

Supplementary Information

Dual engine drive: The synergy of Mn and Ti₄O₇ achieves high-performance acidic water oxidation

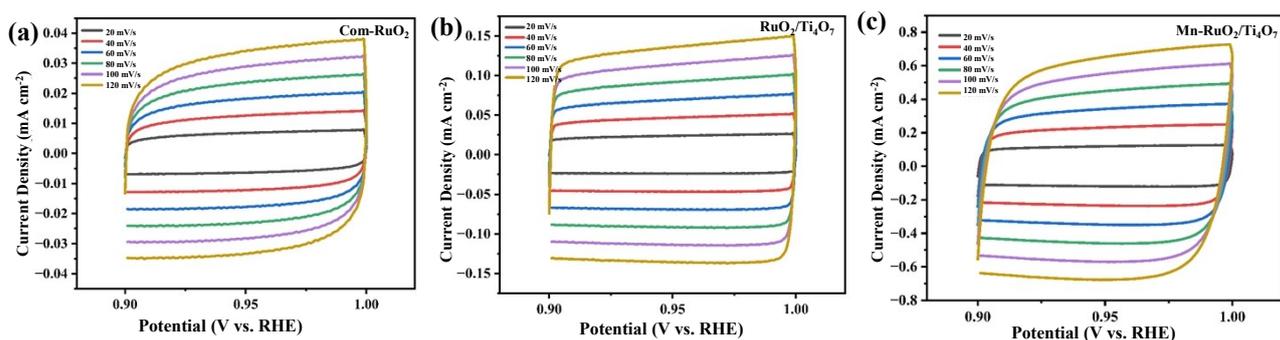


Figure. S1. Cyclic voltammograms of Com-RuO₂, RuO₂/Ti₄O₇ and Mn-RuO₂/Ti₄O₇ recorded at various scan rates.

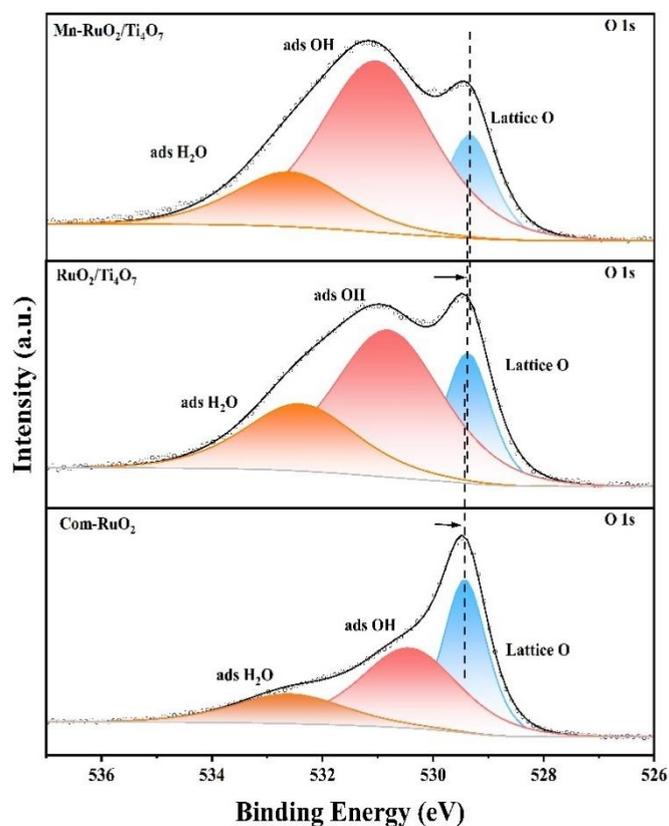


Figure. S2. XPS spectra of O 1s of Com-RuO₂, RuO₂/Ti₄O₇ and Mn-RuO₂/Ti₄O₇.

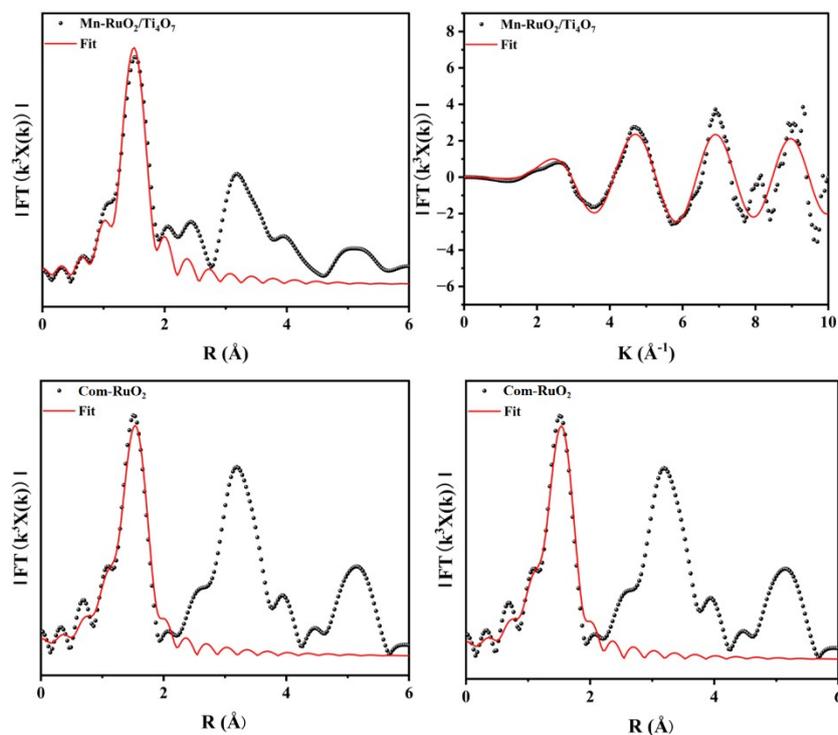


Figure. S3. First shell fitting of FT-EXAFS for Mn-RuO₂/Ti₄O₇ and Com-RuO₂. Left: R spacing fitting. Right: K spacing fitting.

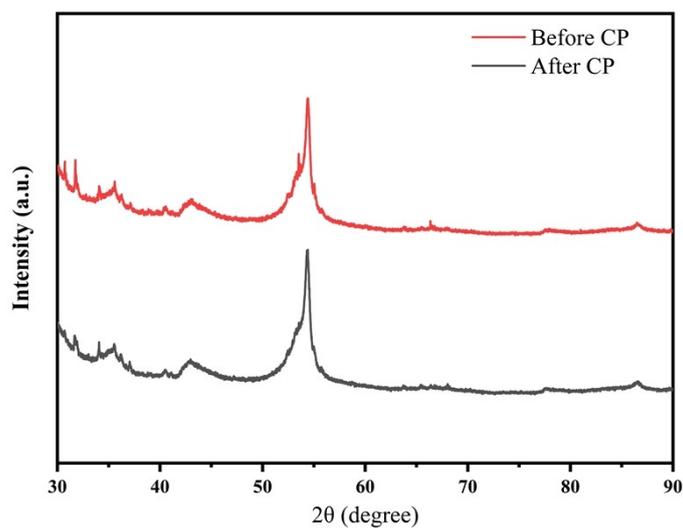


Figure. S4. XRD pattern of Mn-RuO₂/Ti₄O₇ before and after the 95h CP test(on carbon paper).

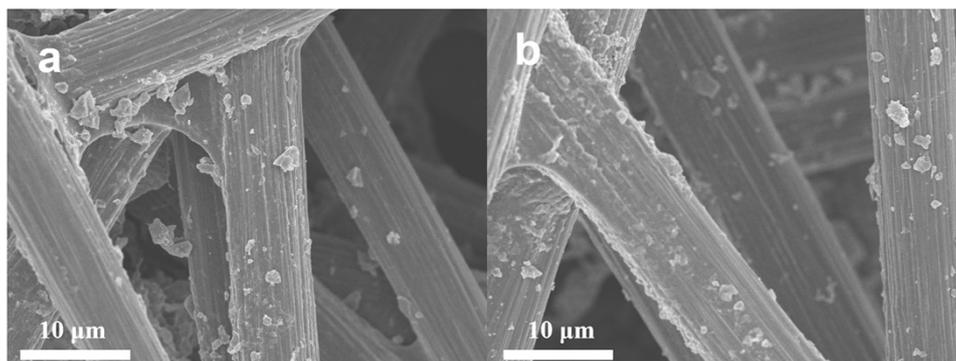


Figure. S5. SEM images of Mn-RuO₂/Ti₄O₇ before(a) and after(b) the 95h CP test(on carbon paper).

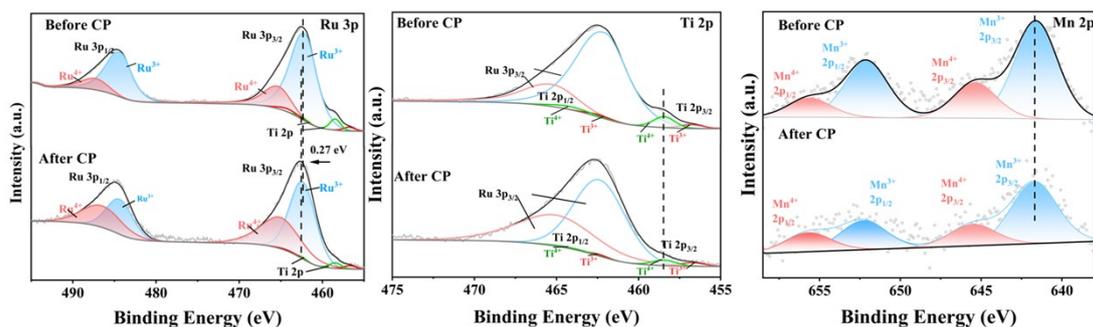


Figure. S6. XPS spectra of Mn-RuO₂/Ti₄O₇ before and after the 95h CP test.

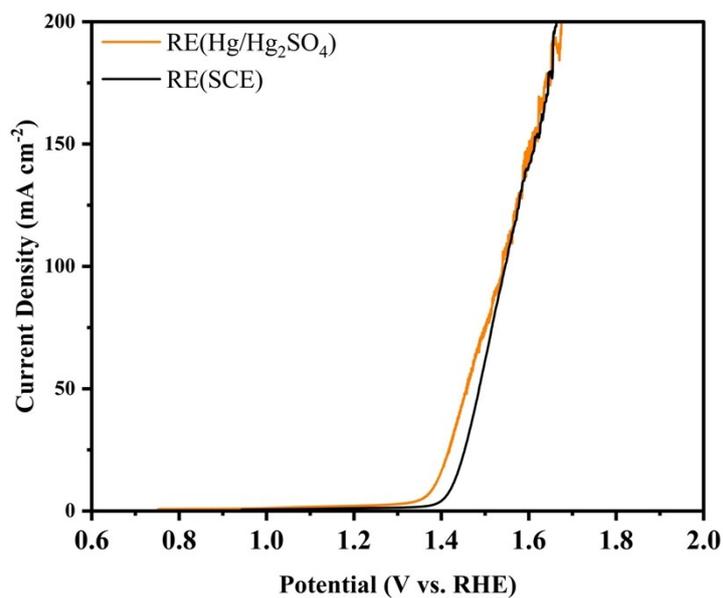


Figure. S7. OER LSV curves of Mn-RuO₂/Ti₄O₇ catalysts using different reference electrodes

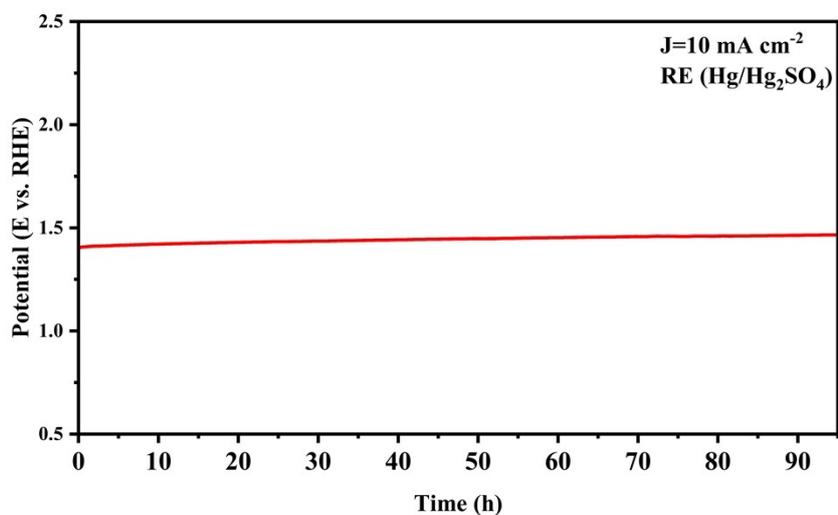


Figure. S8. The CP test image of the Mn-RuO₂/Ti₄O₇ catalyst using the Hg/Hg₂SO₄ electrode.

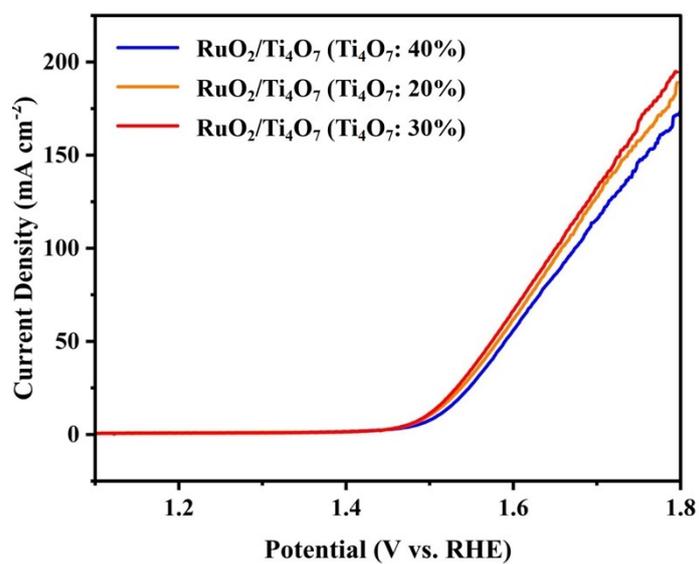


Figure. S9. OER LSV curves of the catalysts (Different contents of Ti₄O₇)

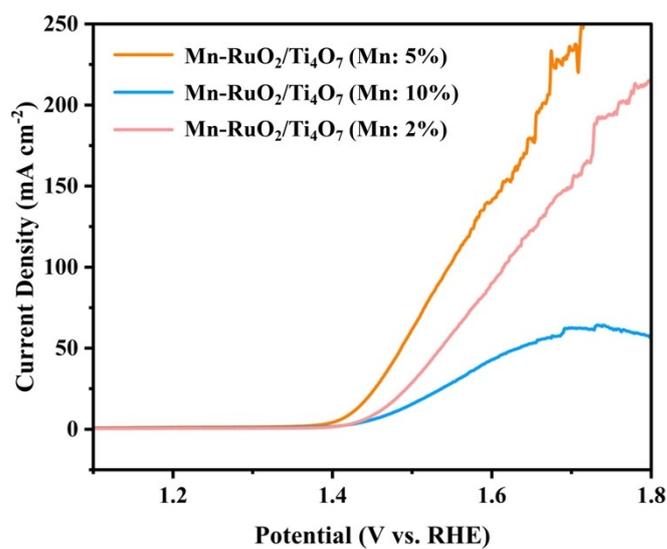


Figure. S10. OER LSV curves of the catalysts (Different contents of Mn)

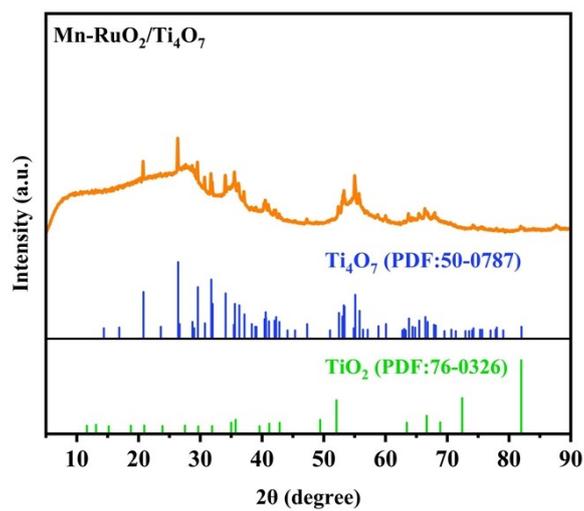


Figure. S11. The XRD pattern of Mn-RuO₂/Ti₄O₇, compared with that of TiO₂ and Ti₄O₇.

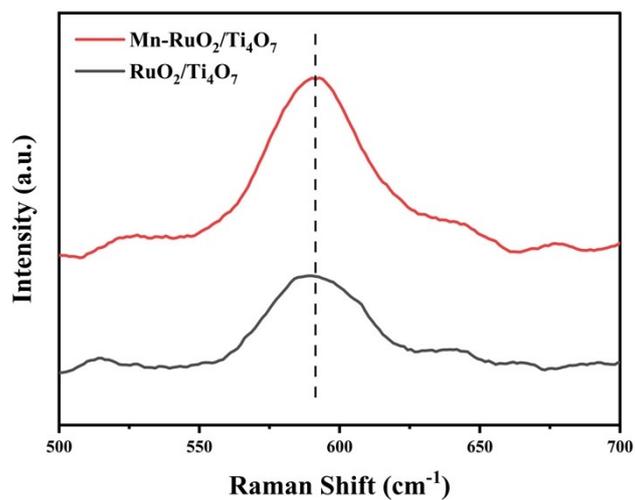


Figure. S12. Raman spectra of Mn-RuO₂/Ti₄O₇ and RuO₂/Ti₄O₇ catalyst.

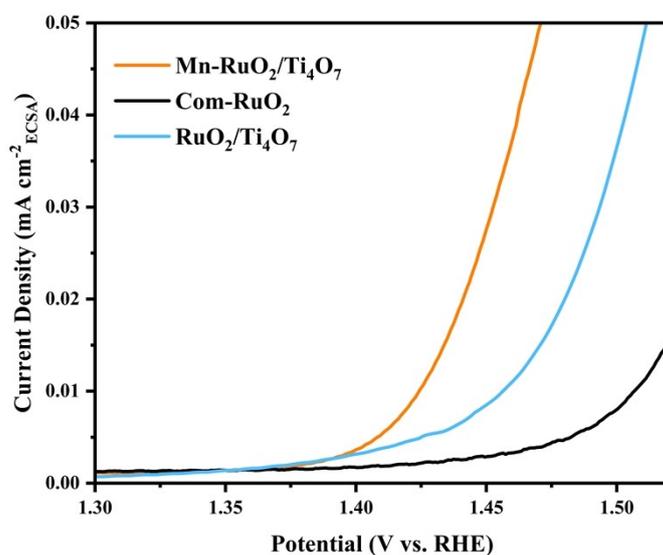


Figure. S13. OER LSV curves of the catalysts normalized by ECSA.

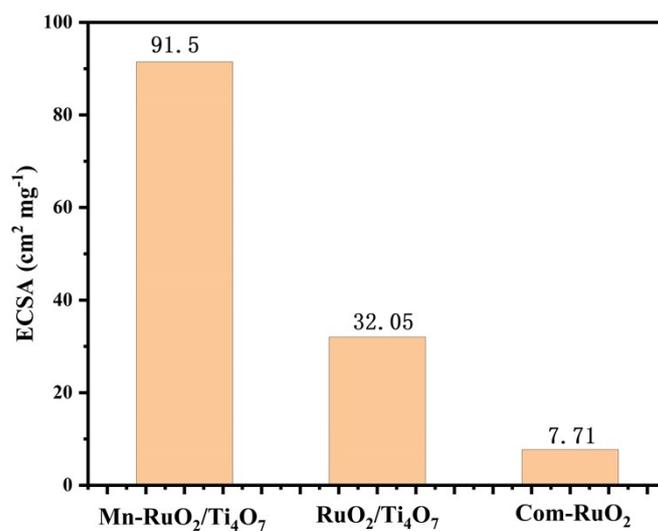


Figure. S14. ECSA of Mn-RuO₂/Ti₄O₇, RuO₂/Ti₄O₇, and Commercial RuO₂.

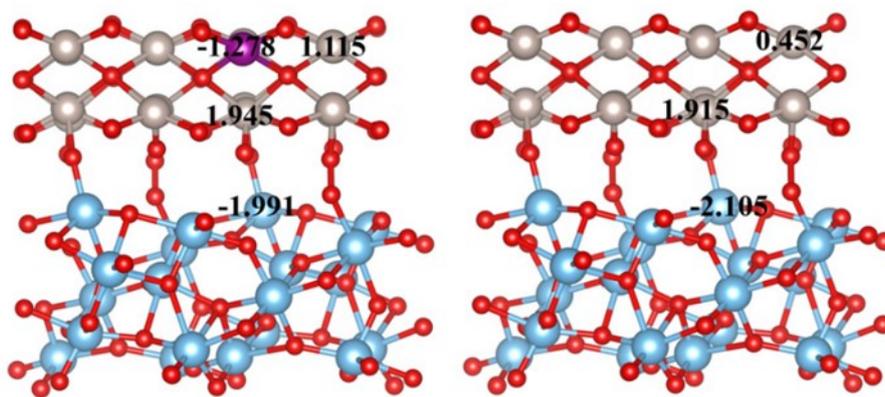


Figure. S15. Bader charge plots for Mn-RuO₂/Ti₄O₇ and RuO₂/Ti₄O₇.

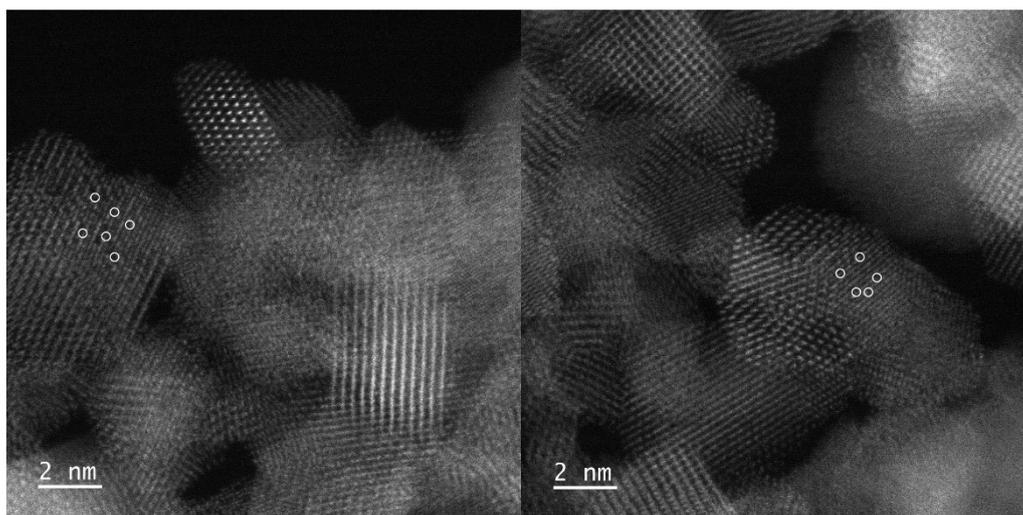


Figure. S16. AC-HAADF-STEM images of Mn-RuO₂/Ti₄O₇

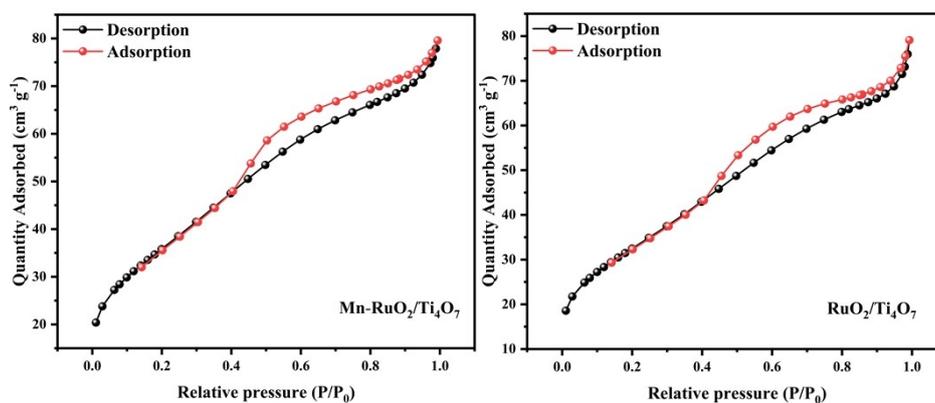


Figure. S17. Nitrogen adsorption/desorption isotherm of the of Mn-RuO₂/Ti₄O₇ and RuO₂/Ti₄O₇

Table S1 | Parameters used in EXAFS fittings.

Catalysts	Shell	R (Å)	σ^2 (Å²)	ΔE_0(eV)	R factor
Mn-RuO₂/Ti₄O₇	Ru-O	1.962	0.0018	-0.149	0.012
Com-RuO₂	Ru-O	2.084	0.0022	+1.597	0.005

Table S2 | The element ratio in the electrocatalysts (Mn-RuO₂/Ti₄O₇) has been probed by ICP-MS.

Element	Mn	Ru	Ti
Content	4.59%	38.89%	20.59%

Table S3 | ICP analysis of the electrolyte after 95h CP test

Element	Mn	Ru	Ti
Concentration	0.0581 mg/L	0.5632 mg/L	0.0167 mg/L

Table S4 | Overpotential of different catalysts

Catalysts	Overpotential (At 10 mA cm ⁻²)/mV
Mn-RuO ₂ /Ti ₄ O ₇ (Mn:5% ,Ti ₄ O ₇ :30%)	194
Mn-RuO ₂ /Ti ₄ O ₇ (Mn:2% ,Ti ₄ O ₇ :30%)	235
Mn-RuO ₂ /Ti ₄ O ₇ (Mn:10% ,Ti ₄ O ₇ :30%)	246
RuO ₂ /Ti ₄ O ₇ (Ti ₄ O ₇ :30%)	280
RuO ₂ /Ti ₄ O ₇ (Ti ₄ O ₇ :20%)	283
RuO ₂ /Ti ₄ O ₇ (Ti ₄ O ₇ :40%)	287
Com-RuO ₂	305