

Supporting Information

**CoSe₂/Co nanoparticles embedded in Co, N co-doped carbon
nanopolyhedra/nanotube as an efficient oxygen reduction electrocatalyst for Zn-
air battery**

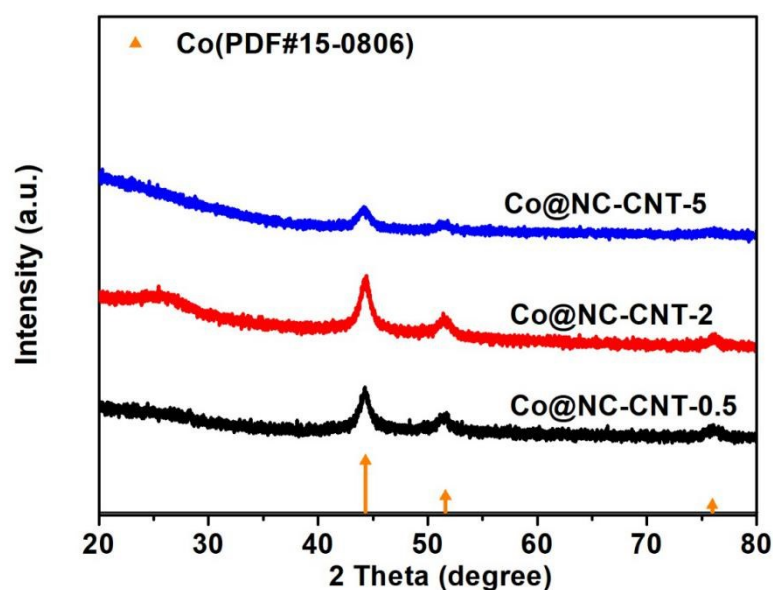


Fig. S1 Powder XRD patterns of Co@NC-CNT-x.

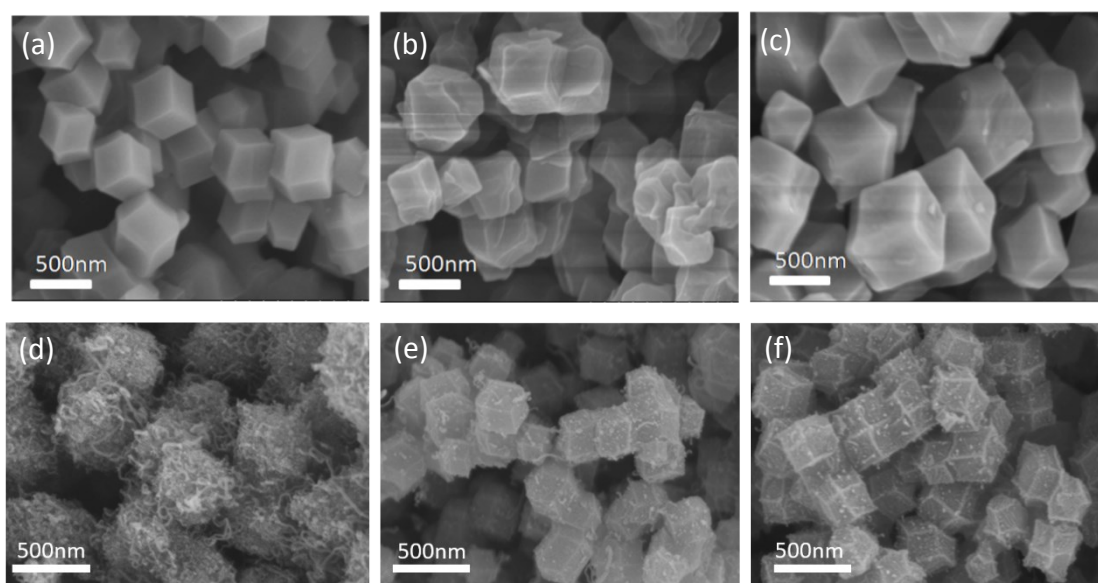


Fig. S2 SEM images of hybrid raw materials (a) Zn/Co-ZIF-0.5, (b) Zn/Co-ZIF-2, (c) Zn/Co-ZIF-5

and corresponding carbonized products (d) Co@NC-CNT-0.5, (e) Co@NC-CNT-2, (f) Co@NC-CNT-5.

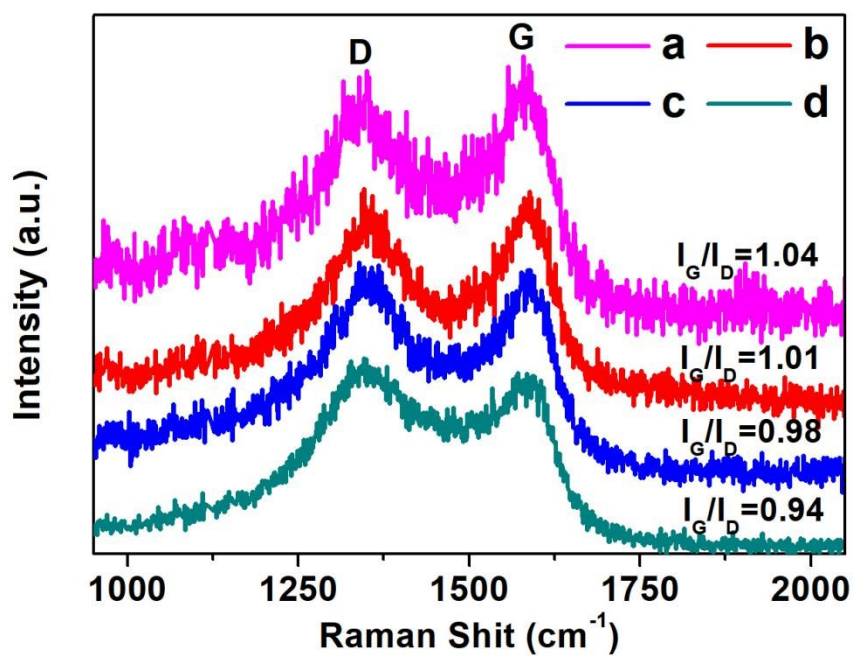
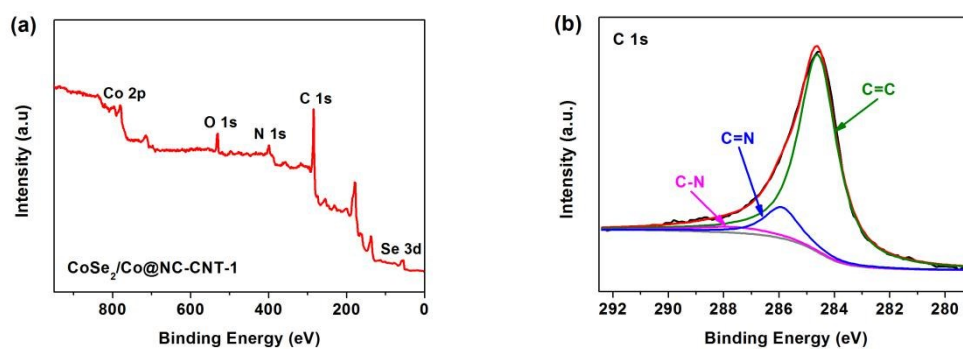


Fig. S3 Raman spectra of (a) CoSe₂/Co@NC-CNT-0.5, (b) CoSe₂/Co@NC-CNT-1, (c) CoSe₂/Co@NC-CNT-2 and (d) CoSe₂/Co@NC-CNT-5.



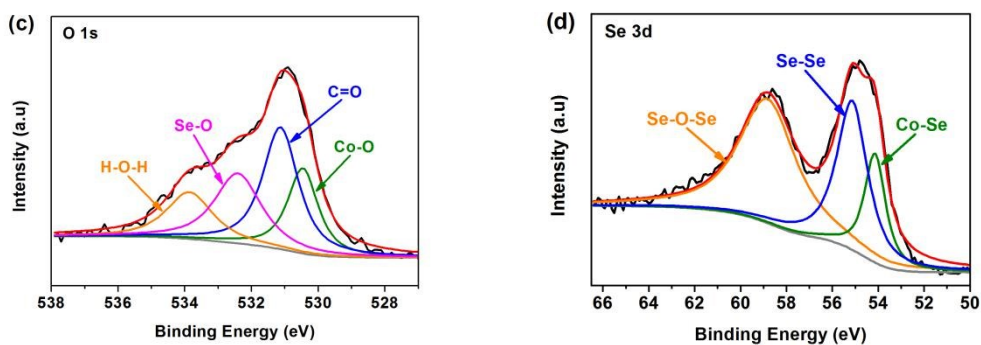


Fig. S4 (a) The XPS survey scan spectrum of CoSe₂/Co@NC-CNT-1. (b) C 1s XPS spectra, (c) O 1s XPS spectra and (d) Se 3d XPS spectra of CoSe₂/Co@NC-CNT-1.

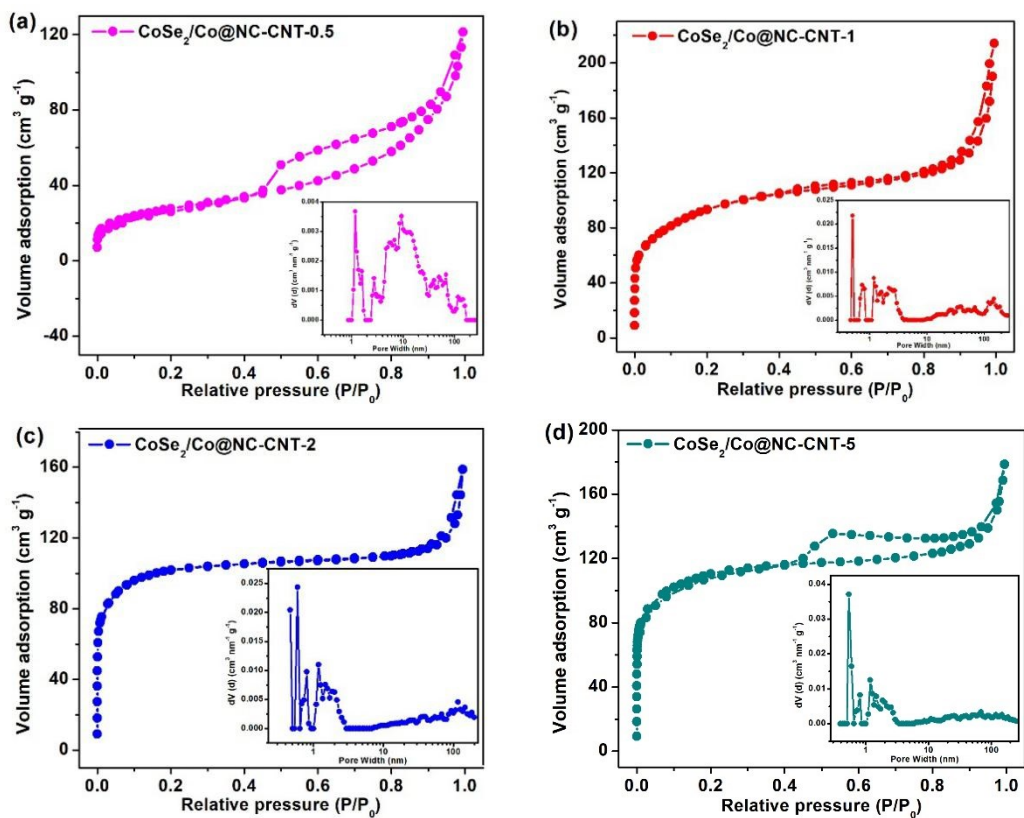


Fig. S5 N₂ sorption isotherms and corresponding pore size distributions (inside) for (a) CoSe₂/Co@NC-CNT-0.5, (b) CoSe₂/Co@NC-CNT-1, (c) CoSe₂/Co@NC-CNT-2, (d) CoSe₂/Co@NC-CNT-5.

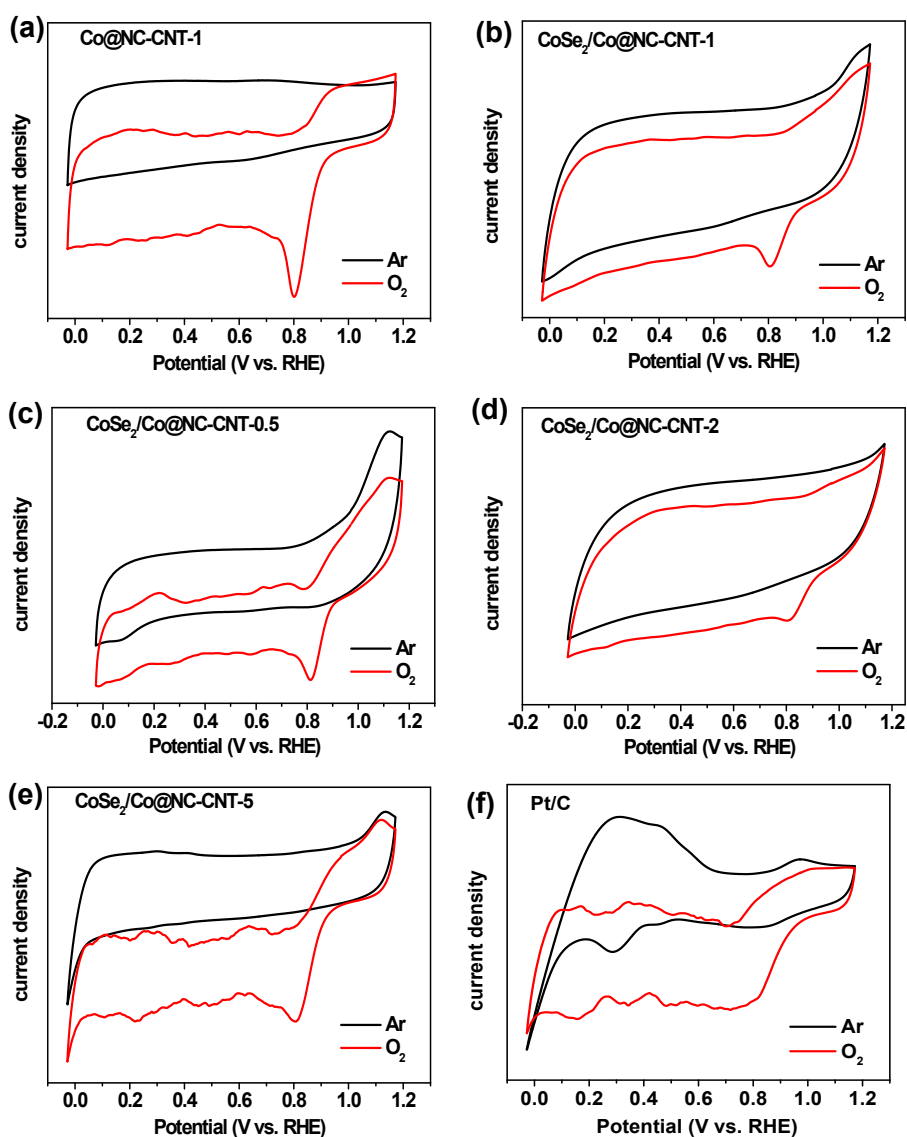
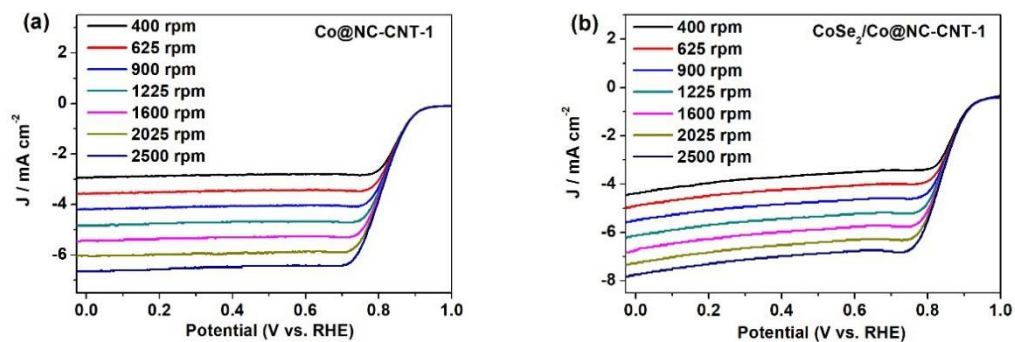


Fig. S6 CV curves of (a) Co@NC-CNT-1, (b) CoSe₂/Co@NC-CNT-1, (c) CoSe₂/Co@NC-CNT-0.5, (d) CoSe₂/Co@NC-CNT-2, (e) CoSe₂/Co@NC-CNT-5, (f) Pt/C in Ar-saturated and O₂-saturated 0.1 M KOH.



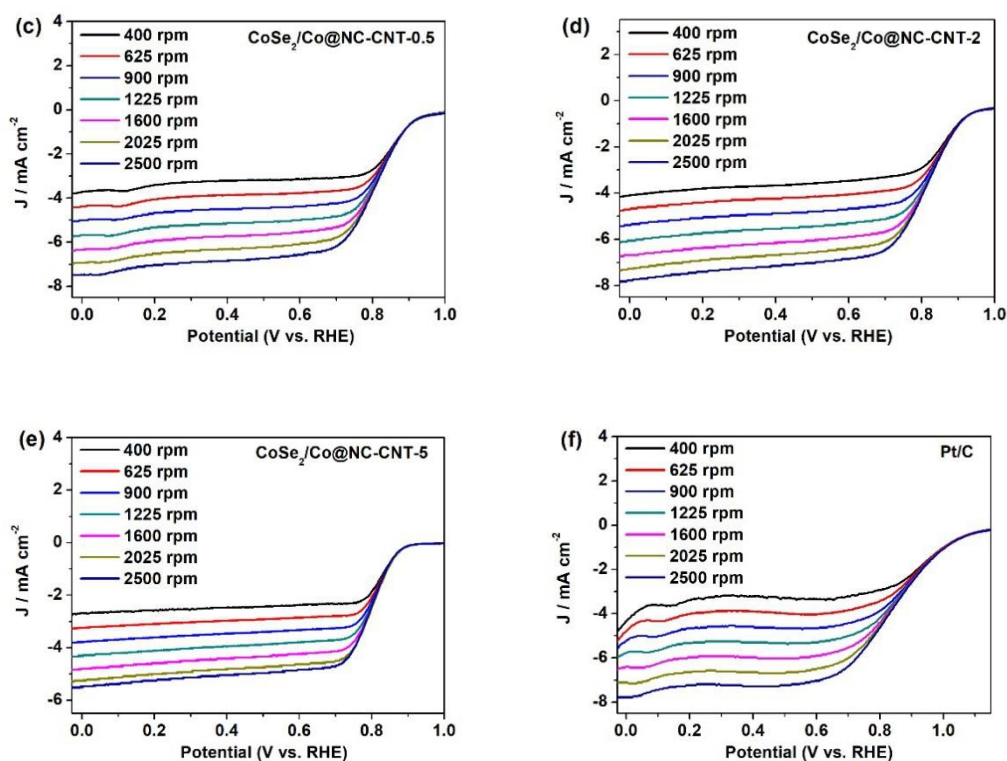
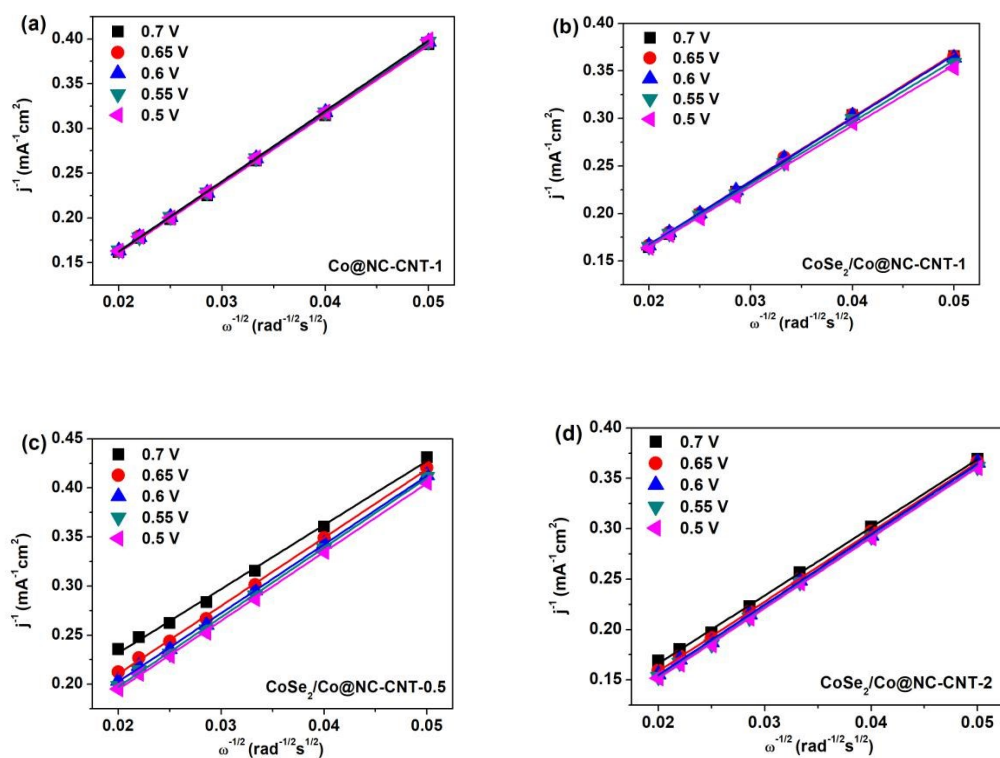


Fig. S7 LSV curves of (a) Co@NC-CNT-1, (b) CoSe₂/Co@NC-CNT-1, (c) CoSe₂/Co@NC-CNT-0.5, (d) CoSe₂/Co@NC-CNT-2, (e) CoSe₂/Co@NC-CNT-5, (f) Pt/C at different rotating speeds.



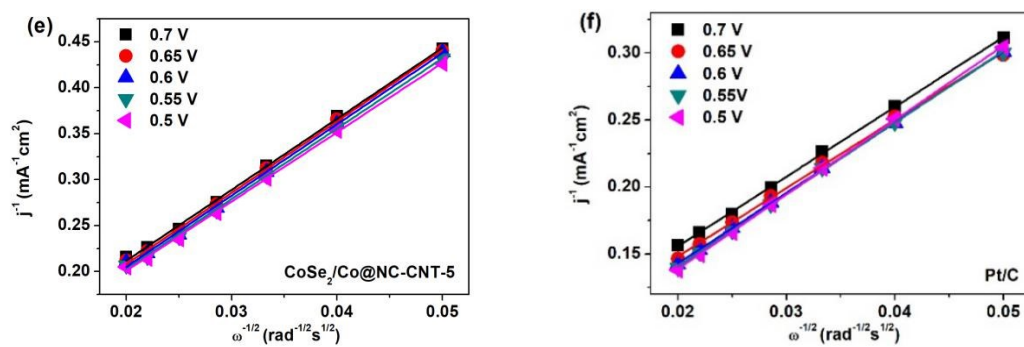
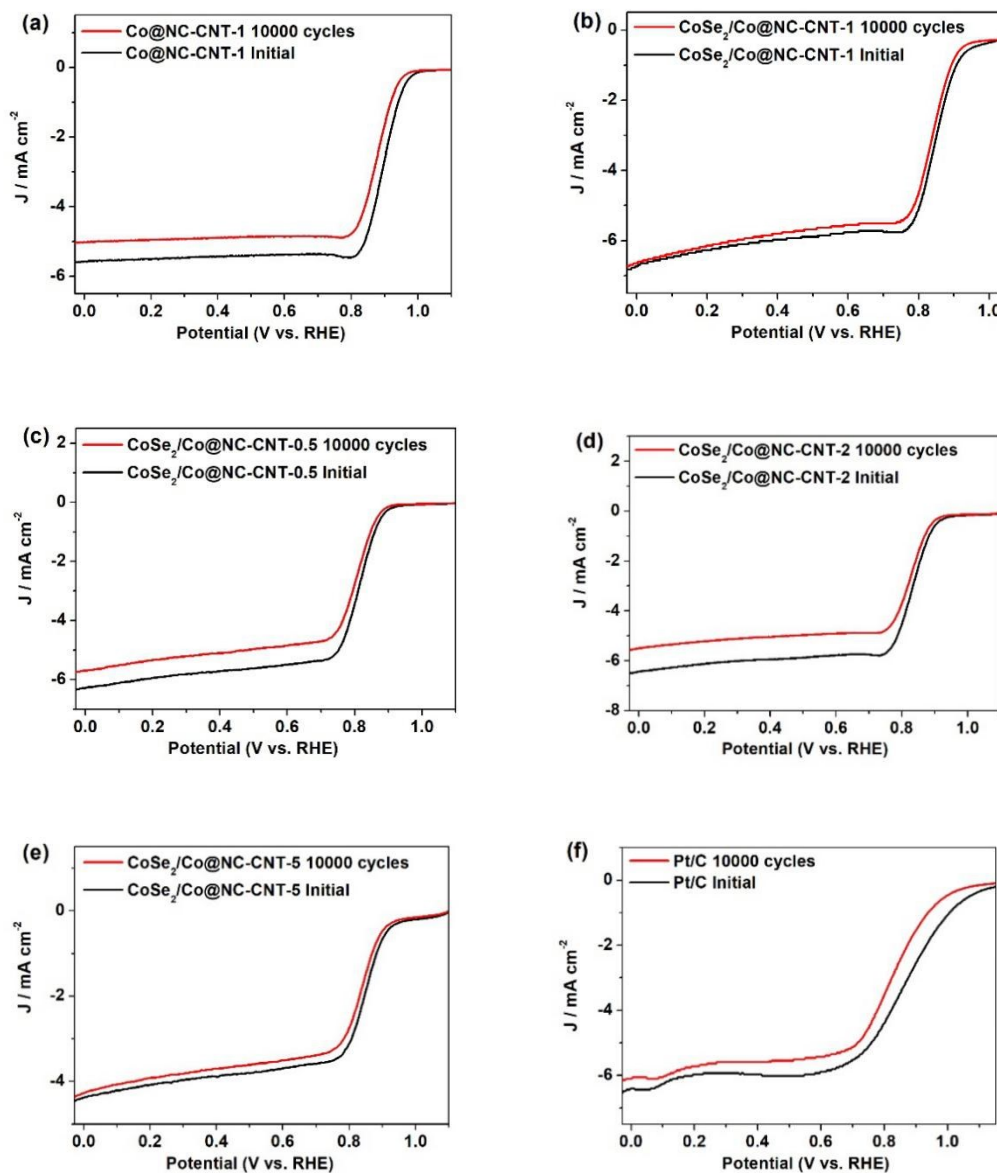


Fig. S8 K-L plots of (a) Co@NC-CNT-1, (b) CoSe₂/Co@NC-CNT-1, (c) CoSe₂/Co@NC-CNT-0.5, (d) CoSe₂/Co@NC-CNT-2, (e) CoSe₂/Co@NC-CNT-5, (f) Pt/C at different potentials.



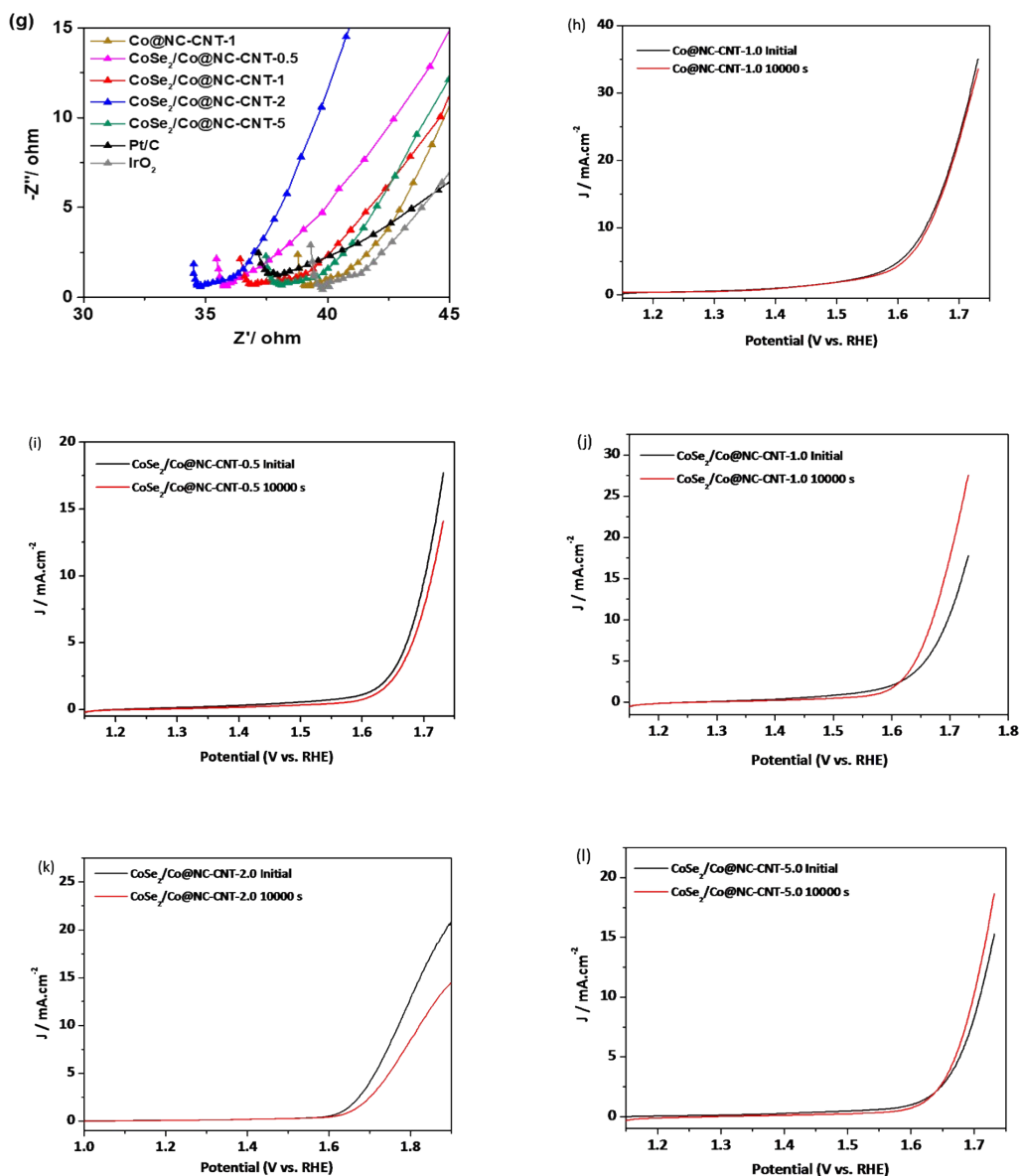


Fig. S9 LSV curves for ORR of (a) Co@NC-CNT-1, (b) CoSe₂/Co@NC-CNT-1, (c) CoSe₂/Co@NC-CNT-0.5, (d) CoSe₂/Co@NC-CNT-2, (e) CoSe₂/Co@NC-CNT-5, (f) Pt/C before and after 10000 potential cycles between -0.4 and 0 V (vs. Ag/AgCl) in O₂-saturated 0.1 M KOH solution. (g) Impedance data for different samples. LSV curves for OER of (h) Co@NC-CNT-1, (i) CoSe₂/Co@NC-CNT-0.5, (j) CoSe₂/Co@NC-CNT-1.0, (k) CoSe₂/Co@NC-CNT-2, (l) CoSe₂/Co@NC-CNT-5, (m) Pt/C before and after 10000 potential cycles between 1.1 and 1.4 V (vs. Ag/AgCl) in O₂-saturated 1 M KOH solution.

Table S1 The onset potentials, half-wave potentials and diffusion-limited current densities derived from LSV curves at 1600 rpm in O₂-saturated 0.1 M KOH solution.

Catalyst	Onset potential		Half-wave potential		Diffusion-limited current density (mA cm ⁻²)
	V vs. Ag/AgCl	V vs. RHE	V vs. Ag/AgCl	V vs. RHE	
Co@NC-CNT-1	-0.07 V	0.90 V	-0.15 V	0.82 V	5.47
CoSe ₂ /Co@NC-CNT-0.5	-0.06 V	0.91 V	-0.16 V	0.81 V	6.40
CoSe ₂ /Co@NC-CNT-1	-0.02 V	0.95 V	-0.13 V	0.84 V	6.82
CoSe ₂ /Co@NC-CNT-2	-0.03 V	0.94 V	-0.16 V	0.81 V	6.73
CoSe ₂ /Co@NC-CNT-5	-0.10 V	0.87 V	-0.17 V	0.80 V	4.84
Pt/C	0.09 V	1.06 V	-0.11 V	0.86 V	6.52