Supporting Information

MOF-templated N-doped Carbon-coated $CoSe_2$ Nanorods Supported on Porous CNT Microspheres with Excellent Sodium-ion Storage and Electrocatalytic Properties

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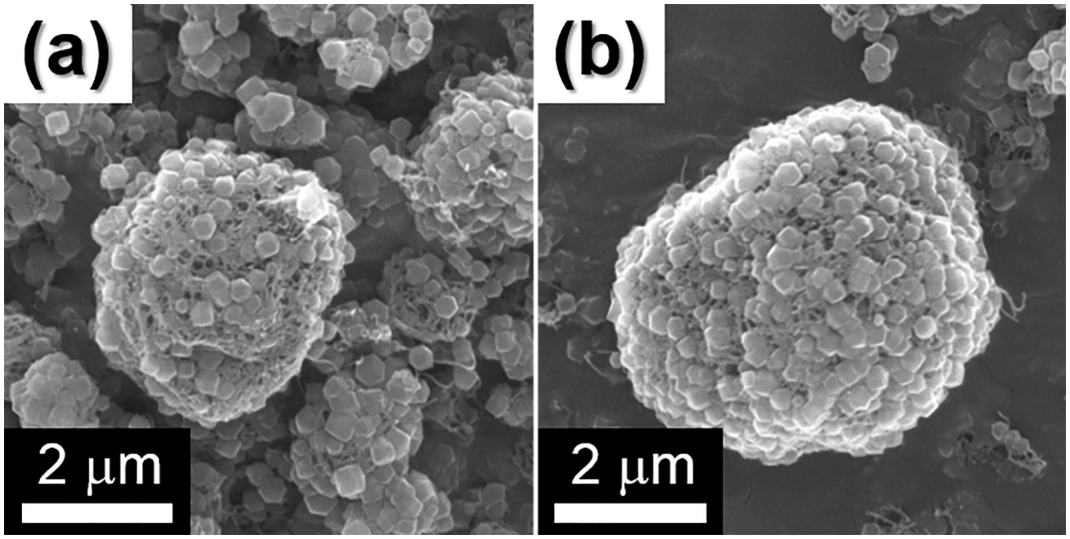

Figure S1. (a, b) SEM images of ZIF-67 polyhedrons grown on untreated CNT porous microspheres.

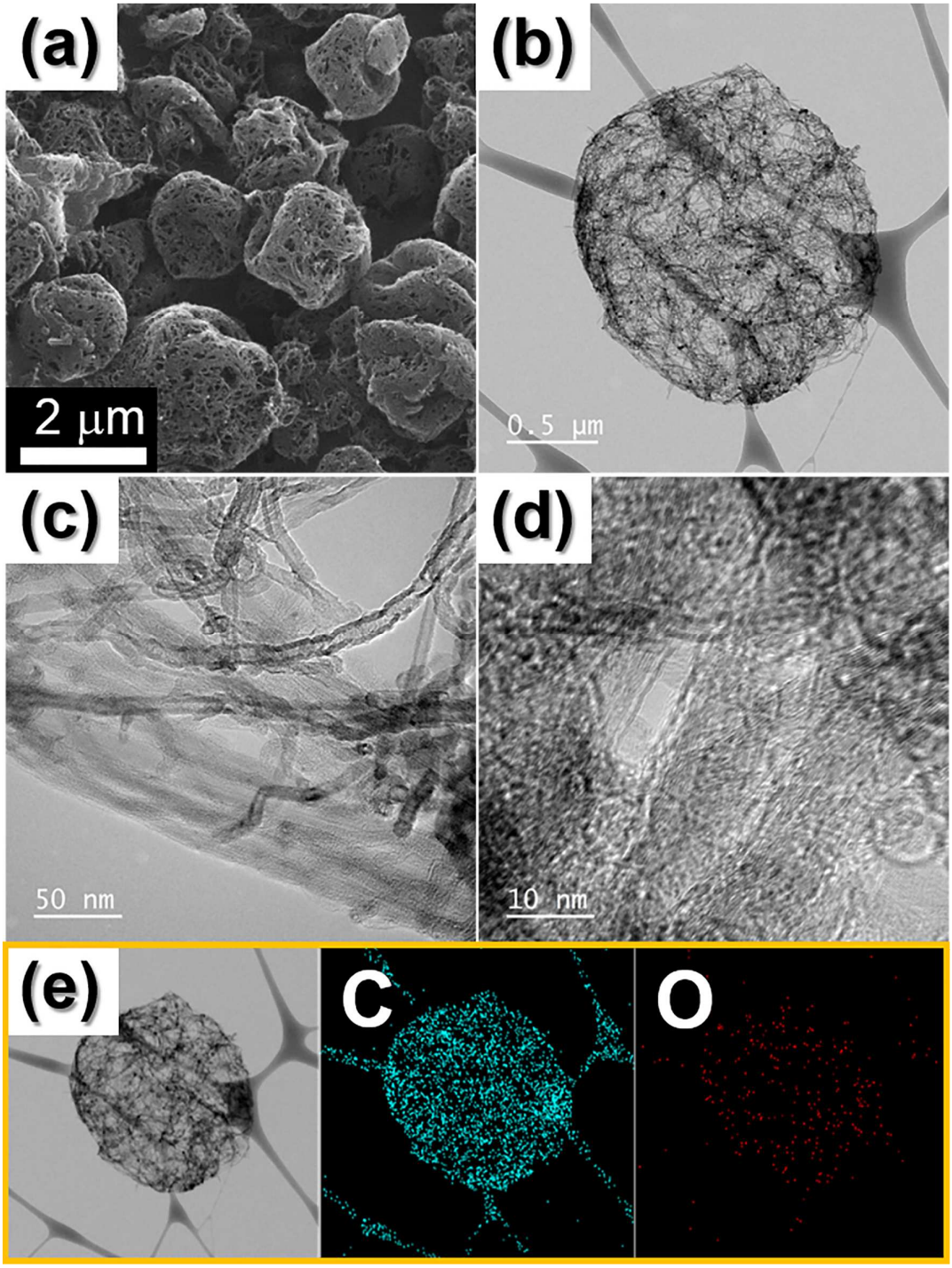

Figure S2. Morphologies of CNT microspheres: (a) SEM image, (b, c) TEM images, (d) HR-TEM image, and (e) EDX mapping images.

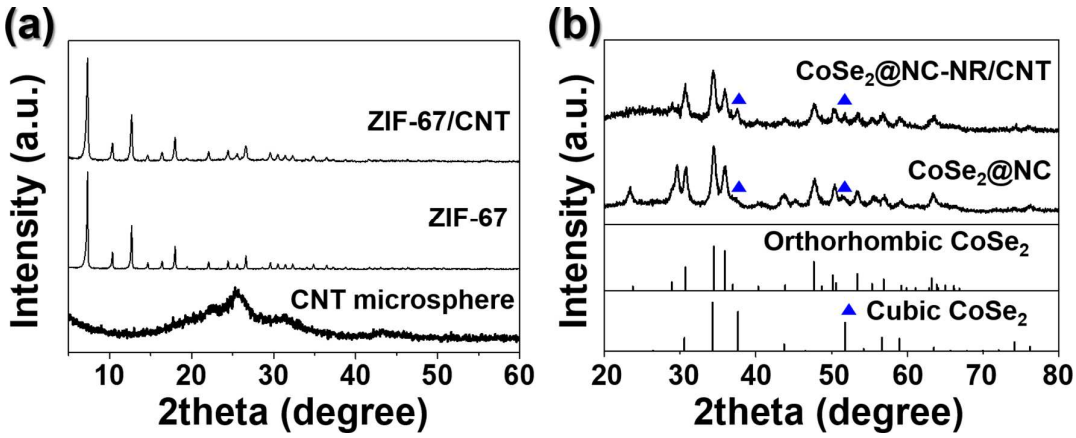

Figure S3. XRD patterns of (a) CNT microspheres, ZIF-67 and ZIF-67/CNT microspheres, and (b) $CoSe_2$@NC and $CoSe_2$@NC-NR/CNT microspheres.

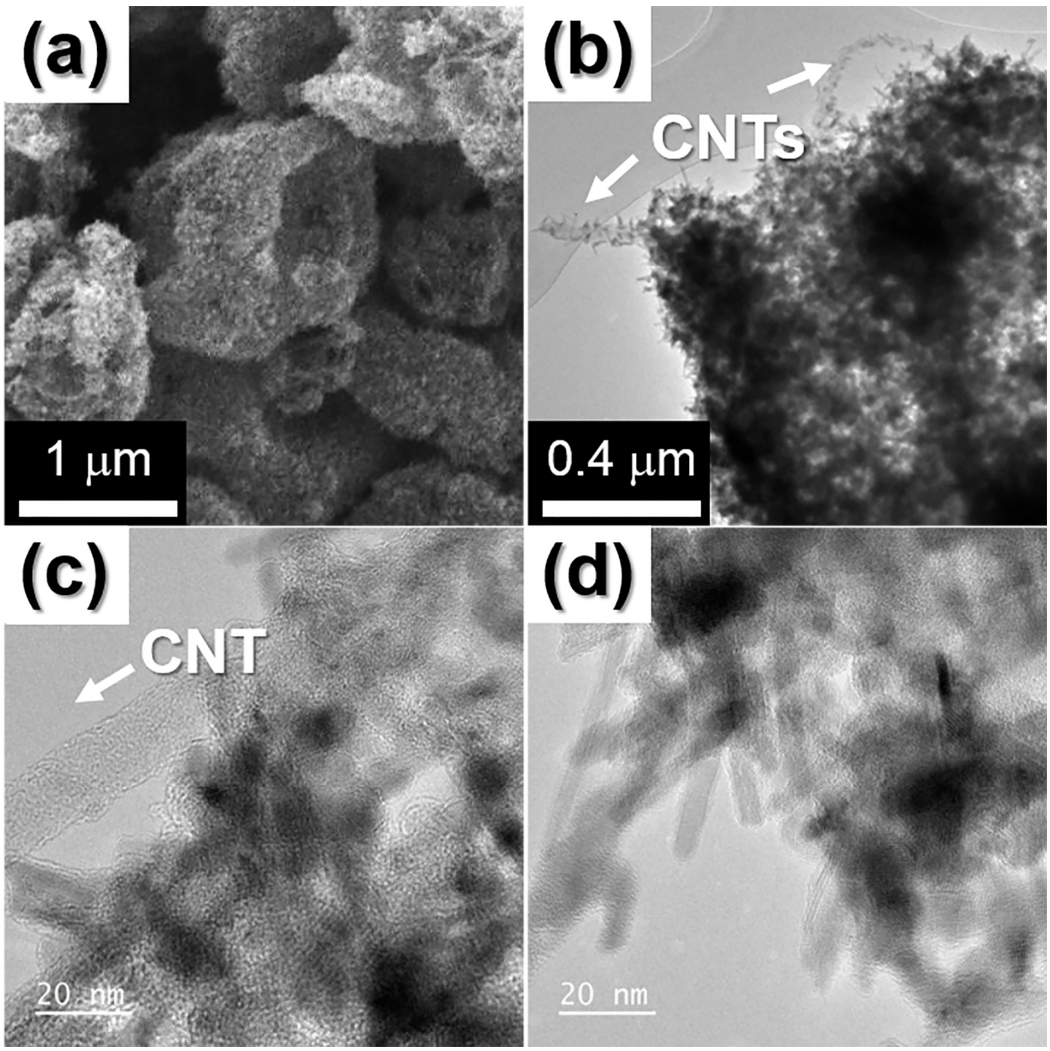

Figure S4. (a) SEM and (b-d) TEM images of $CoSe_2$@NC-NR/CNT microsphere.

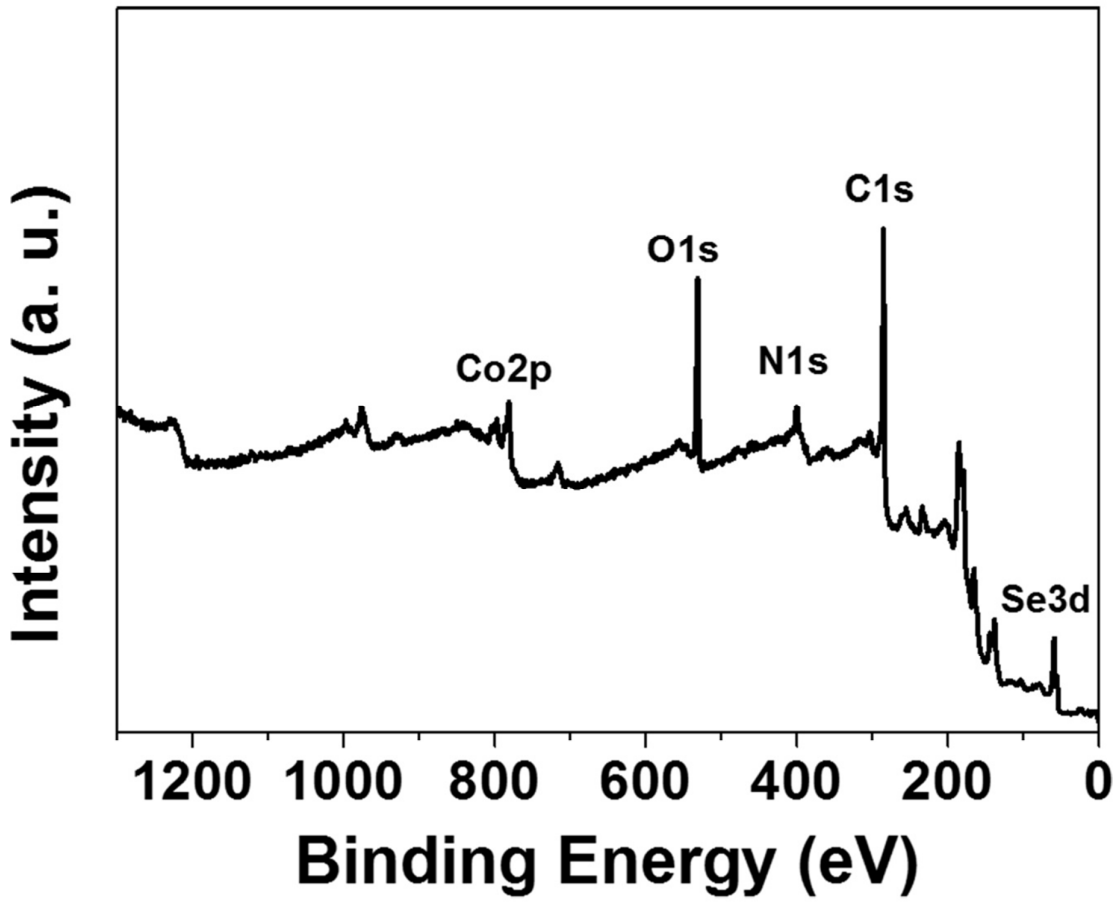

Figure S5. XPS survey of $CoSe_2$@NC-NR/CNT microspheres.

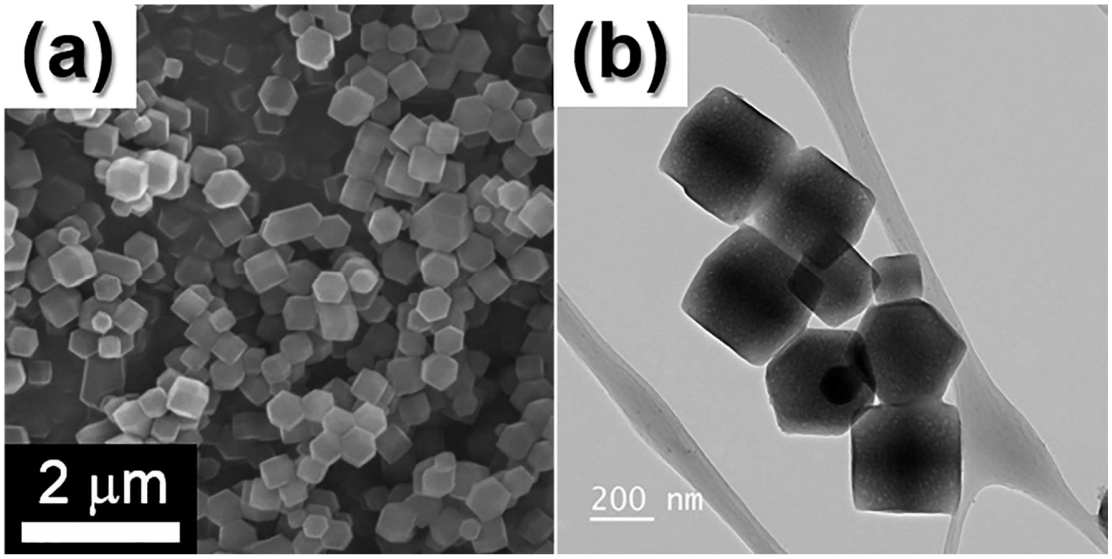

Figure S6. Morphologies of ZIF-67 polyhedrons: (a) SEM and (b) TEM images.

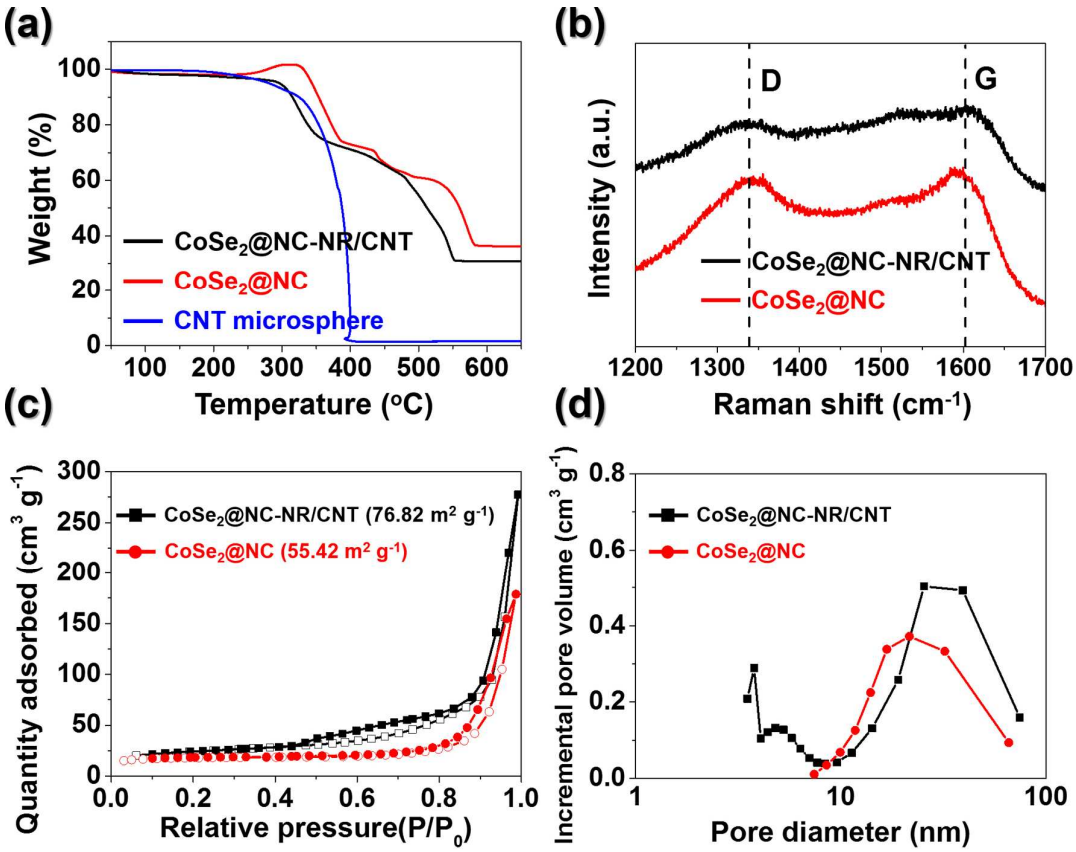

Figure S7. (a) TGA curves, (b) Raman spectra, (c) N_2 adsorption and desorption isotherms, and (d) BJH pore size distributions of $CoSe_2$@NC-NR/CNT microspheres and $CoSe_2$@NC polyhedrons.

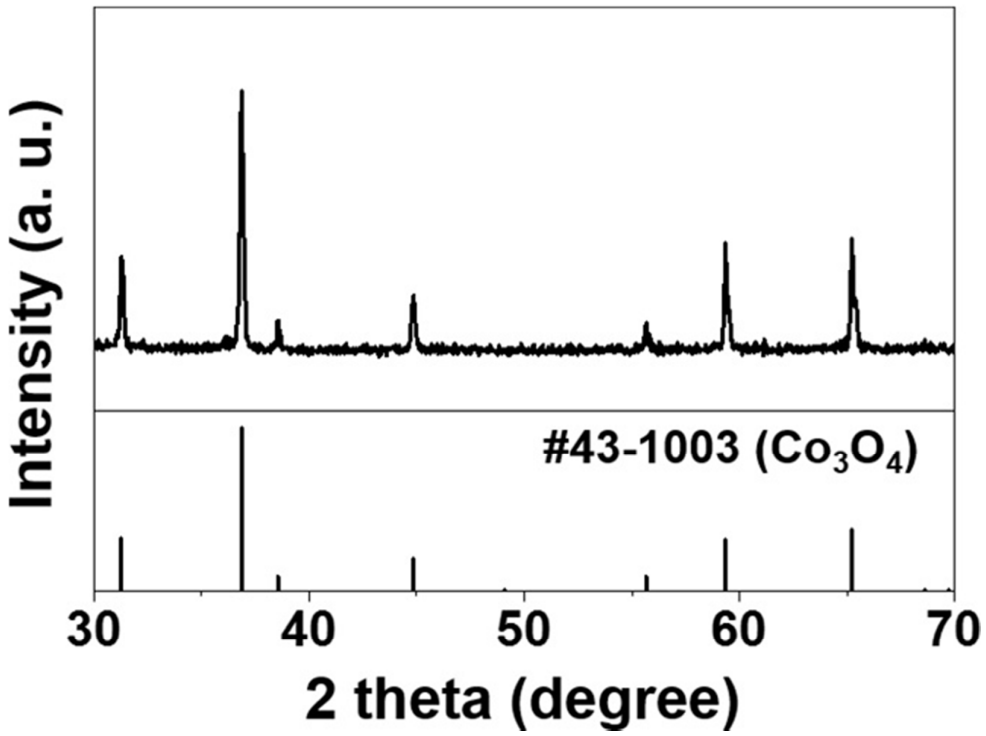

Figure S8. XRD pattern of the final product after TG analysis of $CoSe_2$@NC-NR/CNT microspheres.

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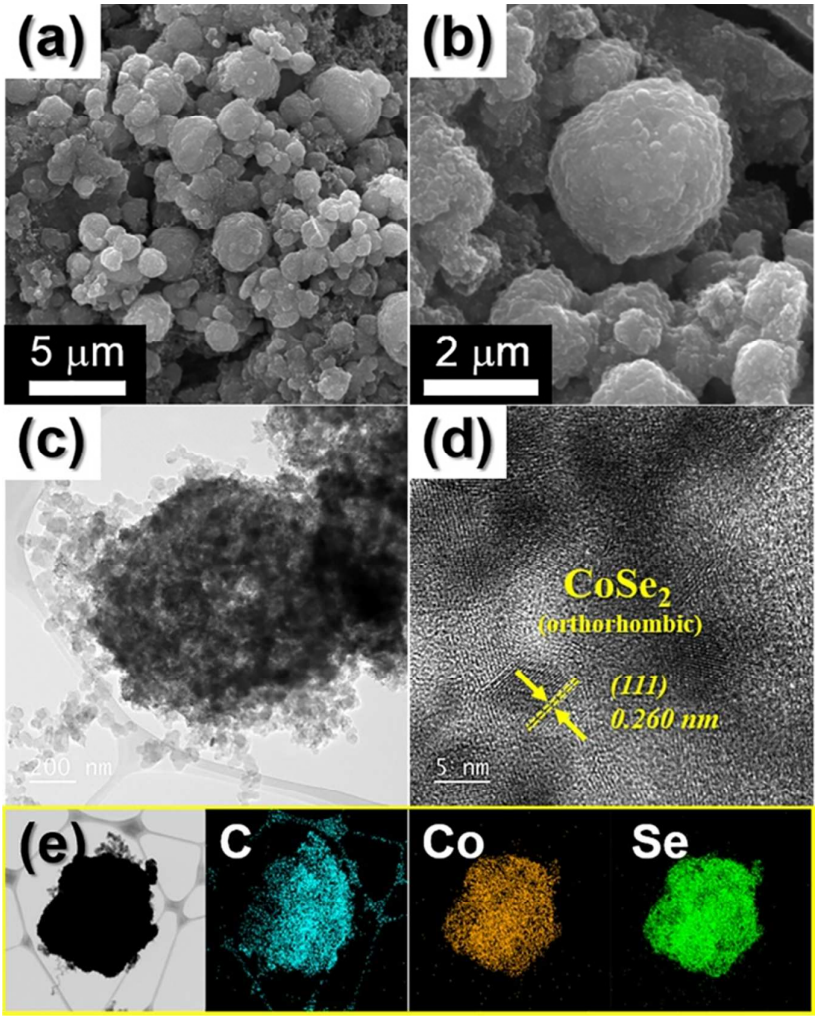

Figure S9. (a,b) SEM, (c) TEM and (d) HR-TEM and (e) EDX mapping images of $CoSe_2$@NC-NR/CNT microspheres after 100 cycles.

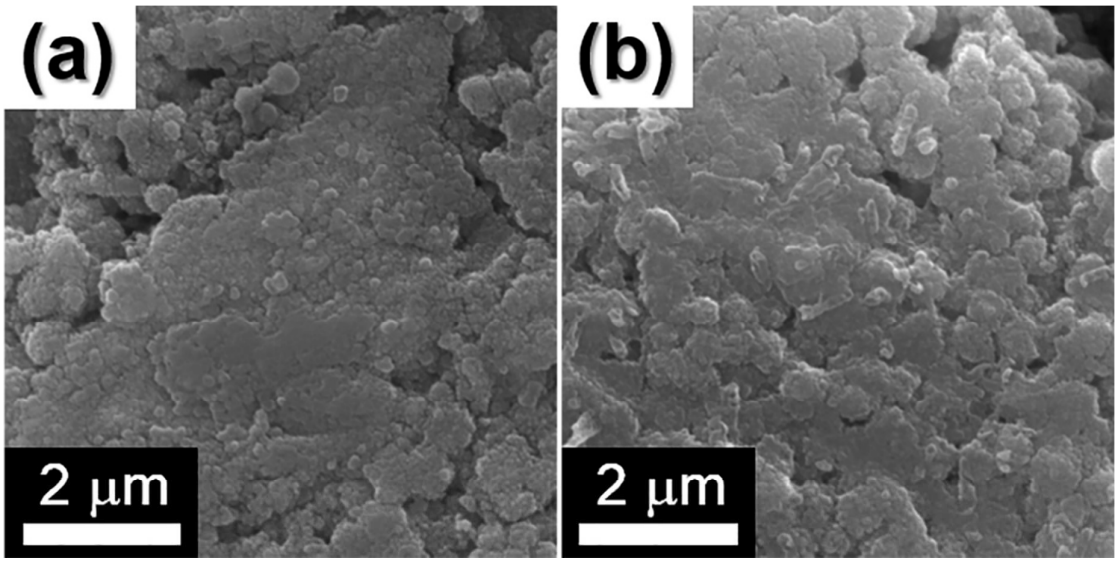

Figure S10. SEM images of (a,b) $CoSe_2$@NC polyhedrons after 100 cycles.

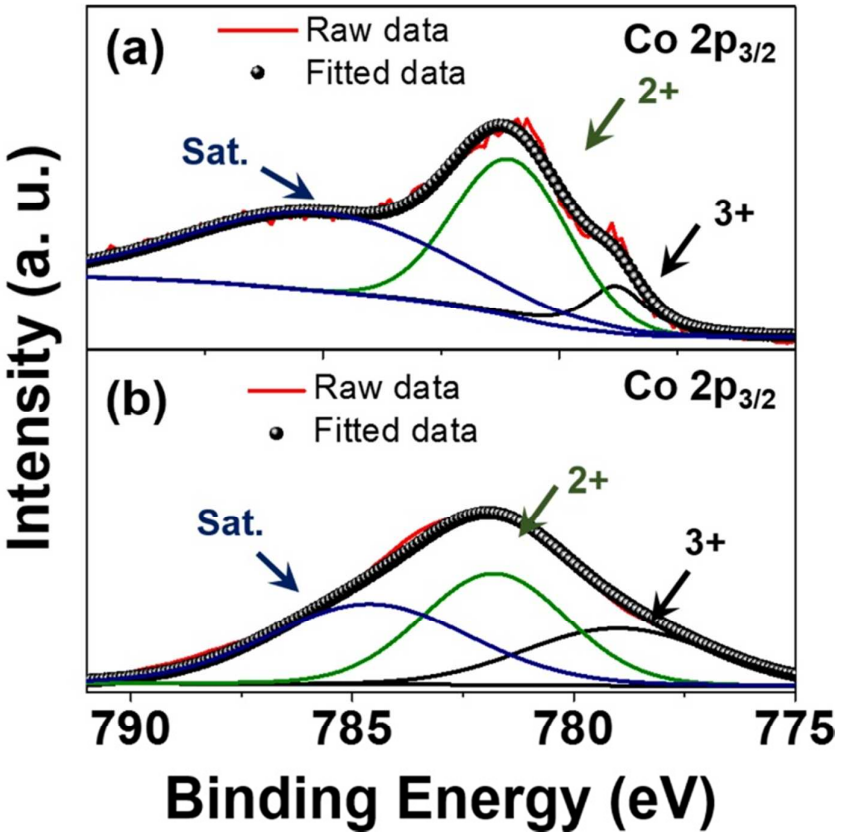

Figure S11. High-resolution XPS spectra of Co 2p of $CoSe_2$@NC-NR/CNT microspheres obtained (a) before and (b) after 20 cycles

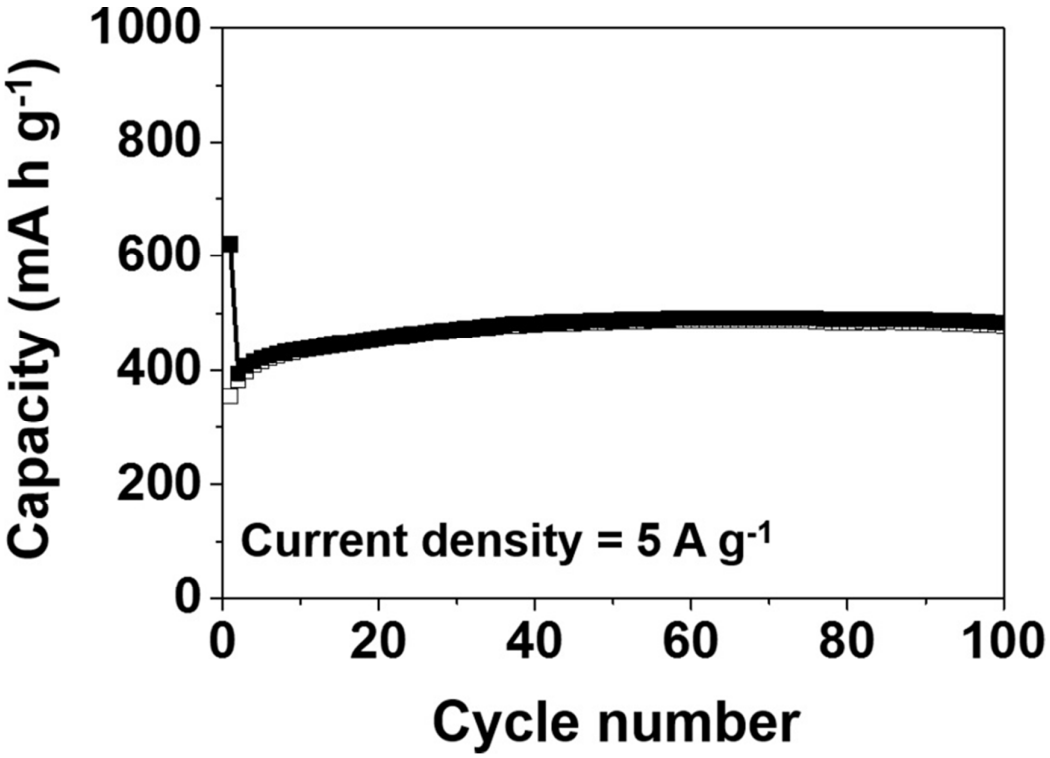

Figure S12. Cycling performance of $CoSe_2$@NC-NR/CNT microspheres at a current density of 5 A g^{-1}.

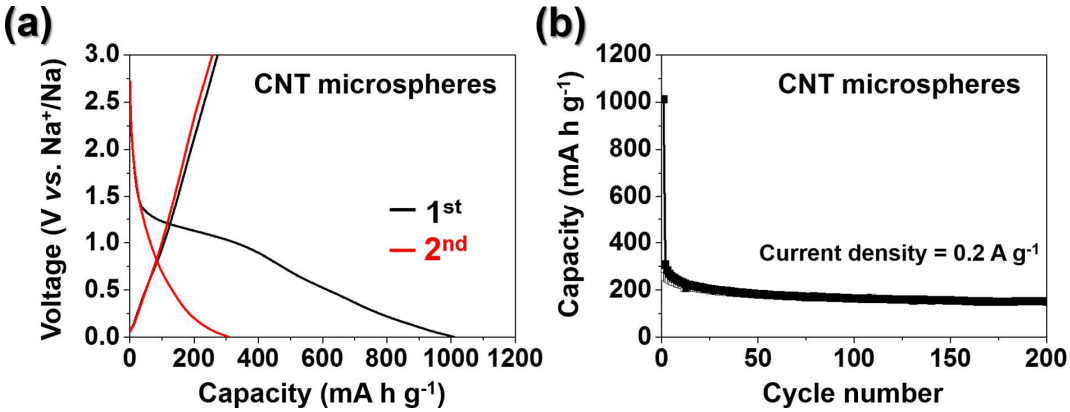

Figure S13. (a) Charge-discharge profiles and (b) cycling performance of CNT porous microspheres at current density of 0.2 A g^{-1}.

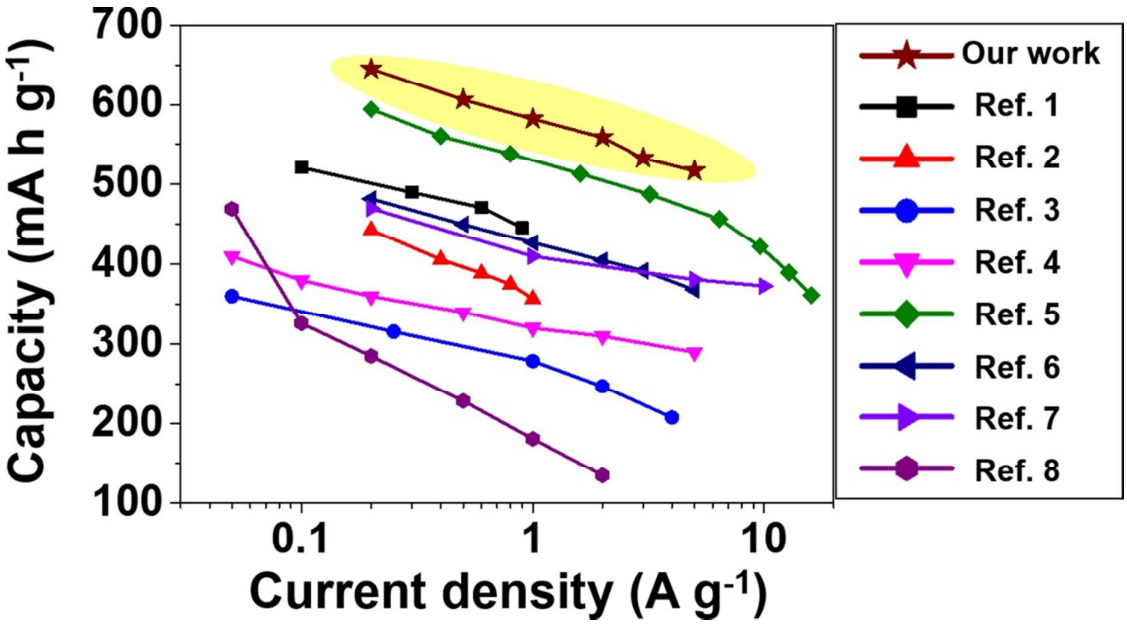

Figure S14. Rate comparison of $CoSe_2$@NC-NR/CNT microspheres with various nanostructured $CoSe_x$-based electrodes.

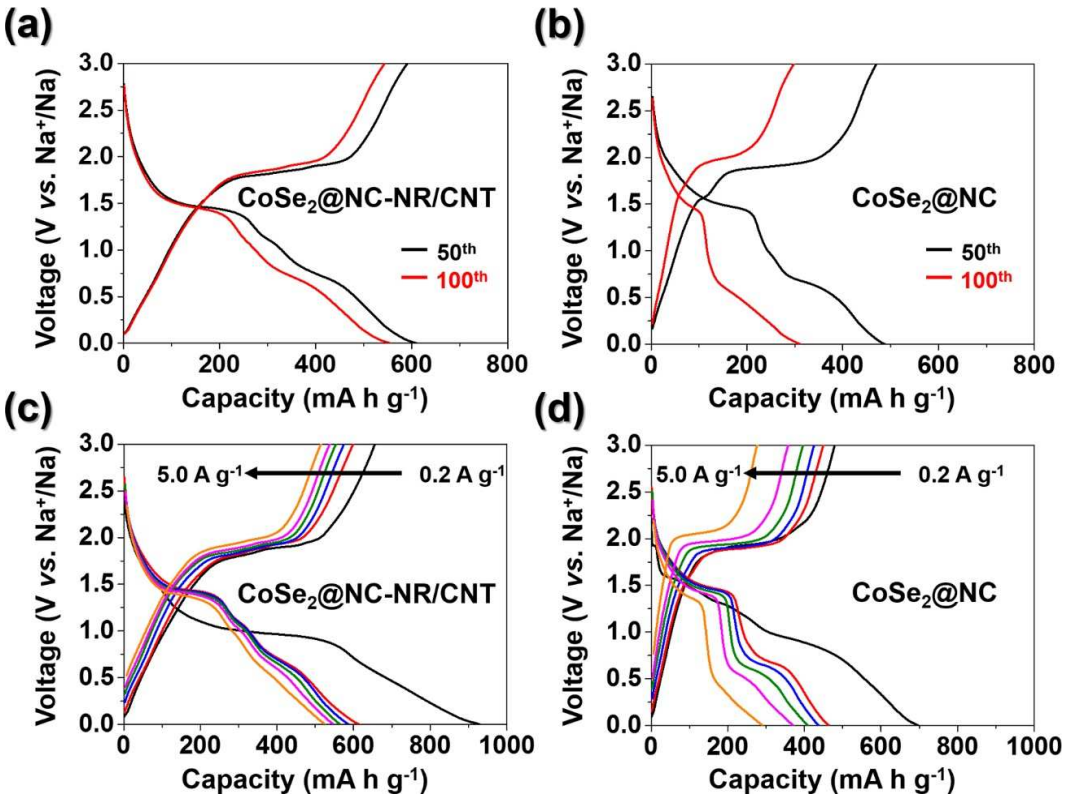

Figure S15. Charge-discharge profiles of $CoSe_2$@NC-NR/CNT microsphere and $CoSe_2$@NC polyhedron (a, b) after 50 and 100 cycles at a current density of 0.2 A g^{-1}, and (c, d) at different current densities (from 0.2 to 5.0 A g^{-1}).

Table S1 Electrocatalytic activity for HER of various nanostructured $CoSe_x$ materials.

Materials	Electrolyte	Tafel slope [mV dec^{-1}]	Overpotential at current density = 10 mA cm^{-2} [mV]	Ref
$CoSe_2$@NC-NR/CNT microspheres	**0.5M H_2SO_4**	**49.8**	**171**	**Our work**
$CoSe_2$ thin film	0.5M H_2SO_4	55	327	Ref. 9
$CoSe_2$ nanoparticles coated on carbon black	0.5M H_2SO_4	42	200	Ref. 10
$CoSe_2$@defective CNT	0.5M H_2SO_4	82	132	Ref. 11
$CoSe_2$ nanocrystals	0.5M H_2SO_4	40	160	Ref. 12
Interwoven $CoSe_2$/CNT	0.5M H_2SO_4	32	186	Ref. 13

References

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