Supporting Information

Competitive Adsorption of Oxygen-containing Intermediates on Ruthenium-tin Solid-solution Oxides for Alkaline Oxygen Evolution

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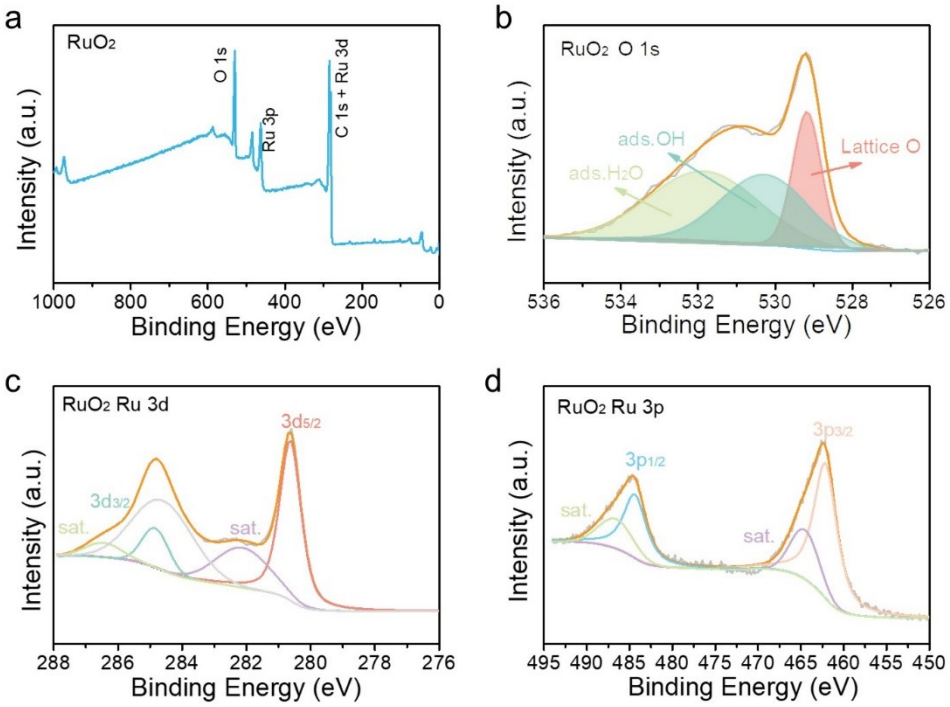

Fig. S1 XPS spectra of RuO_2. a) survey. b) O 1s. c) Ru 3d. d) Ru 3p.

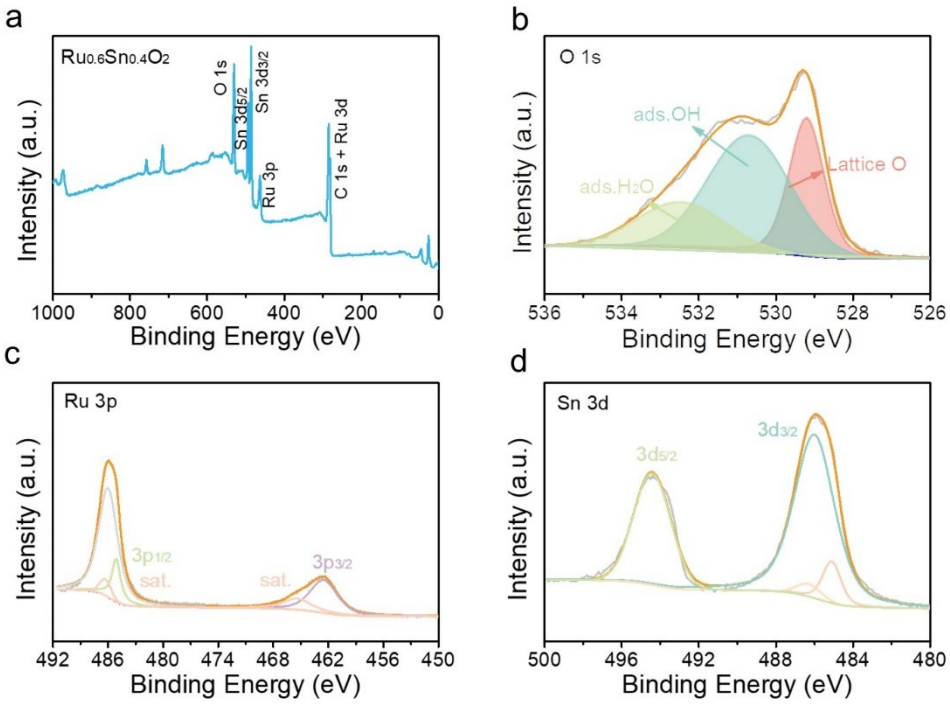

Fig. S2 XPS spectra of $Ru_{0.6}Sn_{0.4}O_2$. a) survey. b) O 1s. c) Ru 3p. d) Sn 3d.

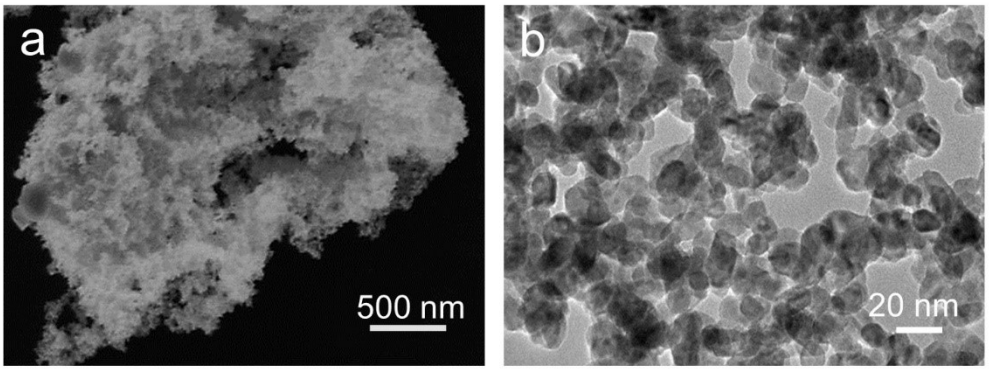

Fig. S3 a) SEM and b) TEM image of $Ru_{0.53}Sn_{0.47}O_2$.

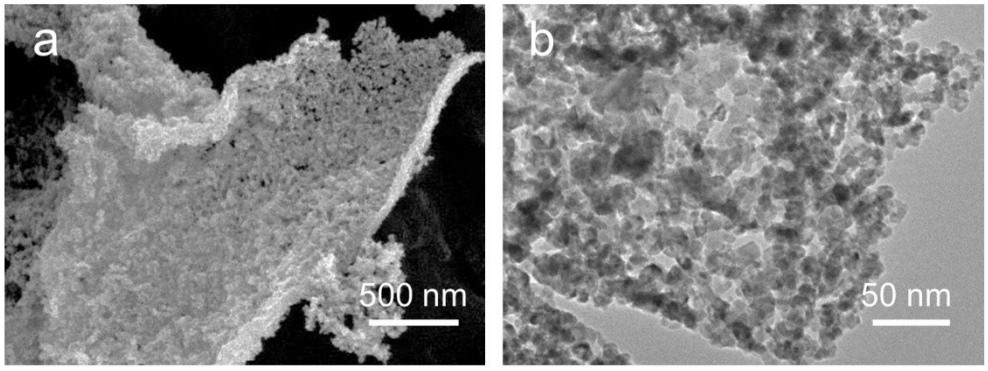

Fig. S4 a) SEM and b) TEM image of $Ru_{0.65}Sn_{0.35}O_2$.

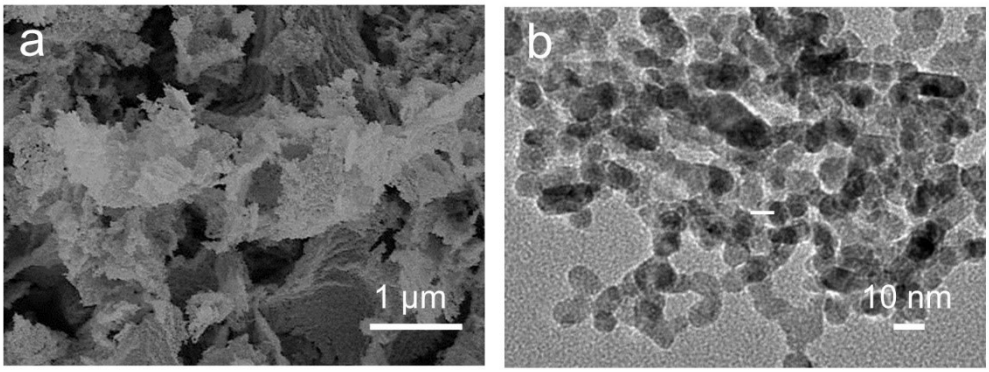

Fig. S5 a) SEM and b) TEM image of RuO_2.

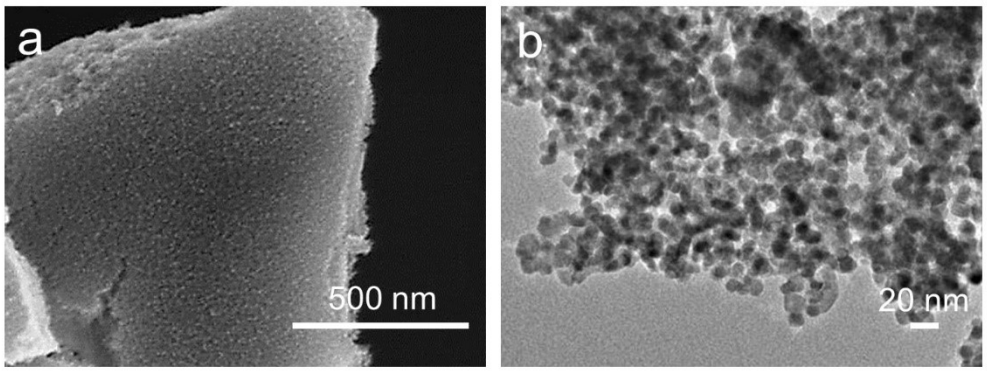

Fig. S6 a) SEM and b) TEM image of SnO_2.

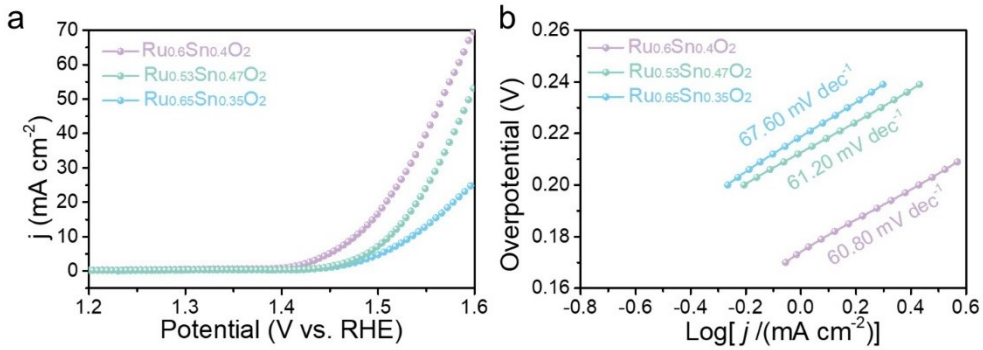

Fig. S7 a) LSV curves (iR compensated) and b) the related Tafel plots of $Ru_{0.6}Sn_{0.4}O_2$, $Ru_{0.53}Sn_{0.47}O_2$, $Ru_{0.65}Sn_{0.35}O_2$ electrocatalysts in 1.0 M KOH at a scan rate of 5 mV s^{-1}.

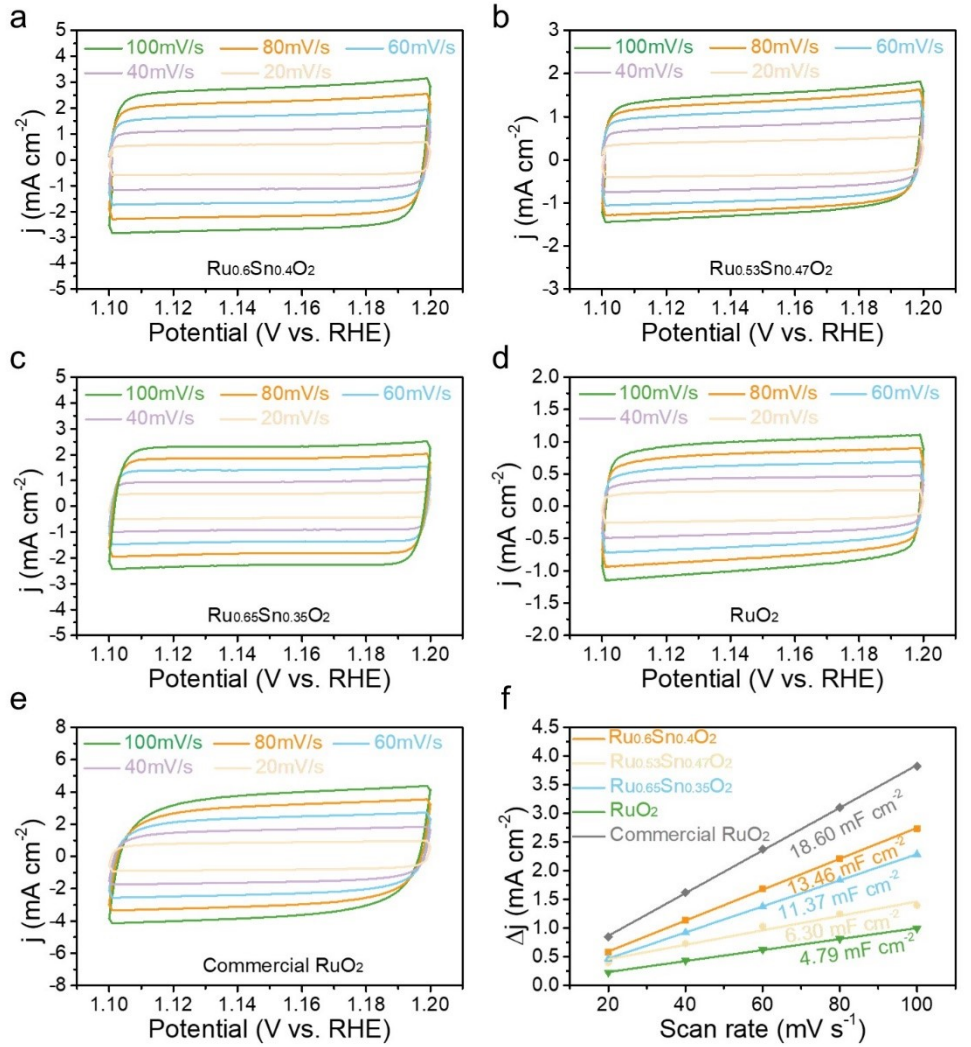

Fig. S8 Cyclic voltammetry curves at different scan rates (mV s^{-1}) for a) $Ru_{0.6}Sn_{0.4}O_2$, b) $Ru_{0.53}Sn_{0.47}O_2$, c) $Ru_{0.65}Sn_{0.35}O_2$, d) RuO_2, e) Commercial RuO_2 and f) The current density differences vs. scan rates and corresponding yielded C_{dl}.

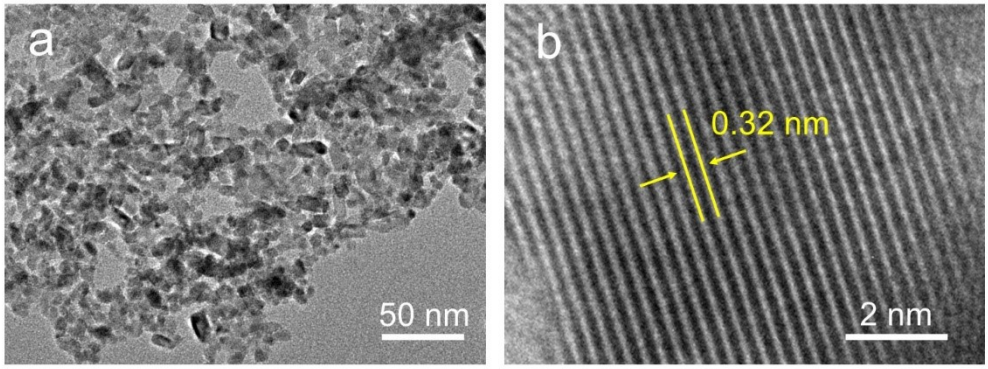

Fig. S9 a) TEM and b) HRTEM images of $Ru_{0.6}Sn_{0.4}O_2$ after durability test.

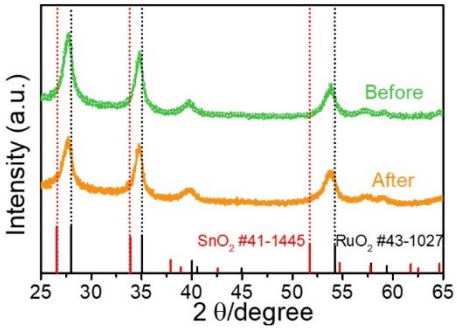

Fig. S10 XRD pattern of $Ru_{0.6}Sn_{0.4}O_2$ powder after durability test.

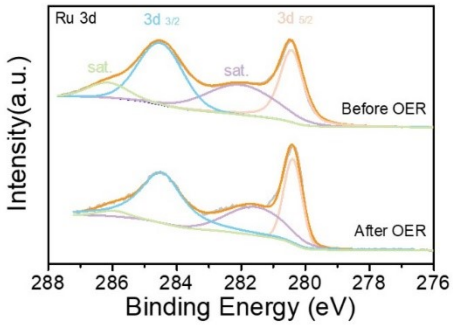

Fig. S11 XPS spectra of Ru 3d of the $Ru_{0.6}Sn_{0.4}O_2$ after durability test.

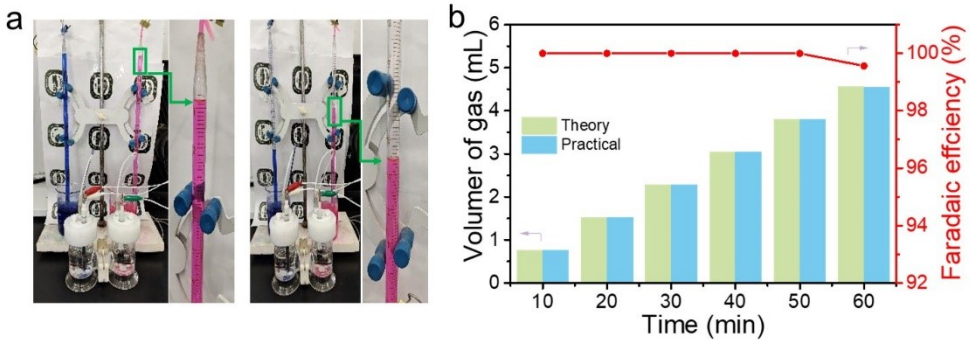

Fig. S12 a) Device diagram for measuring Faraday efficiency, b) Diagram of the amount of O_2 released over time in 1.0 M KOH.

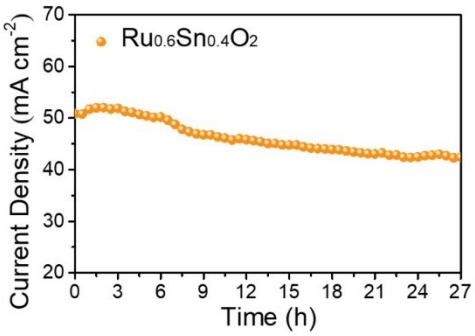

Fig. S13 Chronoamperometric tests of $Ru_{0.6}Sn_{0.4}O_2$.

Table S1. ICP-OES results of different samples.

Sample	Ru (wt.%)	Sn (wt.%)
$Ru_{0.53}Sn_{0.47}O_2$	10.03	8.94
$Ru_{0.6}Sn_{0.4}O_2$	12.42	8.28
$Ru_{0.65}Sn_{0.35}O_2$	14.42	7.76

Table S2. The comparison of performance with some representative RuO_2-based electrocatalysts in alkaline media.

Catalysts	Overpotential (mV) @10 mA cm^{-2}	Tafel slope (mV dec^{-1})	Reference
$Ru_{0.83}Sn_{0.17}O_2$	245	61.8	This work
RuO_2	338	82.6	1
a-$RuTe_2$ PNRs	285	62	2
a/c $CoNiRuO_x$-2	245	82.3	3
x-RuO_2@C	250	68	4
P-RuO_2	310	60.7	5
RuCoO HSs	260	-	6
β-MnO_2-Ru	278	62	7
RuO_2/Co_3O_4 nanocube	302	74.37	8
Ru/RuO_2-MoO_2	260	65	9
RuO_2@$Ti_3C_2T_x$	259	109	10
RuO_2 NR	270	78.31	11
$CuCo_2O_4$/CuO@RuO_2-2	279	115	12
RuO_2/CeO_2	350	74	13

Table S3. Inductively coupled plasma mass spectrometry (ICP-MS) analysis.

Element	After 16 h	After 32 h
Ru (μg/L)	4.90	22.55
Sn (μg/L)	6.80	11.30

The dissolved Ru and Sn elements were traced by ICP-MS analysis in the 30 mL electrolyte of 1.0 M KOH after the chronopotentiometry test at 50 mA cm^{-2} (16 hours and 32 hours). The concentration of Ru in the electrolyte solution was measured to be 4.9 μg/L after 16 hours and increased to be 22.55 μg/L after 32 hours, which demonstrates the comparatively low dissolution rate of $Ru_{0.6}Sn_{0.4}O_2$ in 1.0 M KOH.

References

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