Supporting Information for

Highly Reversible Li–Se Batteries with Ultra-Lightweight N,S-Codoped Graphene Blocking Layer

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Supplementary Figures

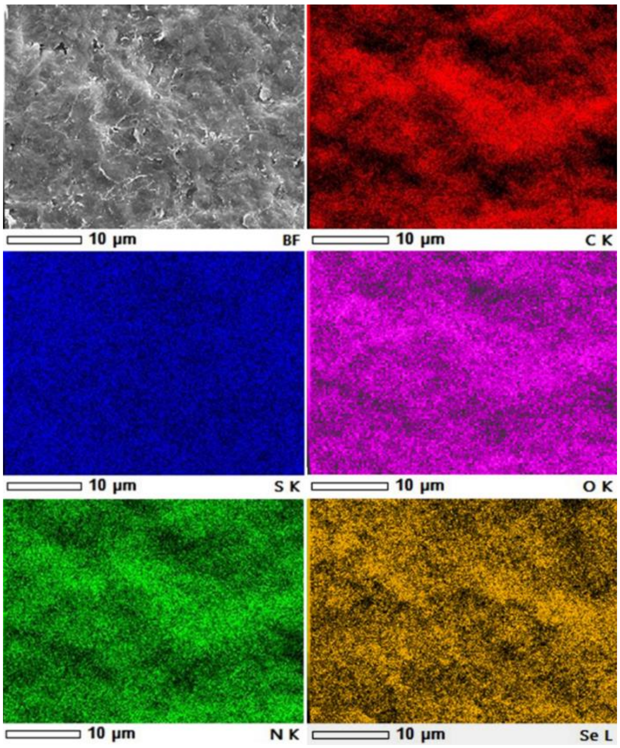

Fig. S1 SEM images of the N,-S-G interlayer after 500 cycles and the corresponding element mapping of C, S, O, N, Se

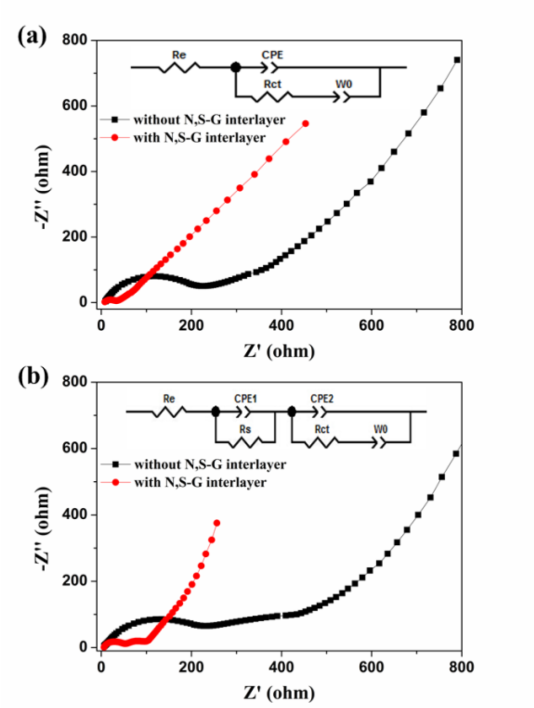

Fig. S2 Nyquist plots and equivalent circuit (inset) of the polyselenides catholyte with and without N,S-G interlayer: **a** before cycling and **b** after 500 cycles

Table S1 Electrochemical performances comparison with different carbon-Se composites cathode and carbon interlayer

Sample name	Selenium content in the cathode (%)	Se loading (mg cm^{-2})	Long-cycle performances	Rate capability	References
polyselenides catholyte with N,S-G interlayer	~79 (including N,S-G weight)	~5.0	330.7 mAh g^{-1} after 500 cycles at 1 C	301.4 mA h g^{-1} at 4 C	This work
Se/porous carbon microcubes composite	40	1.0-1.5	231.4 mAh g^{-1} after 460 cycles at 0.5 C	218.1 mAh g^{-1} at 5 C	[1]
Se-impregnated hollow carbon microspheres	41.7	0.72	525 mAh g^{-1} after 1000 cycles at 0.74 C	496 mAh g^{-1} at 2.97 C	[2]
Se/CNT@microporous carbon composite	50.2	2.0	~200 mAh g^{-1} after 1000 cycles at 1 C	~150 mAh g^{-1} at 5 C	[3]
Graphene-CNT@Se	51	1.6	504.3 mA h g^{-1} after 150 cycles at 0.2 C	436.4 mAh g^{-1} at 4 C	[4]
Se@hollow-core nitrogen-doped carbon nanobelts	62.5	3.0	~453.2 mAh g^{-1} after 1000 cycles at 1 C	~450 mAh g^{-1} at 2.37 C	[5]
Graphene–encapsulated selenium/polyaniline core–shell nanowire	52.9	3.0	461.7 mAh g^{-1} after 200 cycles at 0.2 C	510.9 mAh g^{-1} at 2 C	[6]
Porous carbon nanofibers-selenium	52.3	0.8	516 mAh g^{-1} after 900 cycles at 0.74 C	306 mAh g^{-1} at 5.9 C	[7]

Se/chitosan-derived hierarchical porous carbon	35	1.37-1.77	537.6 mAh g^{-1} after 100 cycles at 0.2 C	325.2 mAh g^{-1} at 4.7 C	[8]
Se/CMK-3	39.2	2.0	600 mAh g^{-1} after 50 cycles at 0.1 C	—	[9]
Se/carbon aerogel	44.8	1.5-2.0	309 mAh g^{-1} after 100 cycles at 0.5 C	301 mAh g^{-1} at 5 C	[10]
Se/porous carbon sphere	56.4	2.0	417 mAh g^{-1} after 1200 cycles at 1 C	384.75 mAh g^{-1} at 20 C	[11]
Se/nitrogen-doped microporous carbon spheres	35	2.0	570 mAh g^{-1} after 350 cycles at 0.5 C	200 mAh g^{-1} at 5 C	[12]
Core-shell structured selenium@ carbon spheres	54.4	1.0-2.0	300 mAh g^{-1} after 100 cycles at 0.1 C	447 mAh g^{-1} at 4.7 C	[13]
Selenium in nitrogen-containing hierarchical porous carbon	45.0	1.0	267 mAh g^{-1} after 100 cycles at 1 C	~300 mAh g^{-1} at 5 C	[14]
Selenium/microporous carbon nanofiber composite	40	1.0−1.2	400 mAh g^{-1} after 2000 cycles at 1 C	420 mAh g^{-1} at 5 C	[15]
Se@Carbide-derived carbon	46.5	1.0	~450 mAh g^{-1} after 150 cycles at 0.2 C	310 mAh g^{-1} at 2 C	[16]
Se@mesoporous carbon/ graphene	49.6	1.2	385 mAh g^{-1} after 1300 cycles at 1 C	274 mAh g^{-1} at 3 C	[17]
Se@erylene-3,4,9,10-tetracarboxylic dianhydride derived carbon	43.2	1.2	430 mAh g^{-1} after 250 cycles at 0.15 C	280 mAh g^{-1} at 1.78 C	[18]
Hollow carbonized polyaniline spheres/selenium composites	32.96	1.5-2.0	298.7 mAh g^{-1} after 100 cycles at 0.5 C	246.8 mAh g^{-1} at 2 C	[19]
Selenium/micro–mesoporous carbon sphere nanocomposite	48	2.0	540 mAh g^{-1} after 100 cycles at 0.1 C	430 mAh g^{-1} at 5 C	[20]
Selenium@mesoporous carbon	38.4	0.55–0.71	306.9 mAh g^{-1} after 100 cycles at 0.5 C	275.9 mAh g^{-1} at 2 C	[21]
Cellulose based carbon interlayer	80 (without carbon interlayer weight)	1.6	282 mAh g^{-1} after 100 cycles at 0.5 C	—	[22]
Se@reduced graphene oxide with CNT interlayer	64% (without CNT interlayer weight)	2.0	265 mAh g^{-1} after 200 cycles at 0.2 C	250 mAh g^{-1} at 5 C	[23]
Graphene-coated polymer separator	52% (including graphene weight)	4.0	331 mAh g^{-1} after 1000 cycles at 0.5 C	~3400 mAh g^{-1} at 5 C	[24]

Table S2 Impedance parameters of the Li-Se batteries calculated according to the equivalent circuits

Sample name	Cycle number	Resistance		
		R_e (Ω)	R_s (Ω)	R_{ct} (Ω)
Without N,S-G interlayer	Before cycling	3.75	—	38.64
	500th cycles	5.87	34.23	65.92
With N,S-G interlayer	Before cycling	7.90	—	176.80
	500th cycles	4.93	195.70	479.10

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