

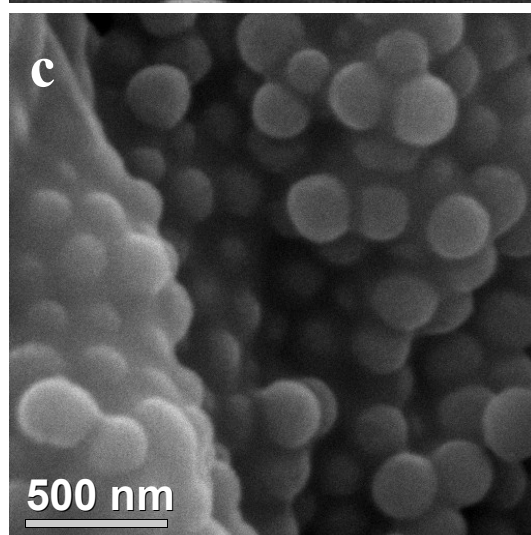
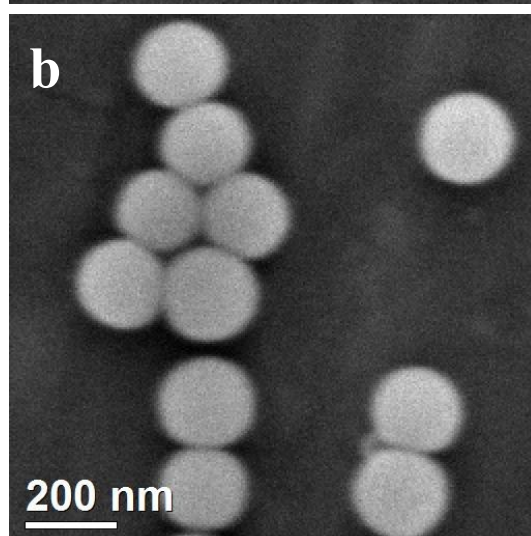
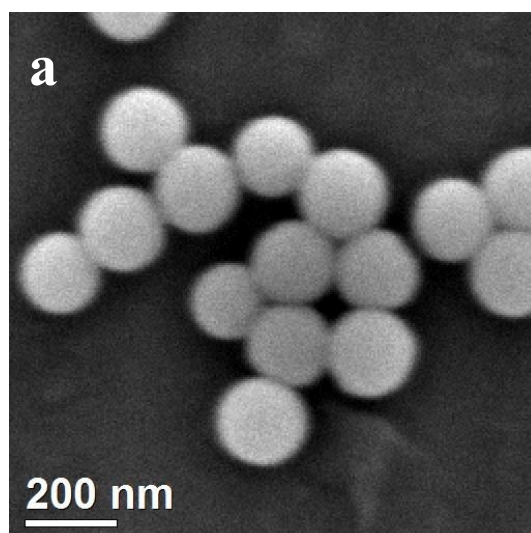
Electronic supplementary information

Uniform nitrogen and sulphur co-doped hollow carbon nanospheres as efficient metal-free electrocatalysts for oxygen reduction

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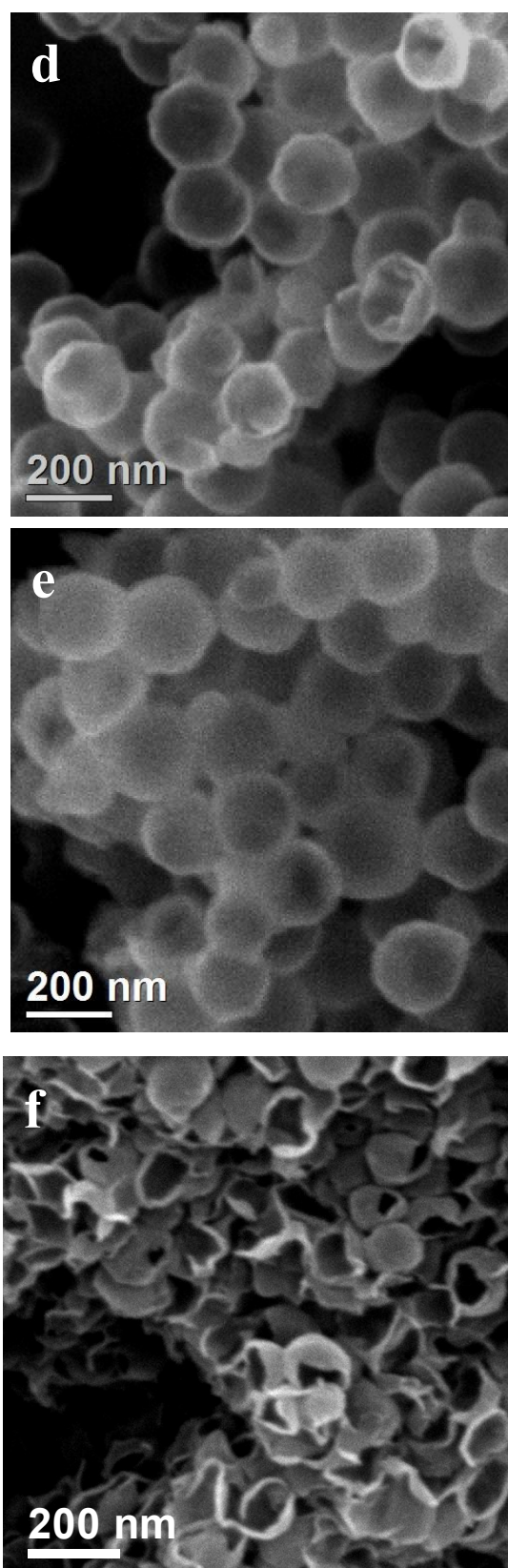
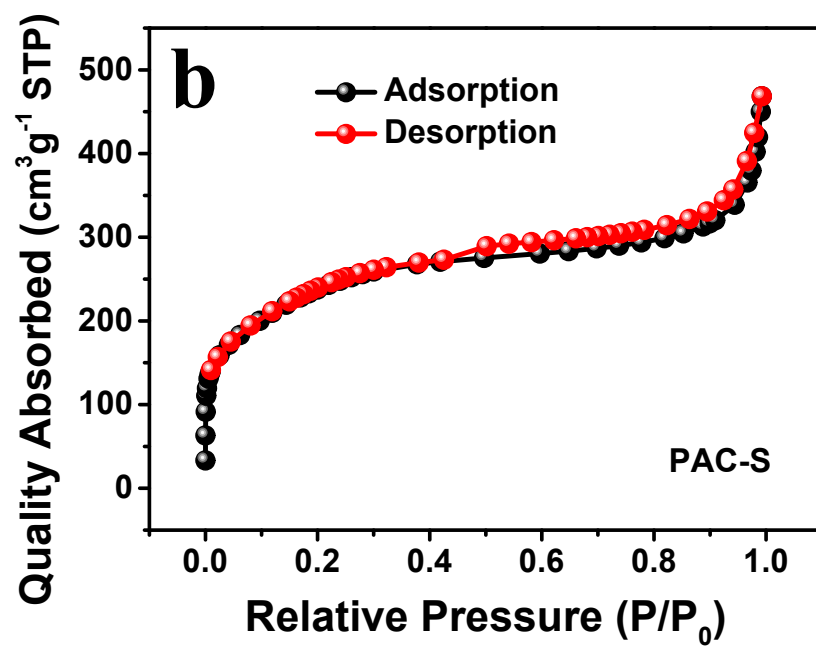
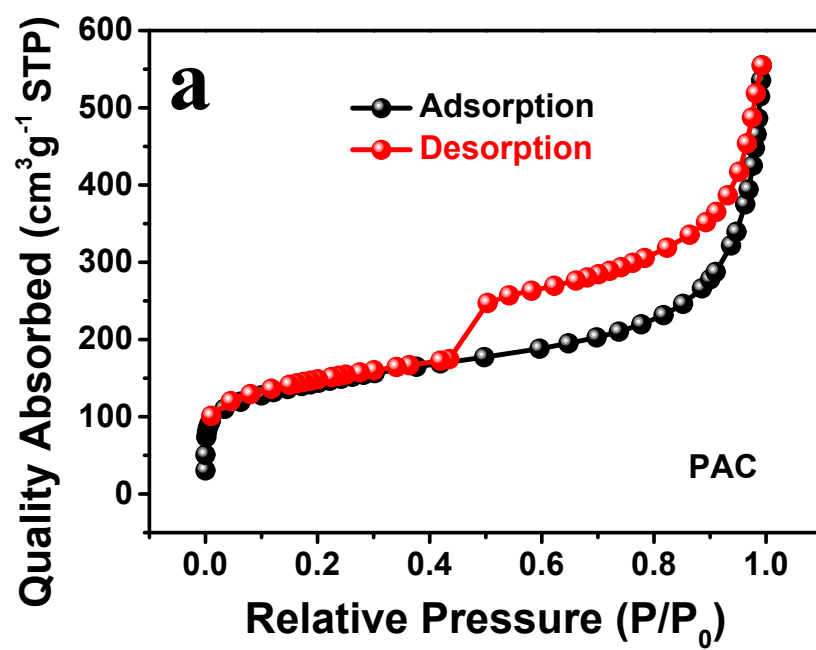
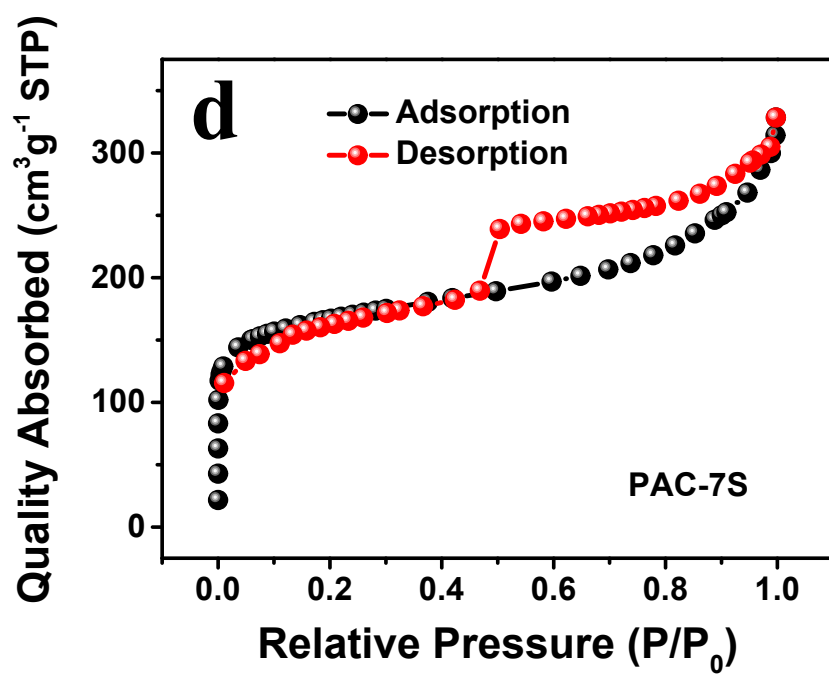
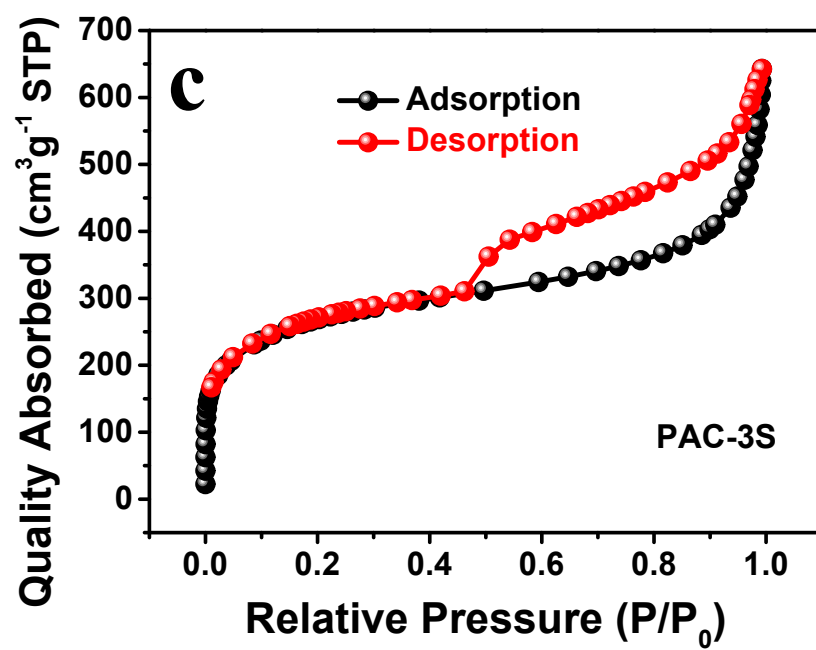
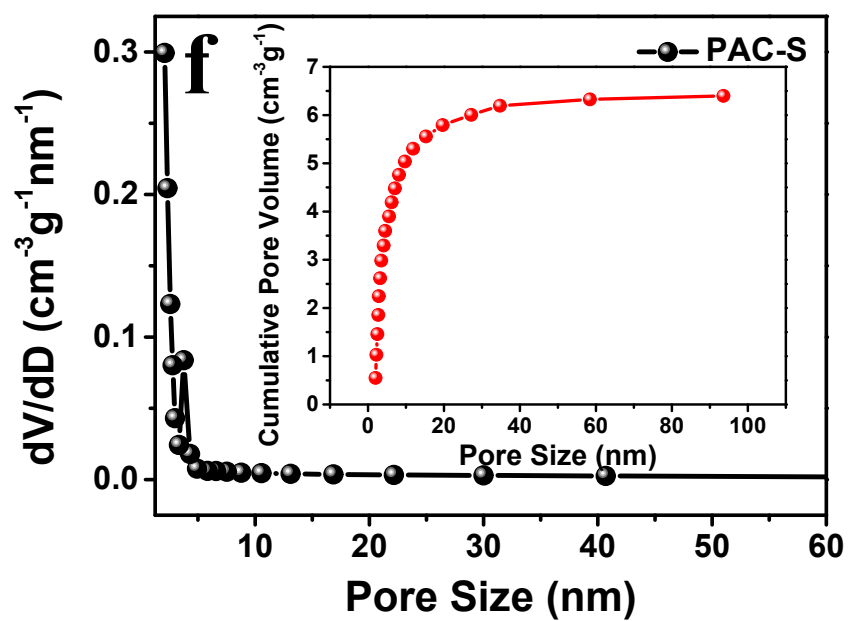
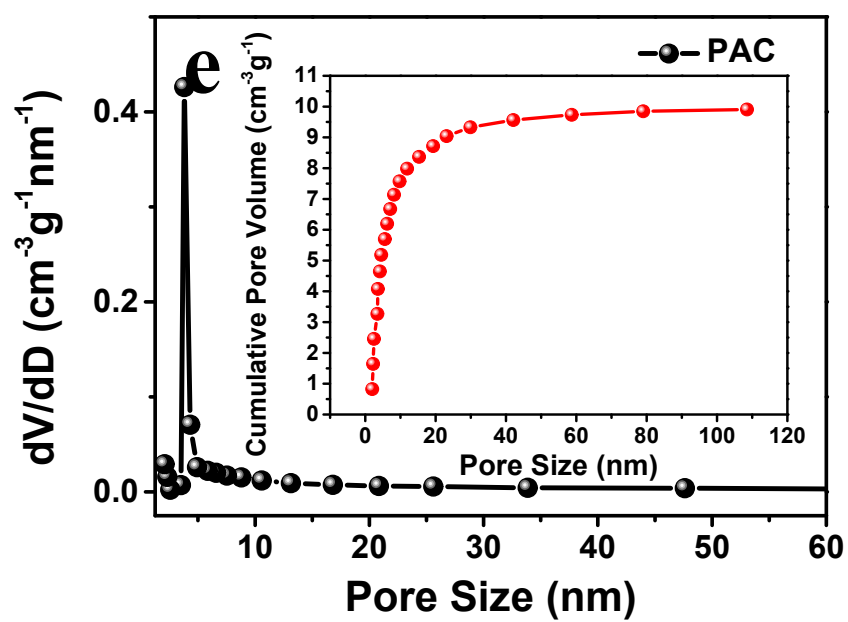


Fig. S1 SEM images: (a) SN; (b) MSN; (c) SN/PA; (d) PAC-S; (e) PAC-3S (f) PAC-7S.







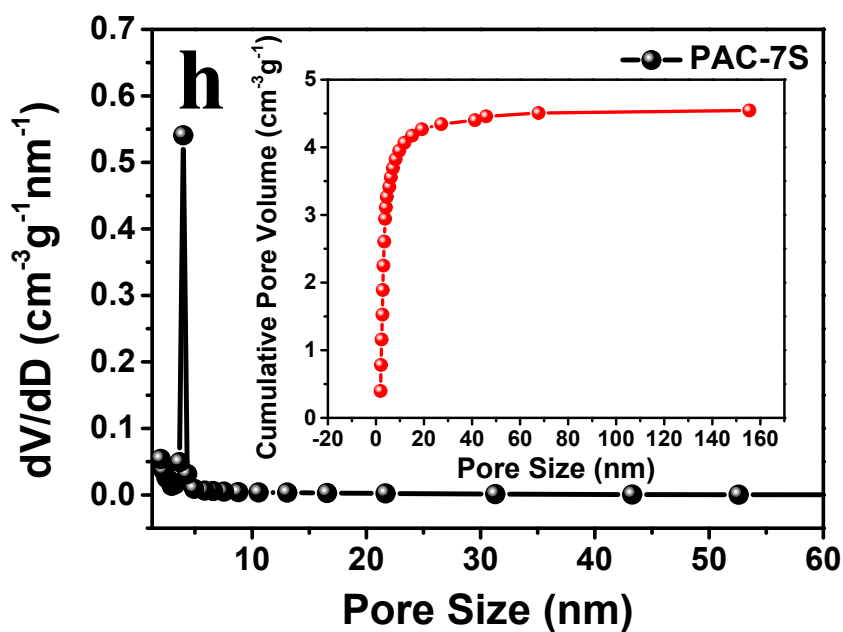
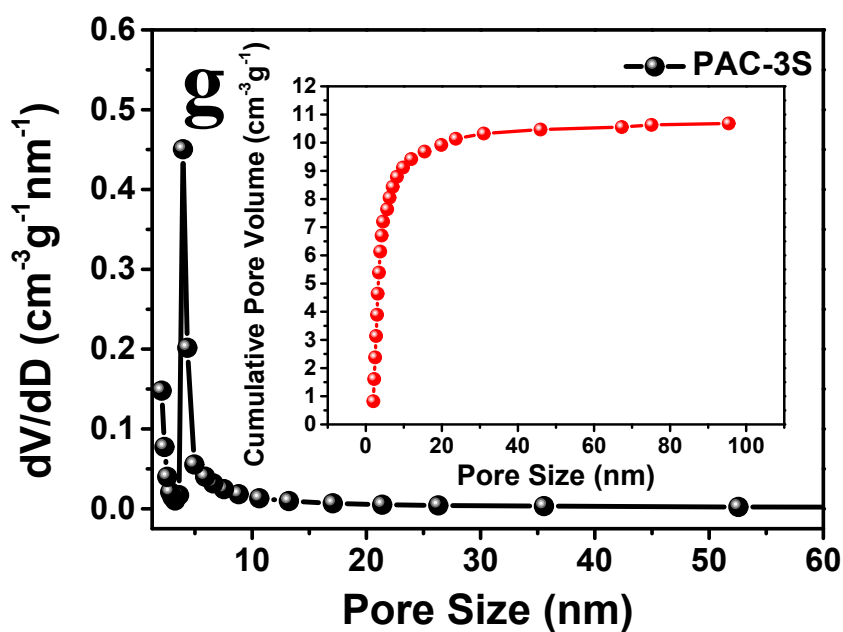
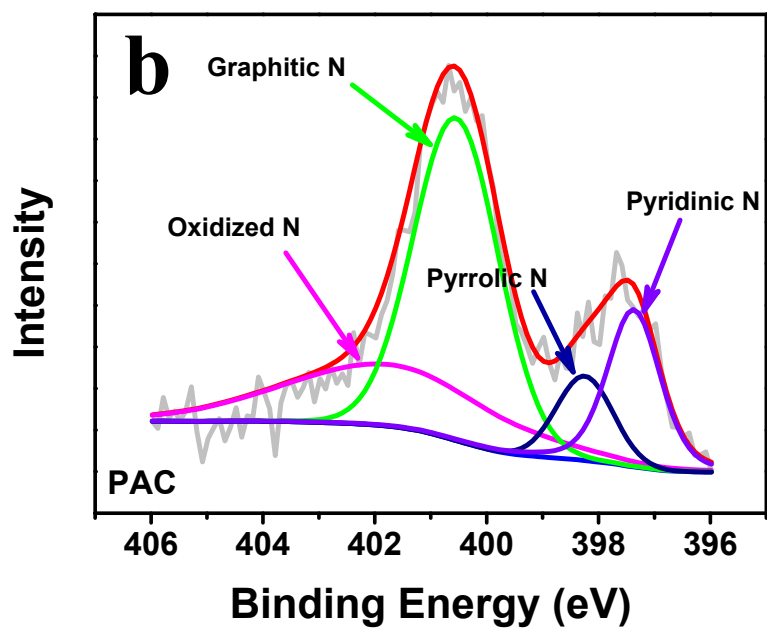
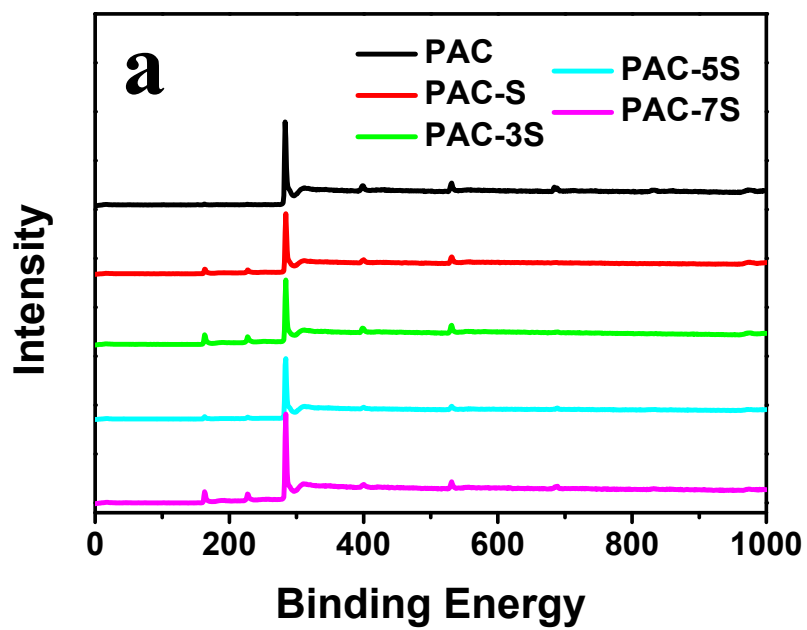
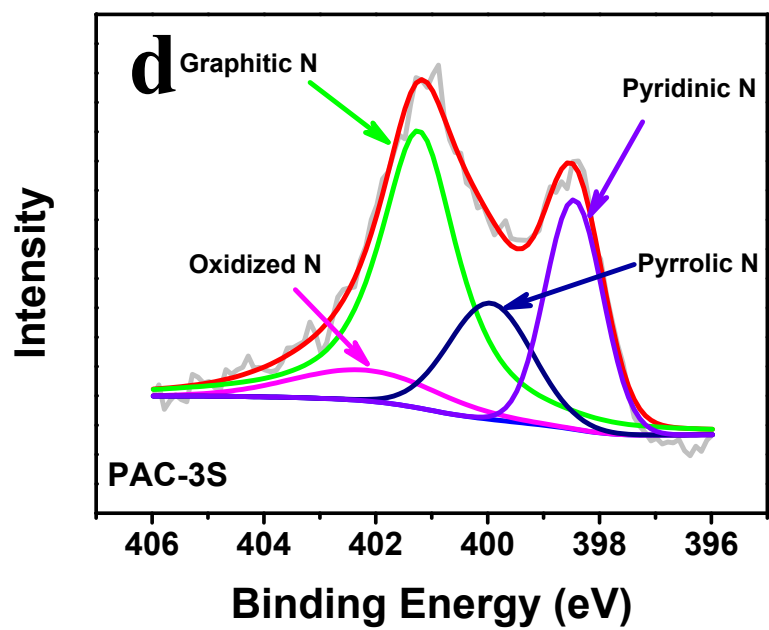
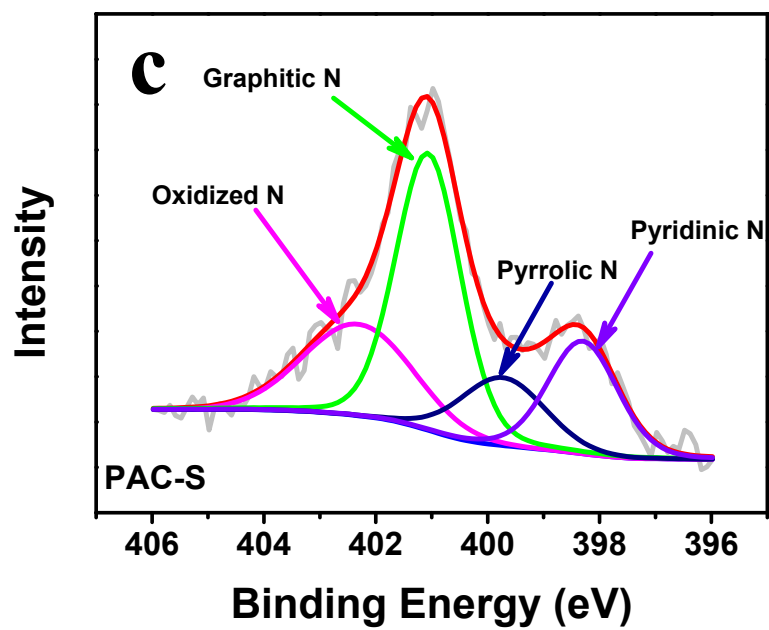
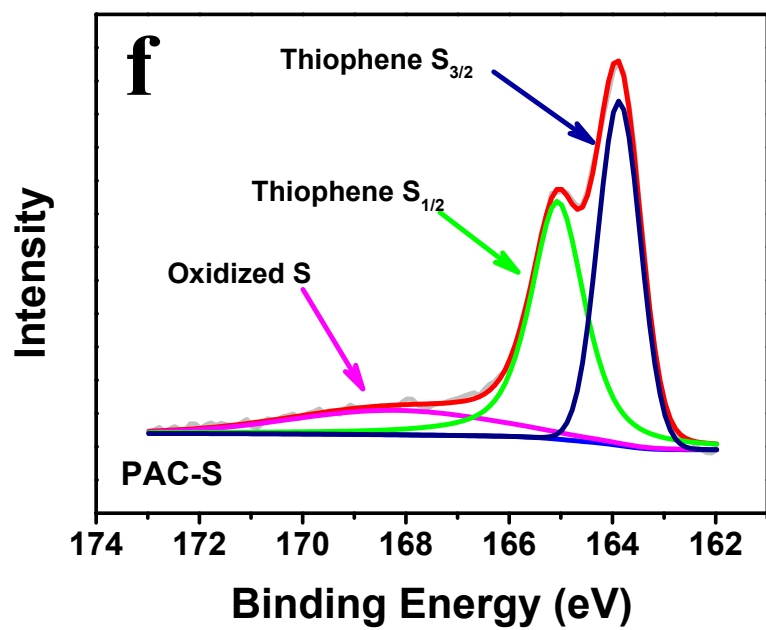
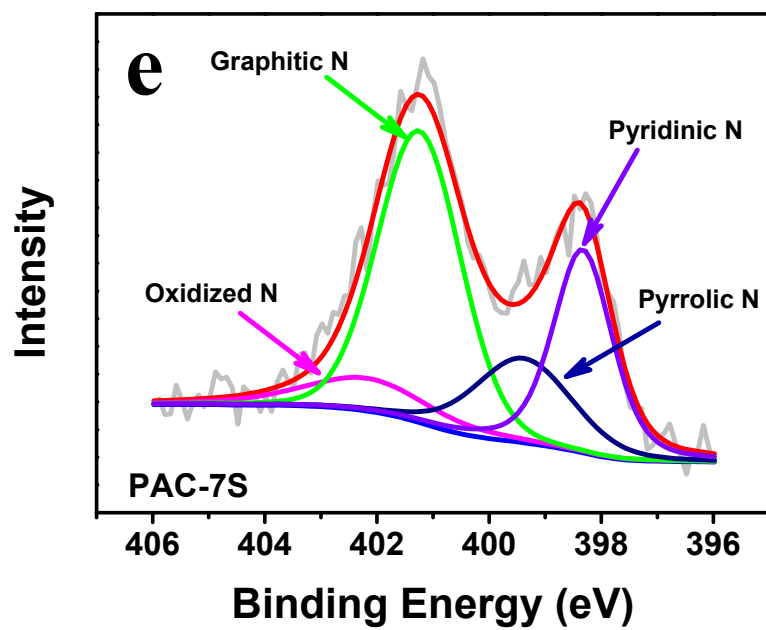


Fig. S2 N_2 adsorption-desorption isotherms: (a) PAC; (b) PAC-S; (c) PAC-3S; (d) PAC-7S. Pore-size distributions and cumulative volumes: (e) PAC; (f) PAC-S; (g) PAC-3S; (h) PAC-7S.







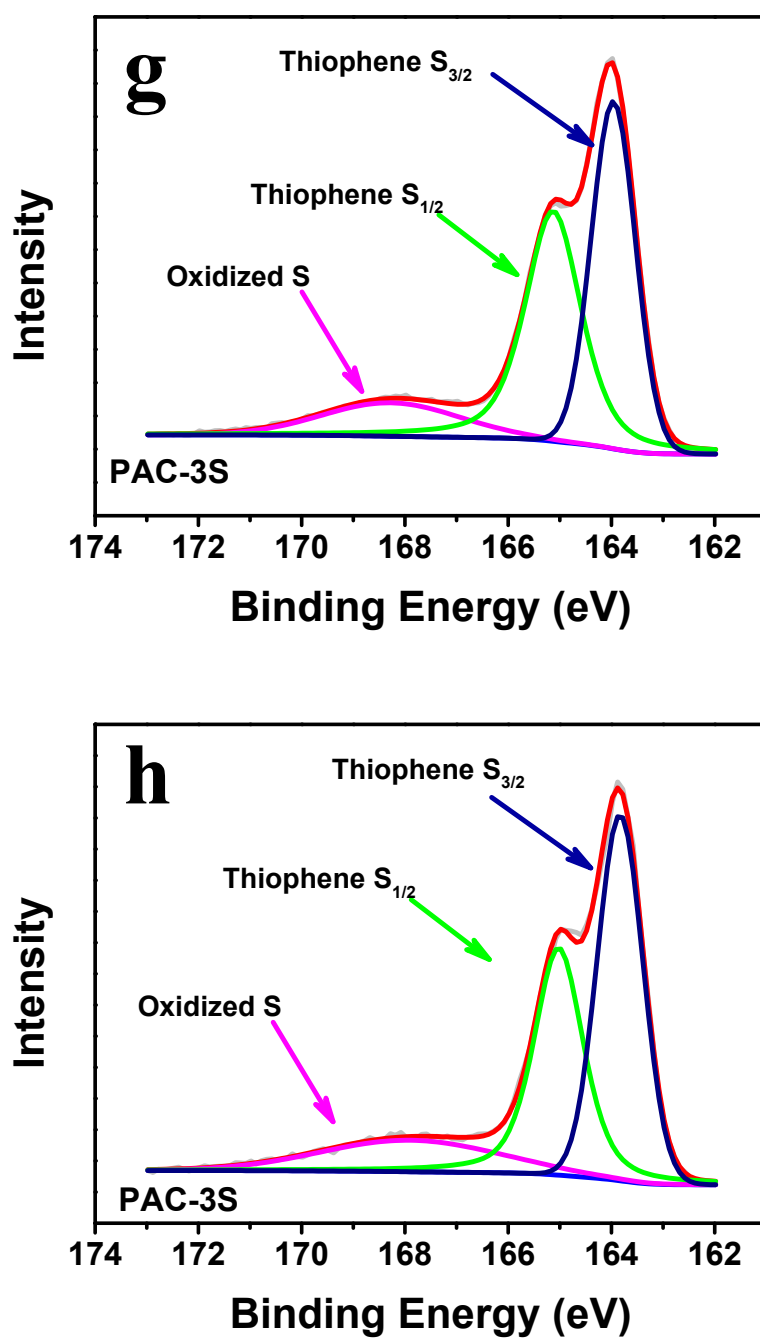


Fig. S3 (a) XPS spectra of various catalysts. (b) N1s spectrum of PAC. (c) N1s spectrum of PAC-S. (d) N1s spectrum of PAC-3S. (e) N1s spectrum of PAC-7S. (f) S2p spectra of PAC-S. (g) S2p spectra of PAC-3S. (h) N1s spectrum of PAC-7S.

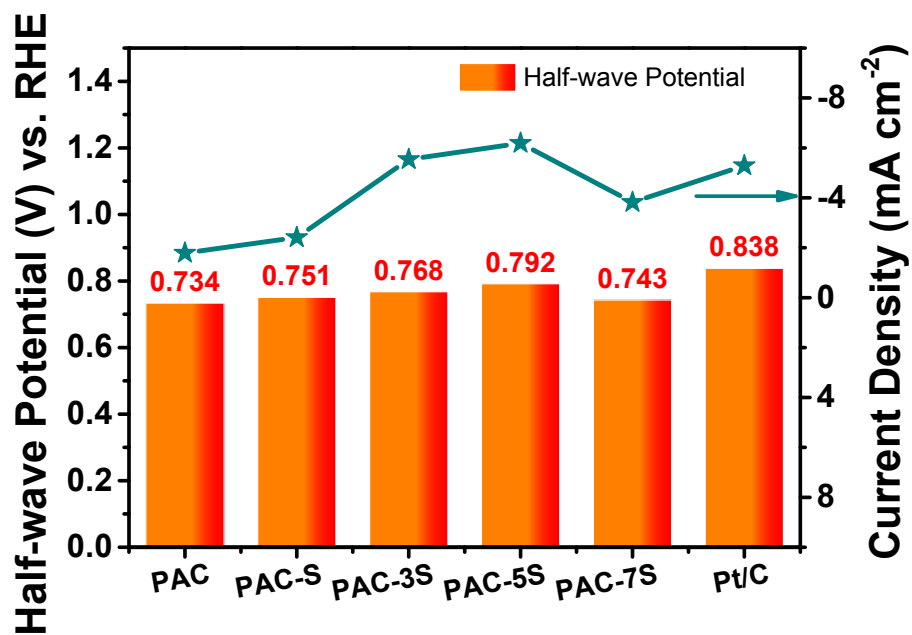
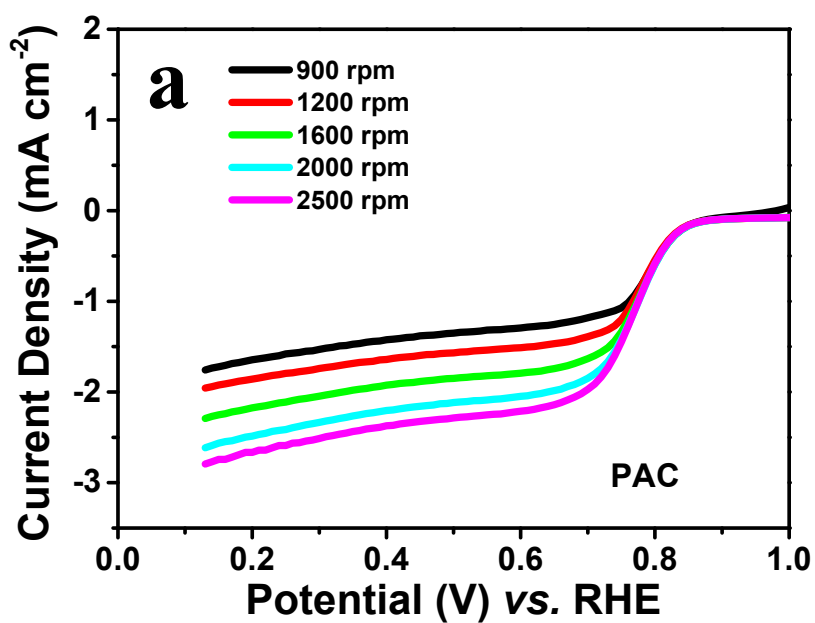
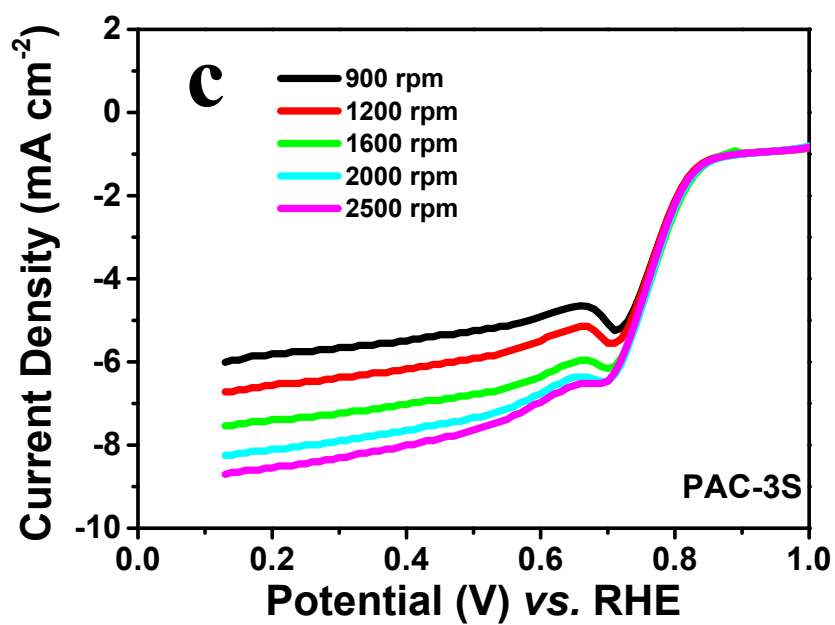
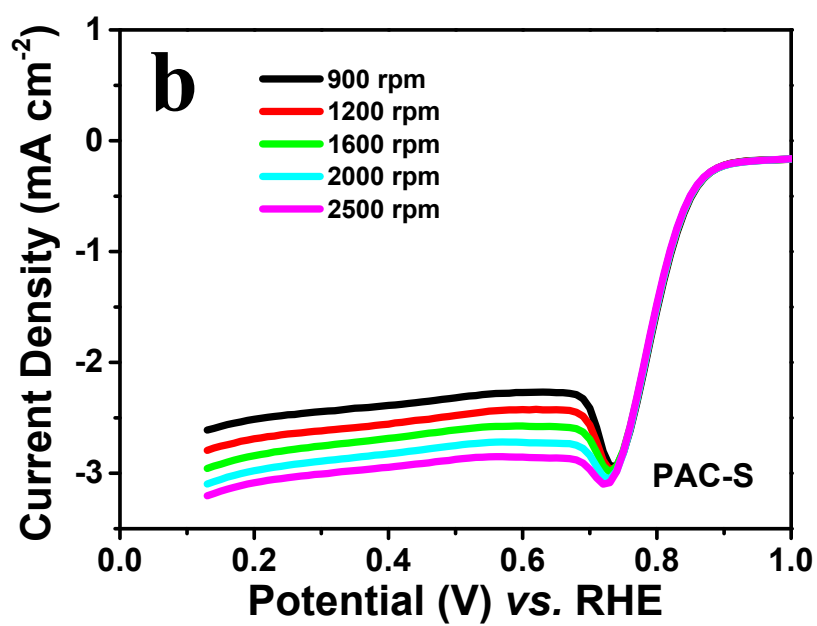


Fig. S4 Half-wave potential and current density of various catalysts.





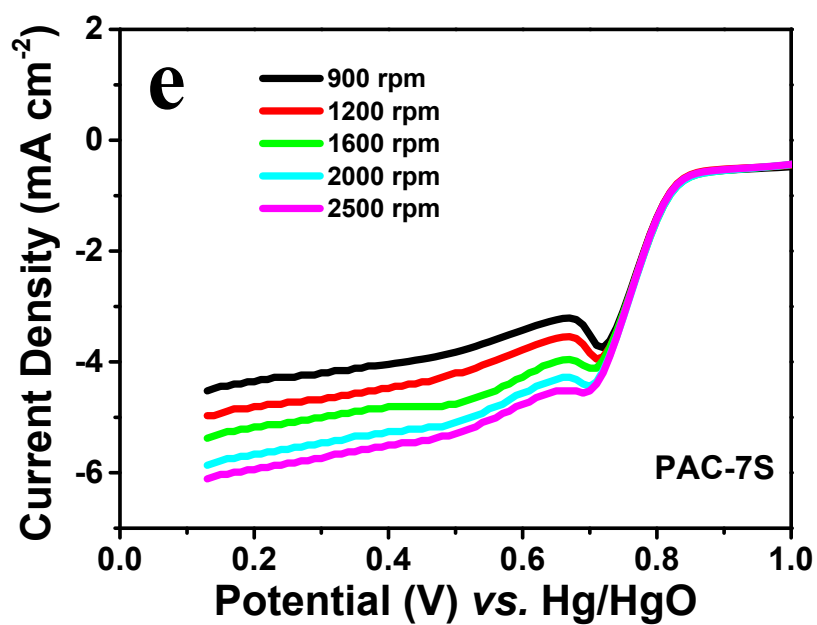
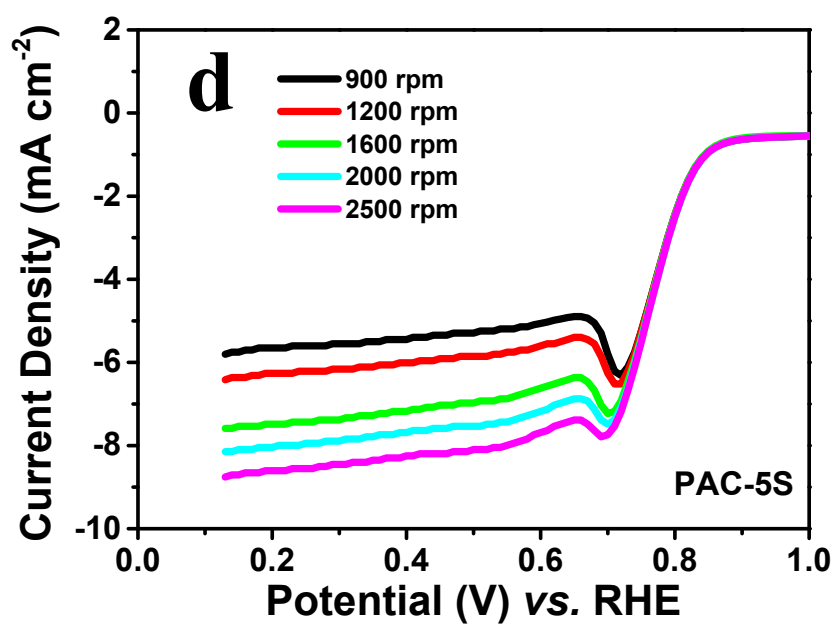
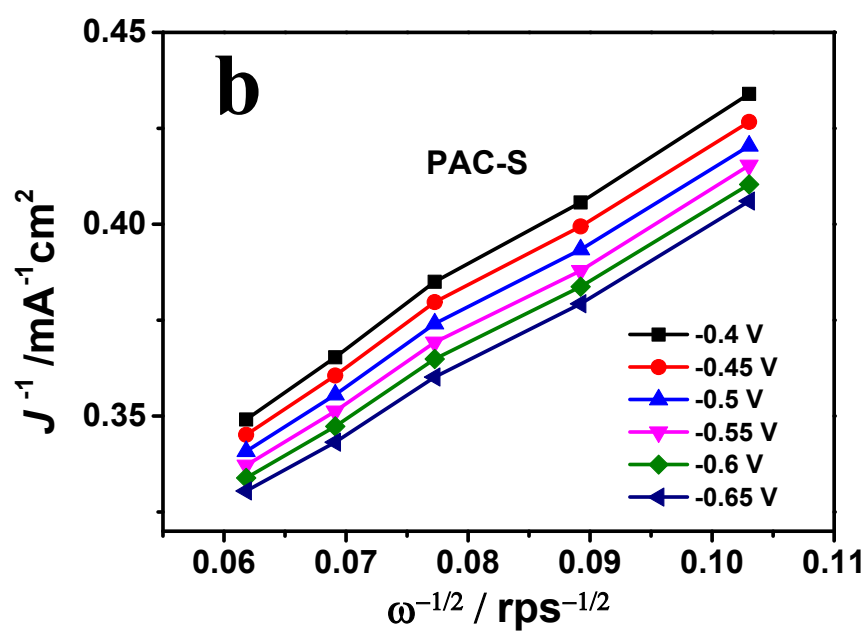
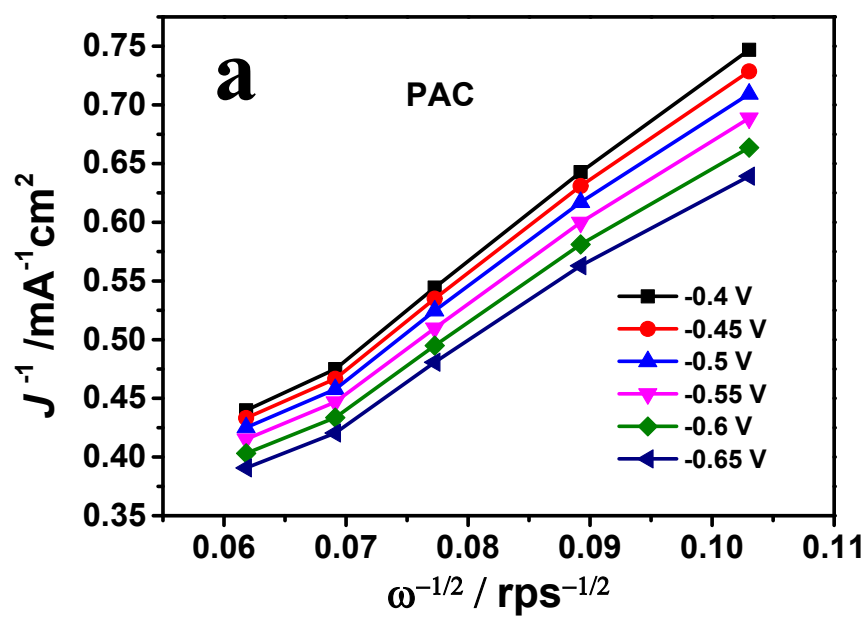
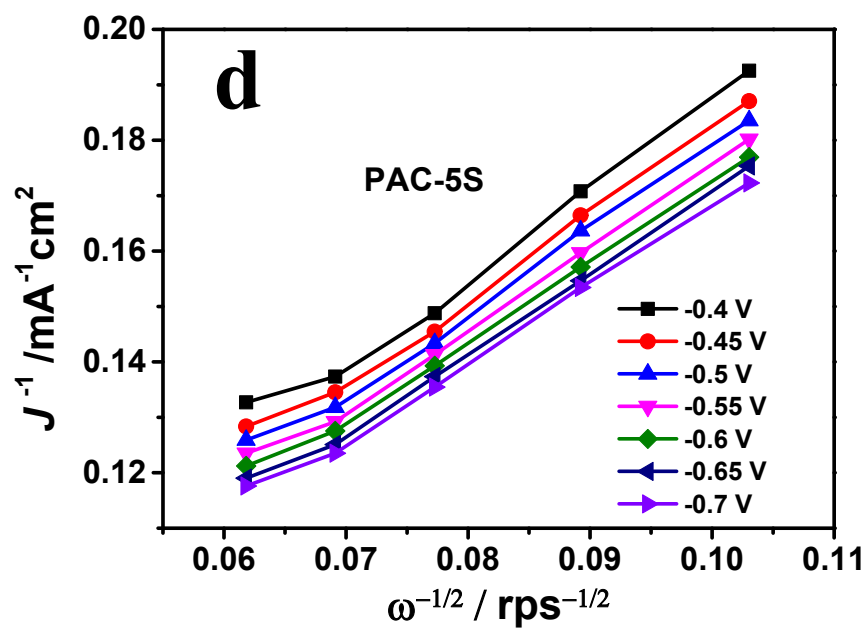
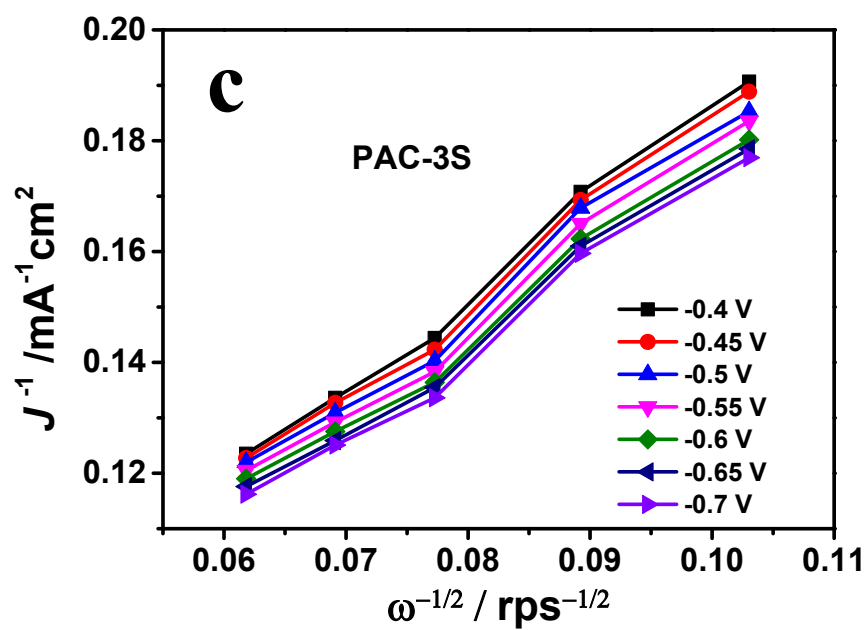


Fig. S5 LSV curves of obtained catalysts under different rotation rates: (a) PAC; (b) PAC-S; (c) PAC-3S; (d) PAC-5S; (e) PAC-7S.





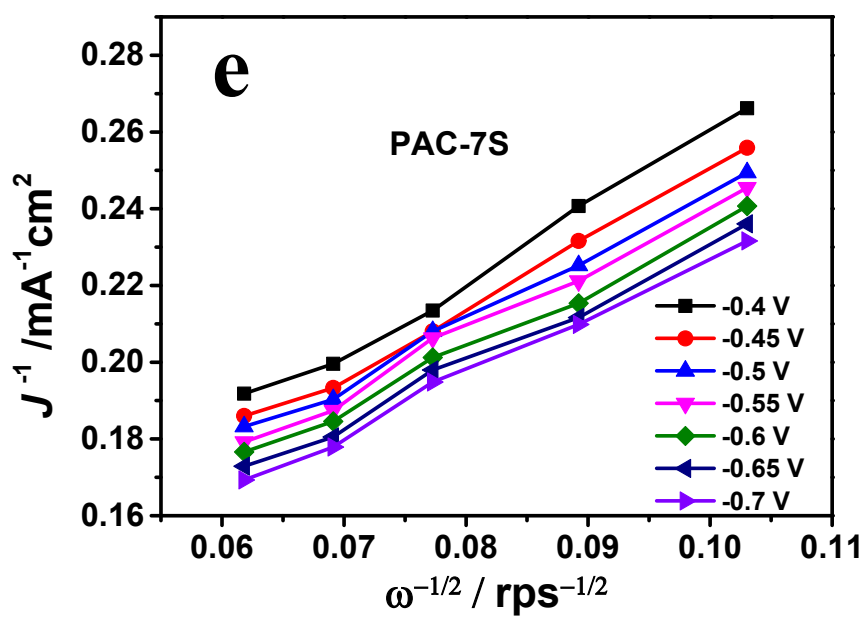


Fig. S5 K-L plots of as-prepared catalysts: (a) PAC; (b) PAC-S; (c) PAC-3S; (d) PAC-5S; (e) PAC-7S.

Table S1 Comparison of ORR performances of PAC-5S with some doped carbon catalysts recently reported.

No.	Catalyst	Half-wave potential* ($E_{1/2}$)	Reference
1	PAC-5S	46 mV inferior	Our work
2	N-DC/G	~200 mV inferior	B. Wang, S. M. Li, X. Y. Wu, J. H. Liu and J. Chen, <i>J Mater Chem A</i> , 2016, 4 , 11789-11799.
3	SG	~150 mV inferior	Z. Ma, S. Dou, A. Shen, L. Tao, L. Dai and S. Wang, <i>Angew Chem Int Edit</i> , 2015, 54 , 1888-1892.
4	CFO/NS+GO	71 mV inferior	W. Yan, X. Cao, J. Tian, C. Jin, K. Ke and R. Yang, <i>Carbon</i> , 2016, 99 , 195-202.
5	NG-SCC _f	~110 mV inferior	Y. P. Lei, Q. Shi, C. Han, B. Wang, N. Wu, H. Wang and Y. D. Wang, <i>Nano Research</i> , 2016, 9 , 2498-2509.
6	PNOHPC	83 mV inferior	C. W. Deng, H. X. Zhong, X. F. Li, L. Yao and H. M. Zhang, <i>Nanoscale</i> , 2016, 8 , 1580-1587.

* compared with Pt/C catalyst.