Supplementary Information

Highly Effective Ir_xSn_{1-x}O₂ Electrocatalysts for Oxygen Evolution Reaction in the Solid Polymer Electrolyte Water Electrolyser

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Table S1. Impedance fitting parameters of	f $Ir_xSn_{1-x}O_2$ and Ir black cells.
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Cell	χ^2	L	R_{arrho}	R_{I}	Q_1		D	Q_{dl}	
					Y_o	п	κ_{ct}	Y_o	n
	E ⁻⁴	$E^{-7}H$	Ωcm^2	Ωcm^2	Fcm ⁻² s ⁿ⁻¹		Ωcm^2	Fcm ⁻² s ⁿ⁻¹	
IrO ₂	1.54	2.28	0.214	0.0290	0.0794	0.997	0.113	0.641	0.876
$Ir_{0.69}Sn_{0.31}O_2$	1.37	1.88	0.211	0.0216	0.0786	1.0	0.107	0.541	0.890
$Ir_{0.52}Sn_{0.48}O_2$	0.95	2.13	0.213	0.0324	0.161	0.909	0.133	0.436	0.895
Ir black	0.72	0.914	0.223	0.0078	0.117	1.0	0.232	0.211	0.943





Fig. S1 Sketch of SPEWE cell.

The cell designed with $2\times2.5 \text{ cm}^2$ active area. The anodic body was made of Pt-plated Ti material with parallel flow fields machined into the Ti body. The graphite flow field was used in the cathode. The Pt-plated porous Ti diffusion layer (0.77µm in thickness) in the anode chosen was based on their high electrochemical stability and good conductivity, since the carbon material could be oxidized at the voltage of oxygen evolution reaction (OER). In the electrolysis process, the power source provided a direct electric current across the electrolytic cell, producing H₂ at the cathode and O₂ at the anode. The solid proton-conducting membrane (Nafion[®] 115 membrane, 127 µm in thickness) is not electrically but ionically conductive. The

membrane serves a dual purpose, as the gas separation device and ion (proton) conductor. Distilled water was circulated (50 mL min⁻¹) by a peristaltic pump through the anode chamber.



Fig. S2 EDS/SEM of (a) $Ir_{0.69}Sn_{0.31}O_2$ and (b) $Ir_{0.52}Sn_{0.48}O_2$. The samples (3mg cm⁻²) were loaded on the wet-proof carbon paper, prior to the EDS test.



Fig. S3 TEM image of the prepared IrO_2 -SnO₂ with nanorod structure (the molar ratio of Ir/Sn was 0.6/0.4 in feed)



Fig. S4 TEM images of (a) $Ir_{0.52}Sn_{0.48}O_2$, (b) $Ir_{0.31}Sn_{0.69}O_2$, (c) Ir black and (d) HRTEM image of $Ir_{0.67}Sn_{0.33}O_2$ after exposing the electron beam for 5 min at an accelerated voltage of 300 kV.



Fig. S5 XRD pattern of Ir black.

Preparation of IrO₂(Adams) and its voltammetric charges:



Fig. S6. Dependence of voltammetric charge of the prepared IrO_2 sample by the Adams-fusion method on scan rates in 0.5 M H₂SO₄.

The IrO_2 sample was prepared using proprietary modification of the Adams-fusion method.^{1,2} The metal precursor (0.5 g of H₂IrCl₆·xH₂O, 35wt% in Ir) was initially dissolved in the distilled water, followed by mixing in an excess of NaNO₃ (25 g). The salt mixture was further carefully heated until dry at 90°C. The resulting sample was subsequently calcined in air at 500 °C for 1 h. The IrO₂(Adams) product was finally obtained after washing with distilled water and drying at 40 °C. In addition, some results of its structure, chemical and electronic features toward OER could be found in our published communication.³ Fig. S6 shows the voltammetric charges of IrO₂(Adams) as a function of scan rates, which was calculated by the following equation:

$$Q = \int_{E_1}^{E_2} \frac{\left|i\right|}{vm_{lr}} dE \tag{S1}$$

Where *i* is the current density obtained in CV curves, v is the scan rate ranged from 2 to 300 mV s⁻¹, m_{Ir} is the noble-metal Ir loading on the glassy carbon electrode, *E* is the scan potential between 0.15 to 1.15 V_{SCE}.

References

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