Electronic Supplementary Information for

CoS_2 Nanoparticles–Graphene Hybrid as Cathodes Catalysts for Aprotic Li-O_2 Batteries

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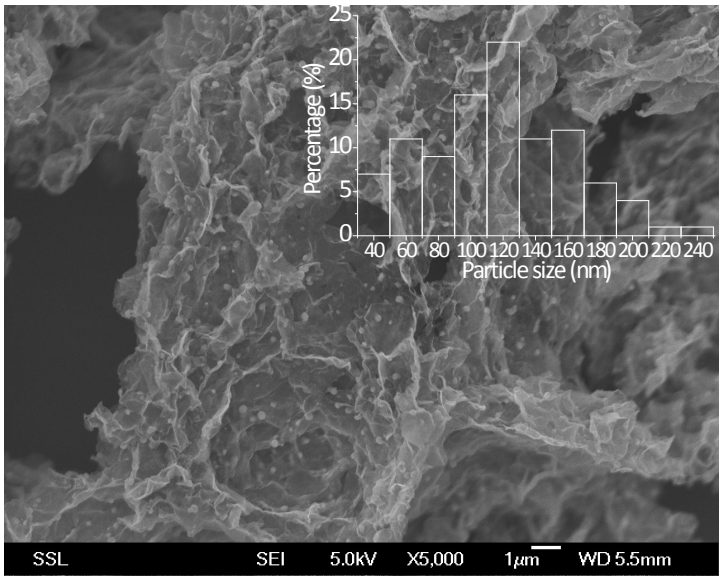

Fig. S1 Low-resolution SEM image of CoS_2/RGO hybrid and the corresponding particle size distribution in the inset.

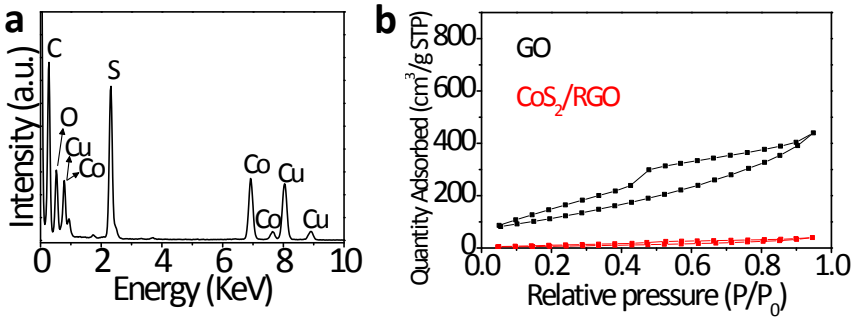

Fig. S2 EDX spectra (**a**) and N_2 adsorption/desorption isotherms (**b**) of the CoS_2/RGO hybrid. In (**b**), the N_2 adsorption/desorption isotherms of the RGO was also presented.

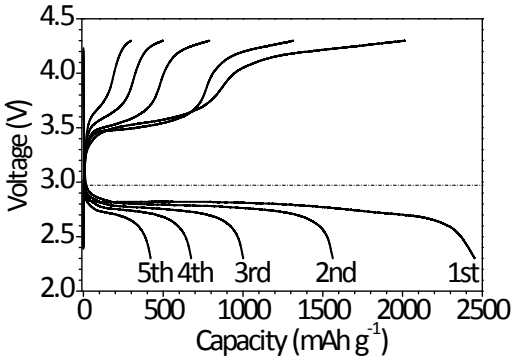

Fig. S3 Full discharge–charge curves of the Li-O_2 cell with CoS_2/RGO cathode and $LiClO_4$-DMSO electrolyte at a current density of 0.1 A g^{-1}.

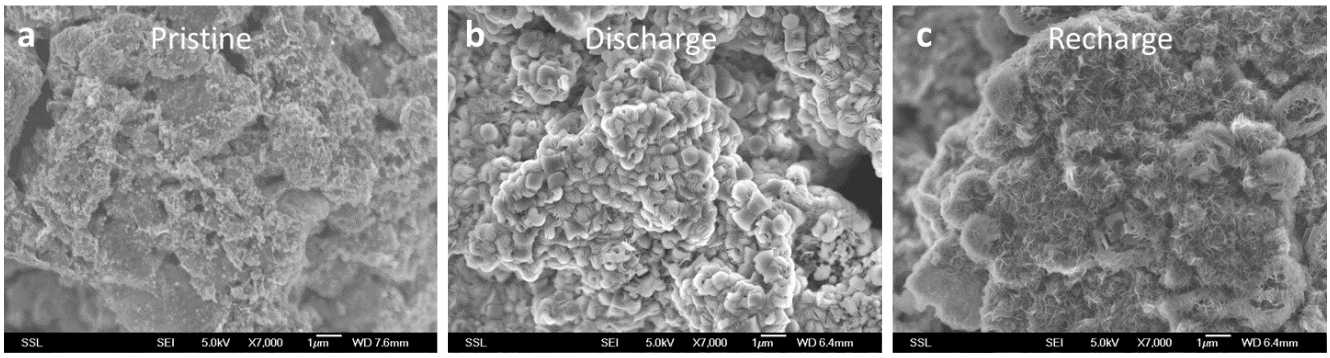

Fig. S4 Low-resolution SEM images for the pristine electrode (a), after discharge (b) and after recharge (c) for clear comparison at the 0.1 A g^{-1} rate and first full discharge-charge states.

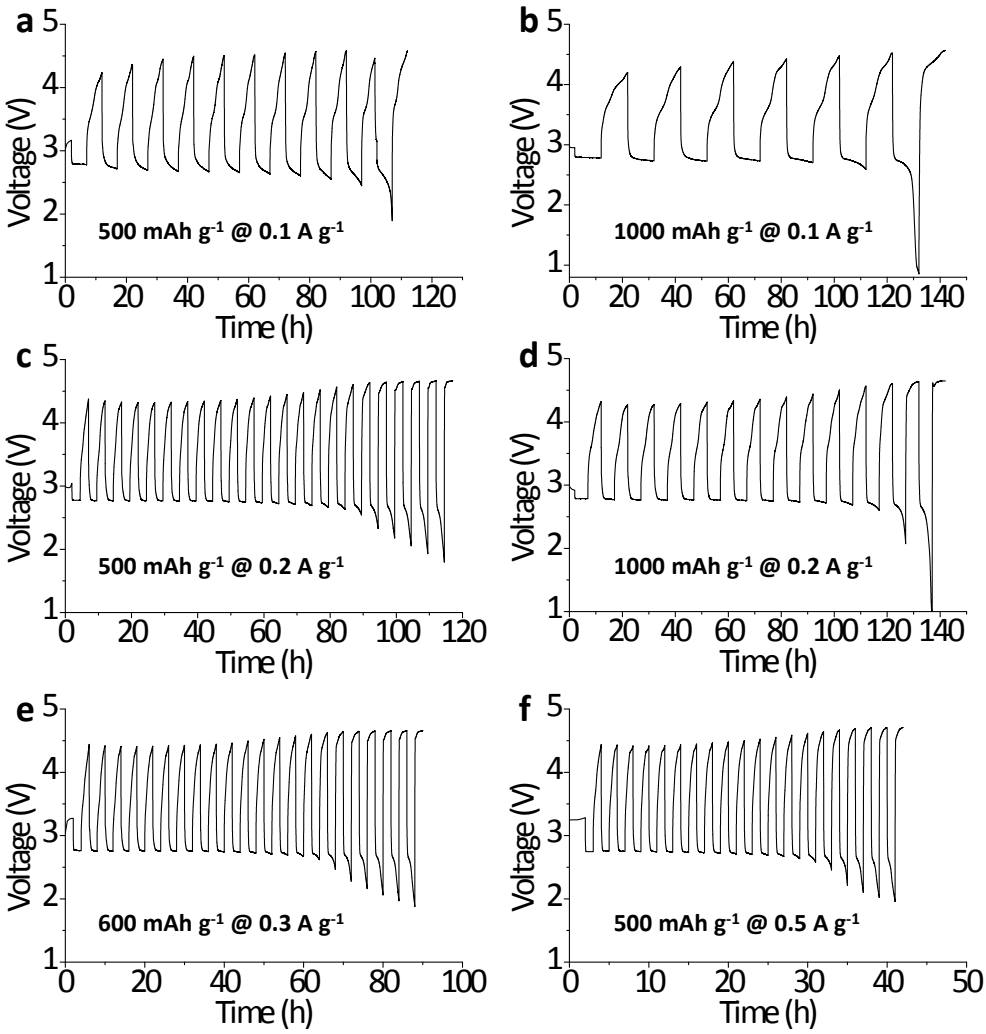

Fig. S5 The performances of the Li-O_2 cells with CoS_2/RGO hybrid cathodes and $LiClO_4$-DMSO electrolytes at different current densities (A g^{-1}) and different limited capacities. (a) 500 mAh g^{-1} @ 0.1 A g^{-1}. (b) 1000 mAh g^{-1} @ 0.1 A g^{-1}. (c) 500 mAh g^{-1} @ 0.2 A g^{-1}. (d) 1000 mAh g^{-1} @ 0.2 A g^{-1}. (e) 600 mAh g^{-1} @ 0.3 A g^{-1}. (f) 500 mAh g^{-1} @ 0.5 A g^{-1}.

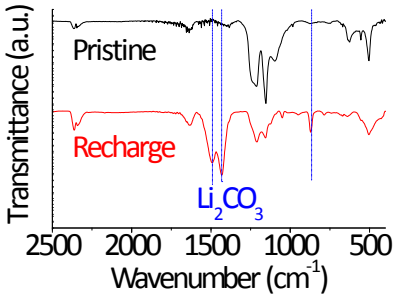

Fig. S6 FTIR spectrum of CoS_2/RGO hybrid at pristine and after 10th charge states.

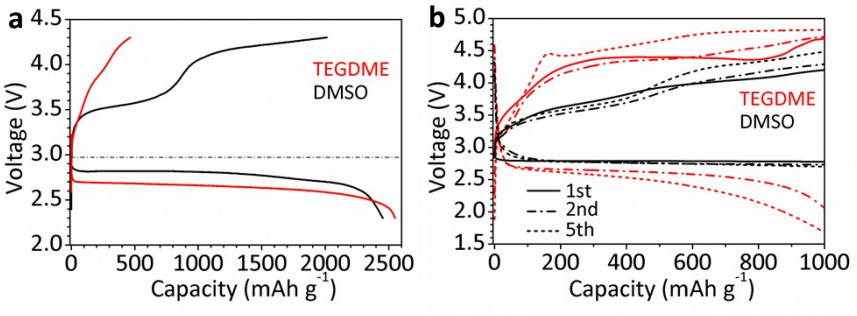

Fig. S7 The performances of the Li-O_2 cells with CoS_2/RGO cathodes and $LiCF_3SO_3$-TEGDME electrolytes in comparison with those of the $LiClO_4$-DMSO electrolytes based Li-O_2 cells. (a) First full discharge–charge curves at the rate of 0.1 A g^{-1}. (b) Discharge–charge curves at the rate of 0.1 A g^{-1} and a limited capacity of 500 mAh g^{-1}.

In comparison with the $LiClO_4$-DMSO electrolyte based Li-O_2 cell, the Li-O_2 cell with $LiCF_3SO_3$-TEGDME electrolyte demonstrated a higher ORR overpotential (~0.28 V) upon discharge at a current density of 0.1 A g^{-1} (Fig. S7a). Especially, no obvious charge platform was observed and a small charge capacity was obtained. This meant that the cell with $LiCF_3SO_3$-TEGDME electrolyte owned a very weak capability of oxidizing the Li_2O_2 upon charge, leading the lower round-trip efficiency (the ratio of discharge to charge voltage). As a result, the cycle stability was also unsatisfied (Fig. S7b).