Supporting Information

Facile Synthesis of Defect-rich RuCu Nanoflowers for Efficient Hydrogen Evolution Reaction in Alkaline Media

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2. References

1. Supporting Results

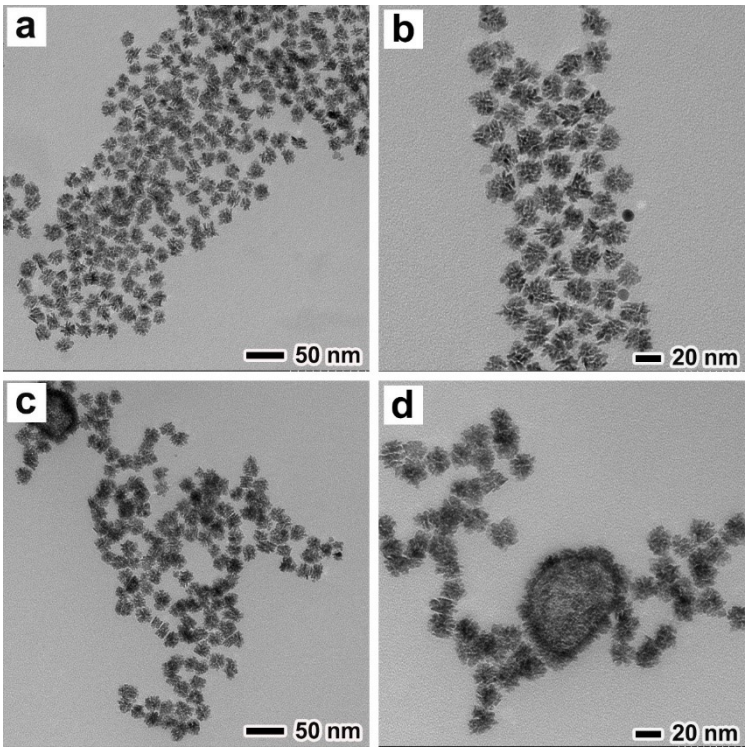

Figure S1. Representative TEM images of Ru_3Cu NFs prepared by the standard procedure, except for different reducing agents. (a, b) Replacing 15 mg CA with 15 mg AA. (c, d) Replacing 15 mg CA with 15 mg glucose.

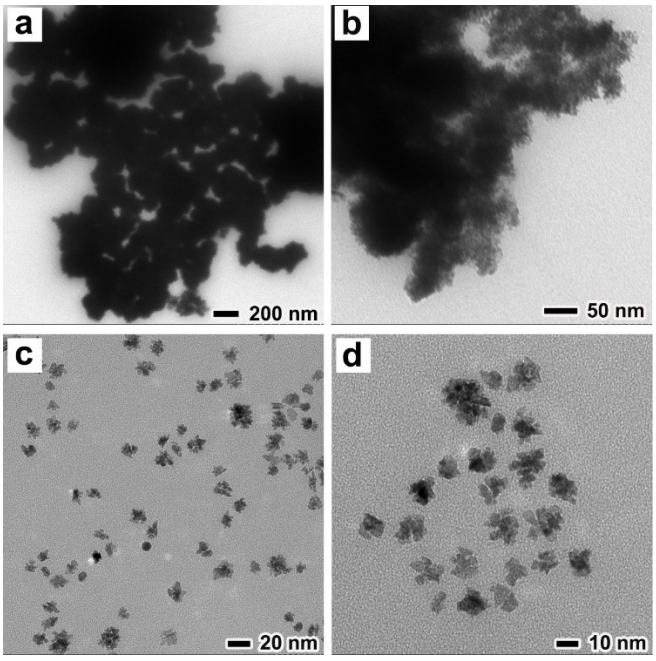

Figure S2. Representative TEM images of Ru_3Cu NFs prepared by the standard procedure, except for: (a, b) in the the absence of PVP and (c, d) replacing benzyl alcohol with ethylene glycol.

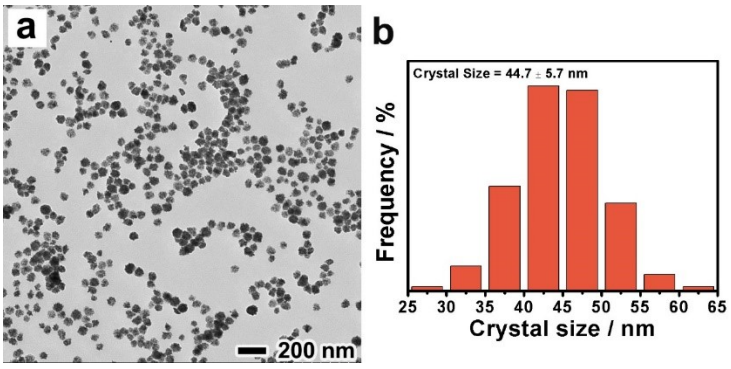

Figure S3. (a) Representative TEM image of the Ru_3Cu NFs at low magnification and (b) the corresponding size distribution.

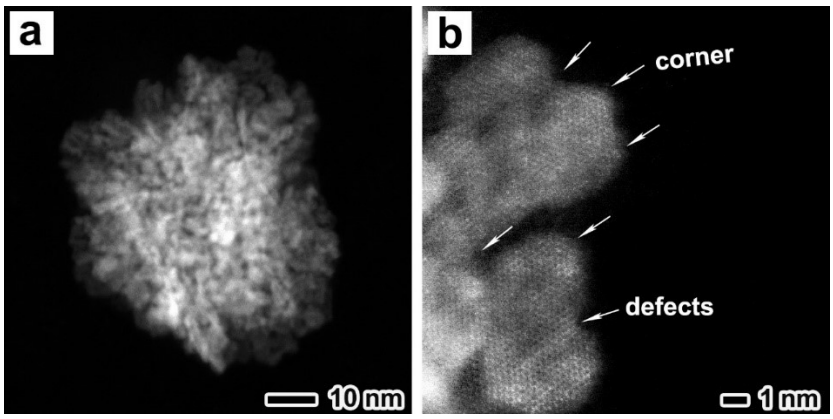

Figure S4. (a) HADDF-STEM image and (b) atomic-resolution HADDF-STEM images at a higher magnification of an individual Ru_3Cu NF.

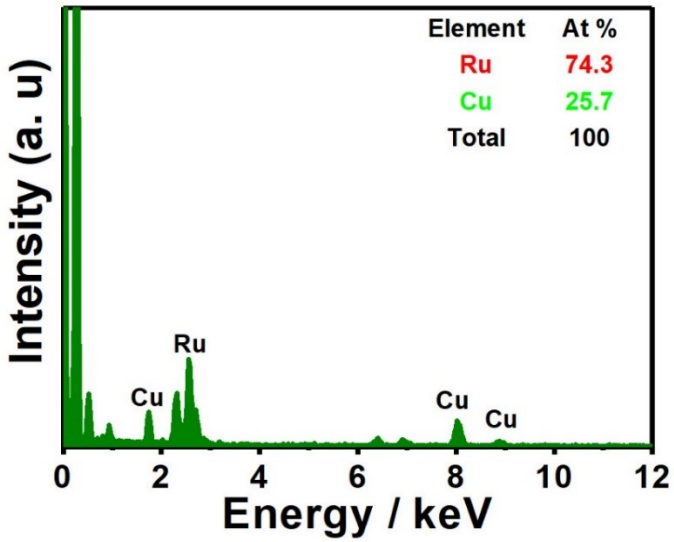

Figure S5. EDX spectrum of the Ru_3Cu NFs.

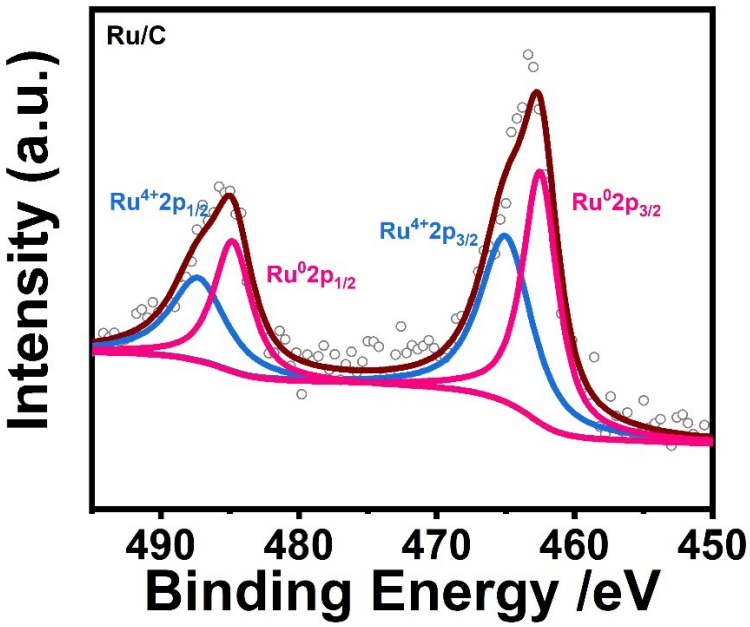

Figure S6. XPS spectra of Ru 3p orbital in Ru/C.

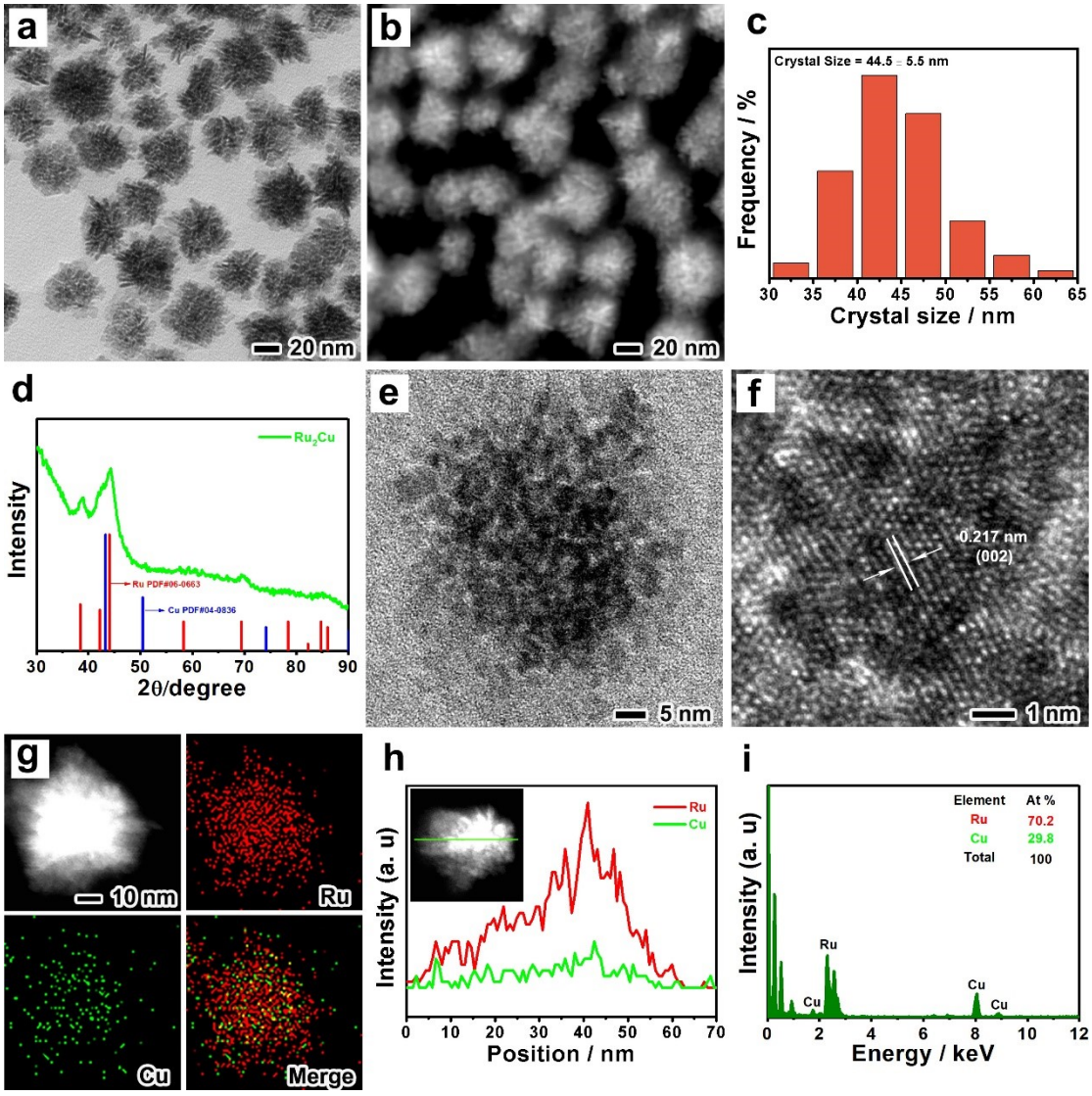

Figure S7. (a) TEM image, (b) HADDF-STEM image, (c) the corresponding size distribution, (d) XRD pattern, (e) HRTEM image, (f) HRTEM image from the selected area in (e), (g) EDX mapping, (h) EDX line-scan profile, and (i) EDX spectrum image of the Ru_2Cu NFs.

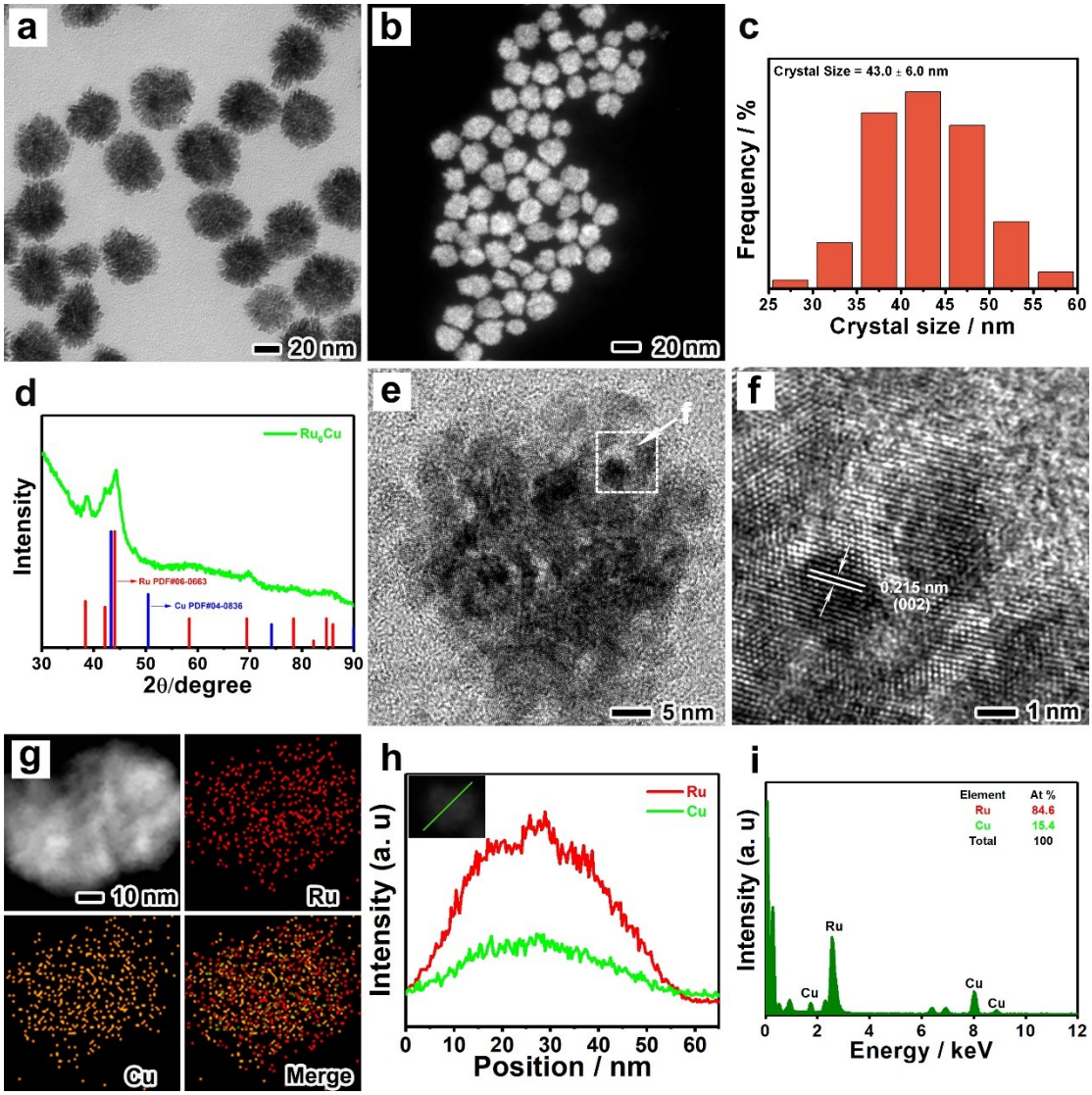

Figure S8. (a) TEM image, (b) HADDF-STEM image, (c) the corresponding size distribution, (d) XRD pattern, (e) HRTEM image, (f) HRTEM image from the selected area in (e), (g) EDX mapping, (h) EDX line-scan profile, and (i) EDX spectrum image of the Ru_6Cu NFs.

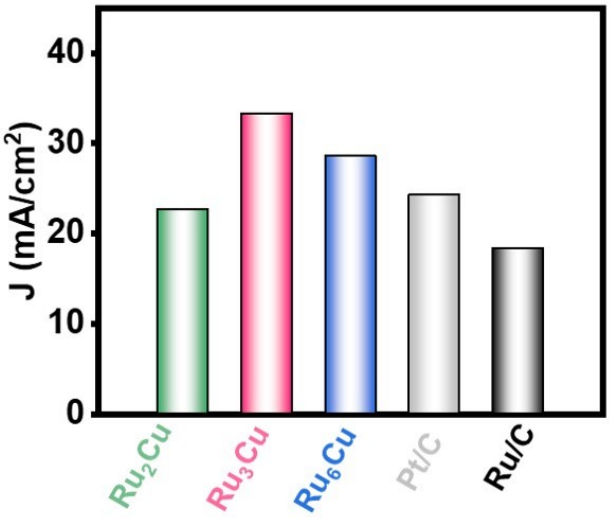

Figure S9. Mass activity of five electrocatalysts at -0.1 V vs RHE.

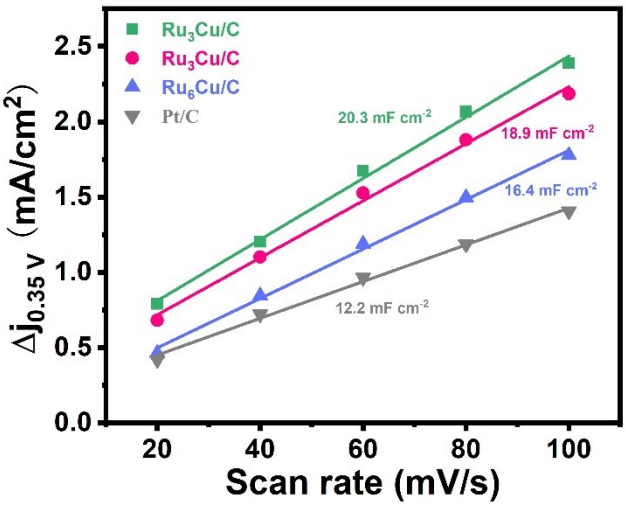

Figure S10. Measured capacitive currents for Ru_2Cu NFs/C, Ru_3Cu NFs/C, Ru_6Cu NFs/C, and Pt/C.

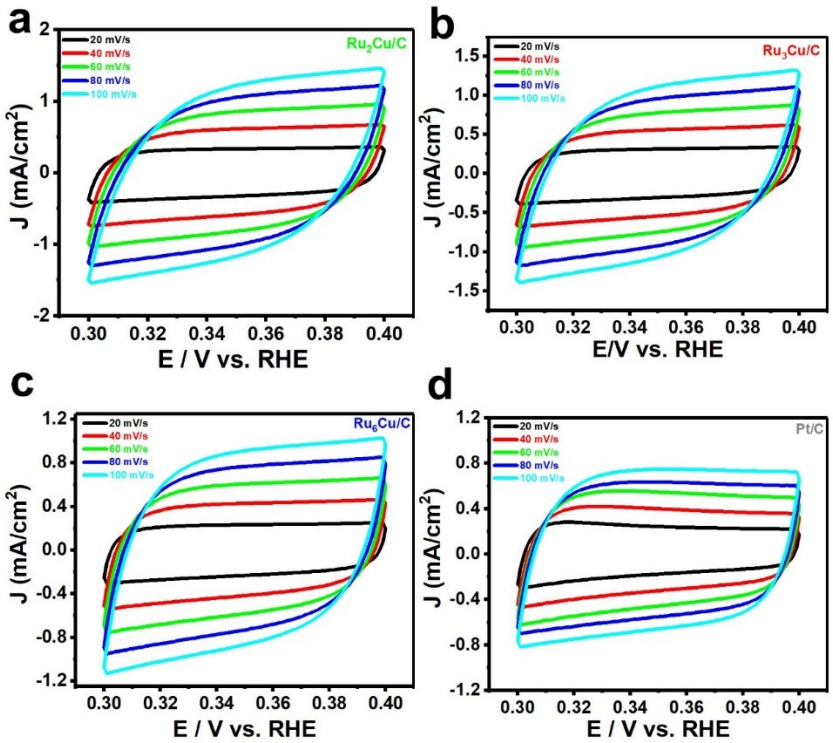

Figure S11. CV curves in 0.1 M KOH for (a) Ru_2Cu NFs/C, (b) Ru_3Cu NFs/C, (c) Ru_6Cu NFs/C and (d) Pt/C between 0.3 and 0.4 V vs. RHE with an increasing scan rate of 20 mV/s in 0.1 M KOH.

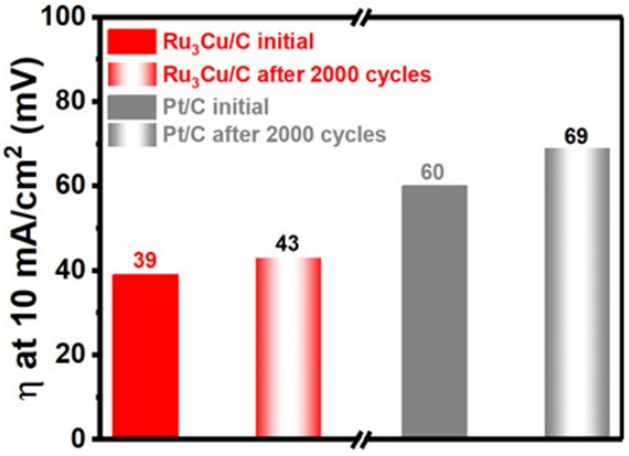

Figure S12. Overpotentials at 10 mA/cm^2 of Ru_3Cu NFs/C and Pt/C before and after 2000 cycles between -0.2 V and 0.1V (vs. RHE) in 0.1 M KOH solution.

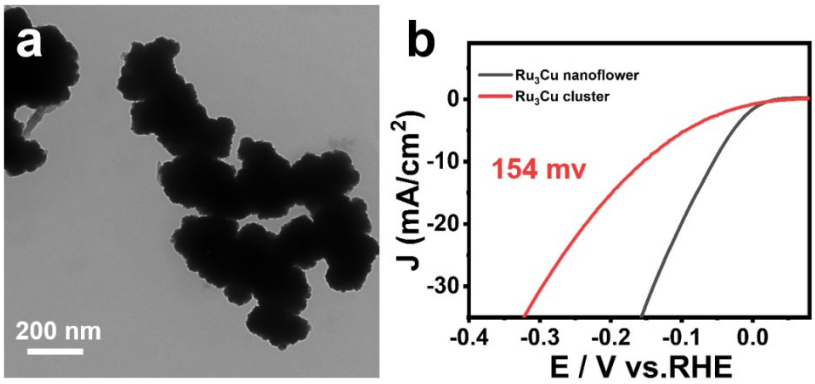

Figure S13. (a) TEM image of Ru_3Cu cluster. (b) HER activity of Ru_3Cu cluster and Ru_3Cu NFs.

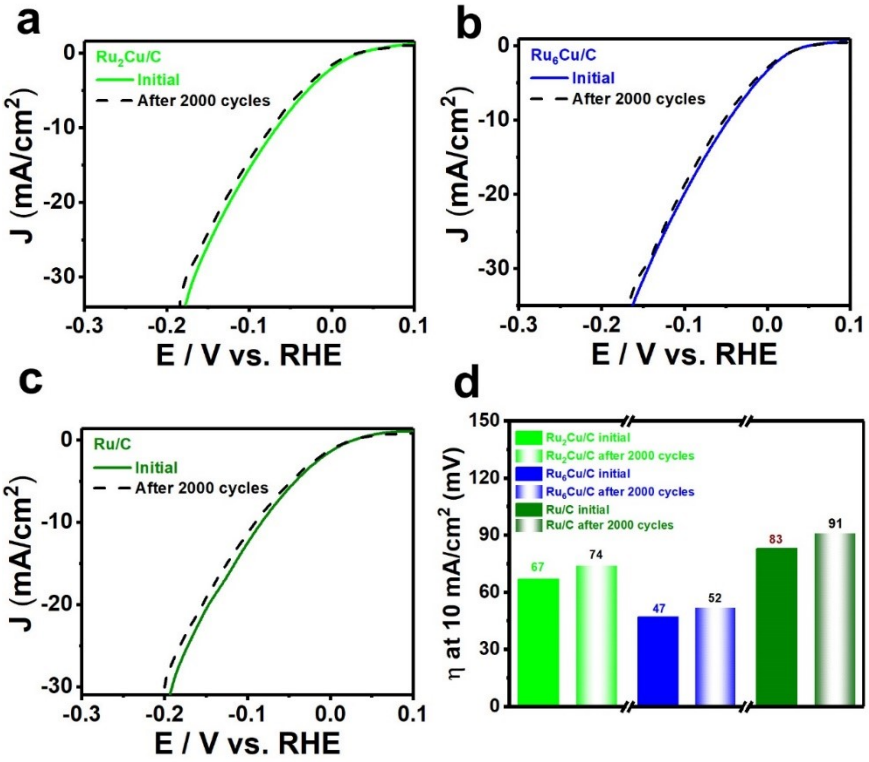

Figure S14. HER polarization curves of (a) Ru_2Cu NFs/C, (b) Ru_6Cu NFs/C, (c) Ru/C before and after 2000 cycles between -0.2 V and 0.1V (vs. RHE) in 0.1 M KOH solution. (d) Overpotentials at 10 mA/cm^2 of the Ru_2Cu NFs/C, Ru_6Cu NFs/C, Ru/C before and after 2000 cycles.

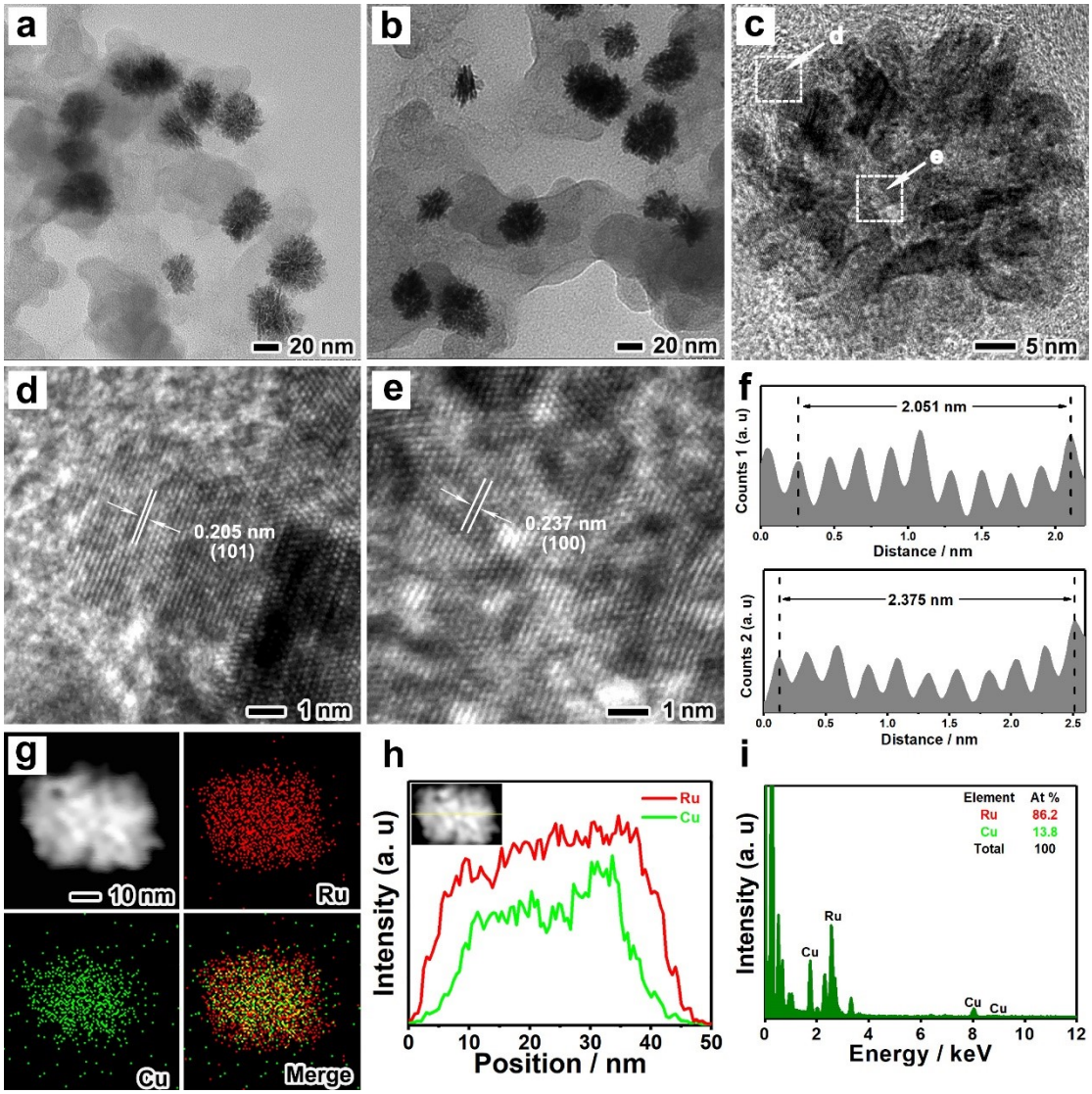

Figure S15. Representative TEM images of the Ru_3Cu NFs/C (a) before and (b) after ADT. (c) HRTEM image, (d, e) HRTEM image from the selected area in (c), (f) line intensity profiles taken along the white solid arrow direction in (d, e), (g) HADDF-STEM-EDX mapping image, (h) EDX-line scan profile, and (i) EDX spectrum of the Ru_3Cu NFs/C after 2000 cycles between -0.2 and 0.1 V versus RHE in Ar-saturated 0.1 M KOH solution.

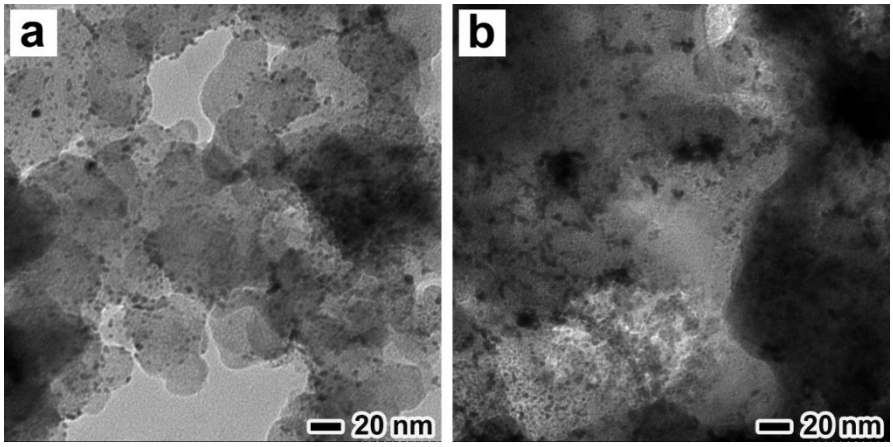

Figure S16. Representative TEM images of the commercial Pt/C (a) before and (b) after 2000 potential cycles between -0.2 and 0.1 V versus RHE in Ar-saturated 0.1 M KOH solution.

Table S1. Comparation of the recently reported HER catalysts.

Catalysts	Overpotential ($10mA/cm^2$)	Tafel slope (mV/dec)	Solution	Reference
Ru_2Ni_2 SNs/C	39.3	25	0.1 M KOH	[1]
Ir/Pt(poly)	80	120	0.1 M NaOH	[2]
Ru-C_3N_4/C	79	/	0.1 M KOH	[3]
Pt/Ni-SP	42	28.5	1M NaOH	[4]
Co-Pt-Co/CC	46	93.7	1M NaOH	[5]
$Cu_{2-X}S$@Ru	82	51	1M NaOH	[6]
RuFeP-NCs/CNF	65.8	43.44	1M NaOH	[7]
Ru-NPs/SAs@N-TC	97	58	1M NaOH	[8]
0.4-Ru@NG-750	40	35.9	1M NaOH	[9]
S-RuP@NPSC-900	92	90	1M NaOH	[10]
Ru3Cu NF	55	54.7	0.1 M NaOH	This work

2. References

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