Supporting Information

In situ grown of cobalt sulfide hollow nanospheres embedded in nitrogen and sulfur co-doped graphene nanoholes as a highly active electrocatalyst for oxygen reduction and evolution

Xiaochang Qiao,[a, b] Jutao Jin,[a] Hongbo Fan,*[a] and Yingwei Li,[b] Shijun Liao,*[b]

a. School of Environment and Civil Engineering, Dongguan University of Technology, Dongguan, 523808, China

b. The Key Laboratory of Fuel Cell Technology of Guangdong Province, School of Chemistry and Chemical Engineering, South China University of Technology, Guangzhou, 510641, China.

**Correspondence - E-mail: chsjliao@scut.edu.cn*

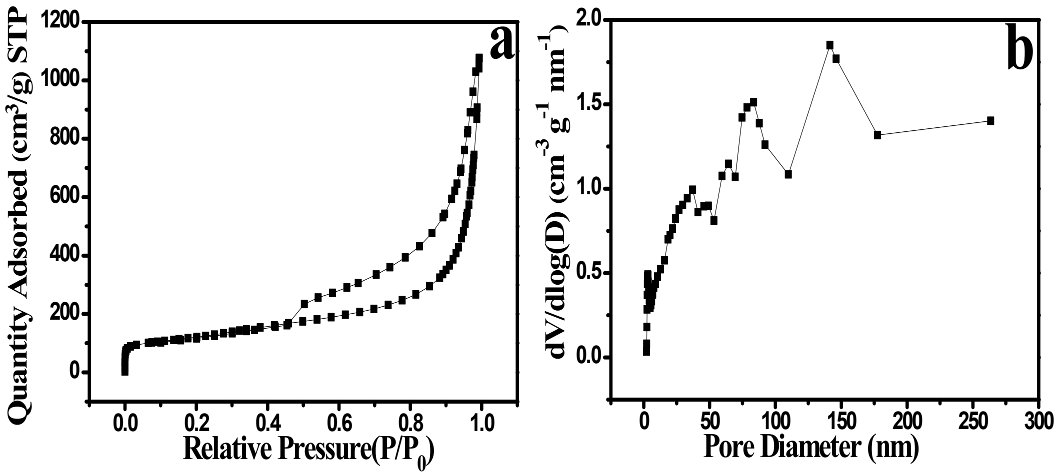

Fig. S1 Nitrogen adsorption–desorption isotherms (a) and pore-size distribution curve (b) of N-S-G.

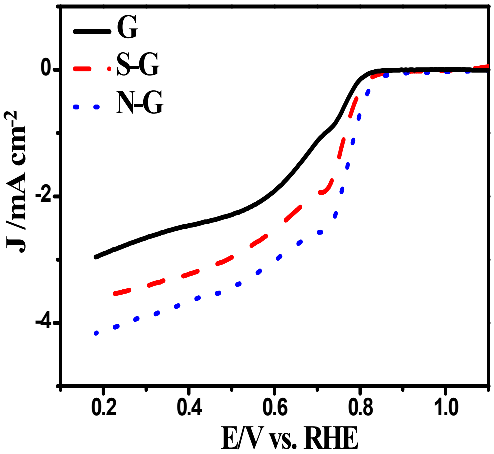

Fig. S2 LSV curves of G, S-G and N-G.

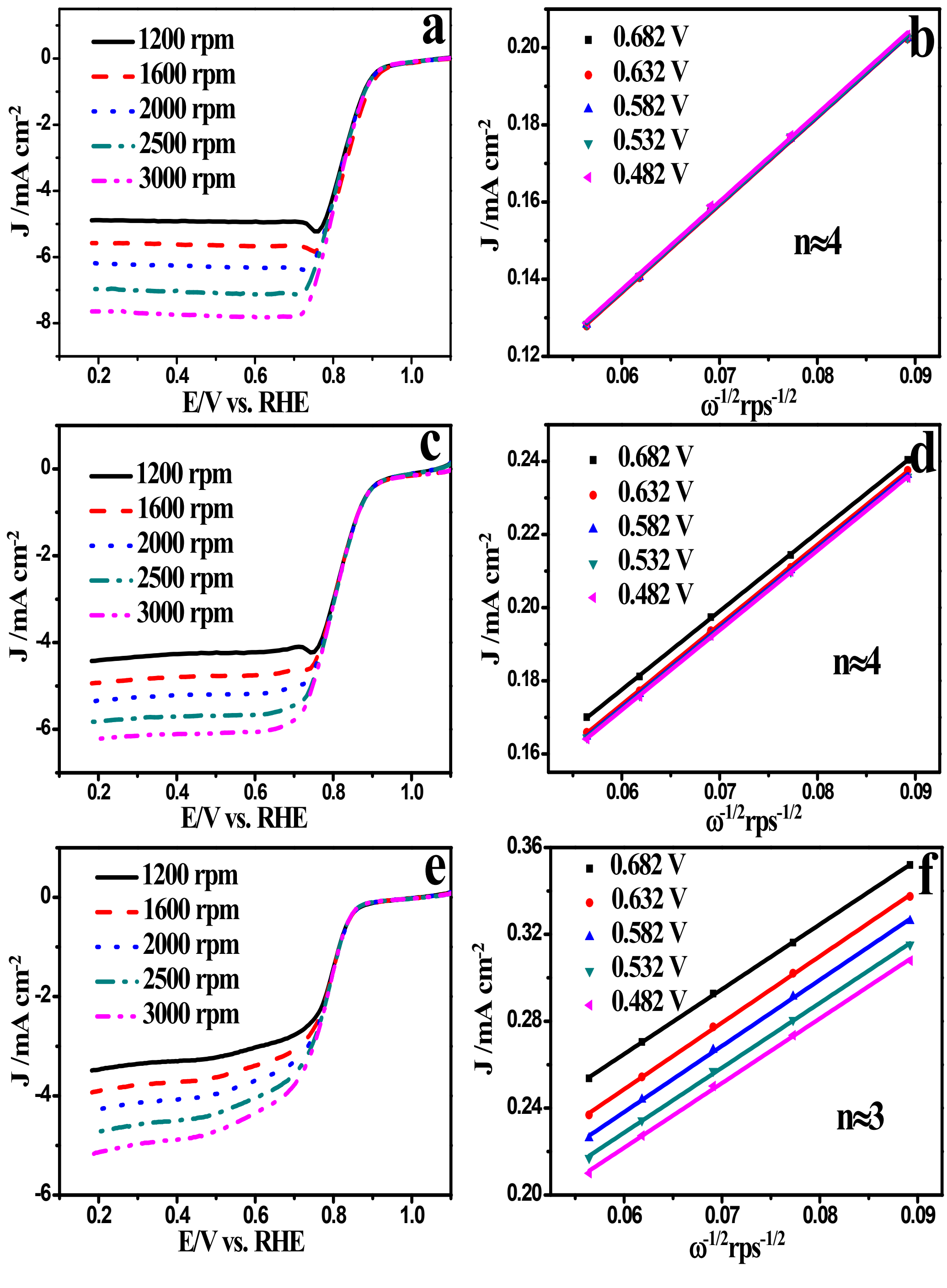

Fig. S3 LSV curves at various rotation rates and K–L plots for $Co_{1-x}S$/N-S-G (a, b); Co-N-S-G (c, d) and N-S-G (e, f).

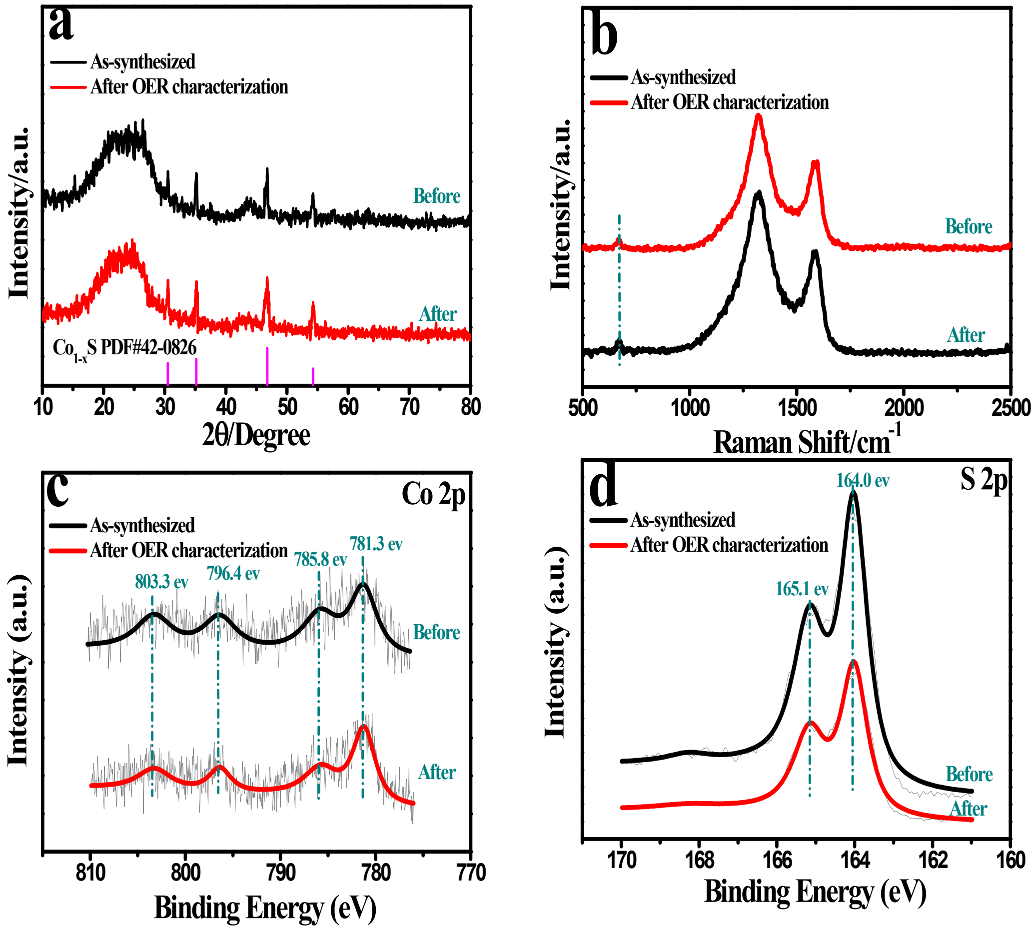

Fig. S4 XRD patterns (a), Raman spectra (b), and X-ray photoelectron spectra of the Co 2p (c) and S 2p (d) regions for as-synthesized and electrochemically characterized $Co_{1-x}S$/N-S-G.

Table S1. Comparison of ORR and OER activity parameters with other recently reported highly active bifunctional electrocatalysts.

Catalyst	$E_{J-3,ORR}$ (V)	$E_{J10,OER}$ (V)	$\Delta E(E_{J10,OER}- E_{J-3, ORR})$	Literature
$Co_{1-x}S$/N-S-G	0.841	1.601	0.760	this study
20 wt% Ir/C	0.69	1.61	0.92	[1]
Co/N-C-800	0.74	1.60	0.86	[2]
Co_3O_4/N-csCNT–GNR	0.79	1.59	0.80	[3]
CoO@N/S-CNF	0.721	1.549	0.828	[4]
3D mesoG	0.76	1.56	0.80	[5]
CoS_2(400)/N,S-GO	0.79	1.61	0.82	[6]
$NiCo_2O_4$/C	0.71	1.67	0.96	[7]
S/N_Fe-27	0.87	1.78	0.91	[8]
Co_3O_4/N-rmGO	0.85	1.54	0.69	[9]
N-graphene/CNT	0.74	1.65	0.91	[10]
Fe_3C@NG800-0.2	0.81	1.59	0.78	[11]

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