

## Electronic Supplementary Information

### **Tungsten coated nano boron carbide as a non-noble metal bifunctional electrocatalyst for oxygen evolution and hydrogen evolution reactions in alkaline media**

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Fig. S1 Digital picture of the mixture ( $m_{\text{B4C}}/m_{\text{W}}=1:60$ ) after the discharge treatment at 870 °C for 40 min.

### ***Experimental section***

The potentials conversion from vs. Hg/HgO to vs. RHE is as follow:

$$E (\text{Hg/HgO (1M KOH)}) \text{ vs. } E (\text{RHE}) = 0.098 \text{ V}$$

$$E (\text{vs. RHE}) = E (\text{vs. Hg/HgO}) + 0.098 \text{ V} + (0.0591 \text{ V}) \text{ pH} = E (\text{vs. Hg/HgO}) + 0.8663 \text{ V}$$

The synthesis process of  $\text{RuO}_2$  was presented as follows: a solution of 5 ml of  $\text{RuCl}_3$  (0.05 M) and 100 ml deionized water was heated in water bath at 100 °C for 10 min under stirring. Then 1 ml KOH (1 M) was added into the above solution and stirred for 45 min. The suspension was centrifuged and washed by deionized water 3 times and dried at 80 °C for 5 h, leading to precipitation of  $\text{Ru(OH)}_2$ . Finally,  $\text{RuO}_2$  electrocatalyst was synthesized by heating of  $\text{Ru(OH)}_2$  under air condition at 300 °C for 3 h.

Microwave-assisted reduction method was used to acquire the 20 wt% Pt/C electrocatalysts: First, Vulcan XC-72 carbon black (20 mg) was mixed with 1 mL aqueous  $\text{H}_2\text{PtCl}_6$  solution (0.05 M) and 25 ml EG in a 100 ml beaker. After 30 min ultrasonic vibration, the beaker was put into the center of the microwave oven and heated for 60 s at 750 W. After cooling to room temperature, the resulting material was centrifuged and washed with acetone and deionized water 2 times, respectively. And the as-prepared electrocatalyst was dried in a vacuum oven at 100 °C for 24 h.

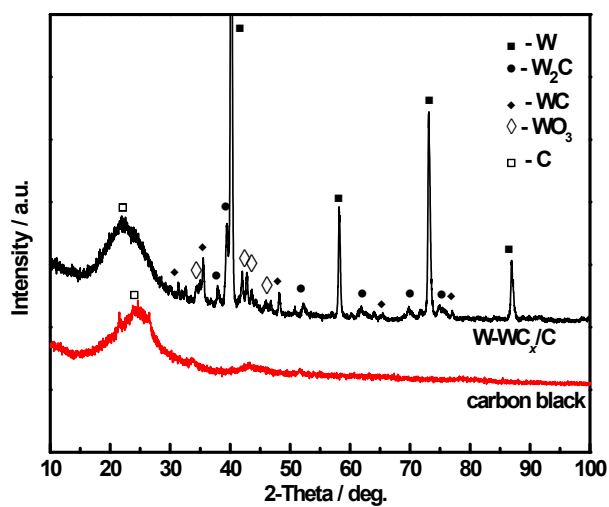


Fig. S2. XRD pattern of W-WC<sub>x</sub>/C and carbon black.

Table S1 Chemical composition of W-coated B<sub>4</sub>C.

	B	C	O	W
Peak area	6308	17142	1445	747
Weight percentage	43.68	49.92	3.45	2.95
Atomic percentage	47.86	49.22	2.55	0.36

Table S2 OER performance of some benchmark catalysts in alkaline solutions at 10 mA cm<sup>-2</sup>.

Catalysts	Electrolyte	$\eta$ / mV	Reference
20% Ir/C	0.1 M KOH	380	3
20% Ru/C	0.1 M KOH	390	3
20% IrO <sub>2</sub> /C	0.1 M KOH	470	4
IrO <sub>2</sub>	0.1 M KOH	490	7
RuO <sub>2</sub>	0.1 M KOH	350	31
W-coated B <sub>4</sub> C	0.1 M KOH	360	This work