Supplementary Information

Corrosion-etching strategy for fabricating RuO_2 coupled with defective $NiFeZn(OH)_x$ for highly efficient hydrogen evolution reaction

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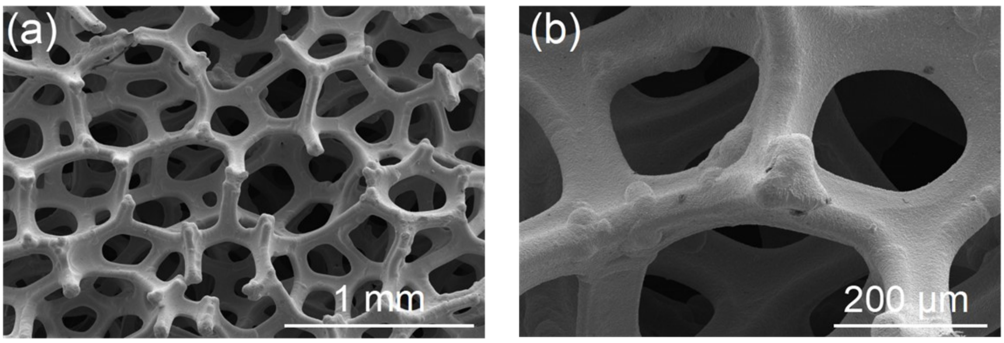

Fig. S1. Low (a) and high (b) resolution SEM images of NFF.

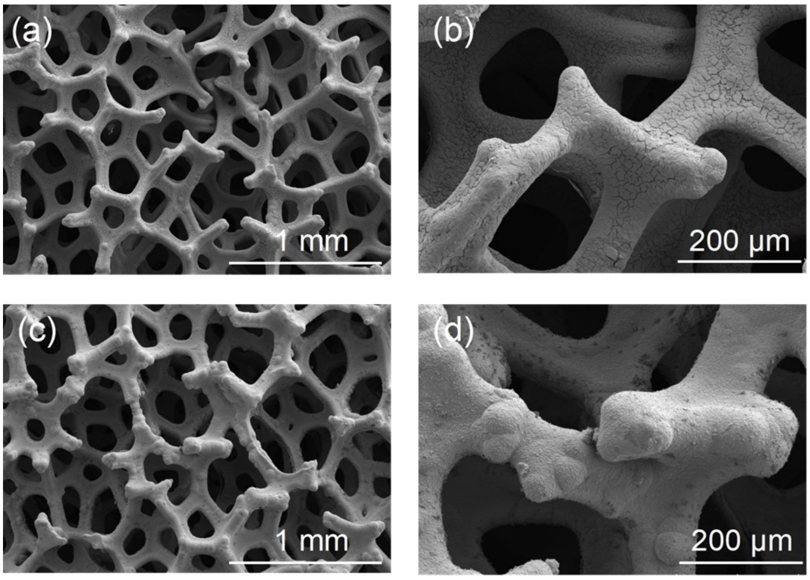

Fig. S2. SEM images of (a-b) NFF-Ru and (c-d) NFF-Ru-Zn.

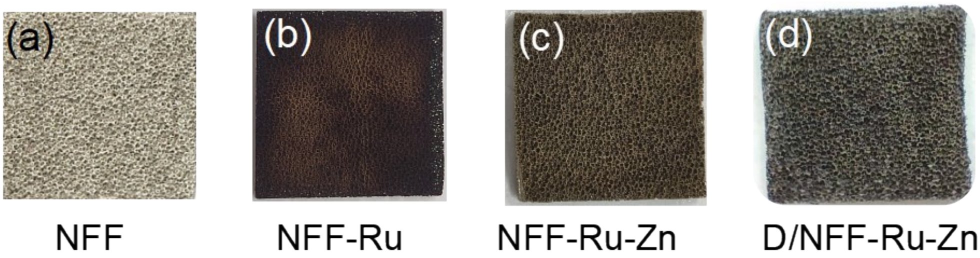

Fig. S3. Photographs of (a) NFF, (b) NFF-Ru, (c) NFF-Ru-Zn, and (d) D/NFF-Ru-Zn.

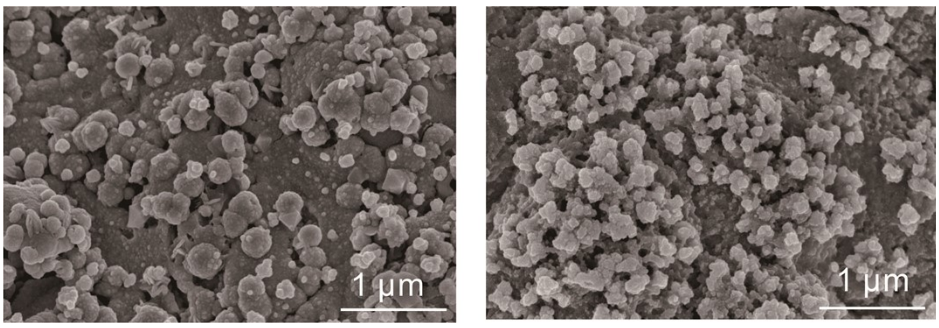

Fig. S4. SEM images of D/NFF-Ru-Zn.

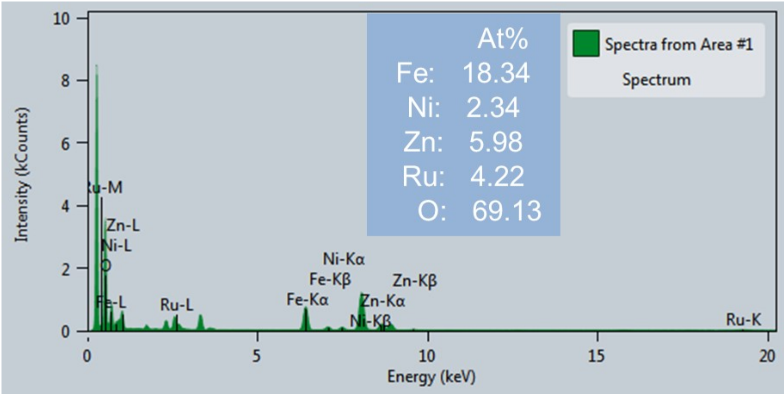

Fig. S5. EDX spectrum of the D/NFF-Ru-Zn.

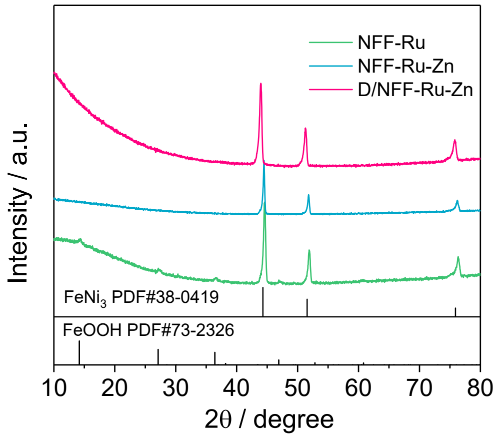

Fig. S6. XRD spectra of the NFF-Ru, NFF-Ru-Zn, and D/NFF-Ru-Zn.

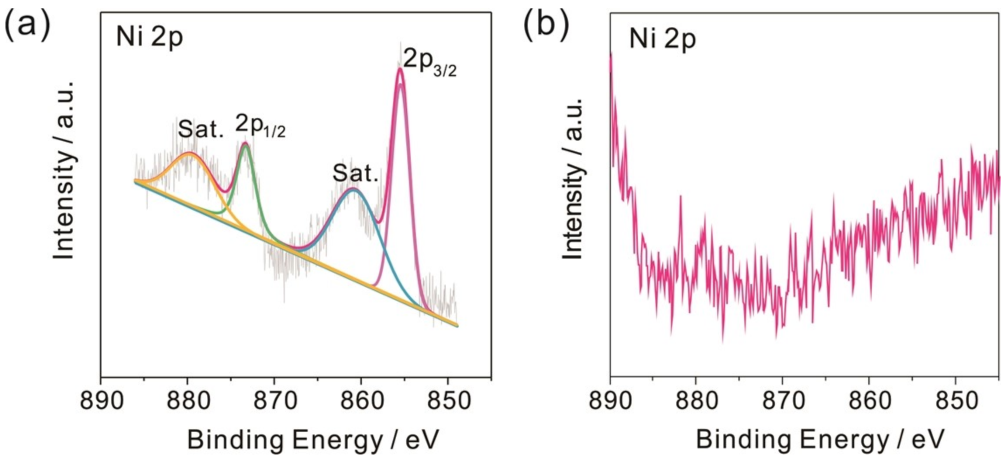

Fig. S7. Ni 2p XPS spectra of (a) D/NFF-Ru-Zn and (b) NFF-Ru-Zn.

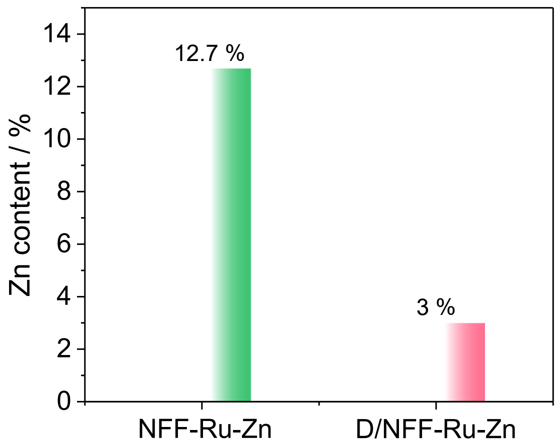

Fig. S8. Zn content in NFF-Ru-Zn and D/NFF-Ru-Zn obtained by XPS analysis.

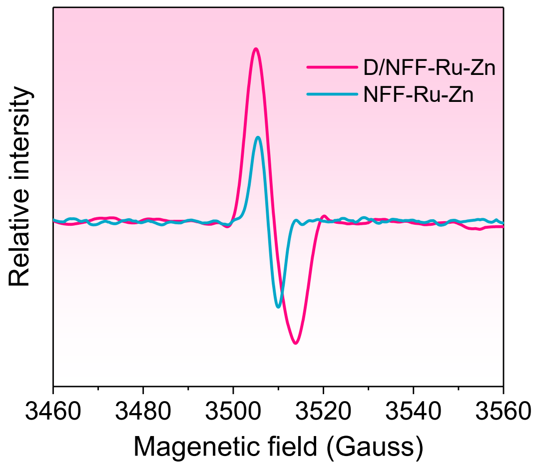

Fig. S9. Electron paramagnetic resonance of NFF-Ru-Zn and D/NFF-Ru-Zn.

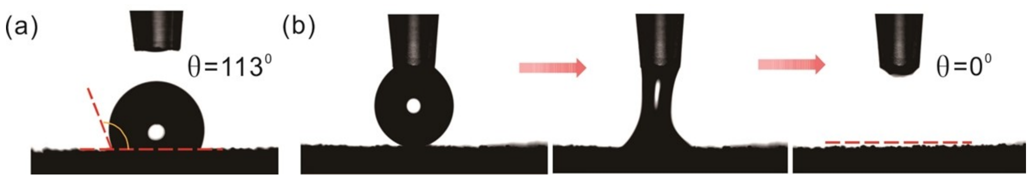

Fig. S10. Contact angles of (a) NFF and (b) D/NFF-Ru-Zn.

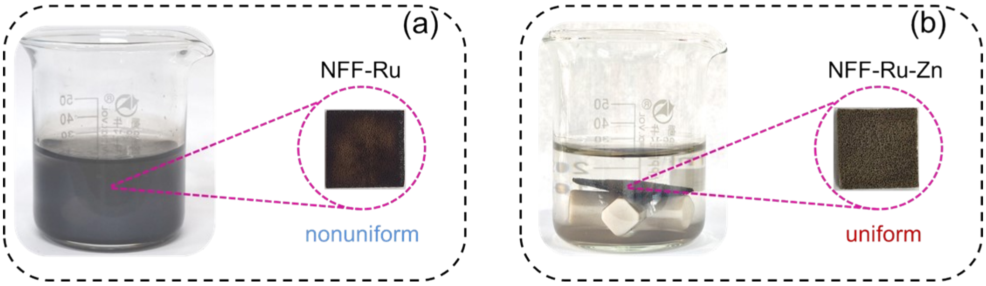

Fig. S11. Photographs of (a) NFF-Ru and (b) NFF-Ru-Zn.

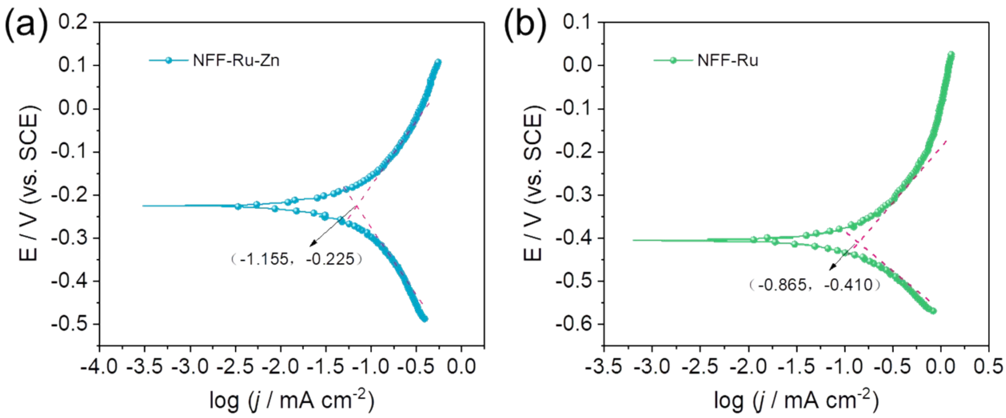

Fig. S12. Corrosion polarization curves of NFF in the solutions of (a) $RuCl_3$-$ZnSO_4$ and (b) $RuCl_3$, respectively.

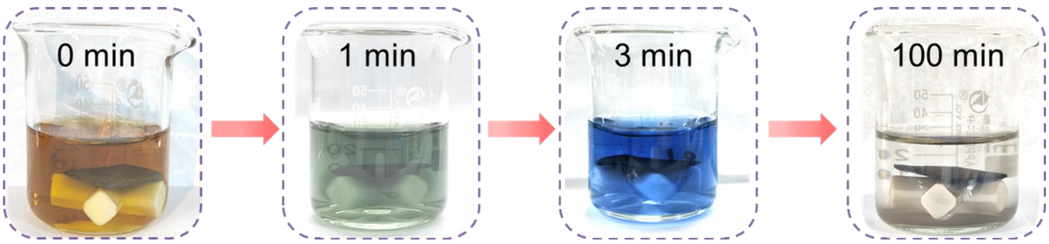

Fig. S13. Color changes of the "$RuCl_3$-$ZnSO_4$" solution in the preparation of NFF-Ru-Zn.

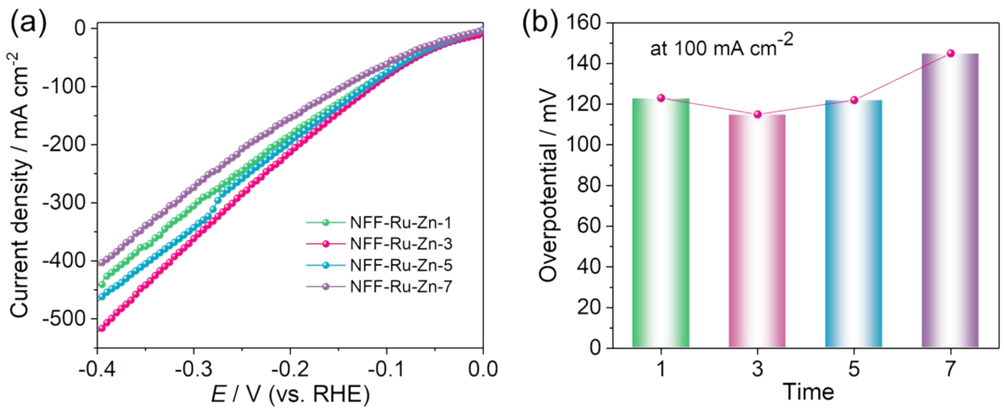

Fig. S14. (a) HER polarization curves of NFF-Ru-Zn under different corrosion time. (b) Comparison of overpotentials at the current density of 100 mA cm^{-2}.

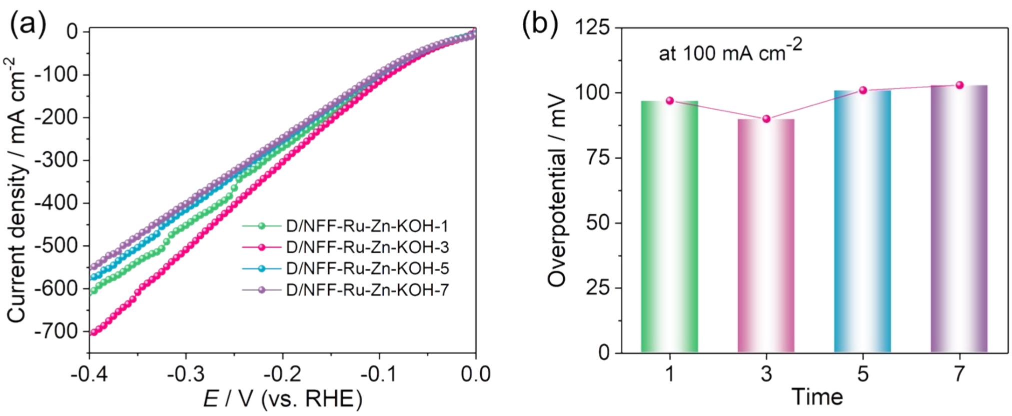

Fig. S15. (a) HER polarization curves of D/NFF-Ru-Zn under different etching time. (b) Comparison of overpotentials at the current density of 100 mA cm^{-2}.

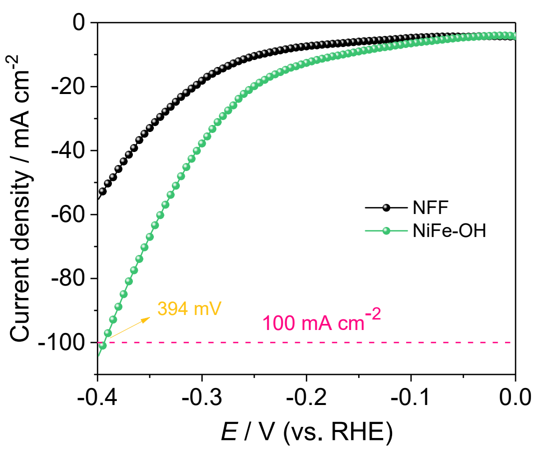

Fig. S16. HER polarization curves of NFF and NiFe-OH.

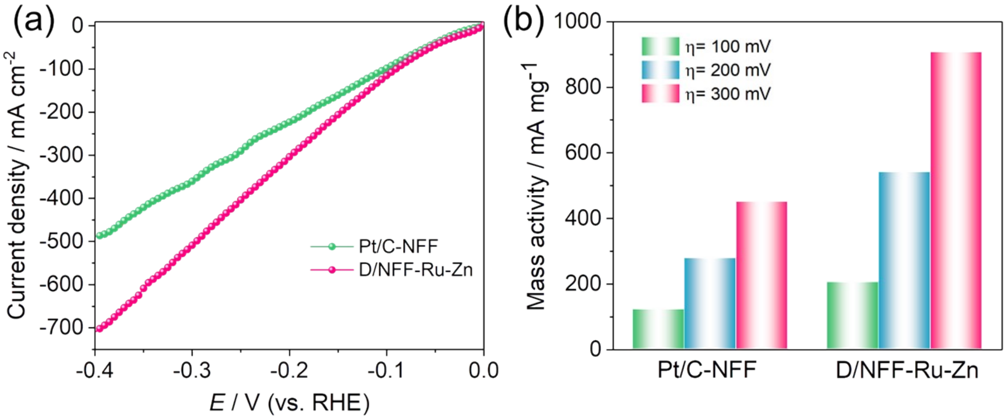

Fig. S17. (a) LSV polarization curves and (b) mass activity of D/NFF-Ru-Zn and Pt/C-NFF (40% Pt) at overpotentials of 100, 200, and 300 mV.

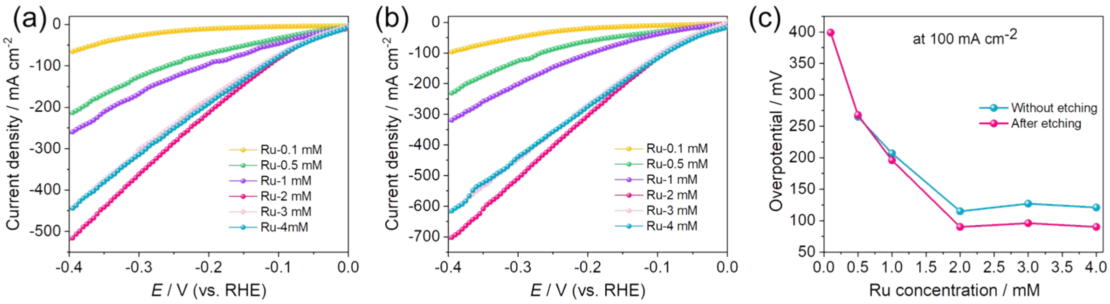

Fig. S18. HER polarization curves of (a) NFF-Ru-Zn and (b) D/NFF-Ru-Zn with different Ru concentrations. (c) Comparison of overpotentials at 100 mA cm^{-2} for NFF-Ru-Zn and D/NFF-Ru-Zn with different Ru concentrations.

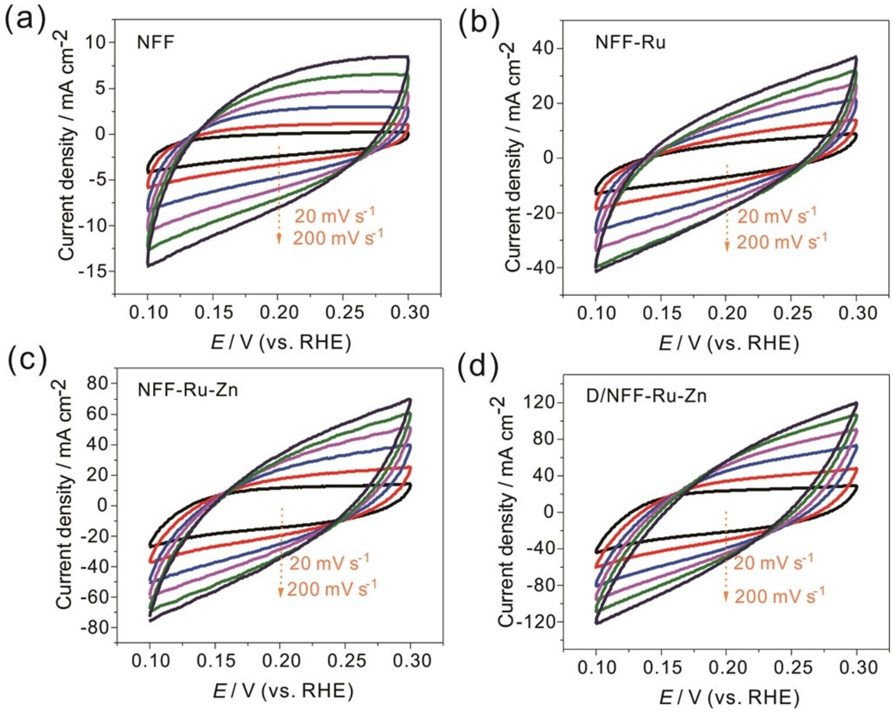

Fig. S19. CV curves of (a) NFF, (b) NFF-Ru, (c) NFF-Ru-Zn and (d) D/NFF-Ru-Zn catalysts in the potential range of 0.1~0.3 V with the scanning rates of 20~200 mV s^{-1}.

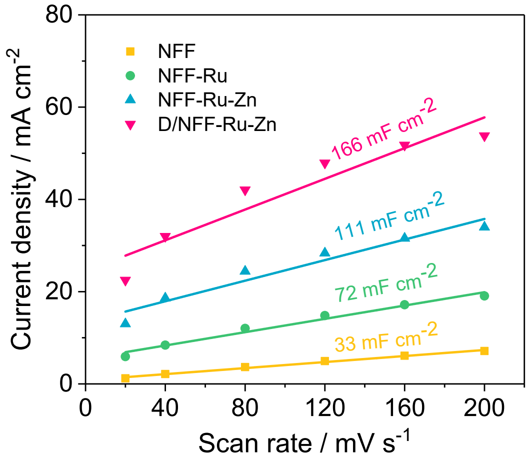

Fig. S20. The C_{dl} values of samples at various scanning rates.

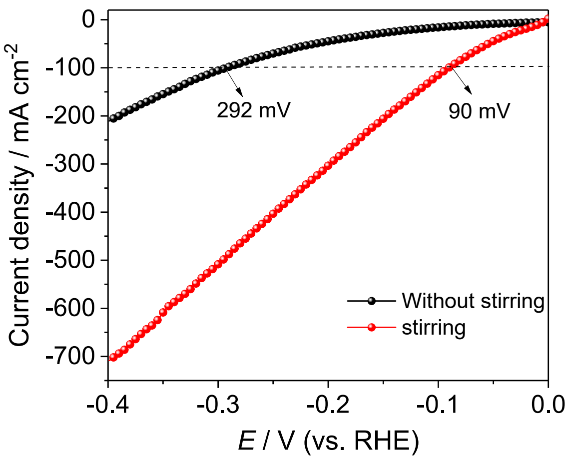

Fig. S21. HER polarization curves of D/NFF-Ru-Zn catalyst with and without stirring.

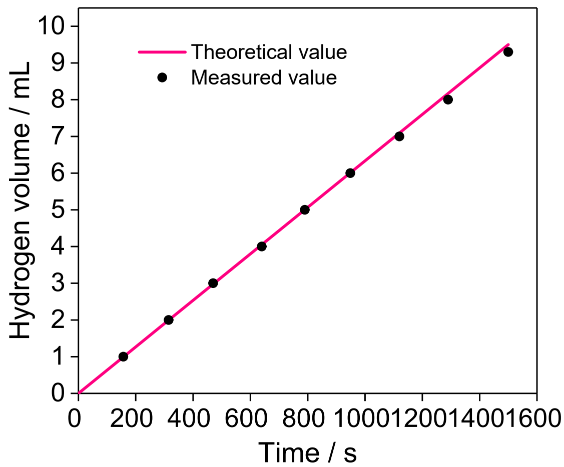

Fig. S22. The volume of theoretical H_2 and experimentally measured H_2 along with the reaction time.

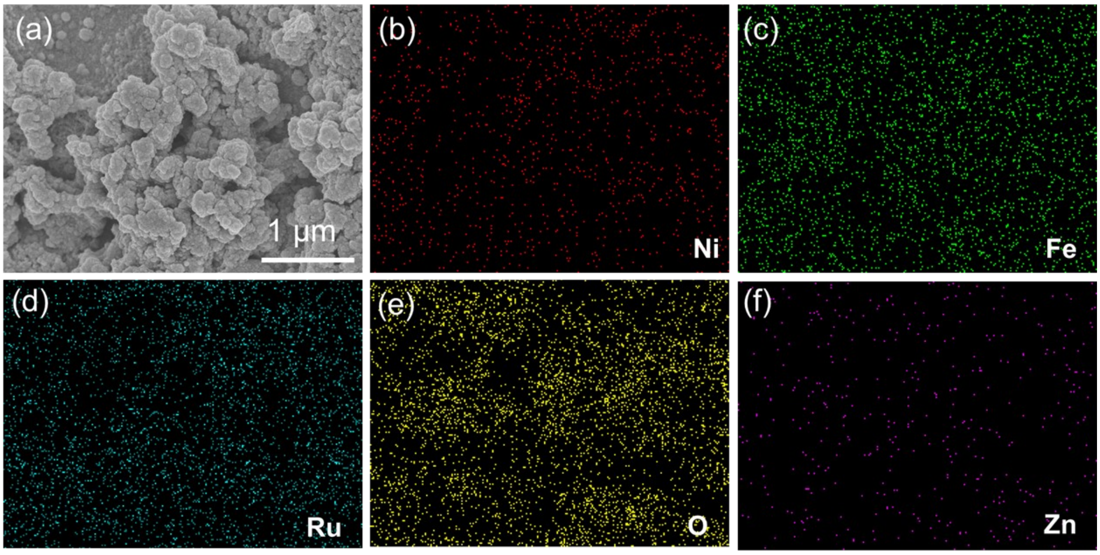

Fig. S23. (a) SEM images, (b-f) corresponding mapping images of Ni, Fe, Ru, O and Zn elements in the D/NFF-Ru-Zn after HER stability test for 100 h.

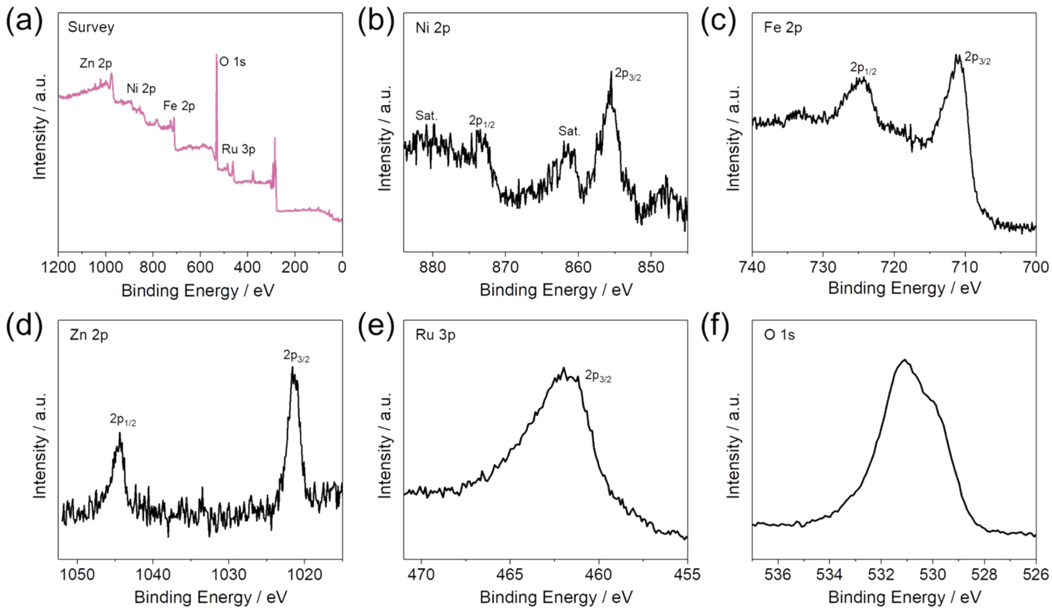

Fig. S24. (a) The XPS survey spectrum, (b) Ni 2p, (c) Fe 2p, (d) Zn 2p, (e) Ru 3p and (f) O 1s spectra of the D/NFF-Ru-Zn after HER stability test for 100 h.

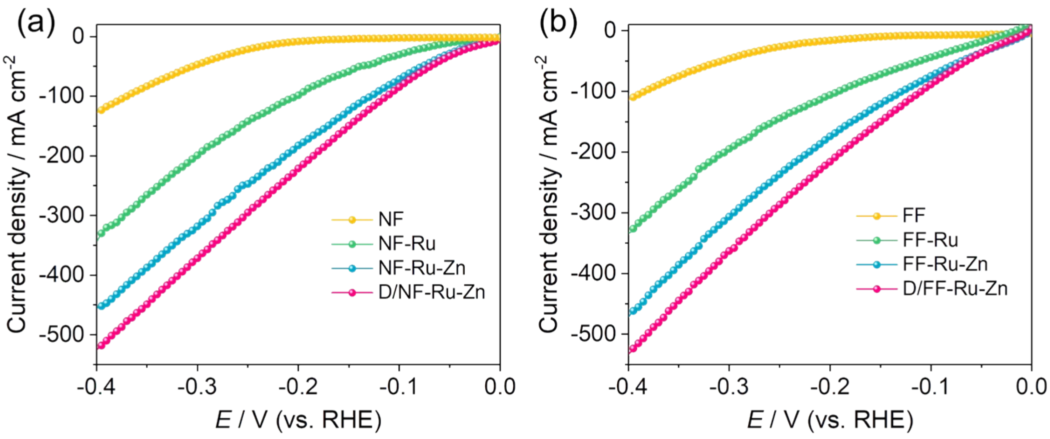

Fig. S25. HER polarization curves of samples derived from (a) Ni foam (NF) and (b) Fe foam (FF) substrates prepared by corrosion-etching strategy.

Table S1. Comparison of overpotentials and Tafel slopes with recently reported HER catalysts at 100 mA cm^{-2} in 1.0 M KOH.

Catalysts	Overpotential / mV	Tafel slope / mV dec^{-1}	References
D/NFF-Ru-Zn	90	41	This work
A-NiCo LDH/NF	151	57	1
NC/Ni_3Mo_3N/NF	136	41.5	2
V-FeP	149	40.97	3
NiFe/NF	132	33.2	4
F-Co_2P/Fe_2P/IF	151.8	115.01	5
Co_4N-CeO_2/NF	149	56.8	6
CF@Ru-CoCH NWs	121	65	7
TiO_2@CoCH	187	80	8
Sn-$Ni(OH)_2$	298	65.5	9
F, P-Fe_3O_4/IF	179.5	127.9	10
$NiCo_2N$	149	78.7	11
NiCoP-NWAs/NF	197	54	12
$Ni_{1.8}Cu_{0.2}$-P/NF	245	70	13
200-SMN/NF	278	72.9	14
V-Ni_3S_2/NW	350	112	15

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