

Supporting Information

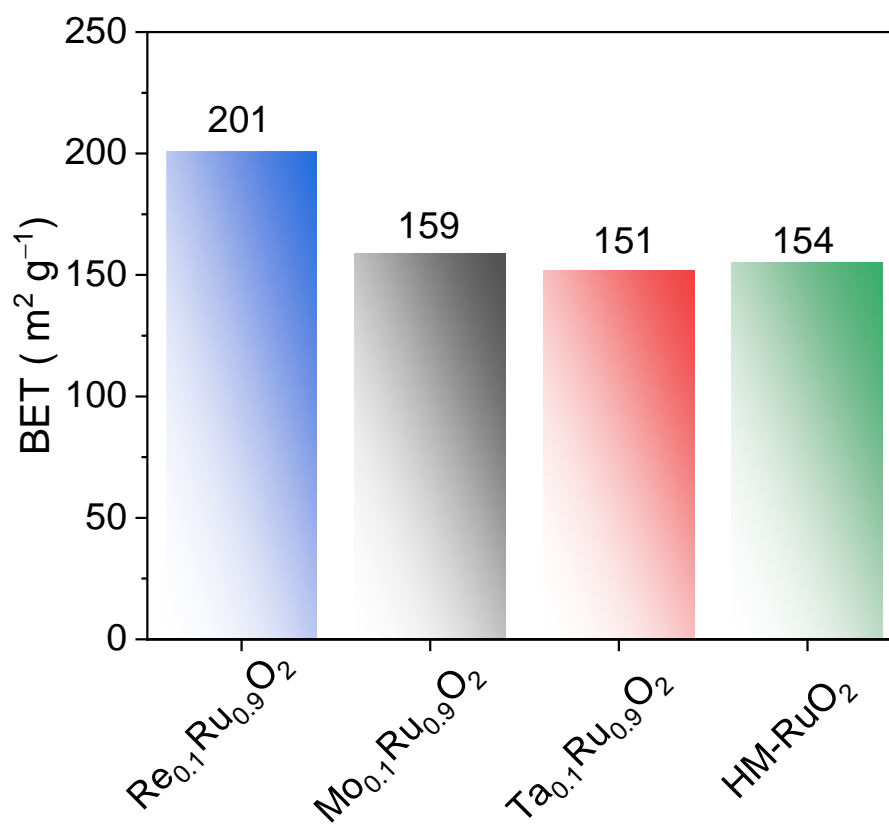


Figure S1. Surface area derived from BET.

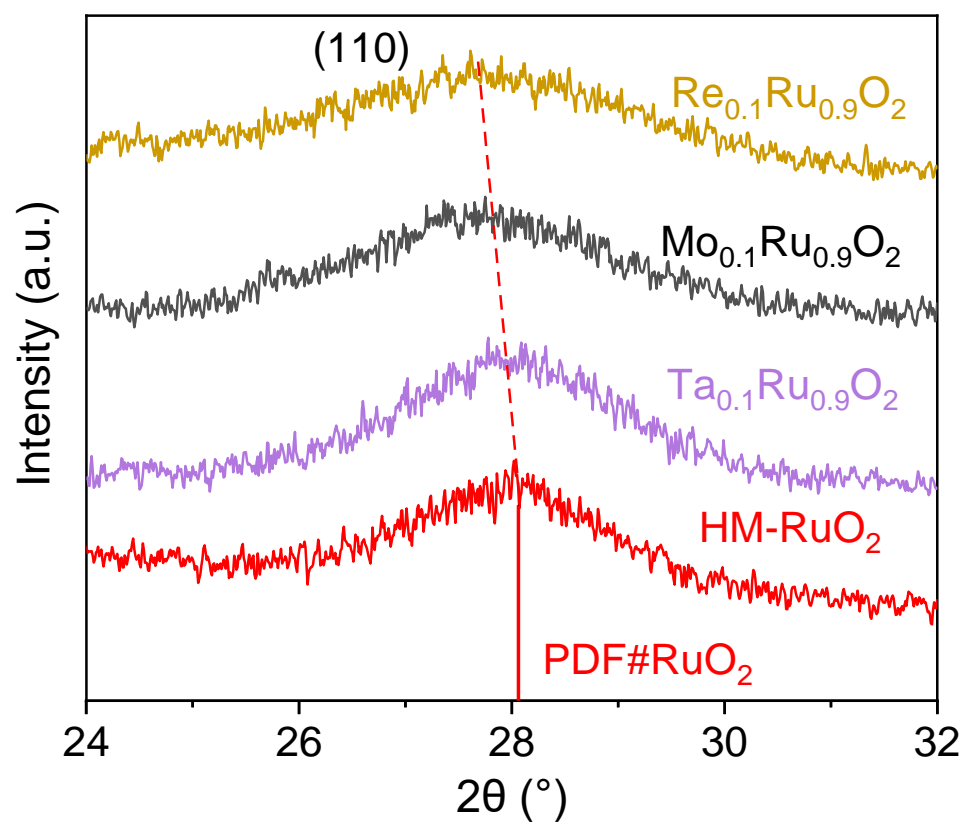


Figure S2. Magnified XRD patterns.

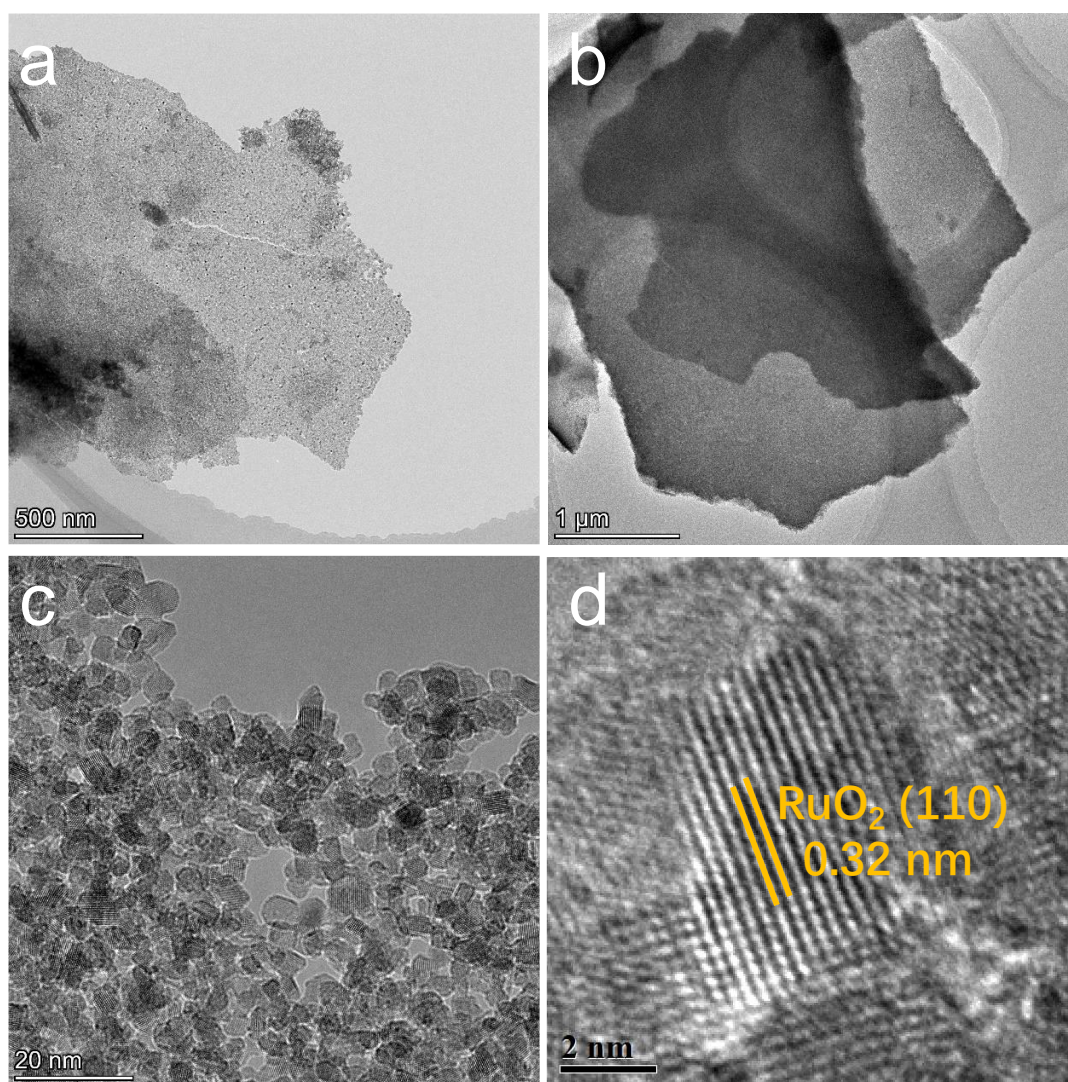


Figure S3. TEM images of (a) $\text{Re}_{0.1}\text{Ru}_{0.9}\text{O}_2$ and (b-d) HM- RuO_2 .

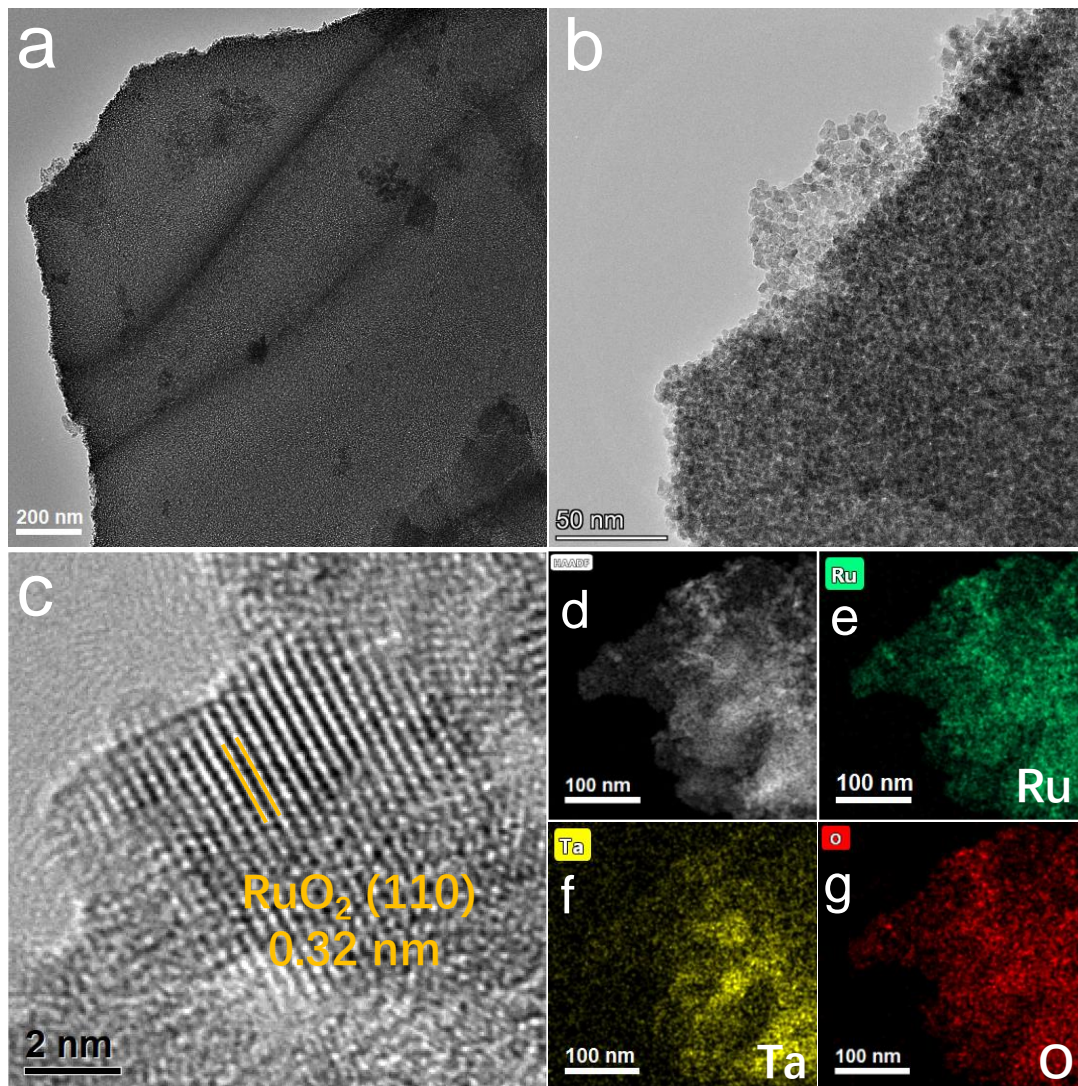


Figure S4. Morphology Structure of $\text{Ta}_{0.1}\text{Ru}_{0.9}\text{O}_2$. (a,b) TEM image, (c) magnified TEM image and (d–g) element mapping images.

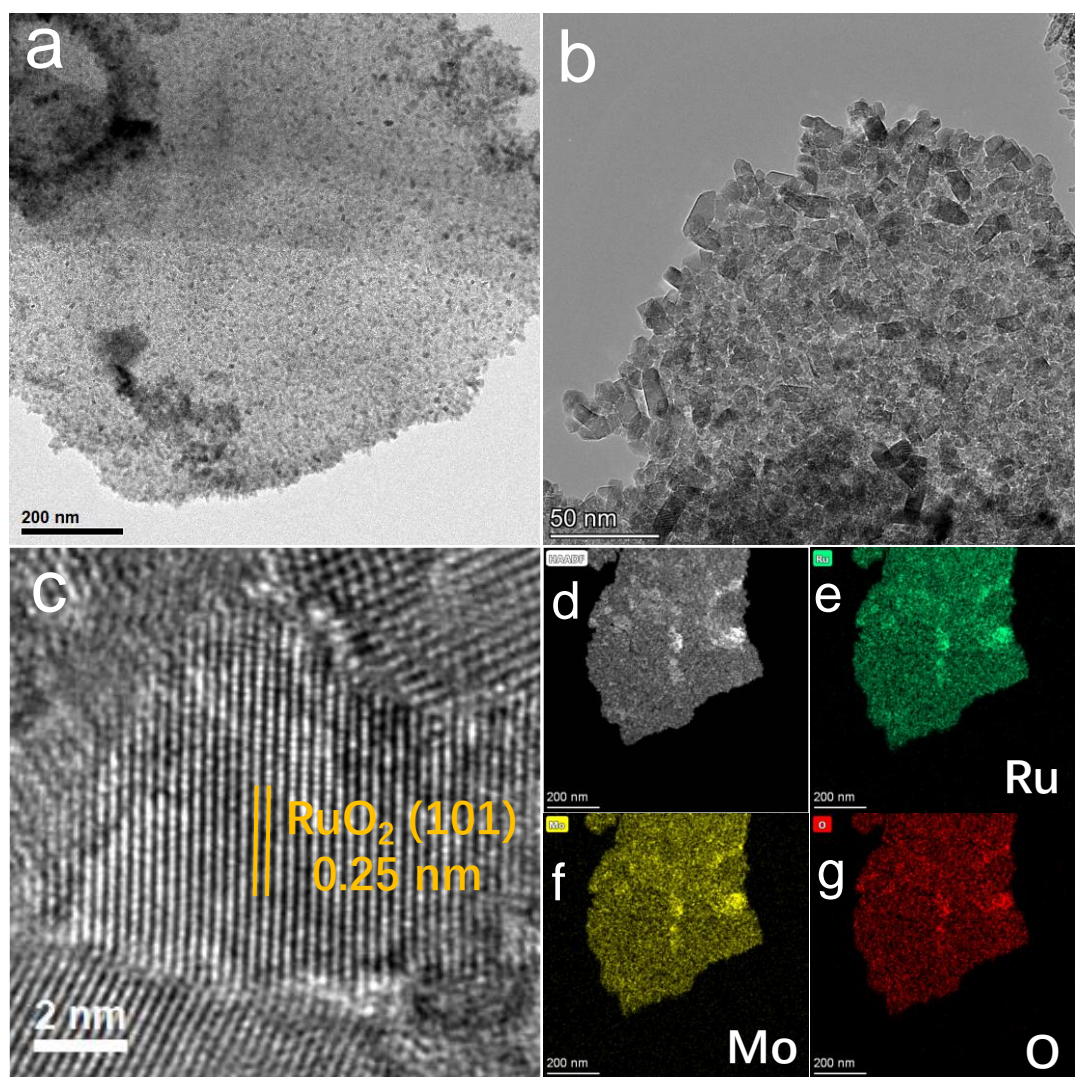


Figure S5. Morphology Structure of $\text{Mo}_{0.1}\text{Ru}_{0.9}\text{O}_2$. (a,b) TEM image, c) magnified TEM image and (d-g) element mapping images.

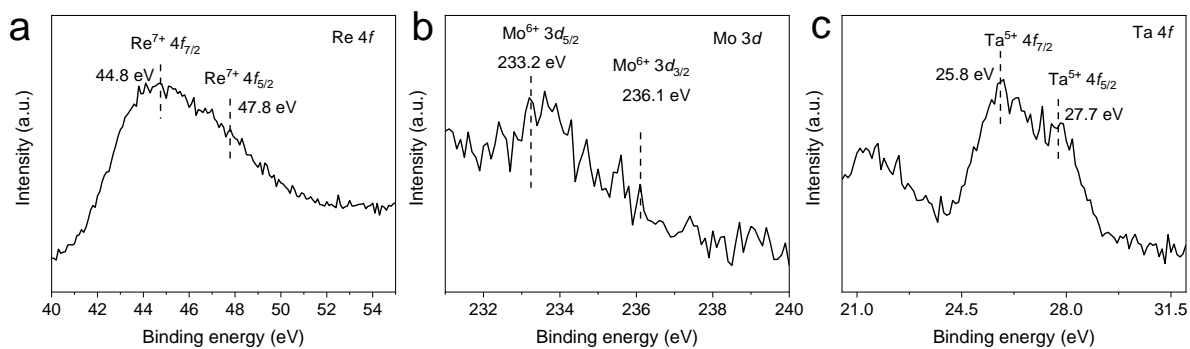


Figure S6. (a) Re 4f XPS spectrum of $\text{Re}_{0.1}\text{Ru}_{0.9}\text{O}_2$. (b) Mo 3d XPS spectrum of $\text{Mo}_{0.1}\text{Ru}_{0.9}\text{O}_2$. (c) Ta 4f XPS spectrum of $\text{Ta}_{0.1}\text{Ru}_{0.9}\text{O}_2$.

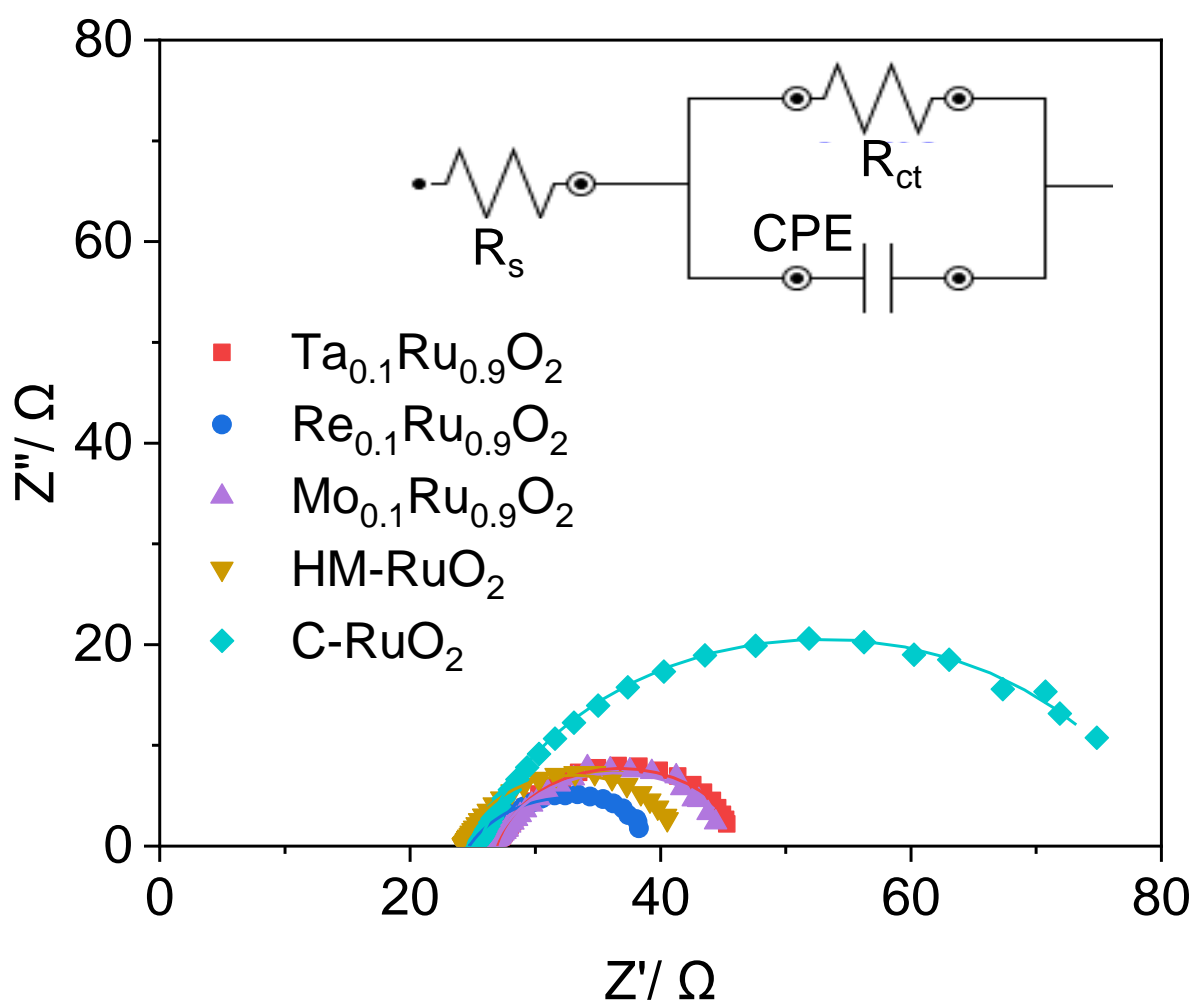


Figure S7. Nyquist impedance plot with fitted Randles circuit of $\text{M}_{0.1}\text{Ru}_{0.9}\text{O}_2$ ($\text{M} = \text{Re}, \text{Mo}, \text{Ta}, \text{Ru}$) and C-RuO_2 . The obtained solution resistance was used for iR correction in electrocatalytic measurements at overpotential of 230 mV.

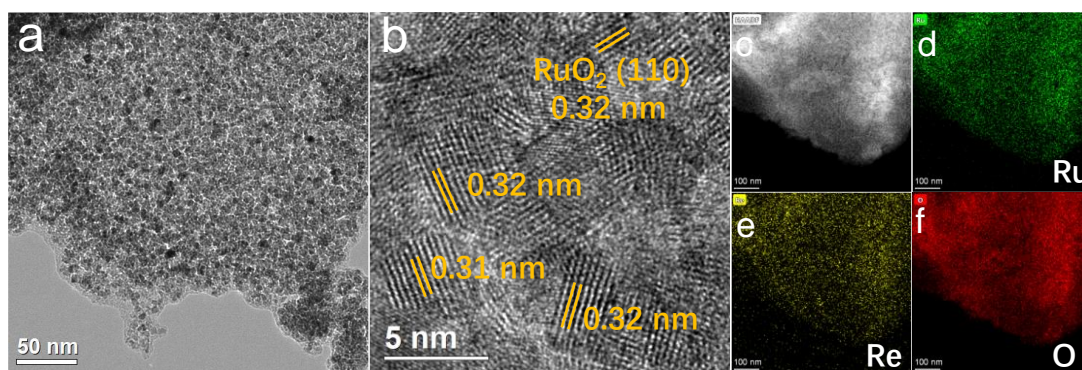


Figure S8. Structure characterizations for the post-stability $\text{Re}_{0.1}\text{Ru}_{0.9}\text{O}_2$. (a) TEM image. (b) HR-TEM image. (c–f) TEM and corresponding elemental mapping images.

Table S1. The fitting results of $\text{Ru } 3p_{3/2}$ spectra from XPS of pre-catalysts.

samples	Ru^{4+}		Ru^{3+}		$\text{Ru}^{4+}/\text{Ru}^{3+}$
	Position/eV	Area	Position/eV	Area	
$\text{Re}_{0.1}\text{Ru}_{0.9}\text{O}_2$	462.3	115618.6	465.5	24618.6	4.7
$\text{Mo}_{0.1}\text{Ru}_{0.9}\text{O}_2$	462.3	108228.1	465.5	25768.09	4.2
$\text{Ta}_{0.1}\text{Ru}_{0.9}\text{O}_2$	462.3	120228.1	465.5	29241.47	4.1
HM– RuO_2	462.3	105767.4	465.5	27767.4	3.8

Table S2. Comparison of OER performance for $\text{Re}_{0.1}\text{Ru}_{0.9}\text{O}_2$ with some benchmark Ru-based oxides under acidic media.

Catalyst	Electrolyte solution	Overpotential (mV)	Stability	Loading amount (mg cm ⁻²)	Ref.
La-RuO ₂	0.5 M H ₂ SO ₄	$\eta_{10} = 208$	28 h (10 mA cm ⁻²)	1.0 (Carbon Paper)	[1]
Si-RuO _x @C	0.5 M H ₂ SO ₄	$\eta_{10} = 220$	100 h (10 mA cm ⁻²)	1.6 (Carbon Paper)	[2]
RuO ₂ -WC NPs	0.5 M H ₂ SO ₄	$\eta_{10} = 347$	10 h (10 mA cm ⁻²)	0.51 (GC)	[3]
Ni-RuO ₂	0.1 M HClO ₄	$\eta_{10} = 214$	200 h	0.4 (GC)	[4]
Ru _{0.85} Zn _{0.15} O _{2-δ}	0.5 M H ₂ SO ₄	$\eta_{10} = 190$	50 h (10 mA cm ⁻²)	0.416 (GC)	[5]
Ru/Se-RuO ₂	0.5 M H ₂ SO ₄	$\eta_{10} = 190$	24 h (10 mA cm ⁻²)	0.5 (GC)	[6]
Mn _{0.73} Ru _{0.27} O _{2-δ}	0.5 M H ₂ SO ₄	$\eta_{10} = 208$	10 h (10 A cm ⁻²)	0.28 (GC)	[7]
RuCo@CD	0.5 M H ₂ SO ₄	$\eta_{10} = 190$	20 h (10 A cm ⁻²)	0.905 (GC)	[8]
Rh-RuO ₂	0.5 M H ₂ SO ₄	$\eta_{10} = 161$	700 h (50 A cm ⁻²)	1.25 (Ti Mesh)	[9]
RuO ₂ /D-TiO ₂	0.5 M H ₂ SO ₄	$\eta_{10} = 180$	100 h (10 mA cm ⁻²)	5.0 (Carbon Paper)	[10]
Re_{0.1}Ru_{0.9}O₂	0.1 M HClO₄	$\eta_{10} = 199$	300 h (10 mA cm⁻²)	1.0 (Carbon Paper)	This work

Table S3. The fitting results of Ru 3p_{3/2} spectra from XPS of post-catalysts.

samples	Ru ⁴⁺		Ru ³⁺		Ru ⁴⁺ /Ru ³⁺
	Position/eV	Area	Position/eV	Area	
Re _{0.1} Ru _{0.9} O ₂	462.5	57576.2	465.5	17176.2	3.4
HM-RuO ₂	462.5	59882.1	465.5	13882.1	4.3

References

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