

Supporting Information

High dispersion Co-N/C ultra-thin carbon nanosheets modified with trace Ce as efficient oxygen reduction reaction catalysts

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Supporting Figures

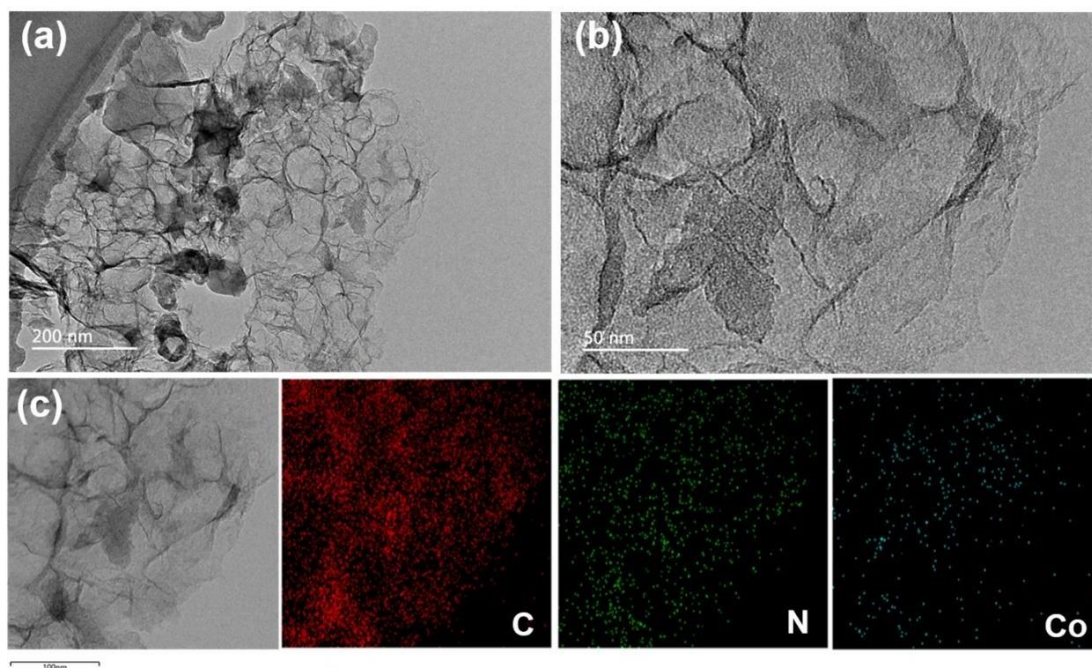


Fig. S1(a) TEM of Co/N/C (b) HRTEM image of Co/N/C (c) STEM and element distribution diagrams of Co/N/C.

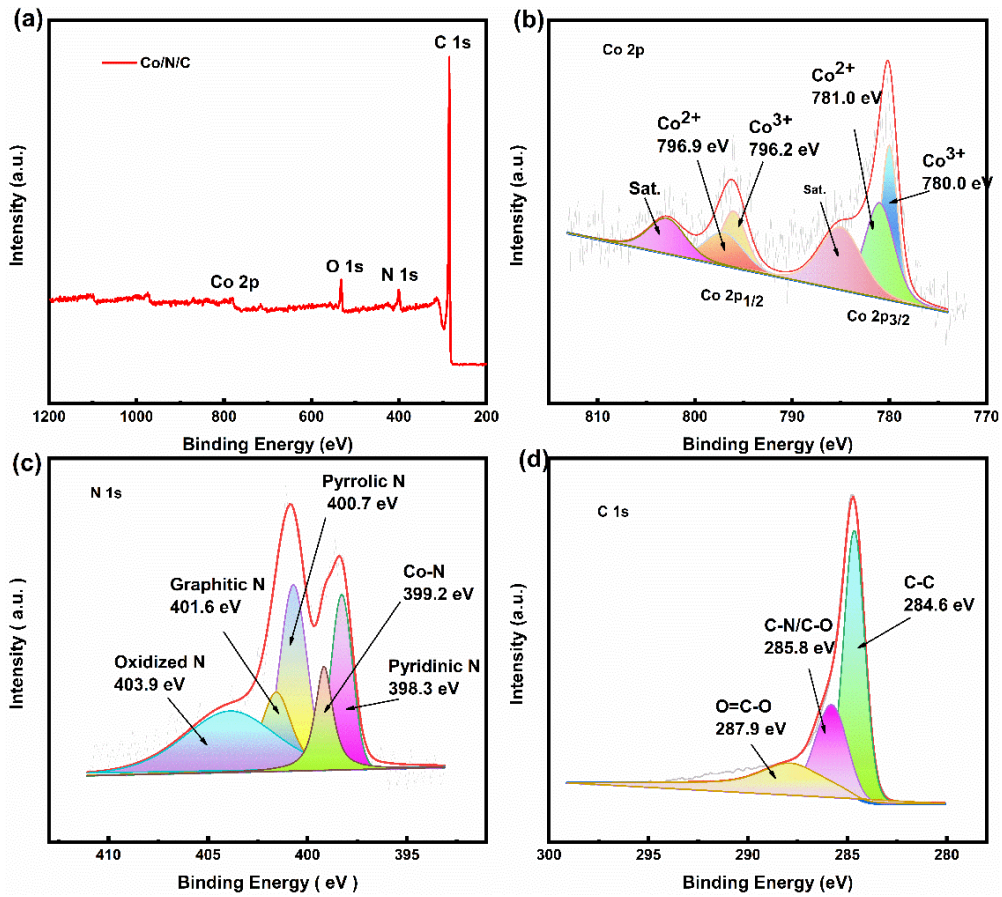


Fig. S2 (a) XPS survey spectra, (b) Detailed Co 2p spectra of Co/N/C, (c) Detailed N 1s spectra of Co/N/C, (d) Detailed C 1s spectra of Co/N/C

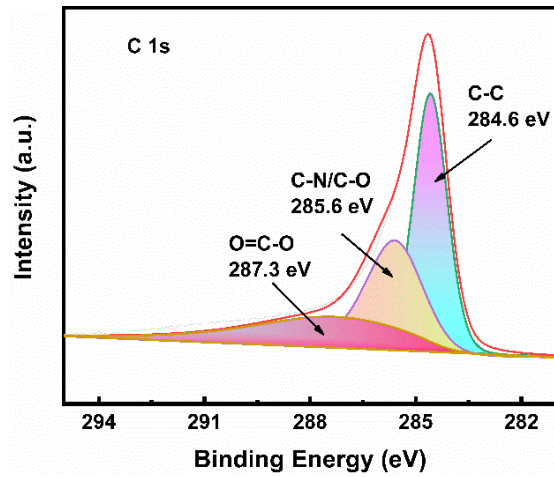


Fig. S3 Detailed C 1s spectra of Ce-Co/N/C

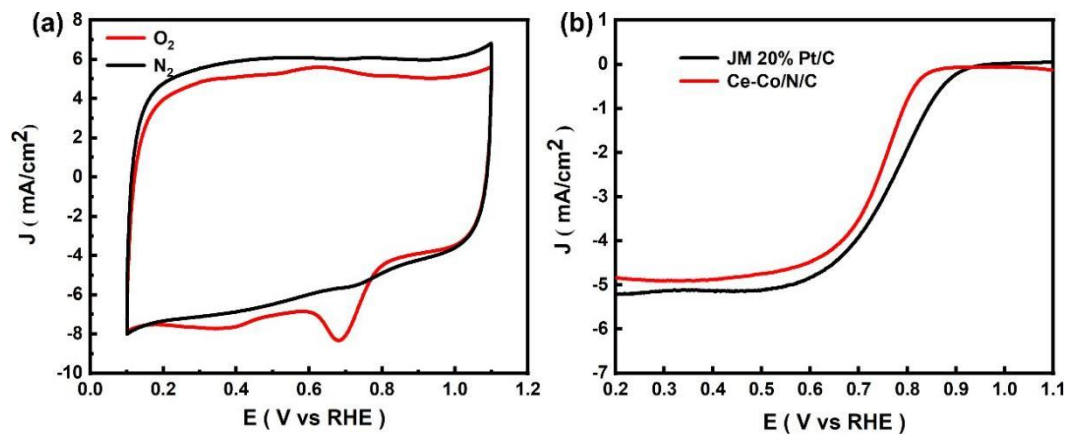


Fig. S4 Ce-Co/N/C polarization curve at 1600 rpm in 0.1 M HClO₄ with a rotating disk electrode (RDE)

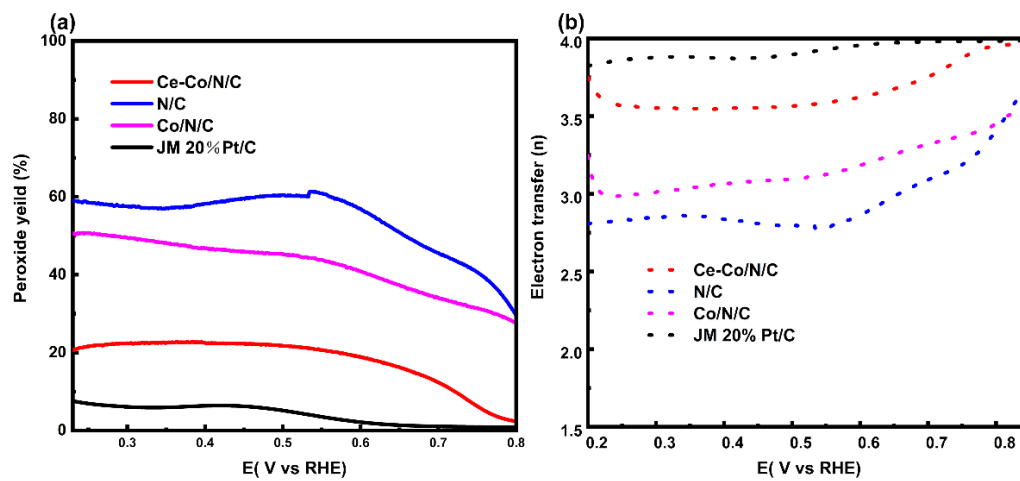


Fig. S5. (a) The H₂O₂ yield and (b) Electron transfer number by rotating ring disk electrode (RRDE).

Supporting Tables

Table S1. Summary of the N₂ adsorption and desorption for the applied samples.

Samples	BET SSA(m ² g ⁻¹)	Pore Volume (cm ³ g ⁻¹)	Pore Size (nm)
Ce-Co/N/C	442.4887	0.299808	2.70
Co/N/C	342.5485	0.352603	4.10
N/C	178.6805	0.117590	2.63
Ce-Co/N/C-no NaCl	232.7048	0.152058	2.61

Table S2. Element analysis of the applied samples based on XPS characterizations.

Sample	C (at%)	N (at%)	O (at%)	Co (at%)	Ce (at%)
Ce-Co/N/C	82.04	11.1	5.38	0.77	0.38
Co/N/C	87.93	6.36	4.86	0.84	

Table S3. Percentage content of different types of nitrogen based on XPS integral area

Sample	Pyridinic-N	Co-N	Pyrrolic-N	Graphitic-N	Oxide-N
Ce-Co/N/C	25.17%	18.16%	17.75%	27.85%	11.07%
Co/N/C	18.02%	11.94%	24.53%	14.47%	31.04%

Table S4. The corresponding parameters from the equivalent circuit simulation.

Sample	Rs (ohm)	Rct (ohm)
Ce-Co/N/C	5.803	38.74
Co/N/C	5.519	41.86
Pt/C	4.307	45.28

Table S5. Comparison of ORR electrocatalytic activities of non-precious materials in 0.1 M KOH solution.

Catalyst	E_{onset} (V)	$E_{1/2}$ (V)	Reference
Ce-CoNCNs	1.02	0.89	This work
Co@NPC/C-MWCNTs	0.93	0.79	1
Co@Co-N-C-A NHs	0.98	0.85	2
Co ₂ N _{0.67} -BHPC	0.93	0.86	3
Cu-N-C-ICHP NDs	0.97	0.85	4
Co-CeO ₂ /C	0.75	0.92	5
Co-C ₃ N ₄ /CNT	0.90	0.85	6
Nd-Co@NC	1.03	0.85	7
Fe _{SA} /FeO _{NC} /NSC	0.99	0.86	8
NPC-Fe	0.95	0.82	9
Fe/N/S-CNTs	0.987	0.887	10

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