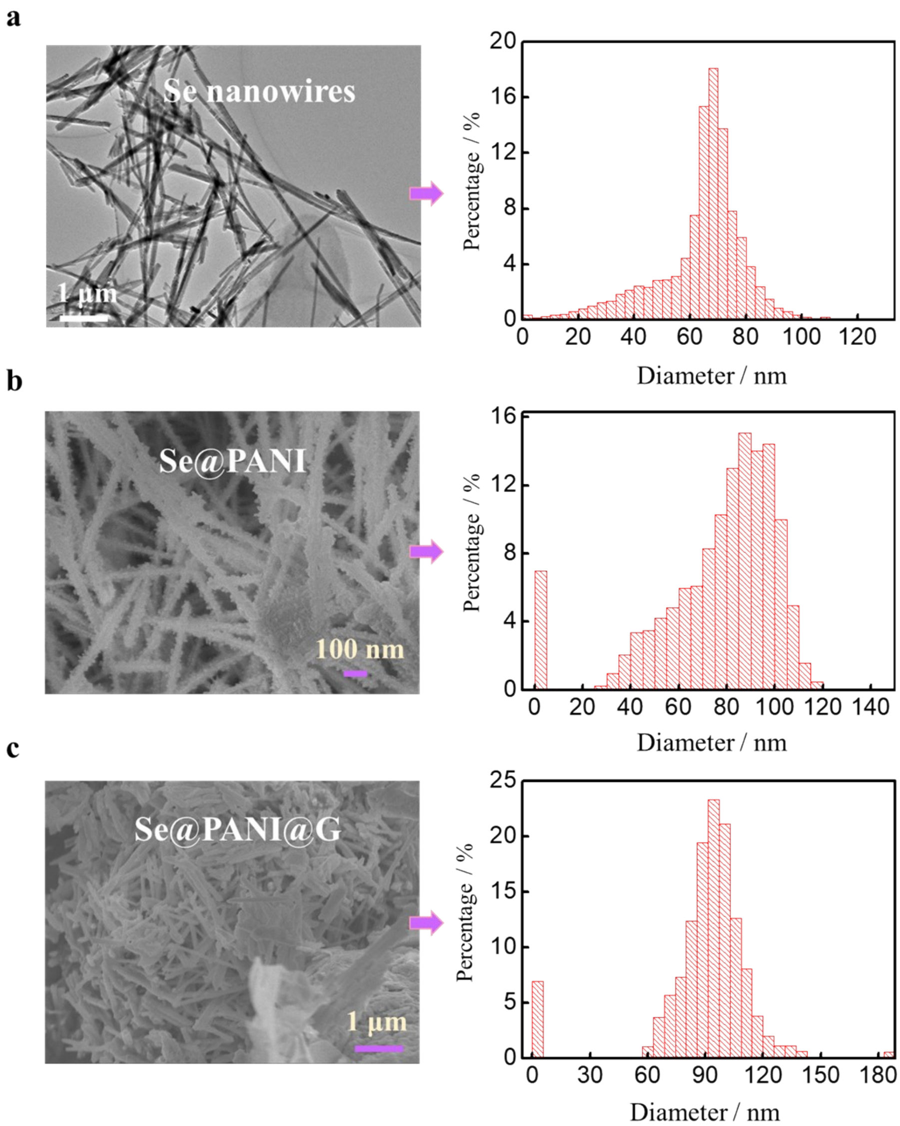

Fig. S6 (a) SEM images of as-prepared Se nanowires and the corresponding histogram of Se nanowires diameter. (b) SEM images of as-prepared Se@PANI and the corresponding histogram of Se@PANI diameter. (c) SEM images of as-prepared Se@PANI@G and the corresponding histogram of Se@PANI@G diameter.

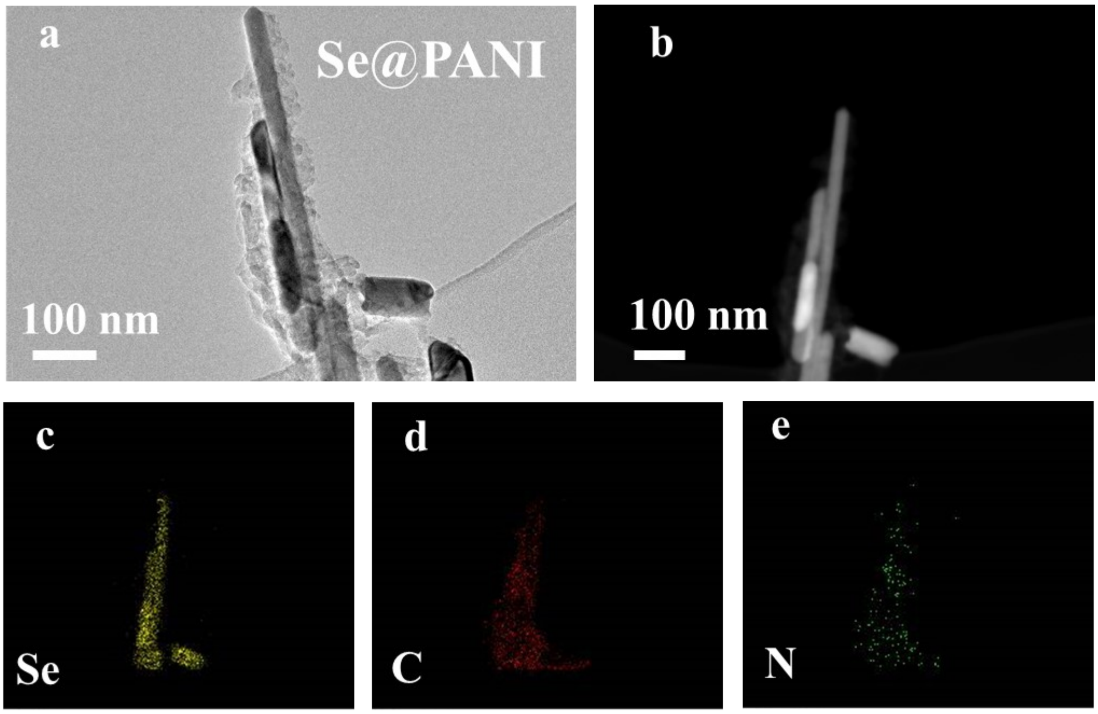

Fig. S7 (a) TEM images of Se@PANI. (b) HAADF (High-Angle Annular Dark Field)-STEM image of the Se@PANI nanowires. (c-e) The corresponding elemental mapping images.

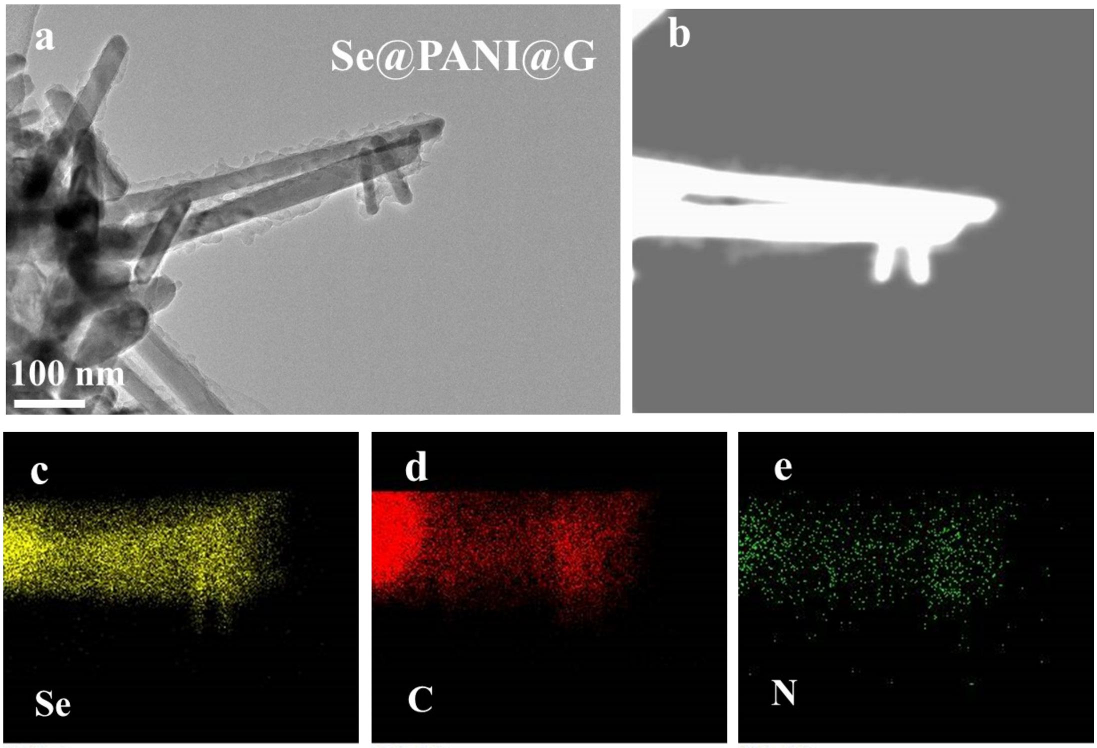

Fig. S8 (a) TEM images of Se@PANI@G. (b) HAADF-STEM image of the Se@PANI@G nanowires. (c-e) The corresponding elemental mapping images.

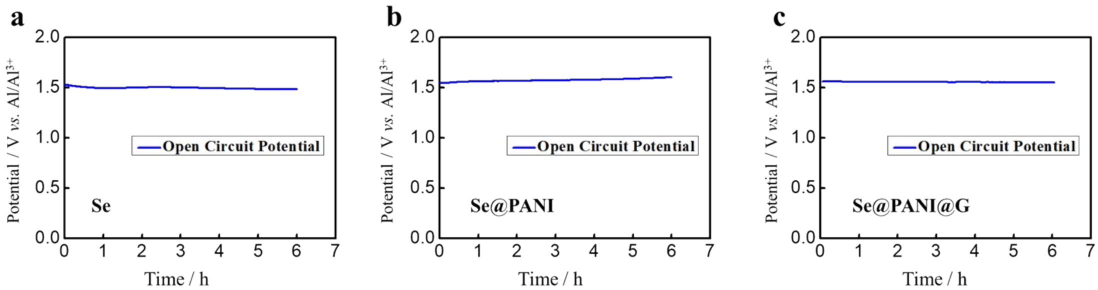

Fig. S9 (a) The open circuit potential of Al/Se battery before cycling. (b) The open potential of Al/Se@PANI battery before cycling. (c) The open potential of Al/Se@PANI@G battery before cycling.

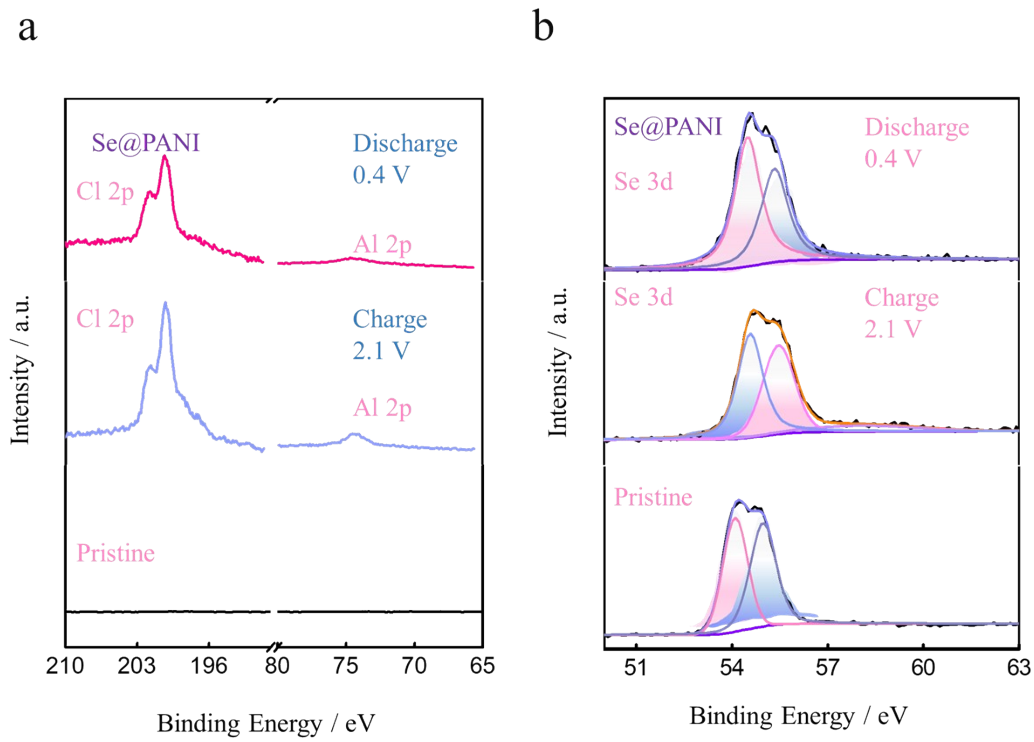

Fig. S10 (a) Al 2p, Cl 2p, and (b) Se 3d, XPS spectra of Se@PANI electrodes after charging to 2.1 V and discharging to 0.4 V.

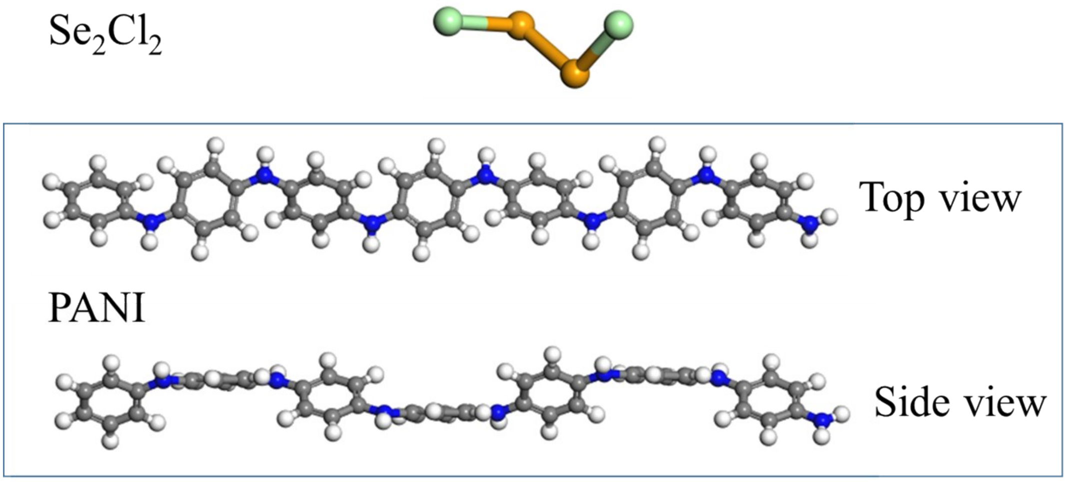

Fig. S11 The structures of Se_2Cl_2 and PANI.

PANI@G

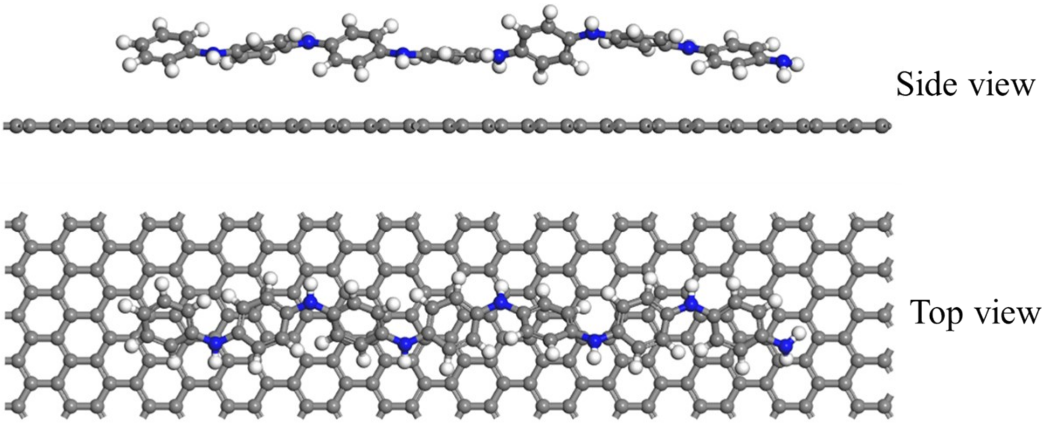

Fig. S12 The optimized structures of PANI@G.

Table S1 The total energies of Se_2Cl_2, PANI, PANI@G, PANI@Se_2Cl_2, and PANI@G@Se_2Cl_2.

	Total energy/eV
Se_2Cl_2	-155720.4302
PANI	-54531.86008
PANI@G	-236923.1305
PANI@Se_2Cl_2	-210254.4815
PANI@G@Se_2Cl_2	-392647.2731

Table S2 Comparison of electrochemical performances of Se@PANI@G positive electrode with previous Se-based positive electrodes.

Positive electrode	Electrolyte	Separator	Voltage range (V)	Discharge capacity (mAh g^{-1})	Current density (mA g^{-1})	Cycles
Se/graphene aerogel (Se/GA)[1]	$AlCl_3/Et_3NHCl$, 1.5:1 by mole	glass fiber(GF/D)	0.01-2.3	~176	1000	50
Se/GA[1]	$AlCl_3/Et_3NHCl$, 1.5:1 by mole	oxidizing CNT (O-CNT) modified separator	0.01-2.3	395	1000	200
MCF-7/Se[2]	$EMImCl/AlCl_3$, 1: 1.1 by mole		1.0-2.3	152	500	2000
TiO_2@Se-rGO[3]	$EMImCl/AlCl_3$, 1: 1.3 by mole	Whatman glass fiber (GF/C)	0.1-2.2	225.8	500	500
Se[4]	$EMImCl/AlCl_3$, 1: 1.3 by mole	CMK-3 modified separators	0.01-2.4	270	1000	500
Se nanowires grown directly on a flexible carbon cloth substrate (Se NWs@CC)[5]	Thiourea-$AlCl_3$		0.01-1.5	195	100	100
Se@CMK-3[6]	$EMImCl/AlCl_3$, 1: 1.3 by mole	Whatman GF/D	0.05-1.5	600	67.5	9
one-dimensional hollow Se@C nanotube (Se@CT)[7]	$EMImCl/AlCl_3$, 1: 1.3 by mole	Whatman glass fiber (GF/C)	0.5-2.3	162.9	500	200
Se nanowires and mesoporous carbon (Se/CMK-3)[8]	$EMImCl-AlCl_3$, 1:1.1 by mole	Glass fiber (Filtech)	1.0-2.3	124	200	50
This work (Se@PANI@G)	$EMImCl/AlCl_3$, 1: 1.3 by mole	glass fiber (GF/A)	0.4-2.1	164	200	160

References

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