Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Hierarchical "tube-on-fiber" carbon/mixed-metal selenide nanostructures for high-performance hybrid supercapacitors

Li-Ping Lv[1†], ChuanweiZhi[1†], Yun Gao[1], Xiaojie Yin[1], Yiyang Hu[1], Daniel Crespy[2], Yong Wang[1]*

[1]*School of Environmental and Chemical Engineering, Shanghai University, 99 Shangda Road, Shanghai, P. R. China, 200444*

[2]*Department of Materials Science and Engineering, School of Molecular Science and Engineering, Vidyasirimedhi Institute of Science and Technology (VISTEC), Rayong 21210, Thailand*

*Corresponding authors: Tel: +86-21-66137723; fax: +86-21-66137725.

Email address: yongwang@shu.edu.cn

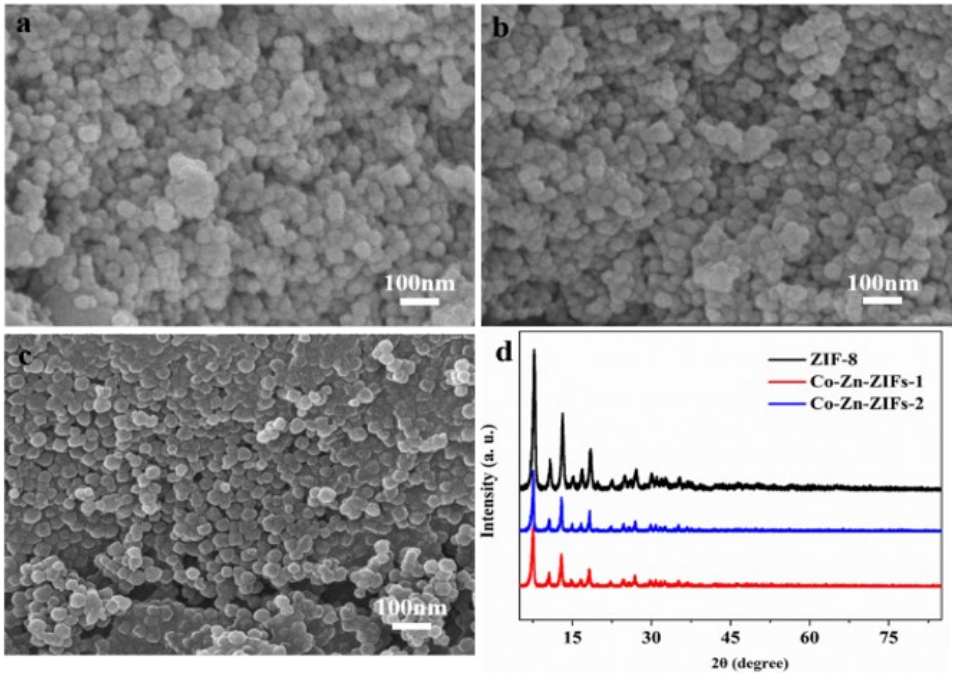

Figure S1. SEM images of (a) ZIF-8, (b) Co-Zn-ZIFs-1, and (c) Co-Zn-ZIFs-2. (d) XRD patterns of ZIF-8, Co-Zn-ZIFs-1, and Co-Zn-ZIFs-2.

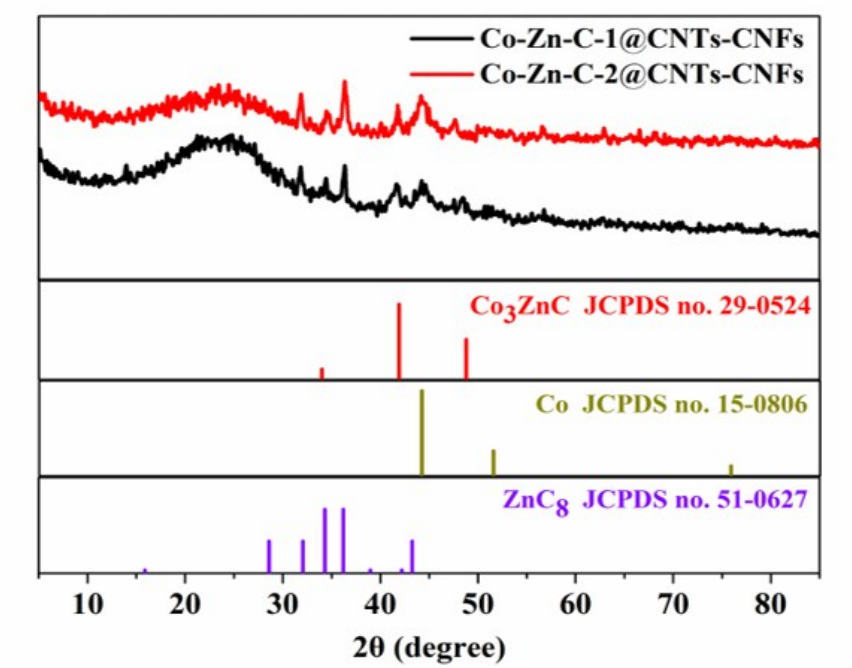

Figure S2. XRD patterns of Co-Zn-C-1@CNTs-CNFs and Co-Zn-C-2@ CNTs-CNFs.

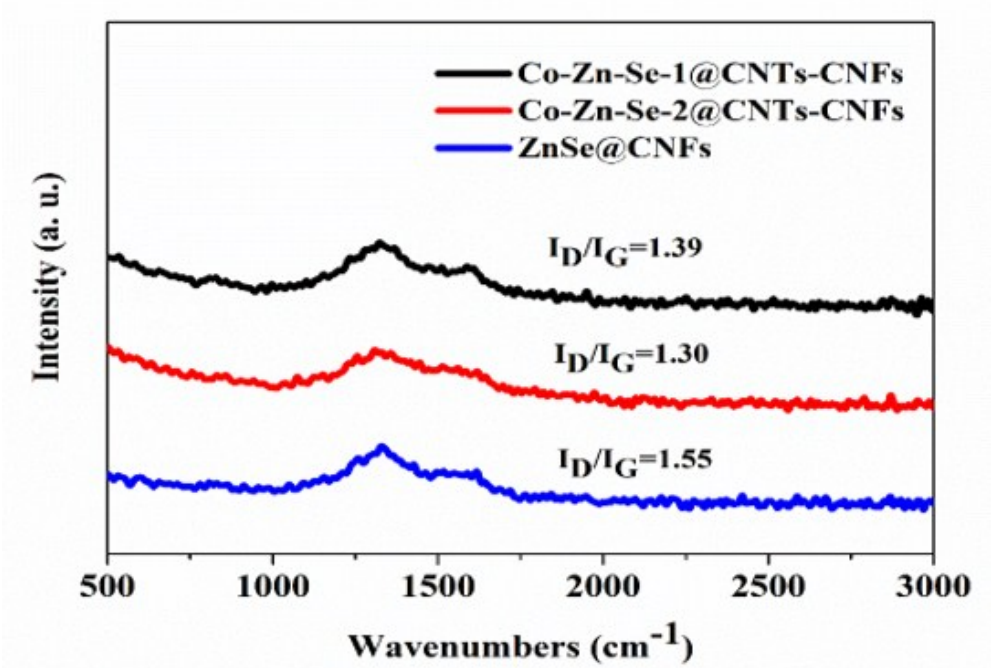

Figure S3. Raman spectra of ZnSe@CNFs, Co-Zn-Se-1@CNTs-CNFs and Co-Zn-Se-2@CNTs-CNFs.

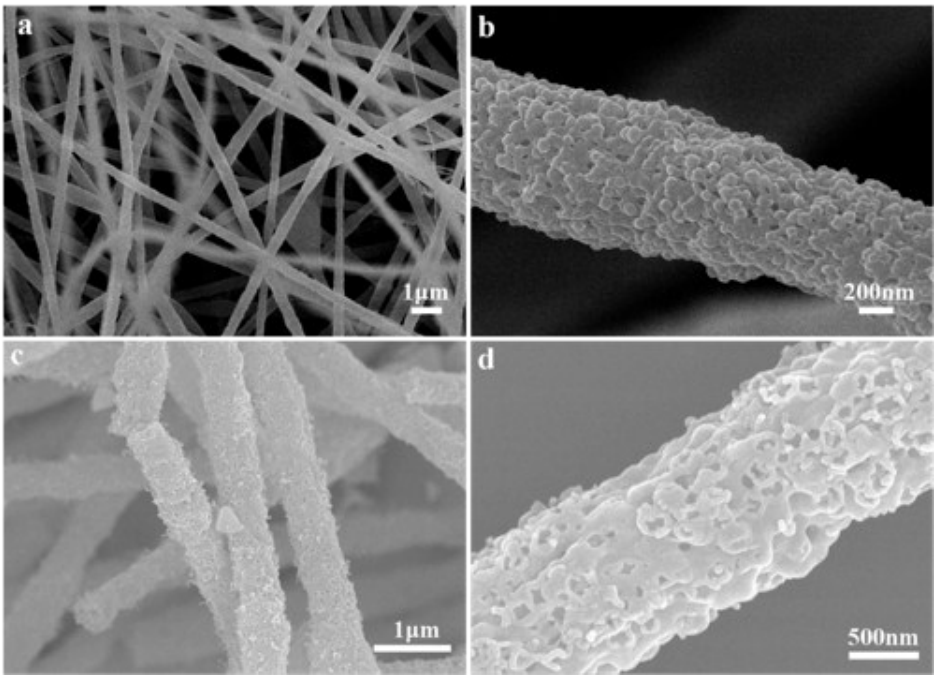

Figure S4. SEM images of (a, b) ZnSe@CNFs and (c, d) Co-Zn-Se-2@CNTs-CNFs.

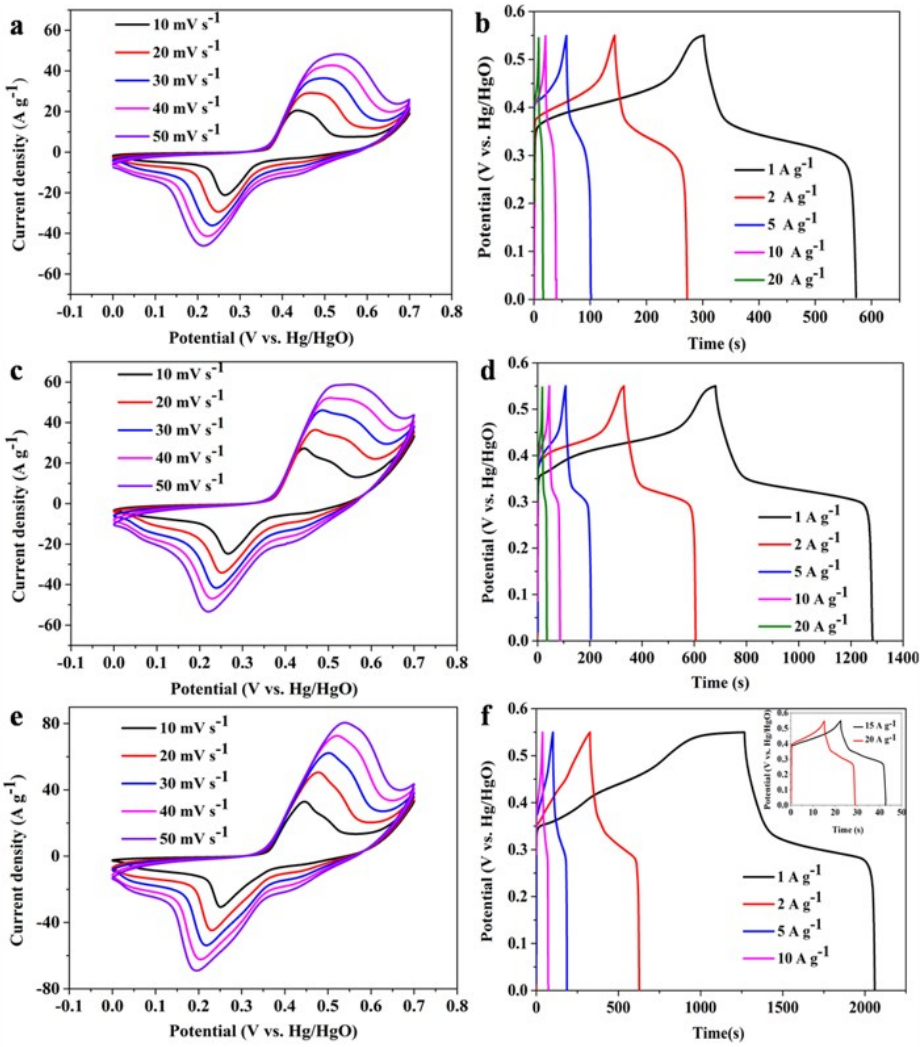

Figure S5. CV curves of (a) ZnSe, (c) ZnSe@CNFs, (e) Co-Zn-Se-2@CNTs-CNFs electrode at various scan rates. GCD curves of (b) ZnSe, (d) ZnSe@CNFs, (f) Co-Zn-Se-2@CNTs-CNFs electrode (1-10 A g^{-1} and 15-20 A g^{-1}, the inset).

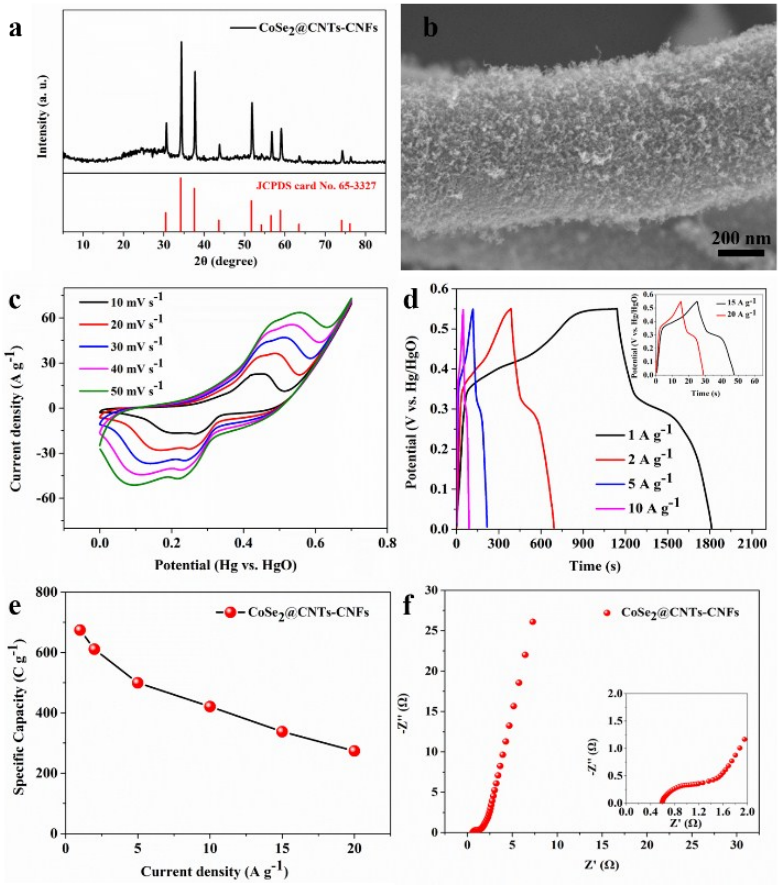

Figure S6 $CoSe_2$@CNTs-CNFs: (a) XRD patterns; (b) SEM image; (c) CV curves at different scan rates; (d) GCD curves at different current densities; (e) the calculated specific capacities from GCD curves at different current densities; (f) EIS spectra.

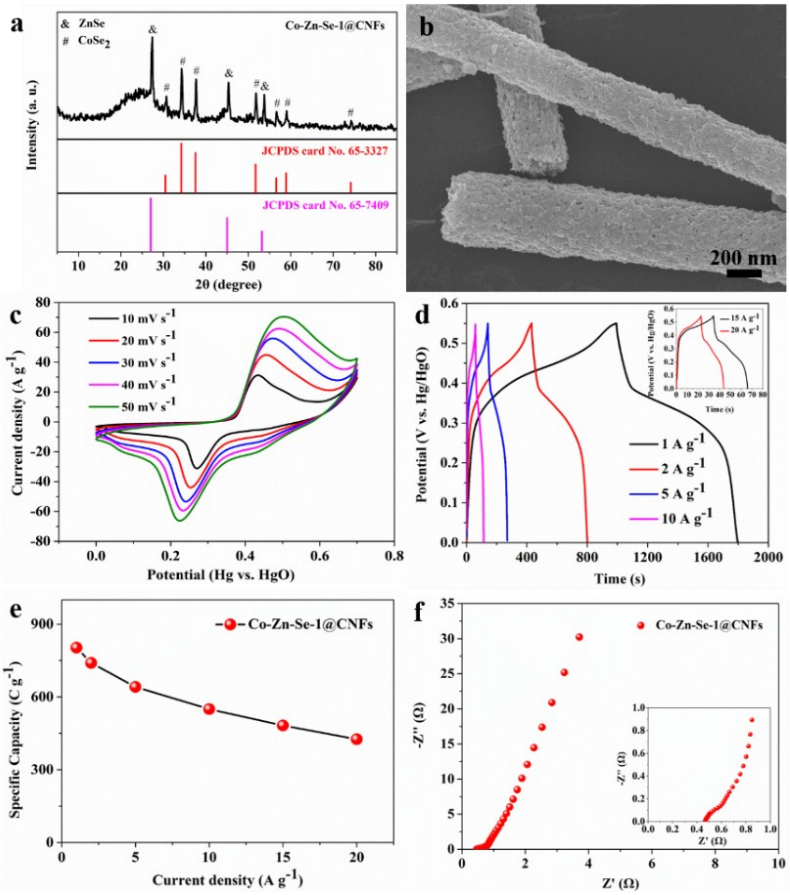

Figure S7 Co-Zn-Se-1@CNFs: (a) XRD patterns; (b) SEM image; (c) CV curves at different scan rates; (d) GCD curves at different current densities; (e) the calculated specific capacities from GCD curves at different current densities; (f) EIS spectra.

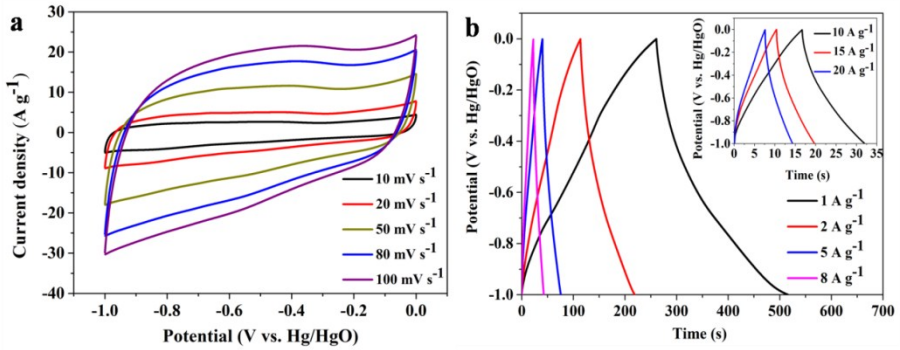

Figure S8. Electrochemical properties of PCNFs: CV curves of PCNFs electrode at various scan rates. (b) GCD curves of PCNFs.

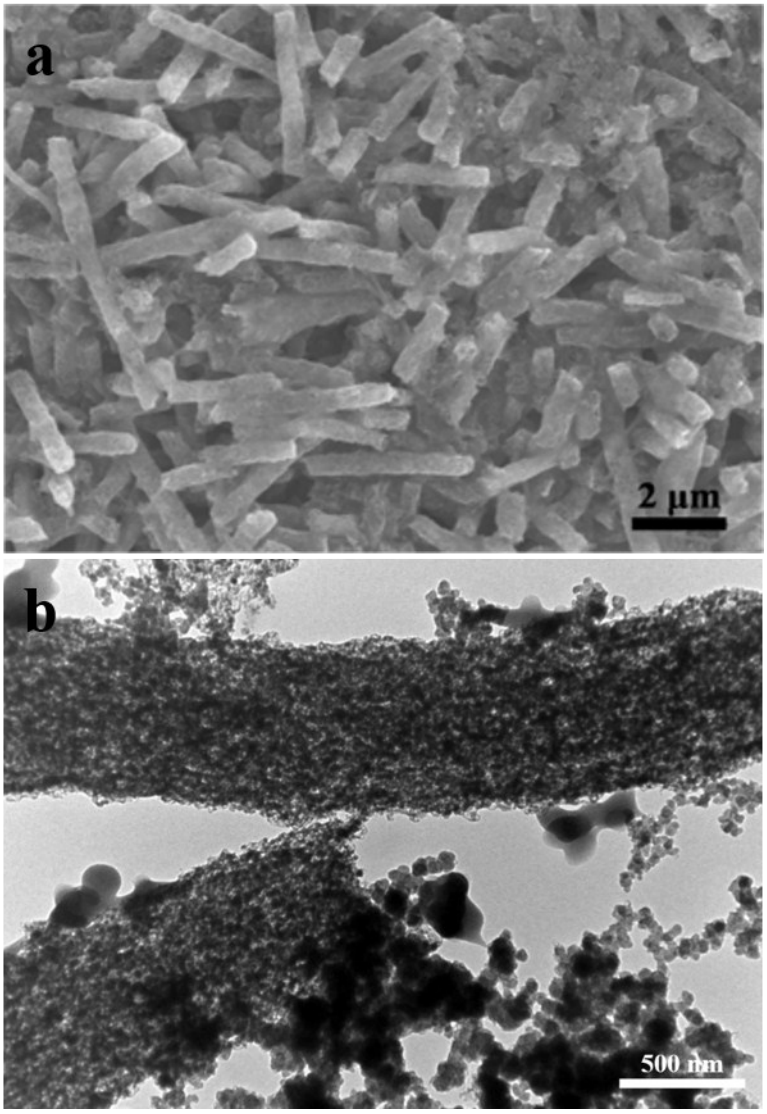

Figure S9. SEM (a) and TEM (b) images of the cathode materials of the Co-Zn-Se-1@CNTs-CNFs//PCNFs HSC device after cycling tests.

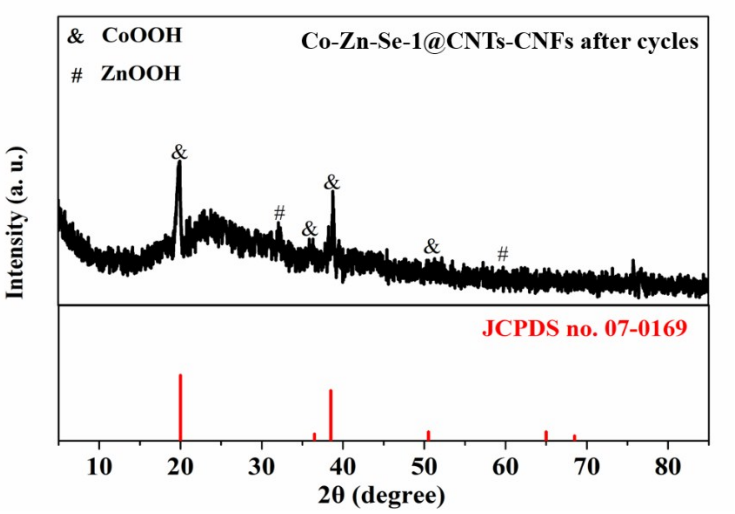

Figure S10 XRD patterns of Co-Zn-Se-1@CNTs-CNFs after 8000 cycles.

Table S1. Parameters of S_{BET}, pore size, and total pore volume of Co-Zn-Se-1@CNTs-CNFs, Co-Zn-Se-2@CNTs-CNFs and ZnSe@CNFs

Entry	S_{BET} (m^2 g^{-1})	Pore Size [nm]	Pore volume [cm^3 g^{-1}]
Co-Zn-Se-1@CNTs-CNFs	324.6	10.8	0.68
Co-Zn-Se-2@CNTs-CNFs	283.1	12.7	0.42
ZnSe@CNFs	307.3	11.0	0.57

Table S2. Results of the elemental content measurements of Co-Zn-Se-1@CNTs-CNFs and Co-Zn-Se-2@CNTs-CNFs.

Samples	Elemental contents (wt%)				
	Zn	Co	Se	C	N
Co-Zn-Se-1@CNTs-CNFs	16.8	2.5	27.5	47.3	5.9
Co-Zn-Se-2@CNTs-CNFs	13.7	5.4	31.8	45.2	3.9

Table S3. Electrochemical performance comparison of metal-selenide based supercapacitor electrodes. (SC: specific capacitance; RP: rate performance; CP: cycling performance.)

Ref.	Composite	SC	RP	CP
This work	Co-Zn-Se-1@CNTs-CNFs	1040.1 C g^{-1} or 1891 F g^{-1} (1 A g^{-1})	52.4% (30 A g^{-1})	97.2% (5000 cycles)
1	cube-like $NiSe_2$	1044 F g^{-1} (3 A g^{-1})	57.5% (30 A g^{-1})	67% (2000 cycles)
2	core-branch $CoSe_2$ nanoarray	759 F g^{-1} (1 mA cm^{-2})	78.8% ((15 mA cm^{-2}))	94.5 % (5000 cycles)
3	$Co_{0.85}Se$ nanosheets	1528 F g^{-1} (1 A g^{-1})	46.7% (20 A g^{-1})	92 % (5000 cycles)
4	$Ni_{0.85}Se@MoSe_2$ nanosheet	774 F g^{-1} (1 A g^{-1})	63% (15 A g^{-1})	--
5	hollow $NiCoSe_2$	750 F g^{-1} (3 A g^{-1})	44% (30 A g^{-1})	92.1 % (5000 cycles)
6	NiSe-G nanohybrids	1280 F g^{-1} (1 A g^{-1})	80.1%(10 A g^{-1})	98 % (2500 cycles)
7	Ni_3Se_2 NSs	251.8 mAh g^{-1} (2 A g^{-1})	58.5%(20 A g^{-1})	101.29% (5000 cycles)
8	Co-Cd-Se	1382 F g^{-1} (1 A g^{-1})	76% (15 A g^{-1})	95.3 % (2000 cycles)
9	hierarchical CFS–CNS	183.4 mAh g^{-1} (1 A g^{-1})	94%(8A g^{-1})	99.2 % (3000 cycles)
10	$(Ni_{0.33}Co_{0.67})Se_2$ CHSs	827.9 Fg^{-1} (1A g^{-1})	78.1% (30 A g^{-1})	113% (2000 cycles)

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