Electronic Supplementary Information (ESI)

High Power Density of Paper-Based Zinc-Air Battery with Hollow Channel Structure

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Materials and Method

Hollow Channel Fabrication. The chromatographic paper is commercially available and purchased from Whatman (Type: CAT.No.3001-887). Hollow channel layers were fabricated using a previously reported wax patterning method. The devices were designed using CorelDrawX6 software. Patterns were printed on Whatman chromatographic paper using a Xerox Colorqube8570 inkjet wax printer. The paper was then placed in an oven at 150 °C for 15 minutes and cool at room temperature. Until it was cooled, it was cut into 45 mm in length, 35 mm in width, cut with a hollow structure of size of 35 mm in length, 4 mm in width in the middle serving as the hollow channel.

Electrode Reaction. The electrochemical reactions at the anode and cathode sides in alkaline solution were showed as following (*Eq*. S1-*Eq*. S4).

Anode side:

$$Zn + 4OH^- \rightarrow Zn(OH)^{2-}_4 + 2e^- \quad \text{(S1)}$$

$$Zn(OH)^{2-}_4 \rightarrow ZnO + H_2O + 2OH^- \quad \text{(S2)}$$

Cathode side:

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^- \quad \text{(S3)}$$

Overall reaction:

$$2Zn + O_2 \rightarrow 2ZnO \quad \text{(S4)}$$

ECSA Calculation. The ECSA can be estimated from C_{dl} resulting from the linear relationship, as showed in the following equation (*Eq*. S5):

$$ECSA = C_{dl}\ of\ catalyst\ (mF)/A\ (mF\ cm^{-2}) \quad \text{(S5)}$$

A means the specific capacitance of 1 cm^{-2} flat surface area, and a constant value determined by the material property (typically is 40 μF cm^{-2}).

Supplementary Figures

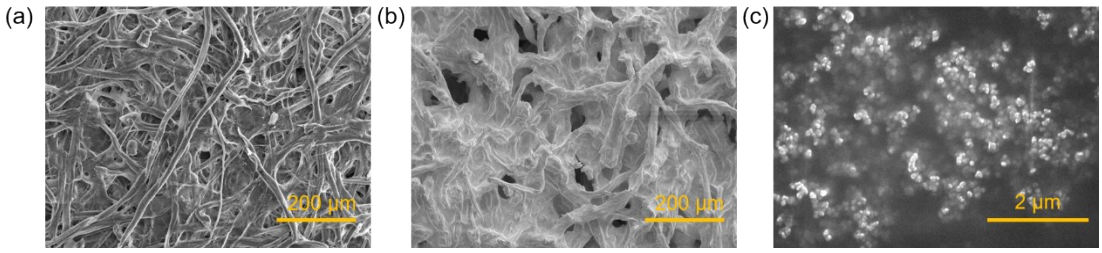

Fig.S1 Microscopic morphologies: (a) pristine filter paper; (b) KOH-saturated filter paper; (c) Pt/C air-cathode.

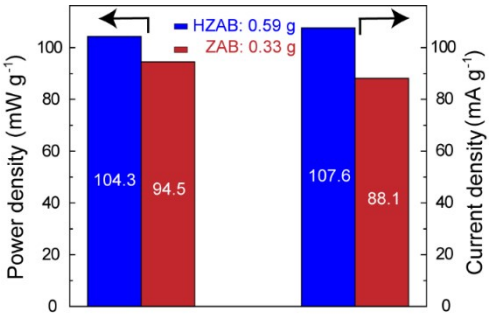

Fig.S2 Comparation of ZAB and HZAB in maximum power density and current density per unit weight.

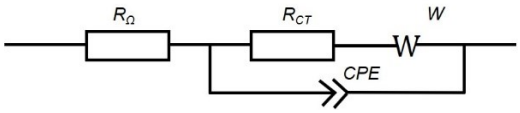

Fig.S3 Schematic of equivalent circuit to fit the Nyquist plots. Abbreviations: R_Ω–ohmic resistance; CPE–constant phase element associated to the double layer at the surface of electrode; R_{CT}–charge transfer resistance; W–Warburg resistance.

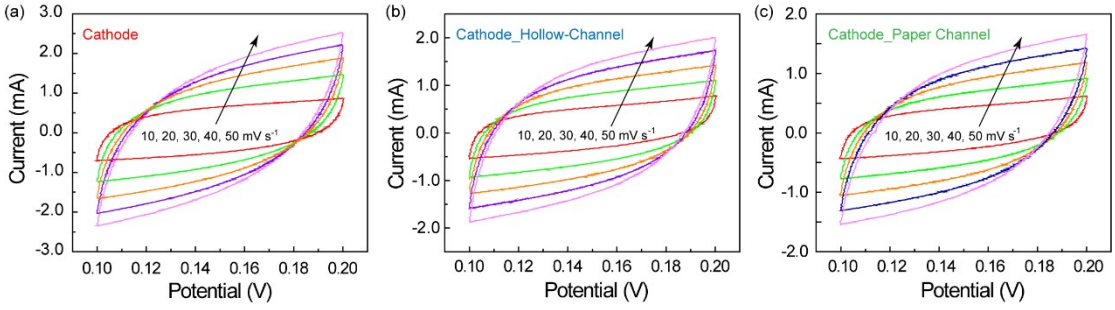

Fig.S4 CV curves: (a) Cathode, (b) Cathode_Hollow-Channel and (c) Cathode_Paper Channel collected at different scan rates over a potential range of 0.1 to 0.2 V.

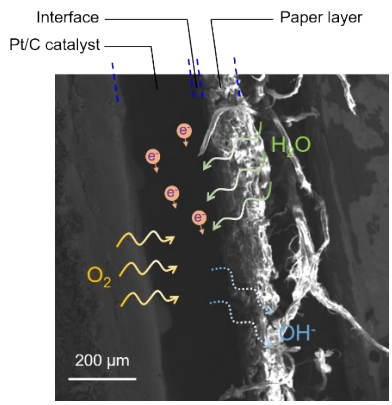

Fig.S5 Schematic illustration of the interface between the catalytic layer and paper fibers.

Supplementary Tables

Table S1 Fitted parameters of some elements in the equivalent circuit.

	R_{Ω}	R_{CT}	*W-R*	*W-T*	*W-P*	*CPE-T*	*CPE-P*
ZAB	3.57	1.1	62.0	4.68	0.57	0.0024	0.78
HZAB	4.06	0.8	33.0	1.71	0.57	0.0002	0.91