Supporting information

Highly Efficient Bifunctional Electrocatalyst (ORR/OER) Derived from GO Functionalized with Carbonyl, Hydroxyl and Epoxy Groups for Rechargeable Zinc-Air Batteries

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Electrochemical measurements

A conventional three-electrode system was employed to evaluate the electrocatalytic performance of the obtained catalyst on a CHI 760E electrochemical workstation. A rotating disk electrode (RDE) with a glassy carbon (GC) disk (electrode area: 0.1256 cm²) was used as the working electrode, Ag/AgCl was used as the reference electrode, and platinum wire was used as the counter electrode. The rotating ring disk electrode measurements for ORR were carried out on RRDE in a N₂ or O₂-saturated 0.1 M KOH electrolyte solution at a scan rate of 10 mV/s. The rotating ring disk electrode measurements for OER was carried out in 1 M KOH electrolyte solution at a scan rate of 10 mV/s. For ORR, before the electrochemical measurements, the electrolyte solution was purged with O₂ for 30 min to achieve an O₂-saturated solution, and stable polarization curves were recorded after 20 cycles. All the potentials were converted to the potential versus the reversible hydrogen electrode (RHE) according to $E_{vs\text{RHE}} = E_{vs\text{Ag/AgCl}} + E_{\text{Ag/AgCl}} + 0.059 \, \text{pH}$.

Rotating ring-disk electrode (RRDE) measurements were recorded with catalyst inks and electrodes prepared by the same method as that for the RDE measurements. The H₂O₂ produced and the electron number (n) transferred during the ORR were
calculated using the following equations:

\[ n = 4 \frac{I_D}{I_D + I_R / N} \]

\[ \text{H}_2\text{O}_2\% = 100 \times \frac{4 - n}{2} \]

The rotating ring-disk electrode was employed to detect the H\(_2\)O\(_2\) yield, where the ring potential was set to 1.3 V (vs. RHE). where \(I_D\) is the Faradaic current at the disk, \(I_R\) is the Faradaic current at the ring, and \(N = 0.37\) is the collection efficiency of ring electrode.

**Fig. S1** SEM of Co-N/rGO.
Fig. S2 TEM of Co-N/rGO.
**Fig. S3** EDS of Co-N/rGO.

**Fig. S4** XRD of Co-N/S/rGO, Co-N/rGO and rGO.
Fig. S5 Tafel plots of Co-N/S/rGO and Pt/C for ORR.

Fig. S6 LSVs of Co-N/S/rGO catalysts before and after 5000 cycles in O$_2$-saturated 0.1 M KOH.
**Fig. S7** Tafel plots of Co-N/S/rGO and Pt/C for OER.

**Fig. S8** EIS of Co-N/S/rGO catalysts before and after 5000 cycles in 1 M KOH for OER.
**Fig. S9** CV curves of Co-N/rGO at different scan rates in 1.0 M KOH solution.

**Fig. S10** CV curves of Co-N/S/rGO at different scan rates in 1.0 M KOH solution.
Fig. S11 Double-layer capacitance for different samples.

Fig. S12 Images of the Co-N/S/rGO based ZABs in series power a light emitting diode (LED) array and charge the smart bracelet, the working voltage is 3.7-5 V.