Supplementary Information

Carbon Spheres with Catalytic Silver Centres as Selenium Host for Stable Lithium-Selenium Batteries

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Fig. S1. (a) SEM image (b) TEM image and (c) UV-Visible spectrum of synthesised silver nanoparticles.

Fig. S2. Raman spectra of all the different compositions.
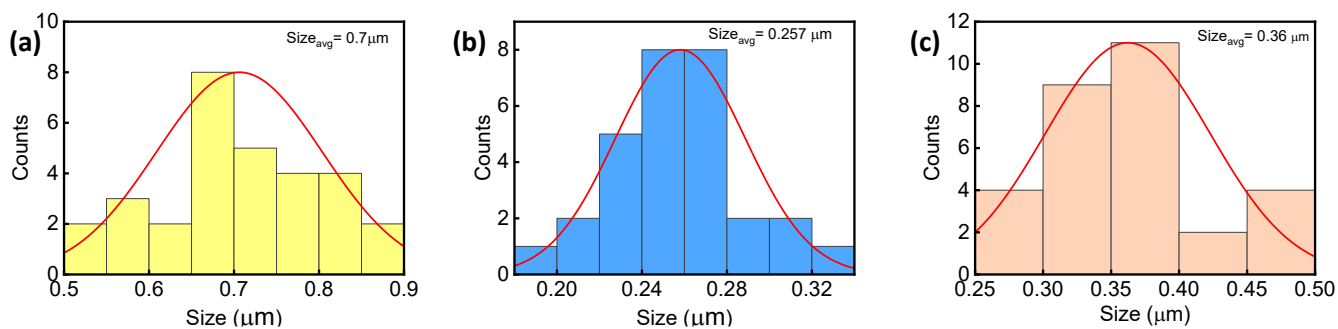
Fig. S3. Particle size distribution of (a) CS (b) Ag@CS and (c) Ag@CS/Se.
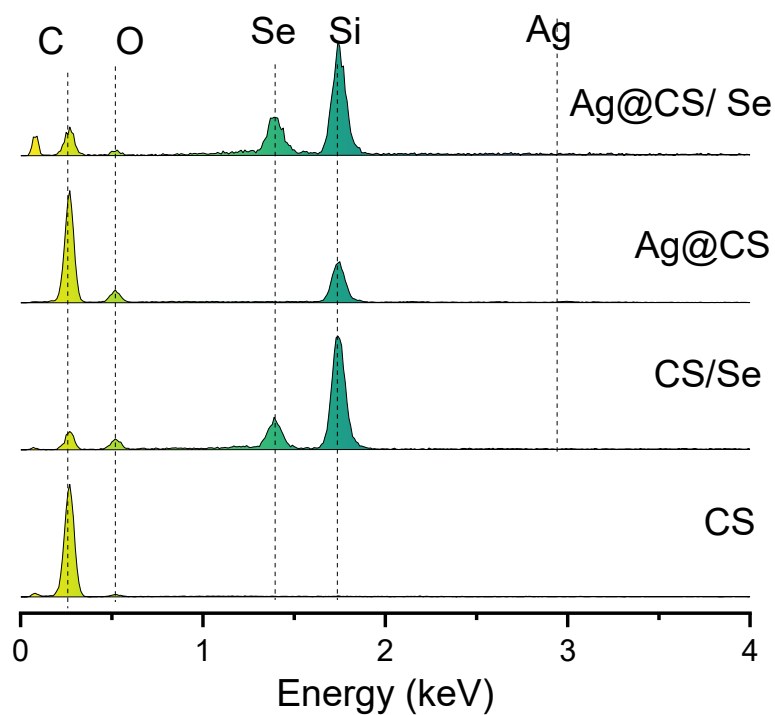
Wt%/At%	C	O	Ag	Se
CS	96/97	4/3	-	-
CS/Se	53/70	27/26	-	20/4
Ag@CS	77/82	22/17	1.0/0.12	-
Ag@CS/Se	59/84	8/9	2/0.3	31/6

Fig S4. EDX spectra of the various cathode candidates and a table showing their composition in Wt% and At%.
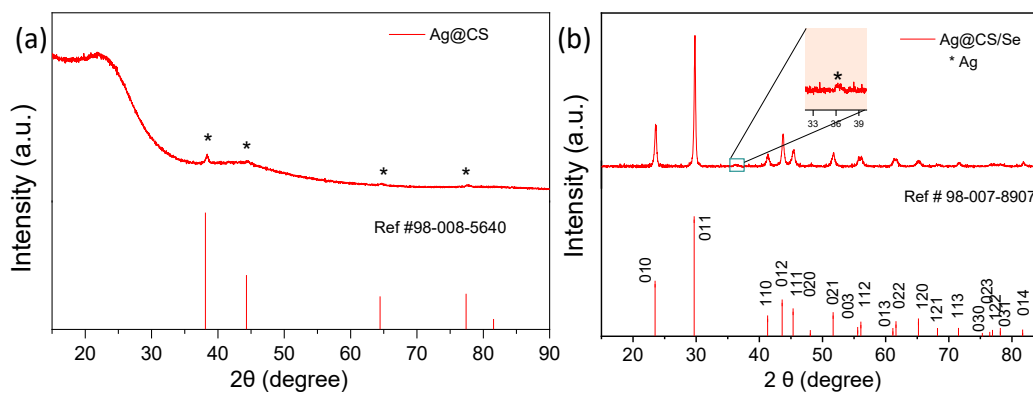
Fig S5. XRD pattern of the silver centred carbon composite (a) before and (b) after selenium incorporation.
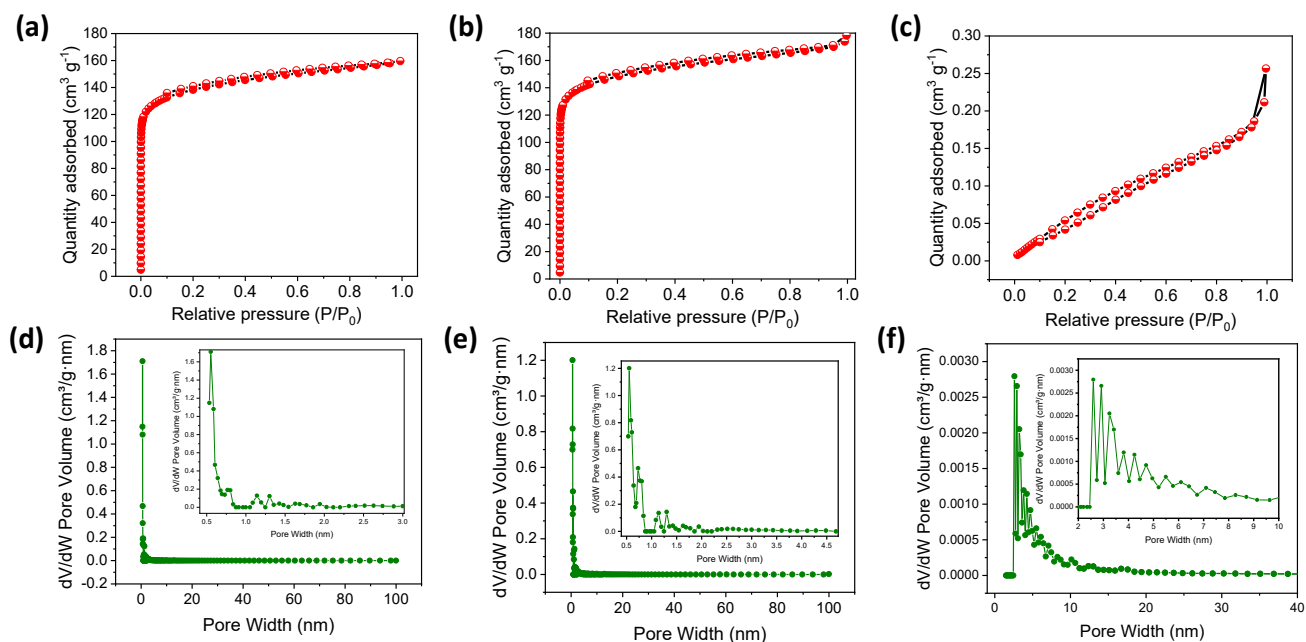
Fig. S6. Nitrogen adsorption/desorption isotherms of (a) CS, (b) Ag@CS and (c) Ag@CS/Se. Pore size distribution plot of (d) CS, (e) Ag@CS and (f) Ag@CS/Se.
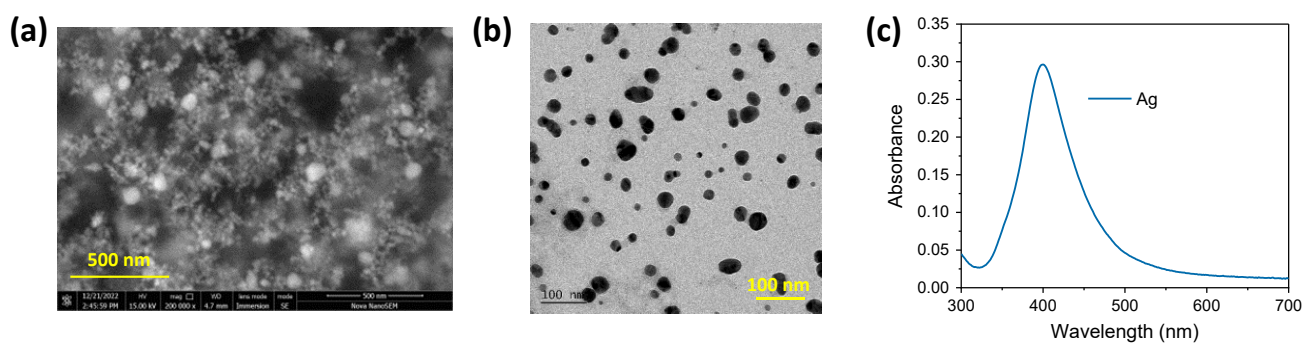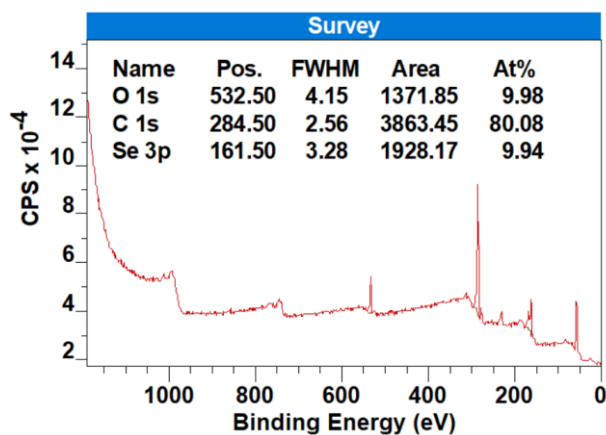
Fig S7. Survey spectrum of Ag@CS/Se.

Name	Pos.	FWHM	Area	At%
O 1s	532.50	4.15	1371.85	9.98
C 1s	284.50	2.56	3863.45	80.08
Se 3p	161.50	3.28	1928.17	9.94
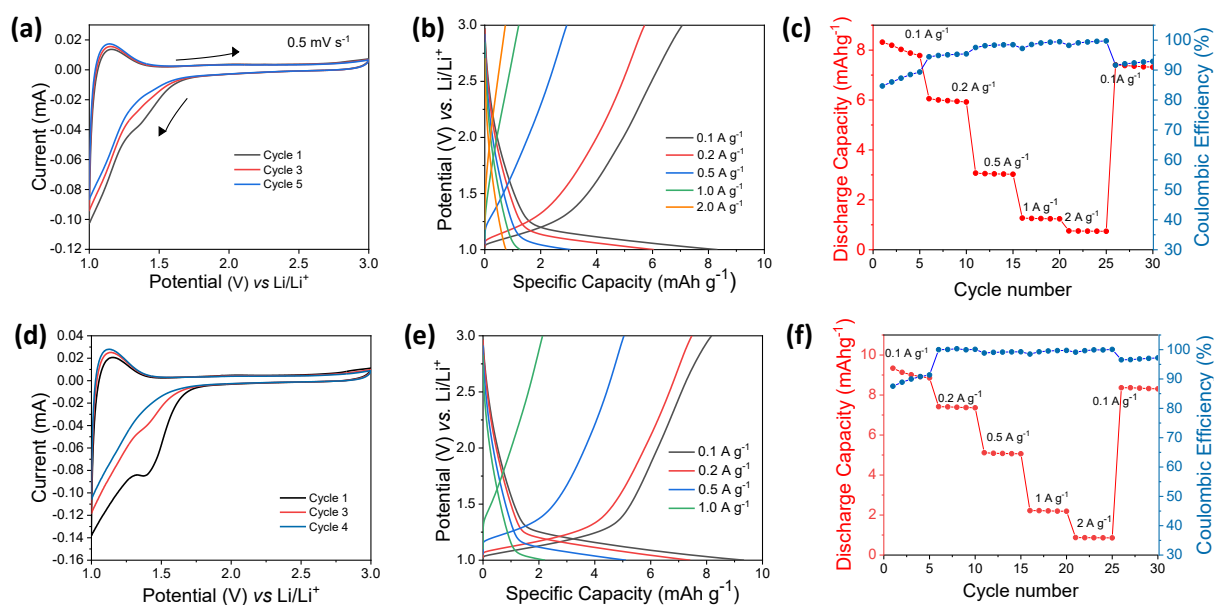
Fig. S8. (a) CVs recorded at 0.5 mV s^{-1} scan rate, (b) galvanostatic cycling profiles obtained at varying current densities and (c) rate capability plot of CS electrode. (d) CVs recorded at 0.5 mV s^{-1} scan rate, (e) galvanostatic cycling profiles obtained at varying current densities and (f) rate capability plot of CS@Ag electrode.
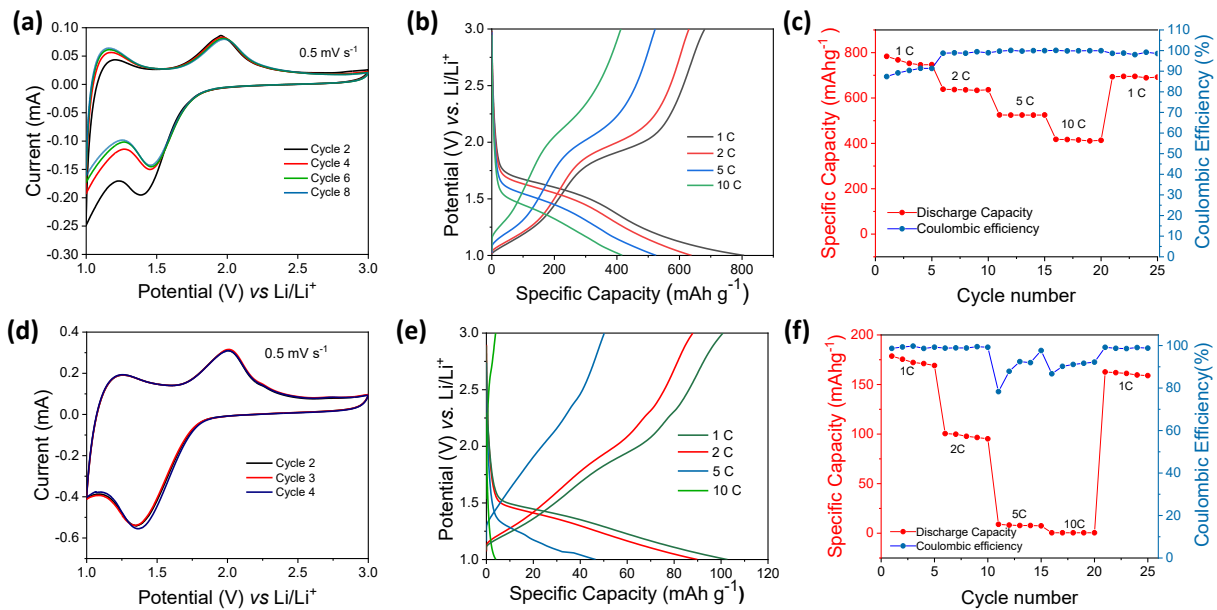
Fig. S9. (a,d) CVs recorded at 0.5 mV s^{-1}, (b,e) galvanostatic cycling profiles obtained at varying C-rates and (c,f) rate capability plot of Li-Se cells with CS@Ag as host with 10% and 40% selenium loading, respectively.
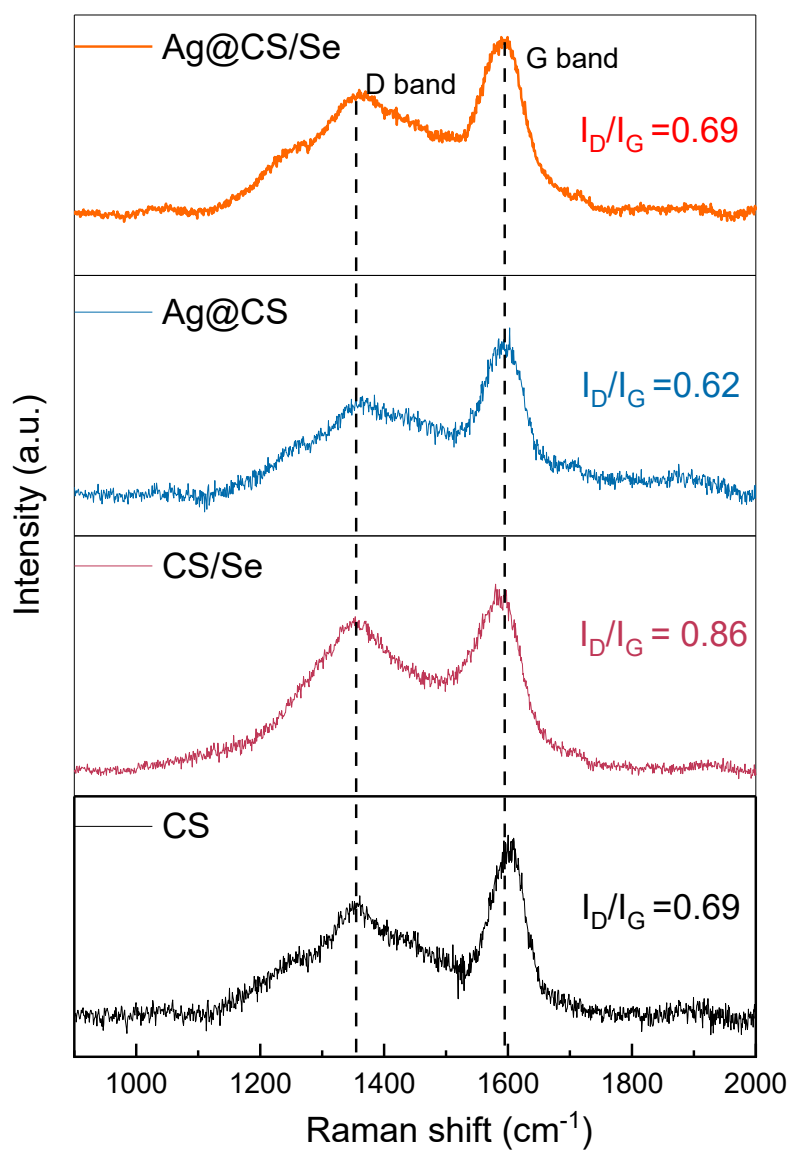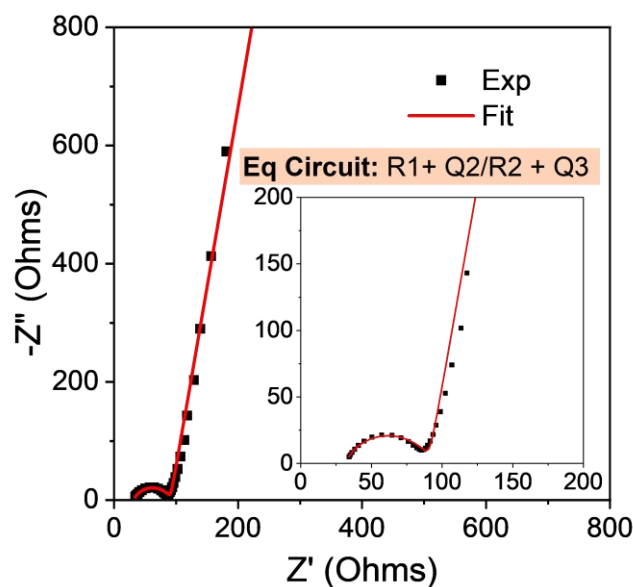

Fig. S10. Nyquist plot of Li-Se cell with silver catalyst centre before cycling.
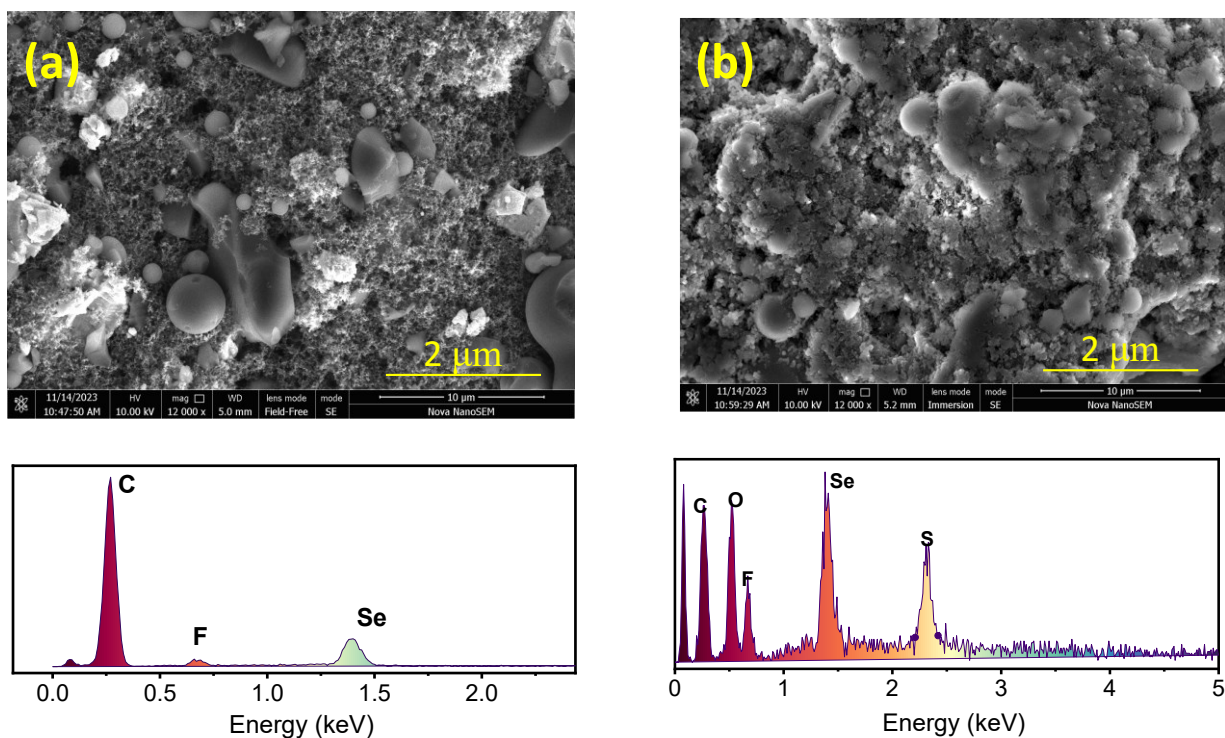
**Fig. S11.** SEM and EDX of Ag@CS/Se cathode (a) before and (b) after cycling.

Table S1. Comparison of the electrochemical performance of Se-based composite cathode presented in this work with those reported in the literature.

Sl No	Year	Cathode	Catalyst/Modifi-cation strategy	Method of preparation	Electrolyte	Capacity @1C in mAh g^{-1}	Long cycling	Ref
1	2013	Se@C	Mesoporous carbon	Melt-diffusion	1 M LiPF$_6$ in EC and DEC (1:1 v/v) 1 M LiTFSI in TEGDME	350	0.25 C- 1000 cycles- 480 mAh.g^{-1}	20
2	2014	Se-CDC	Ordered micro/mesoporous CDC	Melt diffusion	1 M LiTFSI in DME and DOL (1:1 v/v) 0.2M LiNO$_3$	400	0.2C- 150 cycles- 500mAh.g^{-1}	50
3	2014	Se@C	PTCDA	Thermal treatment	1 M LiPF$_6$ in EC and DEC)	NA	100mA.g^{-1} - 250 cycles- 430mAh.g^{-1}	61
4	2014	Se/MCM	Mesoporous carbon	Spray drying hard templateapproach	1 M LiTFSI in DME and DOL (1:1 v/v)	NA	0.5 C- 100 cycles- 300mAh.g^{-1}	62
5	2015	Se/TiO$_2$	Titanium oxide added	Melt-diffusion	DOL	350	2 C- 400 cycles- 230mAh.g^{-1}	63

6	2016	Se@NC@C	Se, LiEt$_3$BH, PAN	Solution processing, thermal treatment,CVD	2.4 M LiTFSI inDOL and DME	250	0.5 C- 100 cycles-310mAh.g^{-1}	64
7	2016	Se@C	SeO$_2$, Sucrose	Microwave-heating	1 M LiTFSI inDOL and DMEc	NA	0.1 C- 100 cycles-300mAh.g^{-1}	65
8	2016	Se/CNTs	CNT incorporation	Pressure enhanced melt-diffusion	1 M LiPF$_6$ in EC and DMC	200	0.1 C- 100 cycles-353mAh.g^{-1}	66
9	2016	Graphene -Se hybrid microballs	Graphene selenium hybrid microball architecture	Spray drying	1 M LITFSI in a mixture of tetraethylene glycol dimethyl ether and 1,3-dioxolane mixed in a volume ratio of 1:1.	400	0.1 C- 100 cycles-544mAh.g^{-1}	34
10	2017	Se/N-MePCs	Se, tetrachloroethylene, cyanuric chloride	Solution processing, thermal treatment, melt-diffusion	1 M LiTFSI inDOL and DME	301	1 C- 500 cycles-301mAh.g^{-1}	67
11	2018	Se/N-MePCs @AgS	phenol, melamine, formaldehyde, AgNO$_3$	Solution processing, thermal treatment, melt-diffusion	1 M LiTFSI inDOL and DMEc	193	0.5 C- 400 cycles- 206 mAh.g^{-1} 1 C- 400 cycles- 193 mAh.g^{-1}	68
12	2020	Se-CMK-3	selenium-infused ordered mesoporous carbon composites	Melt-diffusion from a ball- milled mixture of Se and CMK-3		NA	0.05 C- 100 cycles- 488.7 mAh.g^{-1} 0.5 C- 500 cycles- 268.7 mAh.g^{-1}	69
13	2021	Se$_{1-x}$S$_x$@NC PC	Nitrogen-doped carbon photonic crystal (NCPC)	NCPC-hard template method	1 M LiTFSI + 1 wt % LiNO$_3$ in DME and DOL (1:1 v/v)	NA	0.1 A g- 200 cycles- 240 mAh.g^{-1}	70
14	2022	C/Se		Carbon host	1M LiPF$_6$ in EC:DEC (1:1 v/v)	400	1 C- 500 cycles- 400 mAh.g^{-1}	71
15	2022	3DC/Se		Carbon host	Melt diffusion	1M LiPF$_6$ in EC:DEC (1:1 v/v)	300	0.2 C- 50 cycles- 400 mAh.g^{-1}	72

#	Year	Material	Description	Method	Electrolyte		Cycling	Ref
16	2022	Se@ ZIF-8-C@MWCNT	ZIF-8-C@MWCNT	Melt-diffusion	1 M LiTFSI in DME and DOL (1:1 v/v) 1% LiNO$_3$	450-500	1 C- 500 cycles- 300-250mAh.g^{-1}	33
17	2023	PM-CNF/Se	carbon nanofiber membrane (PM-CNF)	Electrospinning	ether/carbonate-based		5 C- 1750 cycles- 404.2 mAh.g^{-1}	73
18	2023	Se$_{68}$-S$_9$/rGO	Nanofabrication of Se/rGO with S doping via solution co-impregnation	Solution co-impregnation	ACN and LiTFSI + 1,1,2,2- tetrafluoroethyl2, 2,3,3- tetrafluoropropylether	579	1C- 200 cycles- 600 mAh.g^{-1}	74
19	2023	Co-NC/Se	Cobalt doping	Melt diffusion	1 M LiPF$_6$ in EC:DEC (1:1v/v) with 5% FEC	480		75
20	2023	WSe$_2$/WO$_2$@Se	long WO$_2$ nanorods and WSe$_2$ nanosheets	Melt diffusion	1 M LiTFSI in DME and DOL (1:1 v/v) 1% LiNO$_3$	600	1C- 100 cycles- 200 mAh.g^{-1}	76
21	2023	HPC@Se	3D honeycomb porous carbon	Melt diffusion	1 M LiPF$_6$ in EC and DEC	500	0.2 C- 200 cycles- 561 mAh.g^{-1}	49
22	2023	Ag@CS/Se	Silver centred carbon spheres	Microwave reactor and melt diffusion	1 M LiTFSI in DOL/DME (in1:1 v/v)	249	1C-1000 cycles 249 mAh g^{-1}	**Our work**