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.

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**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 10$^{th}$ charge states.
The performances of the Li-O$_2$ cells with CoS$_2$/RGO cathodes and LiCF$_3$SO$_3$-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$_3$SO$_3$-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$_3$SO$_3$-TEGDME electrolyte owned a very weak capability of oxidizing the Li$_2$O$_2$ 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).