

Supplementary Information

Oxygen Vacancies as Electronic Bridges to Reinforce Ru–TiO₂ Metal-Support Interaction toward Efficient Electrocatalytic Acidic Hydrogen Evolution

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Supplementary Figures

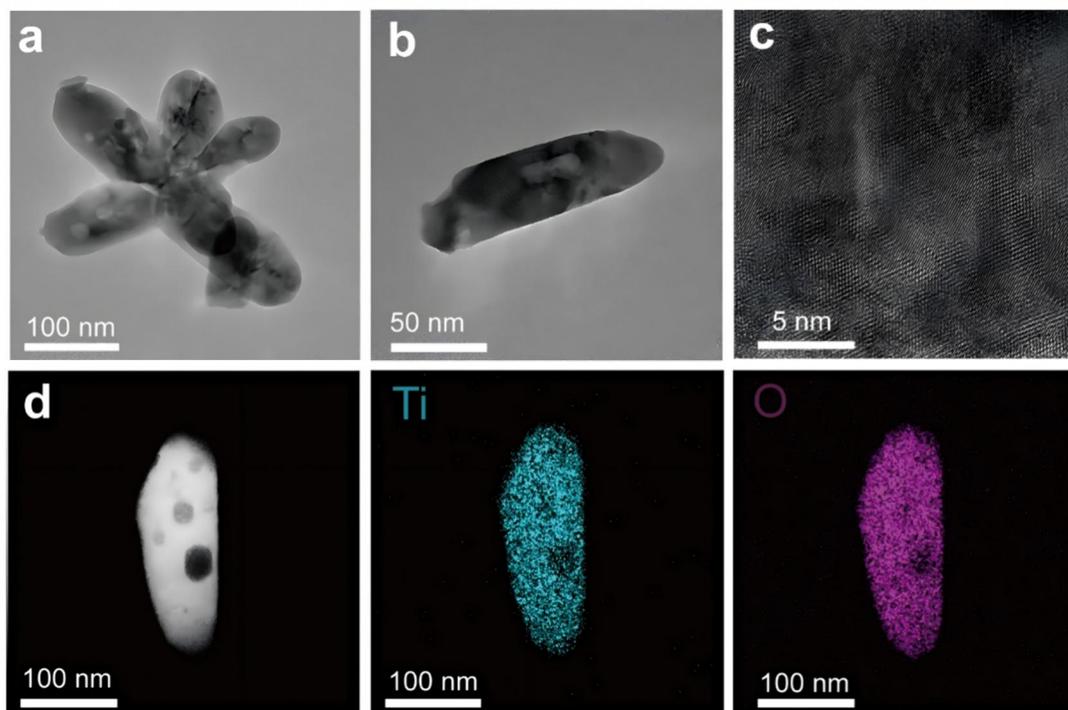


Figure S1. (a–c) TEM images and (d) the corresponding element distributions of TiO₂.

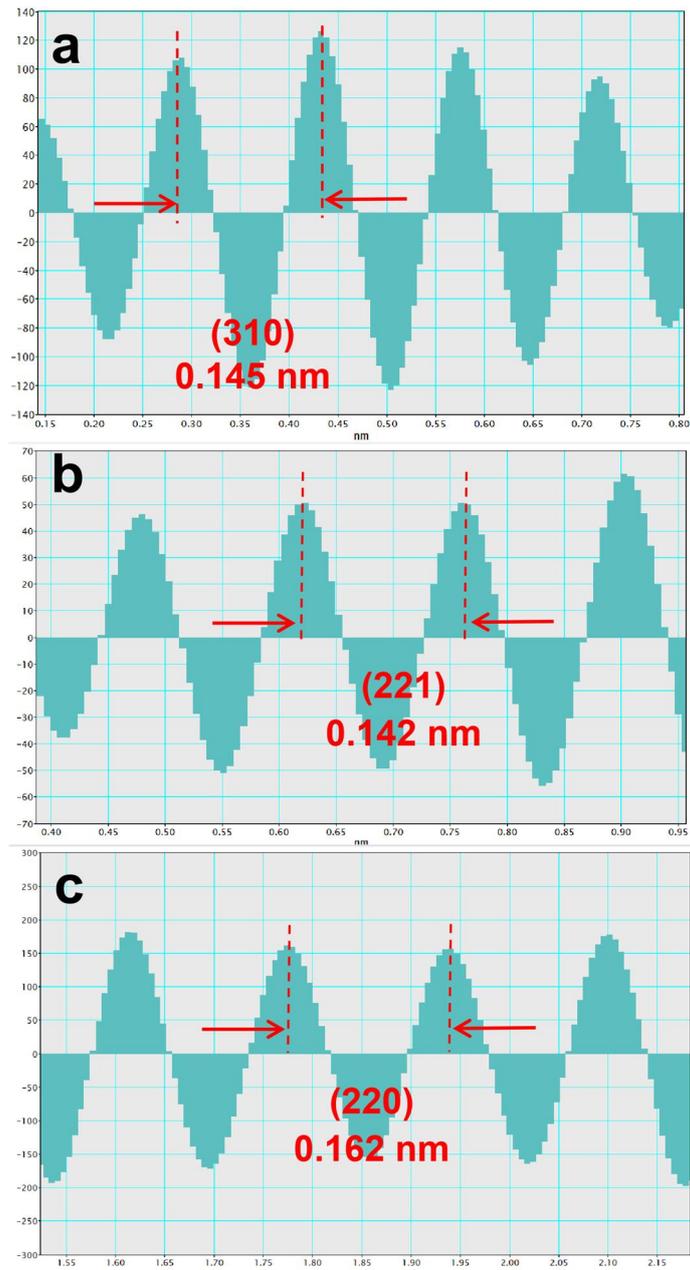


Figure S2. Lattice spacing analysis for TiO₂.

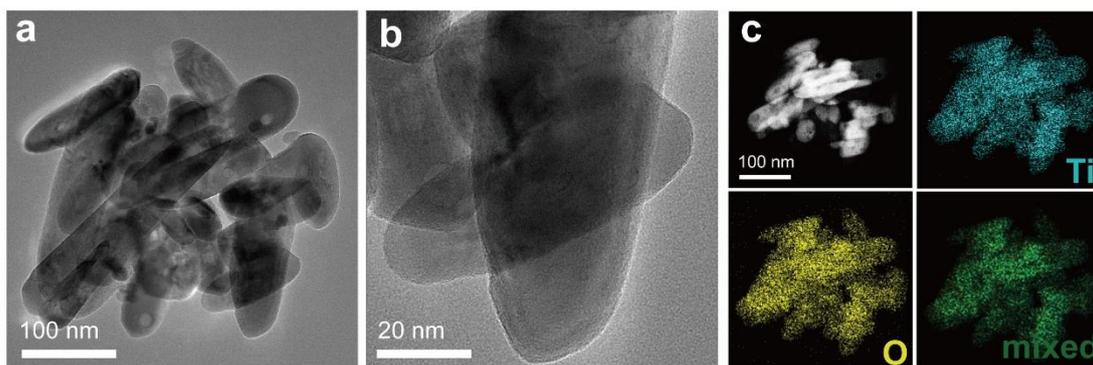


Figure S3. (a, b) TEM images and (c) the corresponding element distributions of TiO_{2-x} .

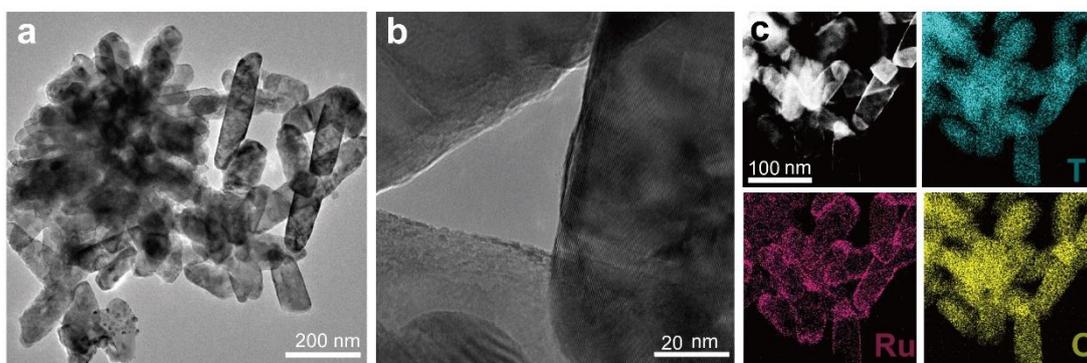


Figure S4. (a, b) TEM images and (c) the corresponding element distributions of Ru/TiO_{2-x} .

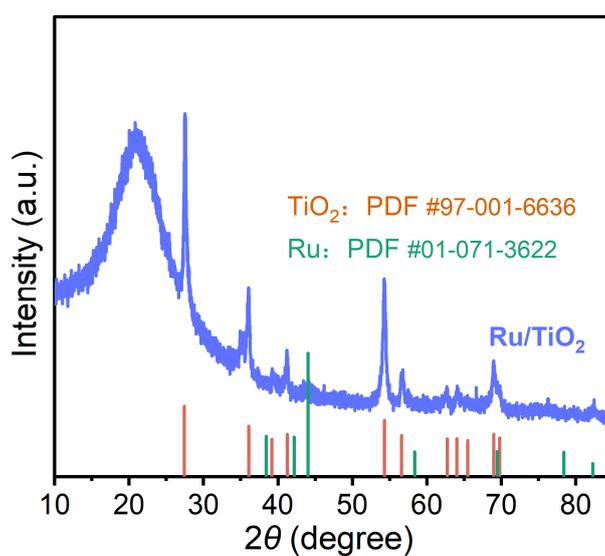


Figure S5. XRD pattern of Ru/TiO_2 .

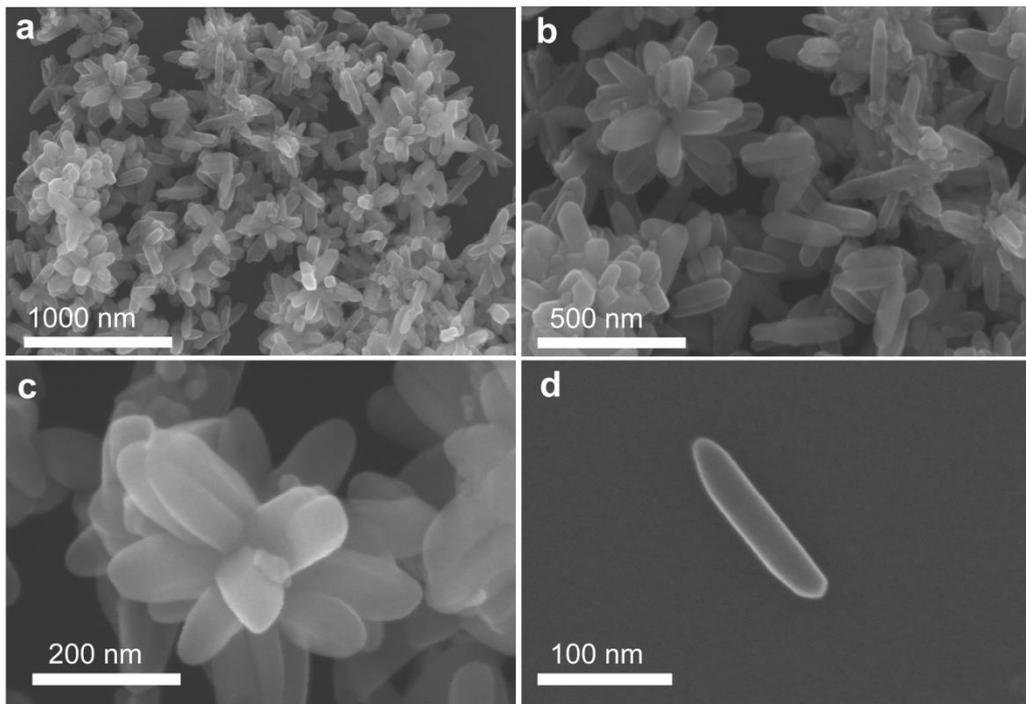


Figure S6. SEM images of pristine TiO₂.

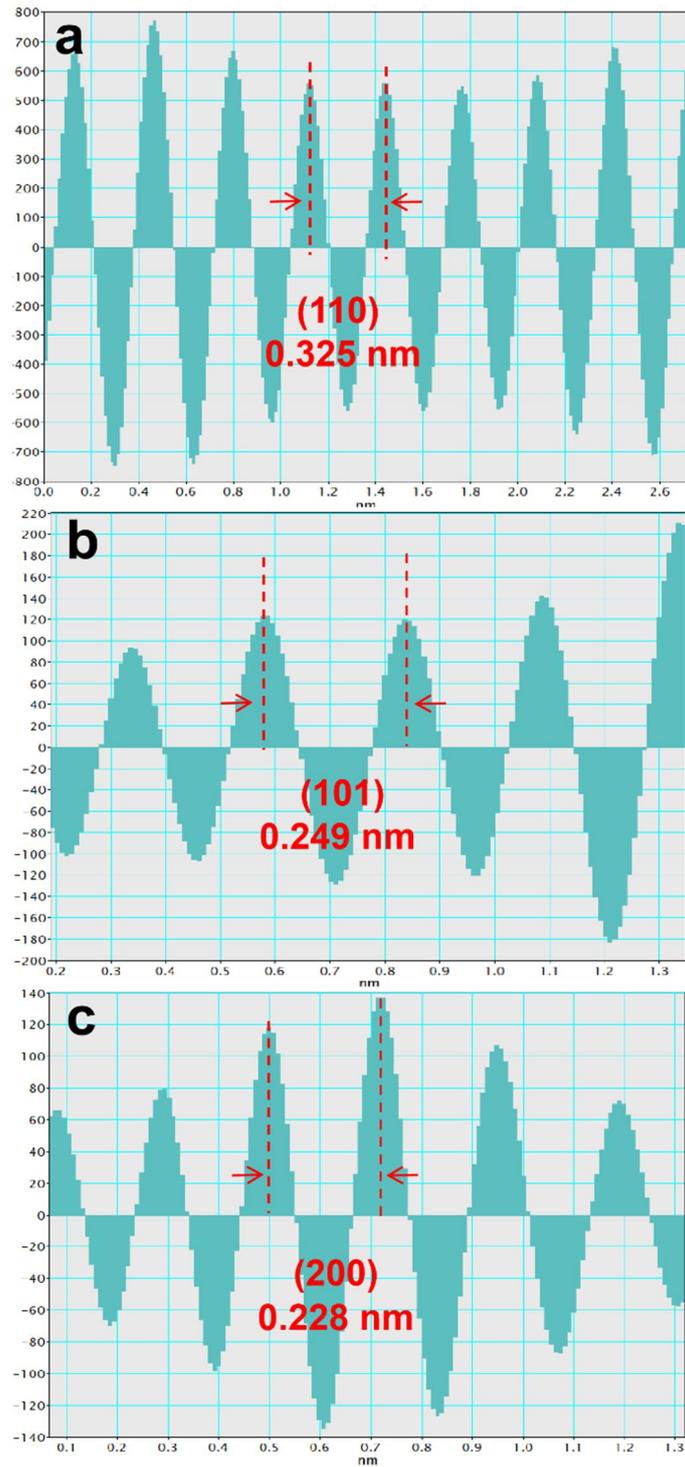


Figure S7. Lattice spacing analysis for TiO_2 within Ru/TiO_{2-x} .

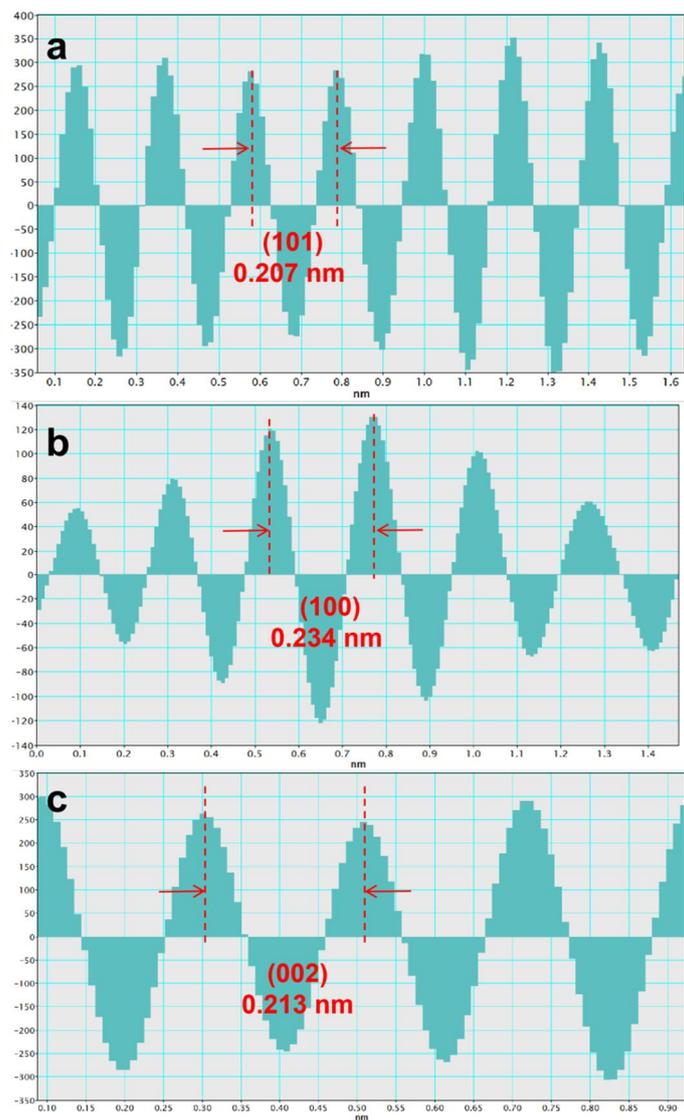


Figure S8. Lattice spacing analysis for Ru within Ru/TiO_{2-x}.

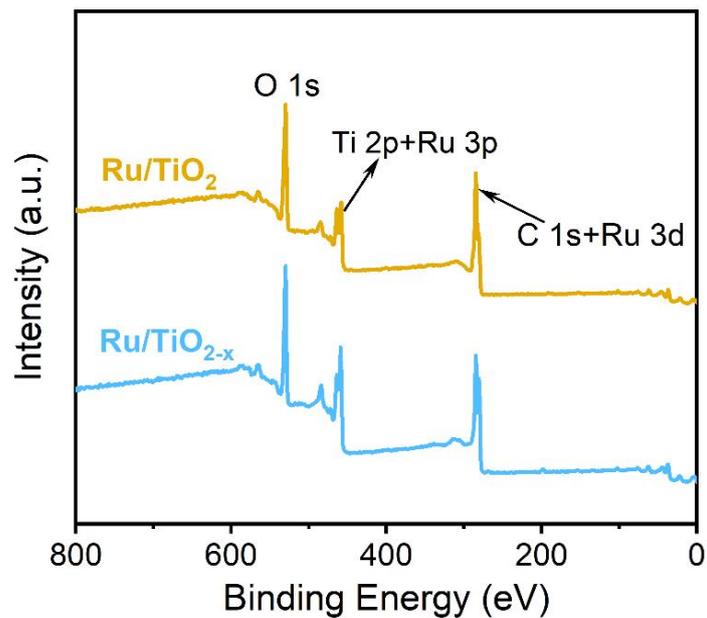


Figure S9. XPS survey of Ru/TiO_{2-x} and Ru/TiO₂.

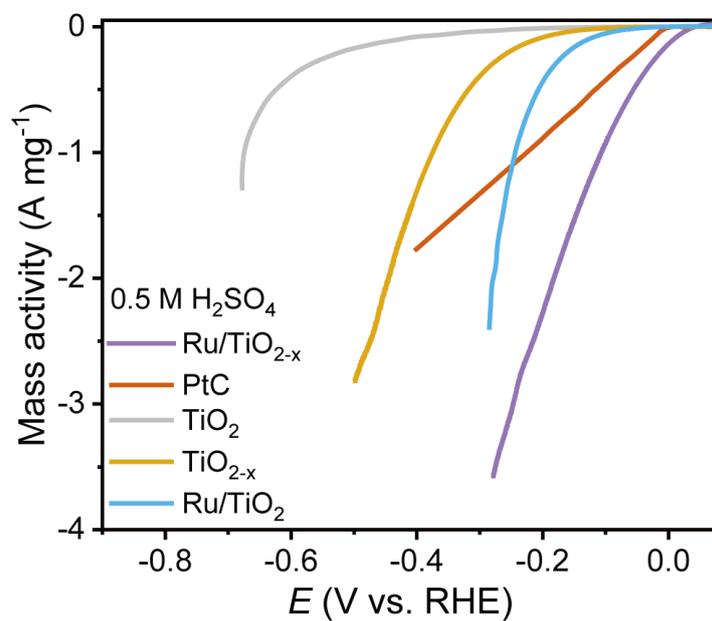


Figure S10. Mass activities of the different samples for HER in 0.5 M H₂SO₄ electrolyte.

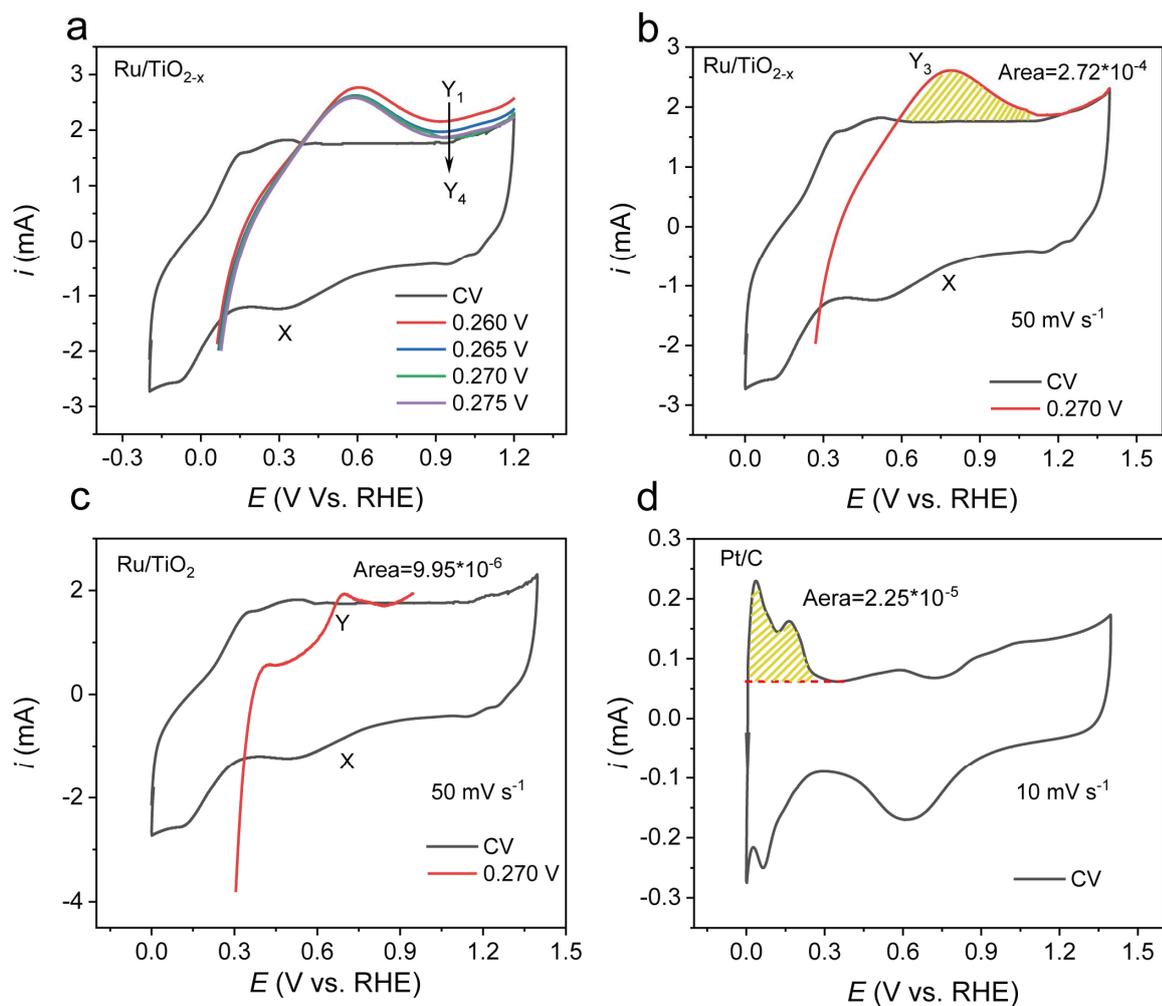


Figure S11. Determination of ECSA values for Ru/TiO_{2-x} and Ru/TiO₂ using Cu-upd and Pt/C using H-upd methods. (a) Cu-upd in 0.5 M H₂SO₄ on Ru/TiO_{2-x} in the absence (X) and presence (Y₁-Y₄) of 0.5 mM CuSO₄. For Y₁-Y₄, the electrode was polarized at 0.260, 0.265, 0.270, and 0.275 V for 100 s to form the UPD layer, respectively. (b) Cu-upd in 0.5 M H₂SO₄ on Ru/TiO_{2-x} in the absence (X) and presence (Y₃) of 0.5 mM CuSO₄. For X and Y₃, the electrode was polarized at 0.270 V for 100 s to form the UPD layer. (c) Cu-upd in 0.5 M H₂SO₄ on Ru/TiO₂ in the absence (X) and presence (Y) of 0.5 mM CuSO₄. For X and Y, the electrode was polarized at 0.270 V for 100 s to form the UPD layer. (d) H-upd and the CV integration in 0.5 M H₂SO₄ on Pt/C.

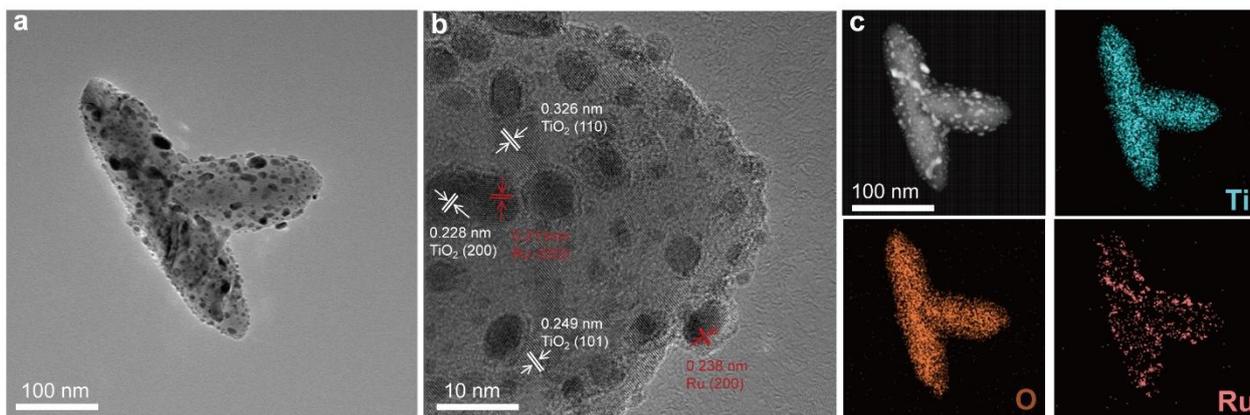


Figure S12. (a, b) TEM morphology characterization results and (c) element distribution after the HER stability test of Ru/TiO_{2-x}.

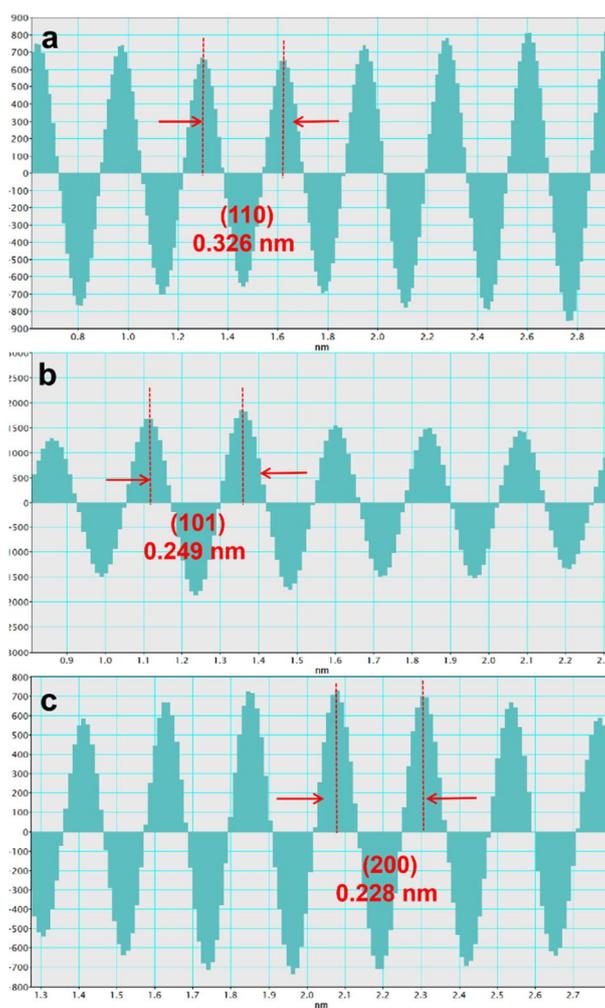


Figure S13. (a-c) Lattice spacing analysis of TiO₂ in Ru/TiO_{2-x} after the HER stability test.

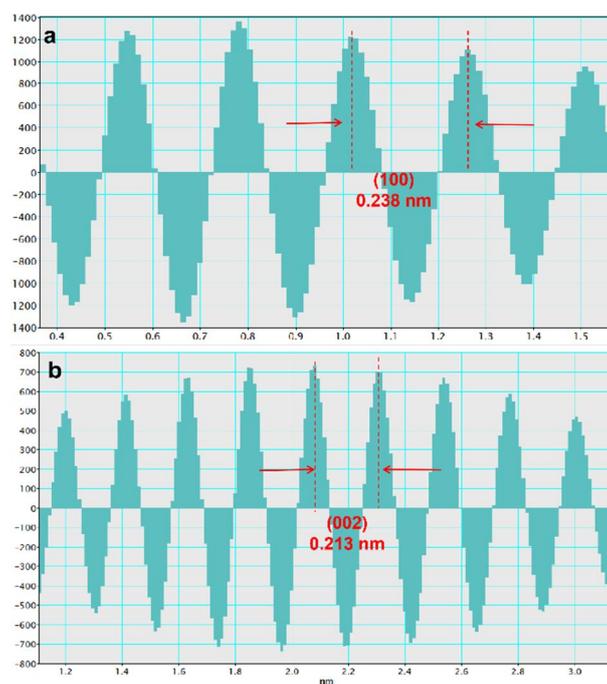


Figure S14. (a, b) Lattice spacing analysis of Ru in Ru/TiO_{2-x} after the HER stability test.

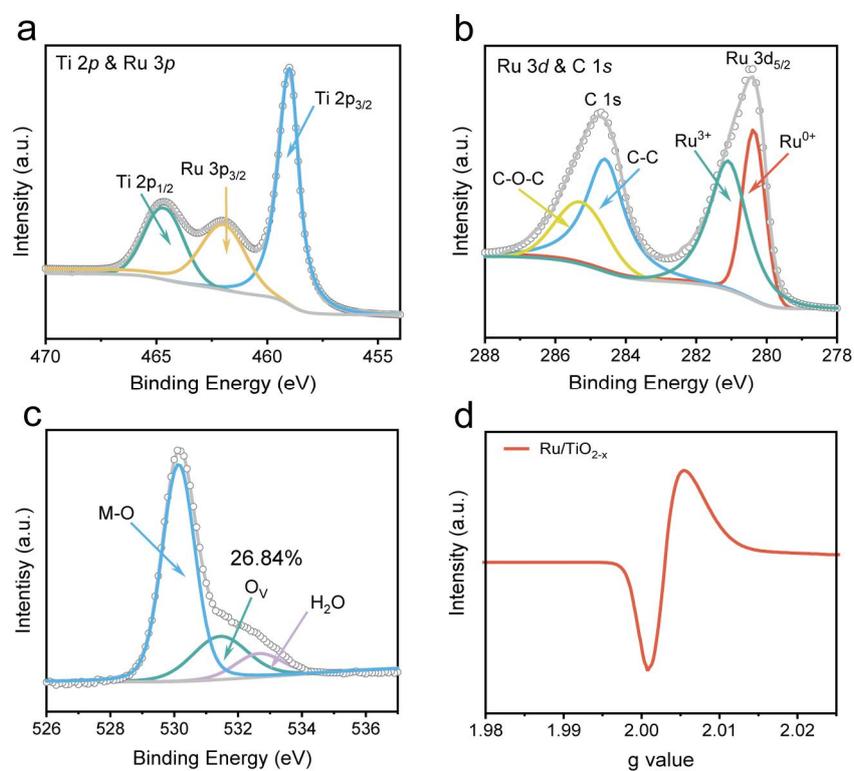


Figure S15. XPS and EPR analysis for Ru/TiO_{2-x} after the HER stability test. (a) Ti 2p and Ru 3p XPS, (b) Ru 3d and C 1s XPS, (c) O 1s XPS of Ru/TiO_{2-x}, and (d) EPR spectrum of Ru/TiO_{2-x}.

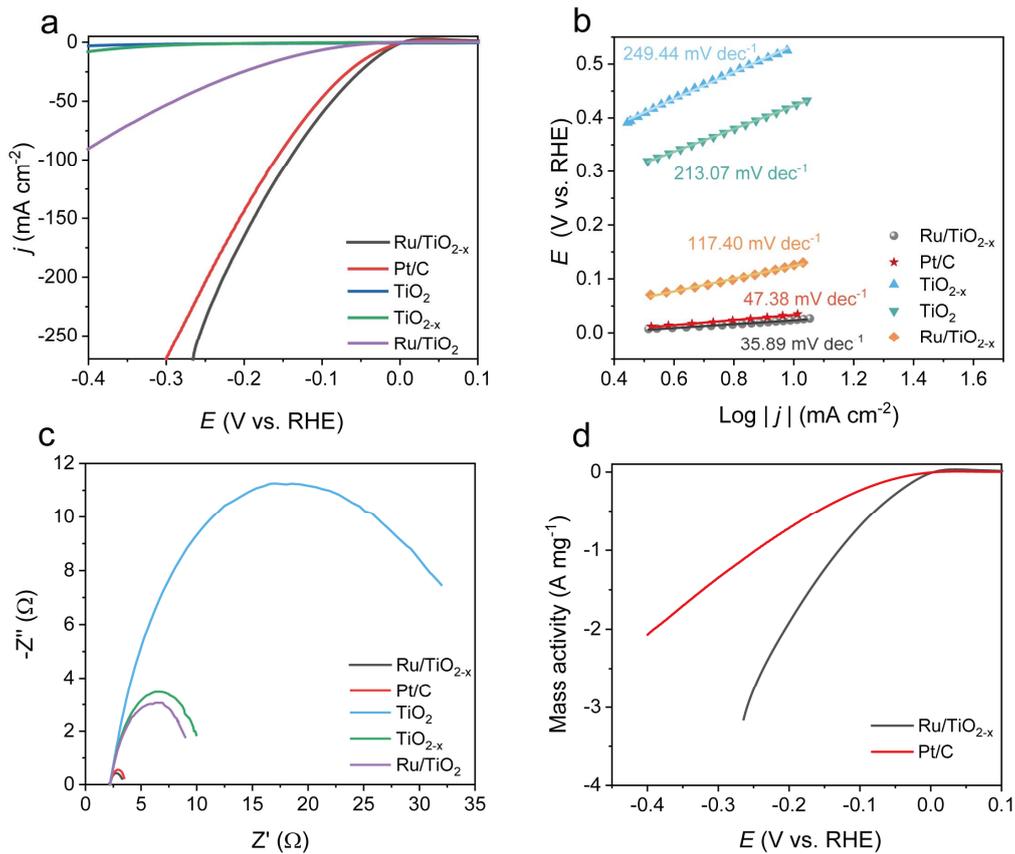


Figure S16. (a) HER polarization curves of Ru/TiO_{2-x}, Pt/C, TiO₂, TiO_{2-x} and Ru/TiO₂ in 1 M KOH. (b) Tafel plots of Ru/TiO_{2-x}, Pt/C, TiO₂, TiO_{2-x} and Ru/TiO₂. (c) EIS Nyquist plots of Ru/TiO_{2-x}, Pt/C, TiO₂, TiO_{2-x} and Ru/TiO₂. (d) Comparison of mass activity of Ru/TiO_{2-x} and Pt/C.

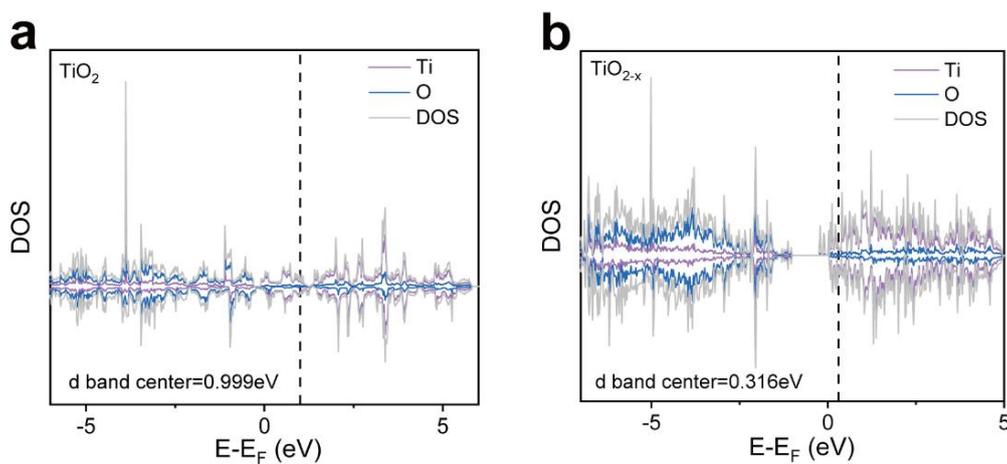


Figure S17. DOS distributions of (a) TiO₂ and (b) TiO_{2-x}.

Supplementary Table

Table S1. Elemental contents in the catalysts were determined by ICP-AES and EA analysis.

Catalyst	Ti (wt%)	Ru (wt%)	O (wt%)	Pt (wt%)
Ru/TiO_{2-x}	54.86	8.48	36.50	/
TiO₂	59.82	/	40.06	/
TiO_{2-x}	59.78	/	39.89	/
Ru/TiO₂	55.36	7.30	37.04	/
Pt/C	/	/	/	20.00