Supporting information

A general synthesis of carbon-guarded cobalt-based nanospheres for oxygen reduction electrocatalysis

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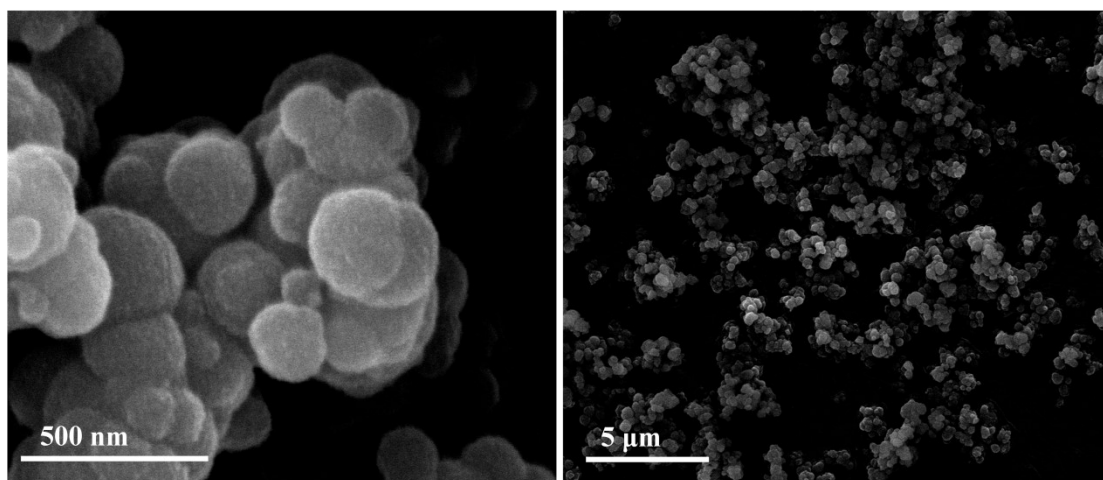
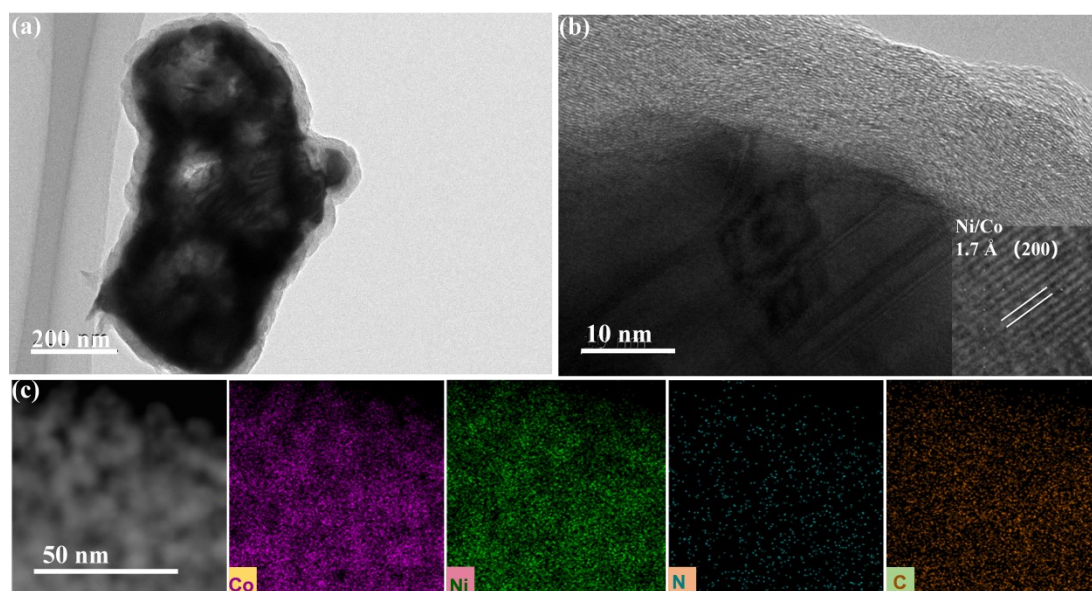Fig. S1 SEM image of Ni/Co microspheres.

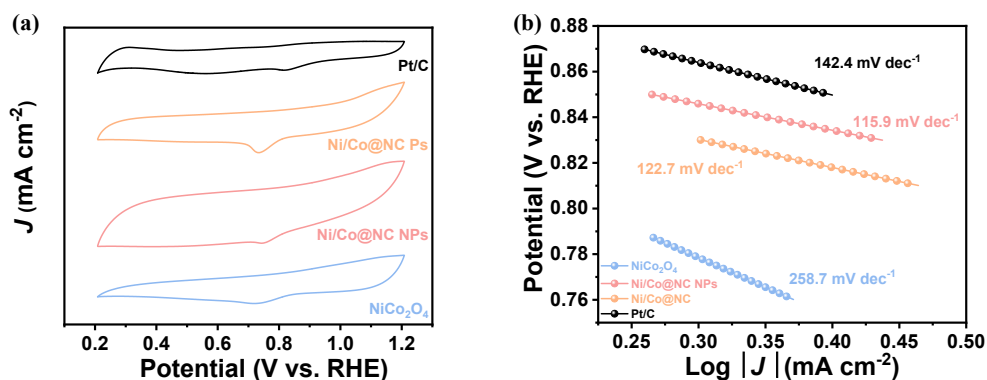Fig. S2 (a) TEM image, (b) high resolution TEM image, and (c) elemental mappings of Ni/Co@NC Ps.

Fig. S3 (a-b) CV curves (a) Tafel plots (b) in O_2-saturated 0.1 M KOH aqueous solution of the catalysts.

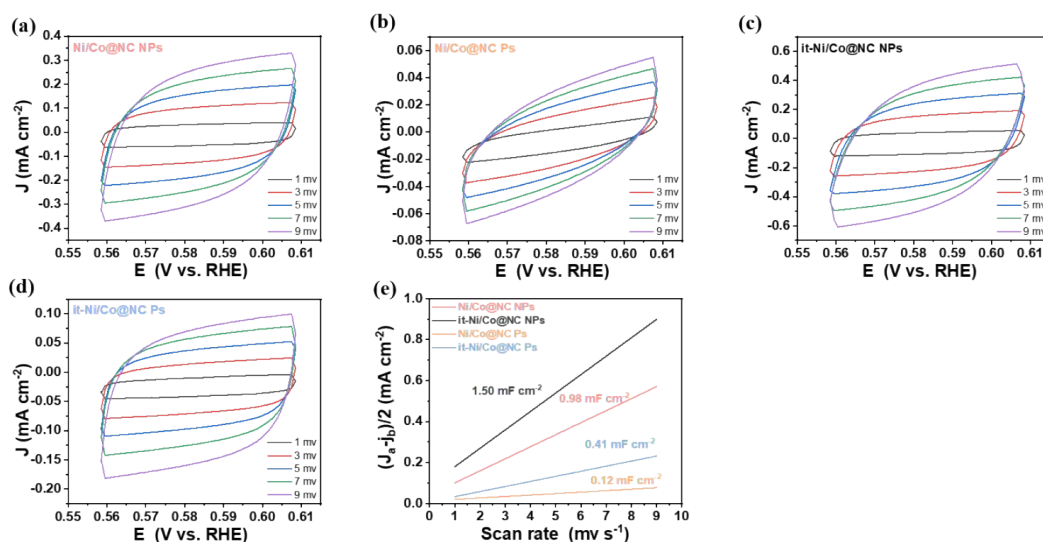Fig. S4 (a-d) CV curves and (e) the half of capacitive current density difference between Ja and Jc as a function of scan rate of the Ni/Co@NC NPs and Ni/Co@NC Ps before and after recording i-t measurements.
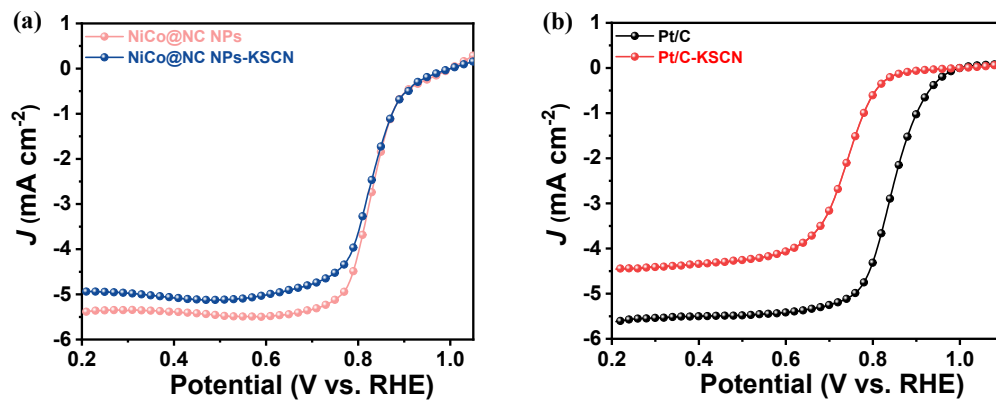
Fig. S5 LSV curves of (a) Ni/Co@NC NPs and (b) Pt/C with and without KSCN solution.
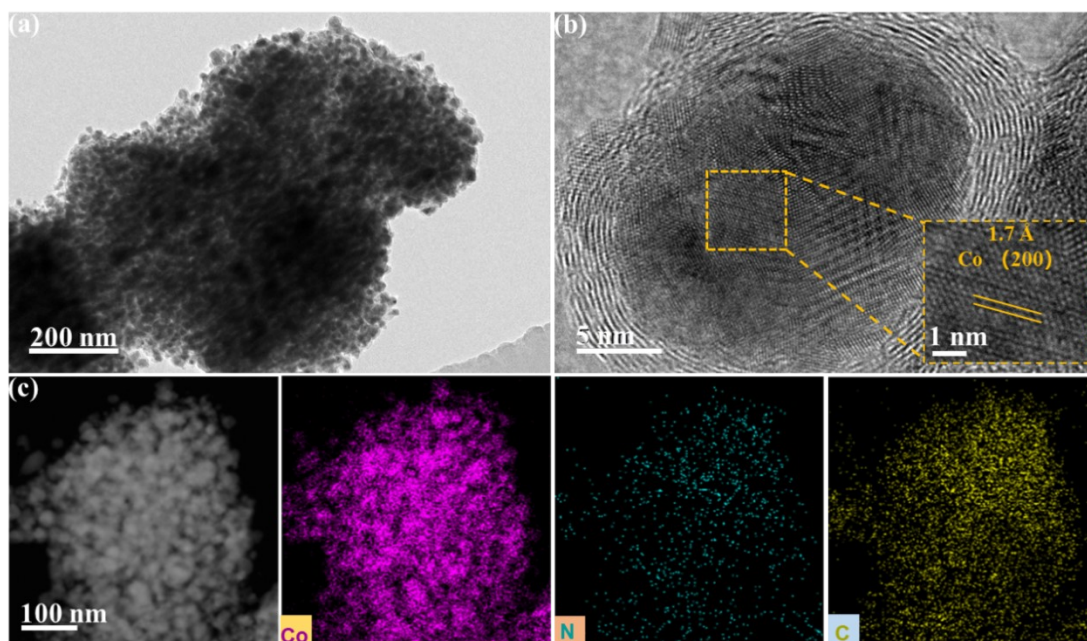

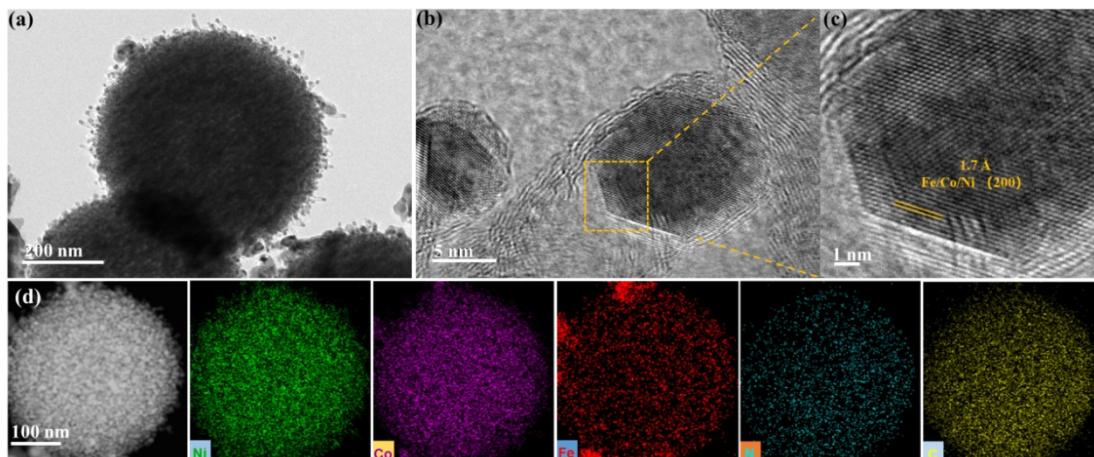Fig. S6 (a) TEM image, (b) high resolution TEM image, and (c) elemental mappings of Co@NC NPs.

Fig. S7 (a) TEM image, (b-d) high resolution TEM image, and (e) elemental mappings of Fe/Co/Ni@NC NPs.
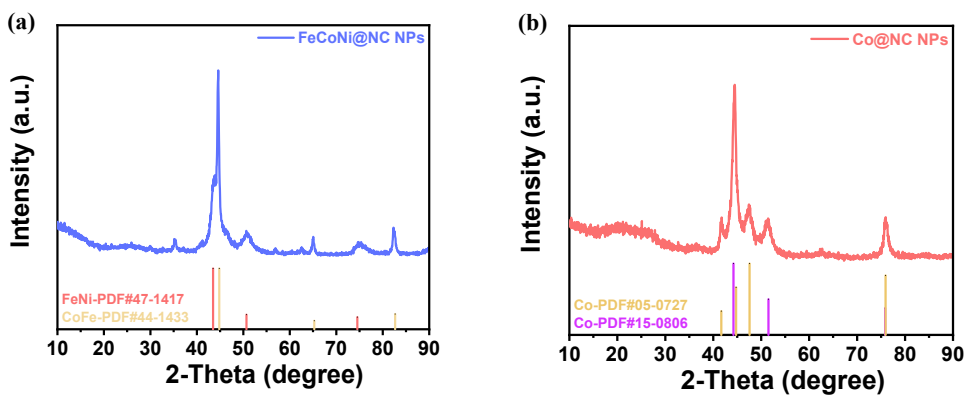

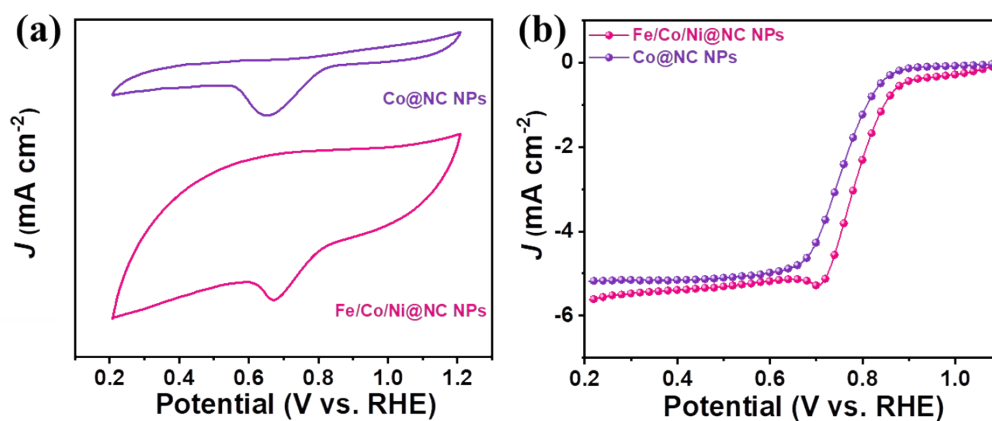Fig. S8 XRD patterns of (a) Fe/Co/Ni@NC NPs and (b) Co@NC NPs.

Fig. S9 CV curves (a) LSV curves (b) of Co@NC NPs and Fe/Co/Ni@NC NPs in O_2-saturated 0.1 M NaOH aqueous solution.

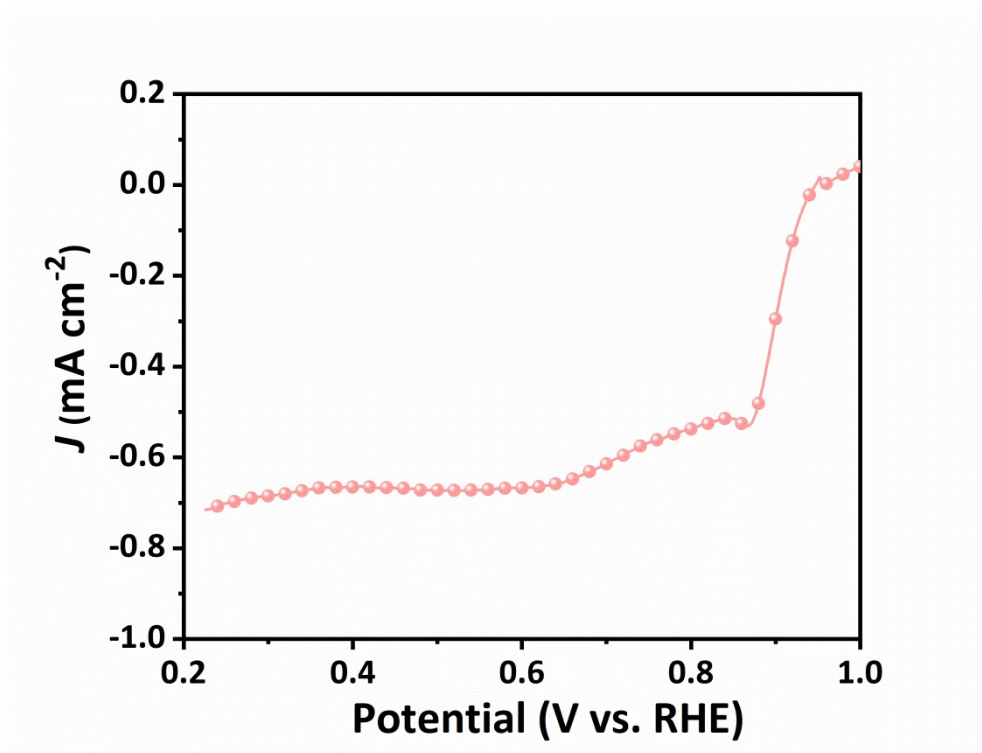Fig. S10 The in situ LSV curve while recording the Raman spectra of Ni/Co@NC NPs.
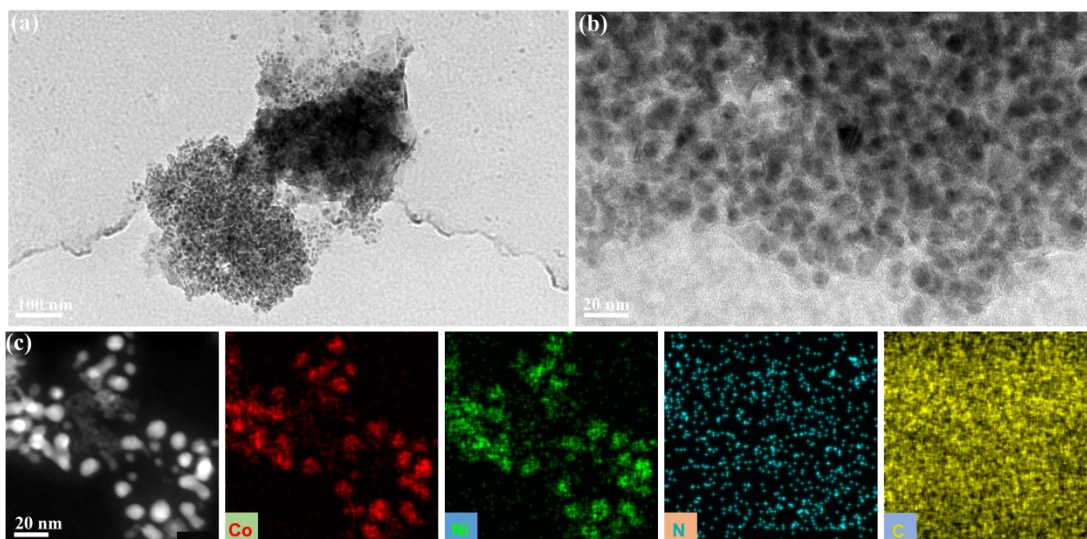
Fig. S11 (a) TEM image, (b) high resolution TEM image, and (c) elemental mappings of Ni/Co@NC NPs after complete discharging of ZAB.
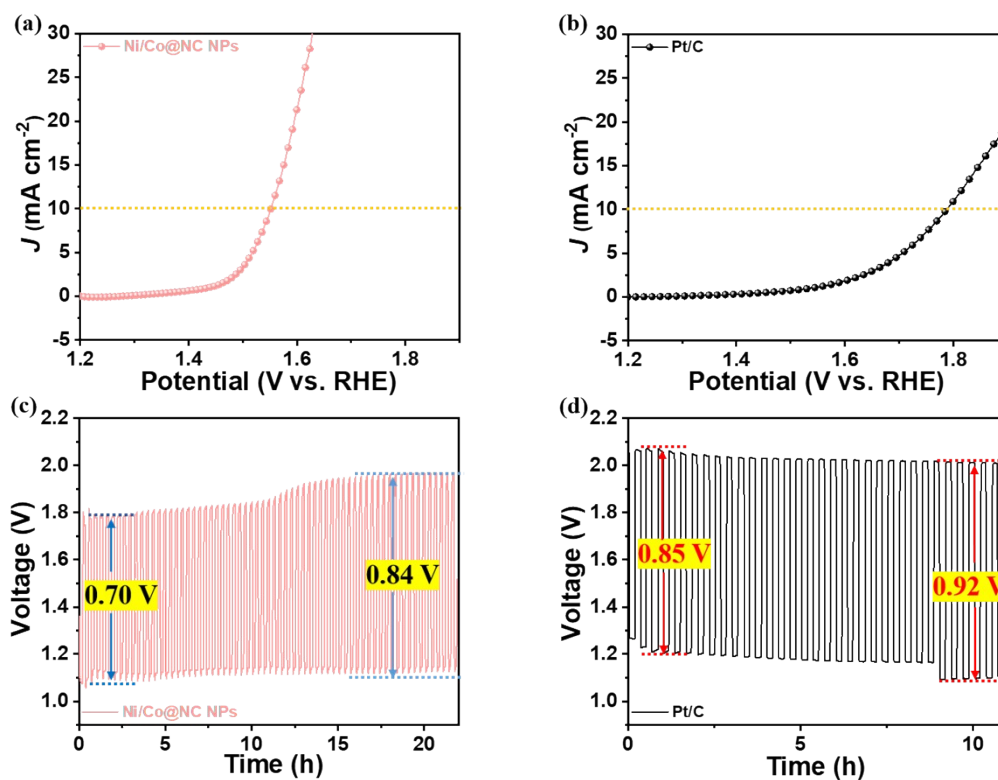

Fig. S12 (a-b) OER curves of Ni/Co@NC NPs (a) and Pt/C (b) in 1 M KOH aqueous solution; (c-d) Long-term charge-discharge cycle curves of ZABs driven by Ni/Co@NC NPs (c) and Pt/C (d) at 5 mA cm^{-2}.

Table S1 Surface compositions of Ni/Co@NC NPs and Ni/Co@NC Ps examined by XPS.

Elements\Catalysts	Ni/Co@NC NPs atomic ratio (%)	Ni/Co@NC Ps atomic ratio (%)
Ni	14.26	12.00
Co	22.41	16.70
C	17.78	44.18
O	17.37	20.12
N	28.18	7.00

Table S2 Electrocatalytic ORR performances of obtained Ni/Co@NC NPs and the recently reported Ni/Co-related non-precious catalysts.

S.No.	Catalyst	Half wave potential (V vs. RHE)	Reference
1	Ni/Co@NC NPs	0.83	This work
2	CoNi-NC	0.83	[1]
3	CoFe/N-GCT	0.79	[2]
4	FeCo-NCNFs800	0.81	[3]
5	CoNi/BCF	0.81	[4]
6	NiCo/PFC	0.79	[5]
7	NiO/CoN	0.68	[6]
8	FeCo-NCps	0.84	[7]
9	Meso/micro-FeCo-Nx-CN	0.83	[8]
10	CoNi-SAs/NC	0.76	[9]
11	Ni-N$_4$/GHSs/Fe-N$_4$	0.83	[10]
12	NiCo$_2$S$_4$/CNNs	0.83	[11]

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