Supporting information

Boosting the Bifunctional Electrocatalytic Oxygen Activities of CoO\textsubscript{x}

Nanoarrays with Porous N-doped Carbon Coating and the Application in Zn-Air Batteries

Yongchao Hao,\textsuperscript{a} Yuqi Xu,\textsuperscript{a} Nana Han,\textsuperscript{a} Junfeng Liu\textsuperscript{a,\,*} and Xiaoming Sun\textsuperscript{a, b, c,\,*}

\textsuperscript{a}. State Key Laboratory of Chemical Resource Engineering, b. College of Energy, c. Beijing Advanced Innovation Centre for Soft Matter Science and Engineering, Beijing University of Chemical Technology, Beijing, 100029, China.

*Authors to whom correspondence should be addressed: ljf@mail.buct.edu.cn; sunxm@mail.buct.edu.cn
Fig. S1 XRD pattern of Co(CO$_3$)$_{0.5}$(OH) on carbon fiber paper.

Fig. S2 (a) Thermogravimetric analysis of PVDF. (b-d) TEM image (b), N$_2$ adsorption-desorption isotherms (c), and pore size distribution curve (d) of PVDF derived carbon.
**Fig. S3** SEM images of CoO$_x$ (a) and CoO$_x$@C (b) nanoarray.

**Fig. S4** TEM images of CoO$_x$ (a) and CoO$_x$@C (b) nanoarray. HRTEM image of CoO$_x$@C nanoarray (c).

**Fig. S5** The N 1s scan XPS patterns of CoO$_x$@C and carbon cloth.
Fig. S6 The OER (a, c) and ORR (b, d) performance of CoO$_x$@NC with different calcination temperature (a, b) and nitrogen source (c, d) in 0.1 M KOH solution.

Fig. S7 OER (a) and ORR (b) performance of CoO$_x$@NC and its acid treated electrode in 0.1 M KOH solution.
Fig. S8 CV plots of CoO$_x$, CoO$_x$@C, and CoO$_x$@NC under different scan rate in 0.1 M KOH solution.

Fig. S9 Co 2p XPS spectrum of CoO$_x$@NC nanoarray after 12 h stability test in 0.1 M KOH solution.
Fig. S10 Comparison of OER and ORR bifunctional activities of samples in this work with some representative electrocatalysts in recent references (from 2015 to now). The dash lines show the $\Delta E$ at constant values.

Fig. S11 OER (a) and ORR (b) performance of CoO$_x$@NC nanoarray, Pt/C and IrO$_2$/C in 0.1 M KOH solution.
Fig. S12 Galvanostatic cycling discharge and charge curves of carbon cloth.

Fig. S13 Galvanostatic cycling discharge and charge curves obtained using air under ambient conditions of Pt/C without Nafion.