Synergistic Activation of Cu_2O/WO_3/CF Heterostructures via Fe Doping for Efficient Neutral Hydrogen Evolution

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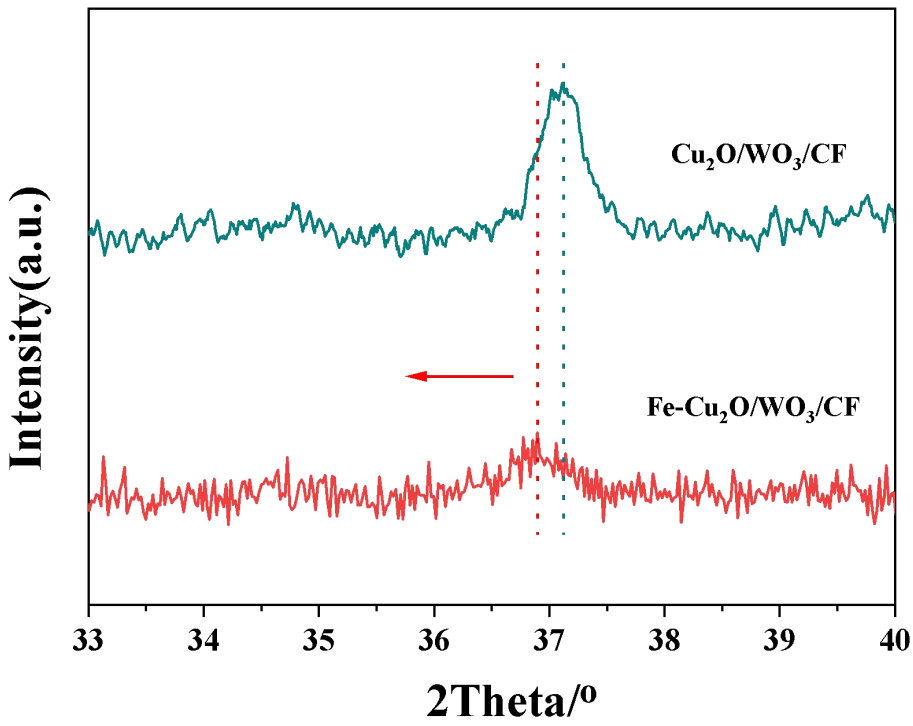

Fig. S1 XRD patterns of Fe-Cu_2O/WO_3/CF.

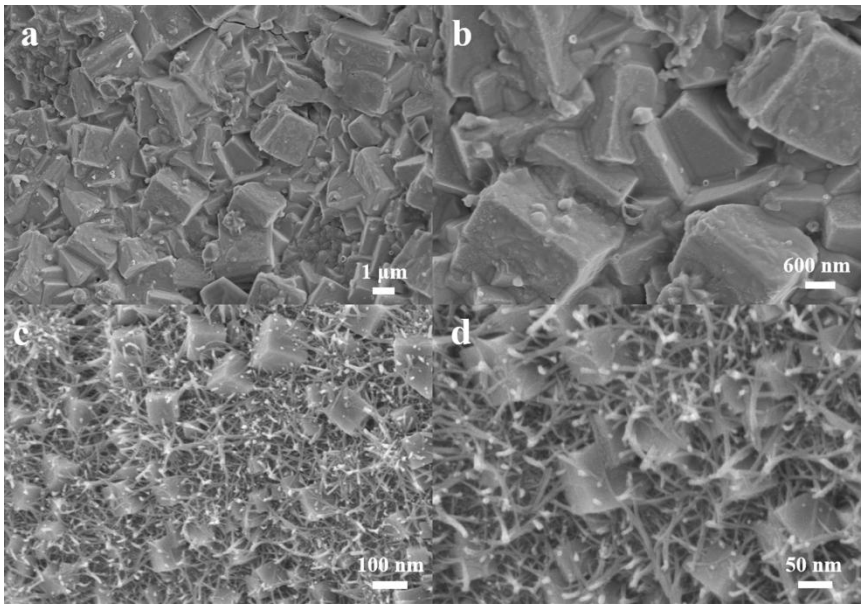

Fig. S2 SEM images of

(a-b) Cu_2O/CF and (c-d) Cu_2O/WO_3/CF.

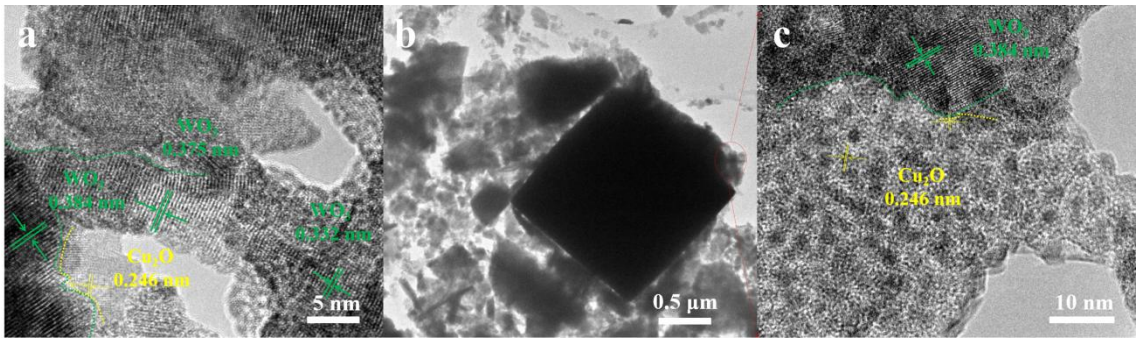

Fig. S3 TEM and HRTEM images of Cu_2O/WO_3/CF.

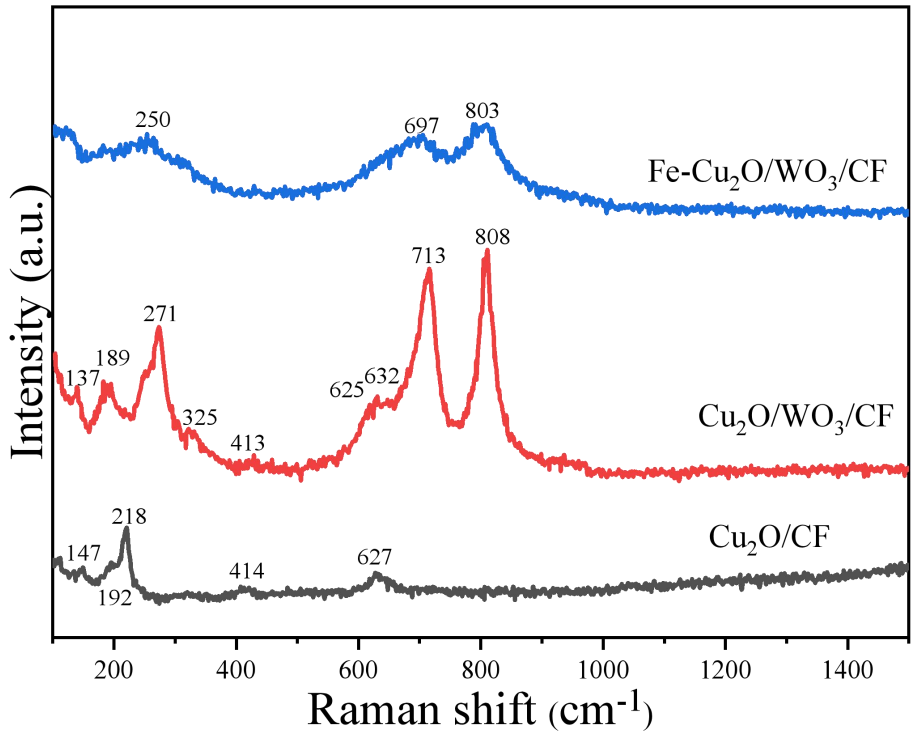

Fig. S4 Raman images of Cu_2O/CF、Cu_2O/WO_3/CF and Fe-Cu_2O/WO_3/CF

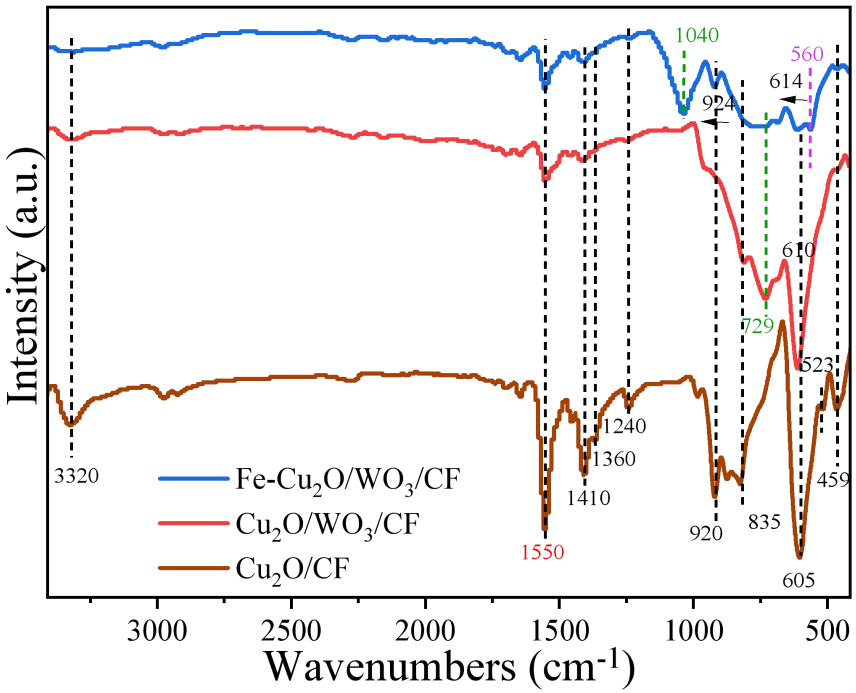

Fig. S5 FT-IR images of Cu_2O/CF、Cu_2O/WO_3/CF and Fe-Cu_2O/WO_3/CF

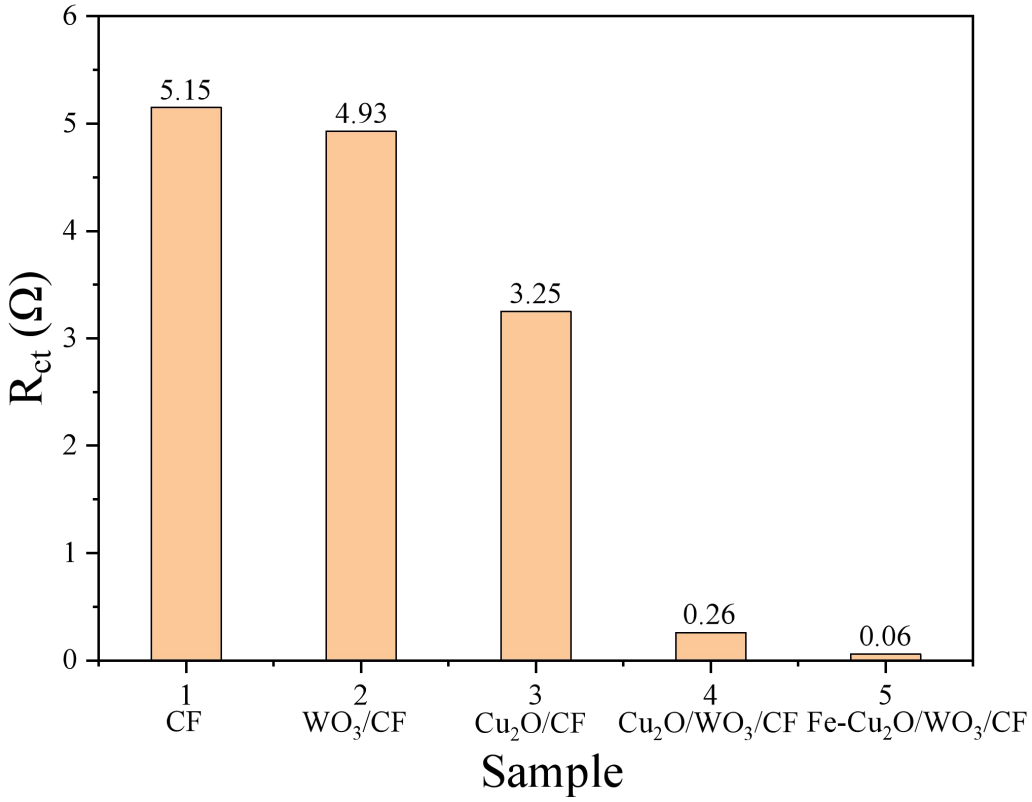

Fig. S6 The R_{ct} values of different samples.

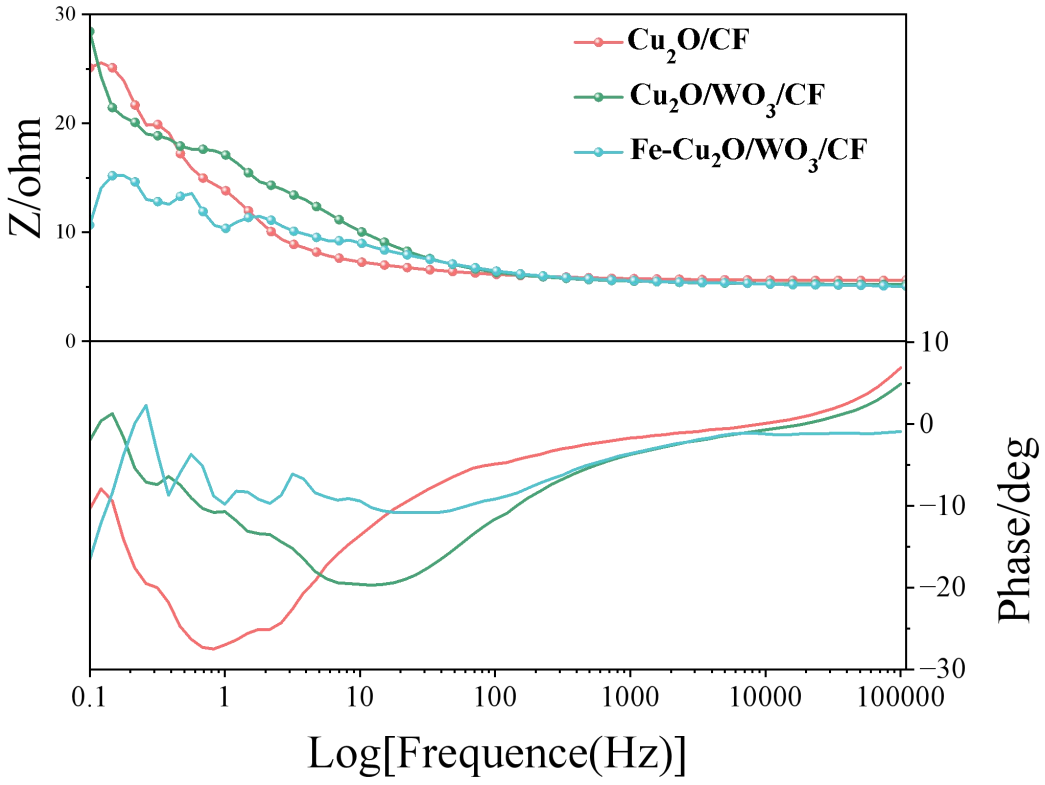

Fig. S7 Bode plots of Cu_2O/CF, Cu_2O/WO_3/CF and Fe-Cu_2O/WO_3/CF.

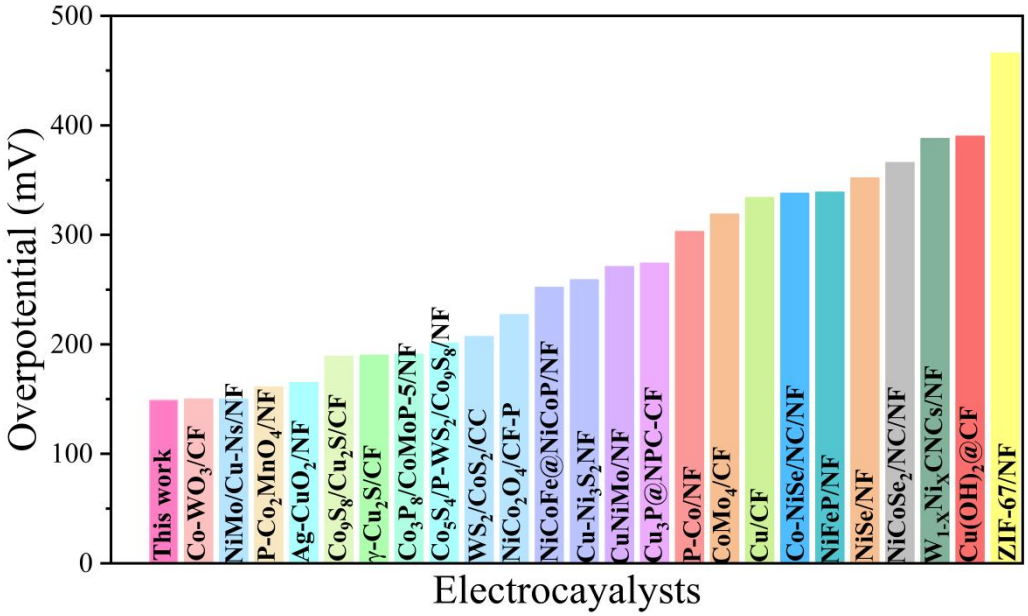

Fig. S8 Overpotentials at a current density of 20 mA·cm^{-2} for Fe-Cu_2O/WO_3/CF and reported catalysts in neutral electrolyte.

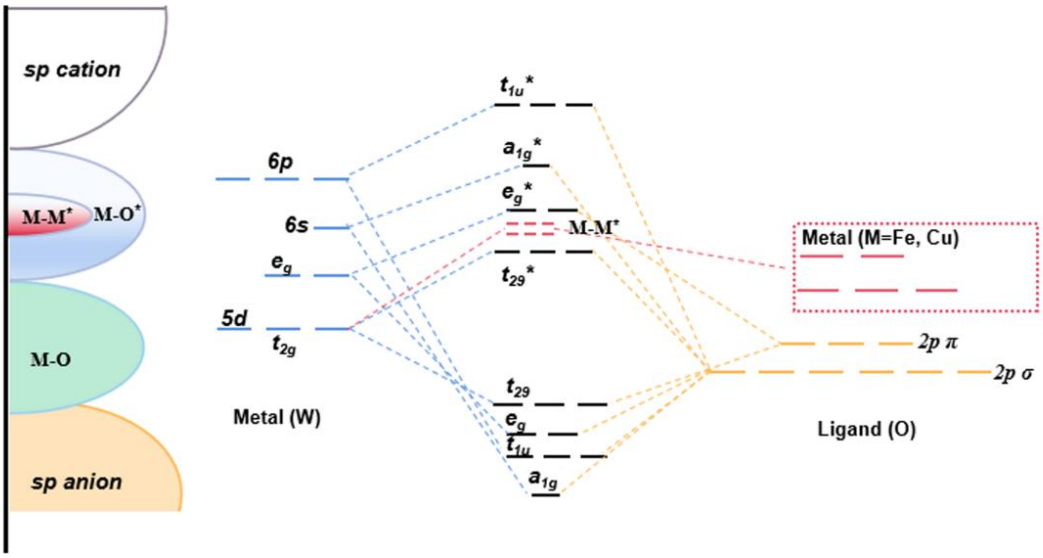

Fig. S9 Schematic illustration of the orbital modulation

Table S1 The characteristic frequency and electron lifetime of Cu_2O/CF, Cu_2O/WO_3/CF and Fe-Cu_2O/WO_3/CF.

Samples	The characteristic frequency (Hz)	The electron lifetime(ms)
Fe-$C_{u2}O/WO_3$/CF	29.58	5.40
Cu_2O/WO_3/CF	11.14	14.20
Cu_2O/CF	0.82	193

Table S2 Results of the fitting analysis of the XPS spectra.

Samples	%Area				%
	Cu2p3/2		Cu2p1/2		
	Cu^{+}	Cu^{2+}	Cu^{+}	Cu^{2+}	Cu^{+}/Cu^{2+}
Fe-Cu_2O/WO_3/CF	15.45	16.32	19.64	48.59	54.04
Cu_2O/WO_3/CF	4.64	21.26	15.47	58.63	25.15

Samples	%Area					%
	W4f5/2			W4f7/2		
	W^{6+}	W^{5+}	W^{4+}	W^{6+}	W^{5+}	$(W^{5+}+W^{4+})/W^{6+}$
Fe-Cu_2O/WO_3/CF	34.09	8.53	13.40	36.03	7.95	42.61
Cu_2O/WO_3/CF	38.11	6.47	8.02	37.36	10.04	32.50