Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

Interconnected Core-Shell Carbon Nanotube/Graphene Nanoribbon Scaffolds for Anchorng Cobalt Oxides as Bifunctional Electrocatalysts for Oxygen Evolution and Reduction

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Table S1. Oxygen electrode activities

Catalyst Material	OER: E(V) at j = 10 mA cm^{-2}	ORR: E(V) at j = -3 mA cm^{-2}	Oxygen electrode Δ ($E_{OER} - E_{ORR}$) (V)
Co_3O_4/N-csCNT-GNR	1.59	0.79	0.80
Co_3O_4/graphene[a]	1.61	0.82	0.79
Co3O_4/MWCNT[b]	1.62	0.58	1.04
20 wt % Ir/C[c]	1.61	0.69	0.92
20 wt % Ru/C[c]	1.62	0.61	1.01
20 wt % Pt/C[c]	2.02	0.86	1.16
Mn oxide[c]	1.77	0.73	1.04

[a]Data from reference [S1]. [b]Data from reference [S2]. [c]Data from reference [S3].

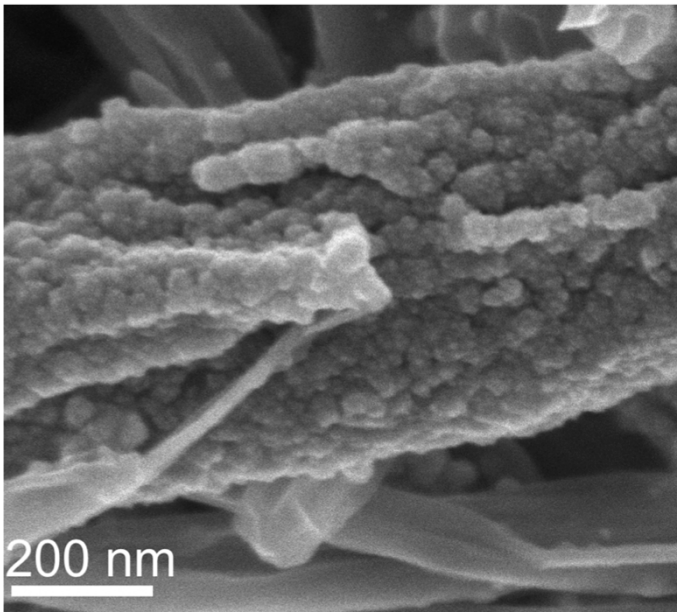

Fig. S1 SEM image of the Co_3O_4/N-csCNT-GNR composite.

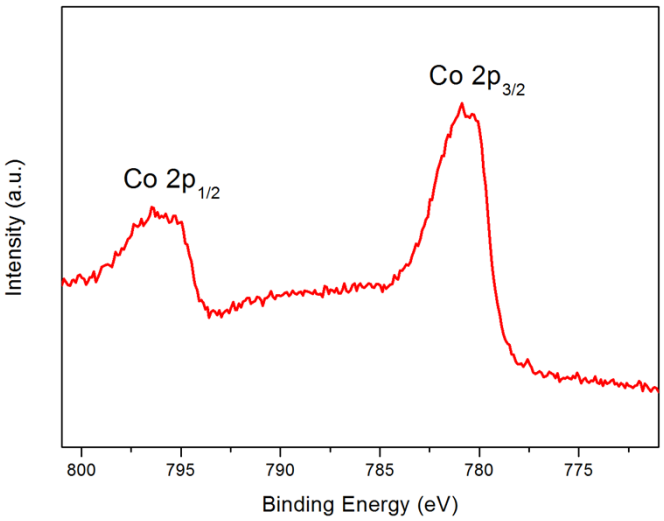

Fig. S2 Co 2p XPS survey spectrum of the Co_3O_4/N-csCNT-GNR composite.

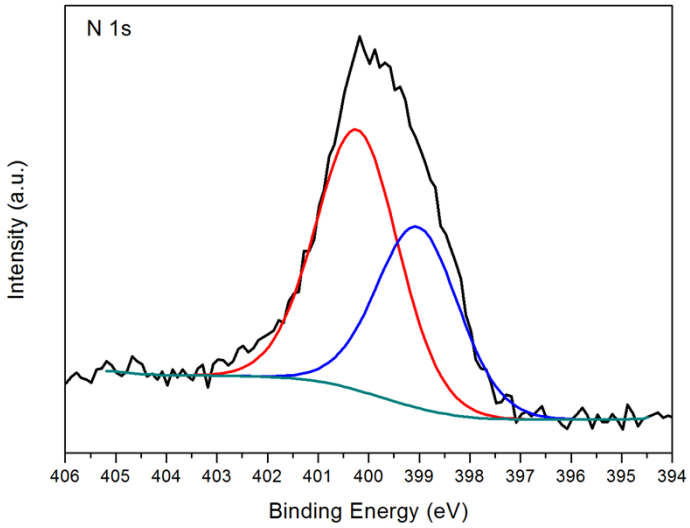

Fig. S3 N 1s XPS survey spectrum of the Co_3O_4/N-csCNT-GNR composite.

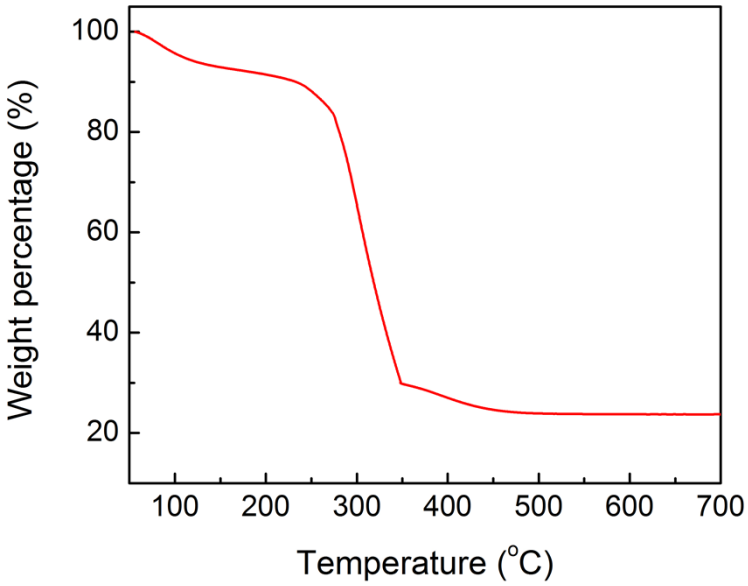

Fig. S4 TGA curve of the Co_3O_4/N-csCNT-GNR composite obtained in air ramped from room temperature to 700 °C.

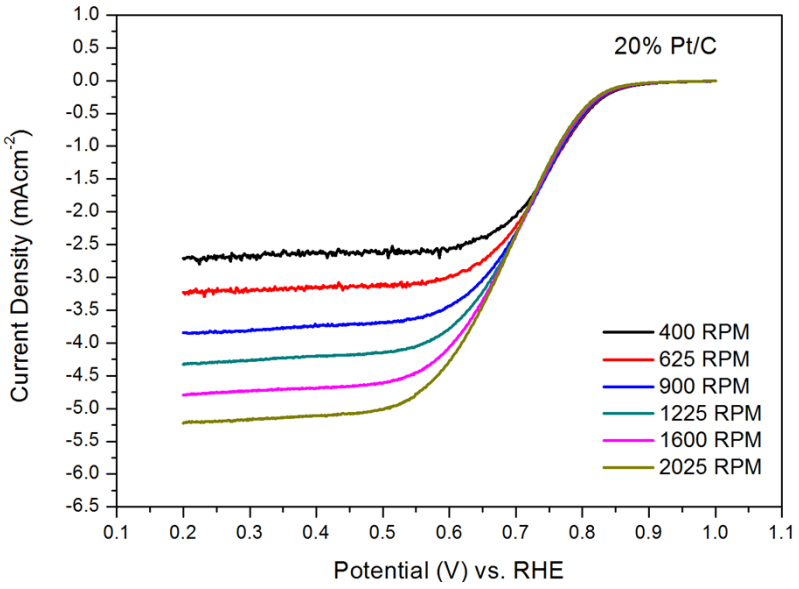

Fig. S5 Rotating disk voltammograms of 20% Pt/C at various rotational speeds in O_2 saturated 0.1 M KOH at a scan rate of 5 mV s^{-1}.

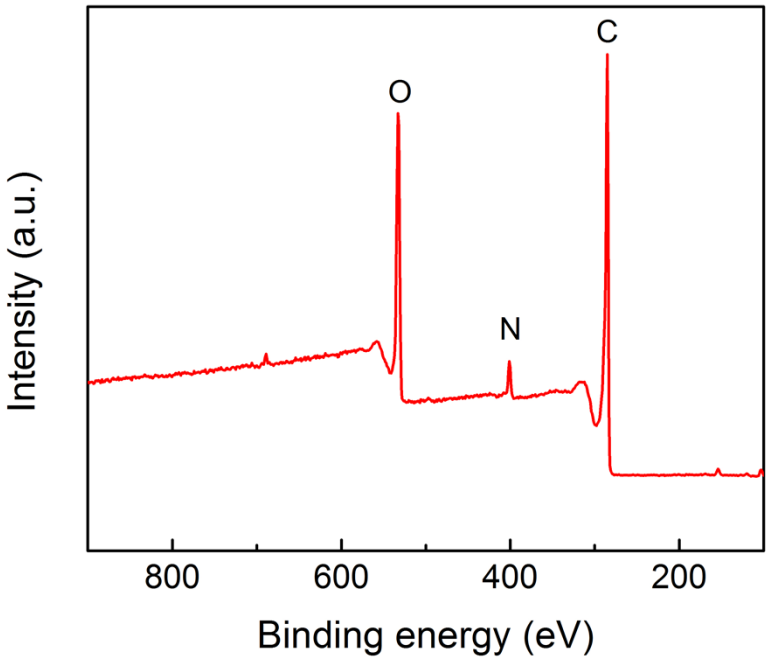

Fig. S6 XPS survey spectra of N-csCNT-GNR.

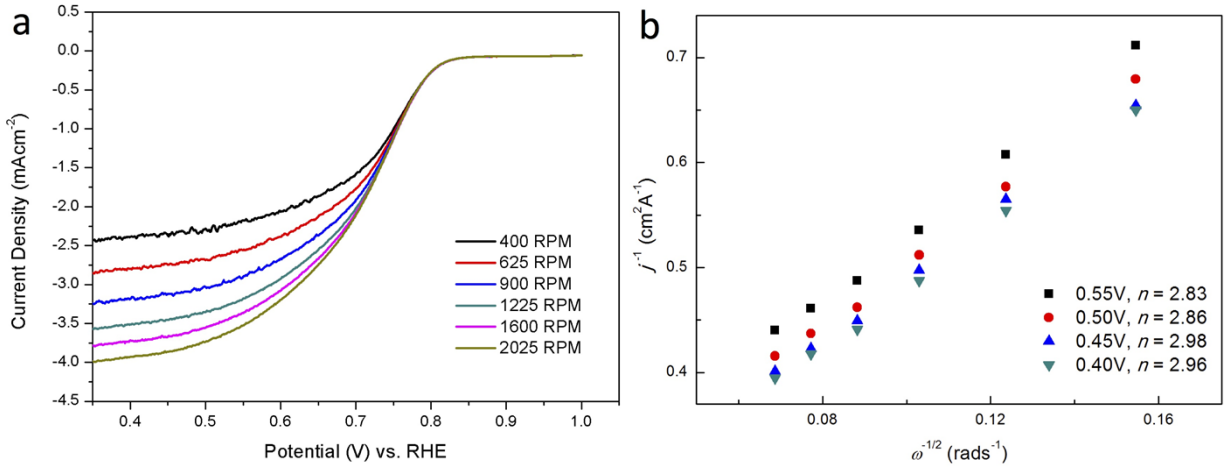

Fig. S7 (a) Rotating disk voltammograms of N-csCNT-GNR at various rotational speeds in O_2 saturated 0.1 M KOH. **(b)** The linear relationship in the Koutecky-Levich plot (J^{-1} vs. $\omega^{-1/2}$).

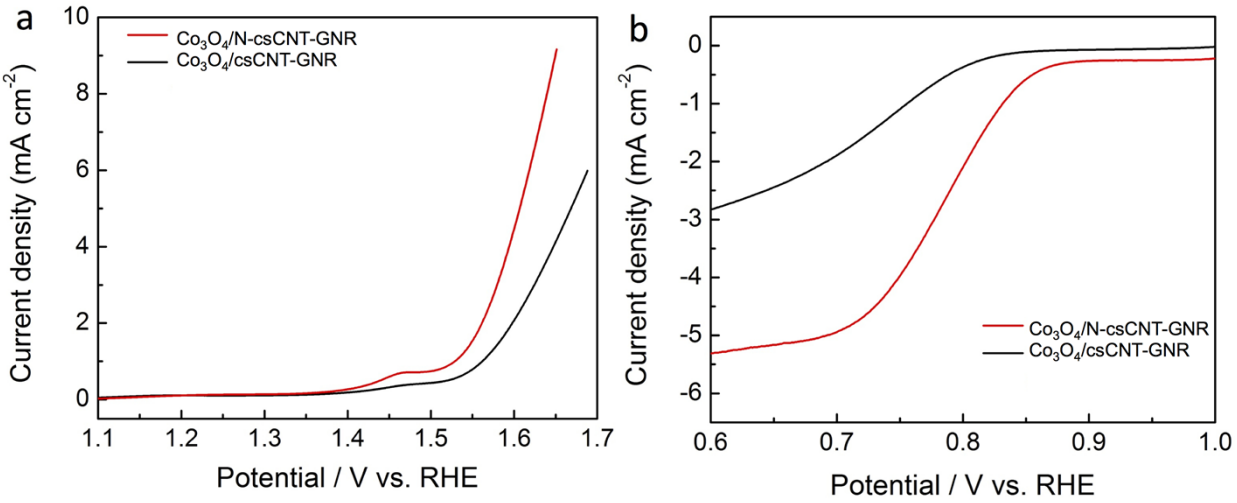

Fig. S8 RDE voltammograms obtained with Co_3O_4/N-csCNT-GNR and Co_3O_4/csCNT-GNR composites loaded GC electrodes at 1600 rpm in 0.1 M KOH with a scan rate of 5mV s^{-1} in the potential range of **(a)** OER and **(b)** ORR, respectively.

References

(S1) Liang, Y. Y.; Li, Y. G.; Wang, H. L.; Zhou, J. G.; Wang, J.; Regier, T.; Dai, H. J. *Nat. Mater.* **2011**, *10*, 780.

(S2) Lu, X. Y.; Zhao, C. *J. Mater. Chem. A* **2013**, *1*, 12053.

(S3) Gorlin, Y.; Jaramillo, T. F. *J. Am. Chem. Soc.* **2010**, *132*, 13612.