

Electronic Supplementary Information

Visualizing spatial potential and charge distribution in Ru/N-doped carbon electrocatalyst for superior hydrogen evolution reaction

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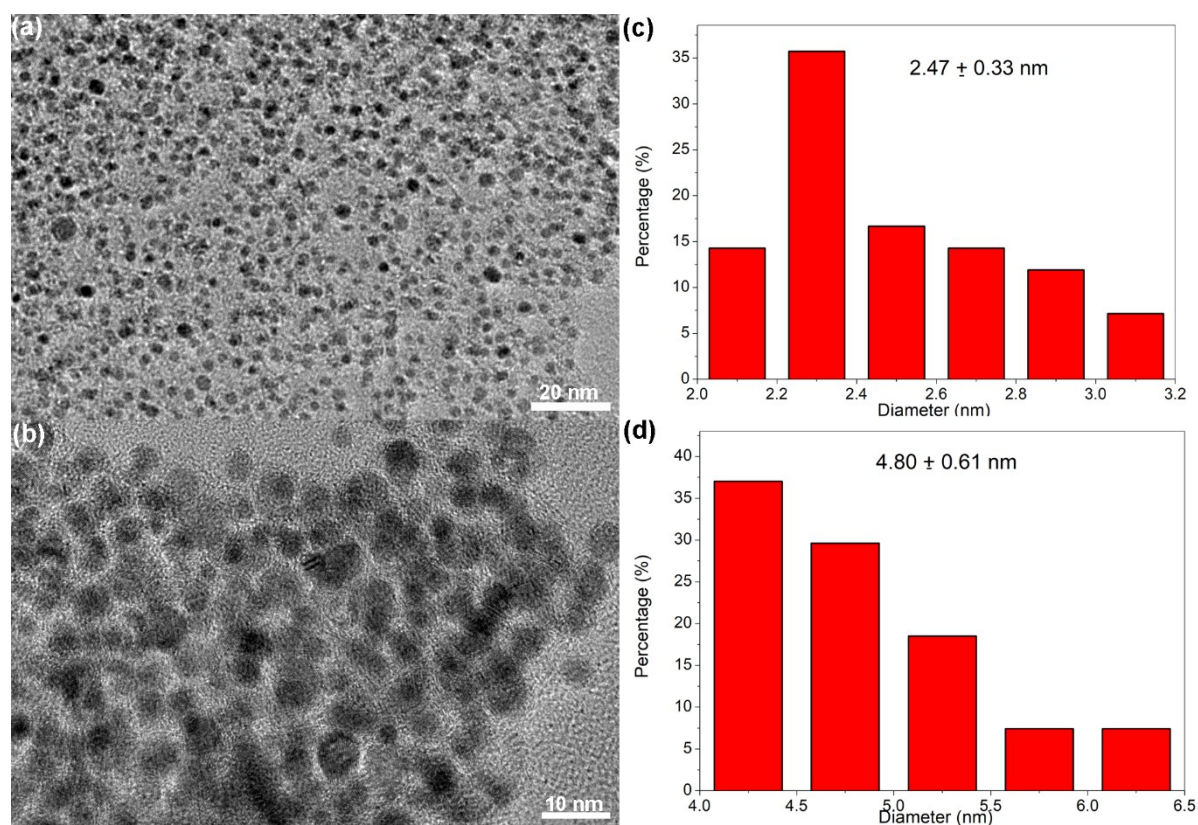


Fig. S1 (a) TEM image and (c) corresponding size distribution of the Ru/NC-0.05. (b) TEM image and (d) corresponding size distribution of the Ru/NC-0.1.

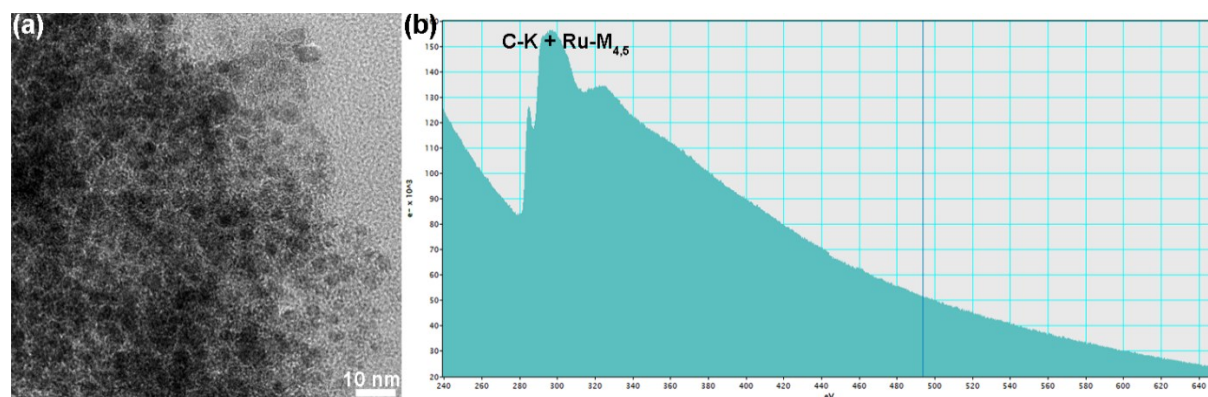


Fig. S2 (a) ZLP energy filtered image and (b) EELS pattern of the Ru/NC-0.01.

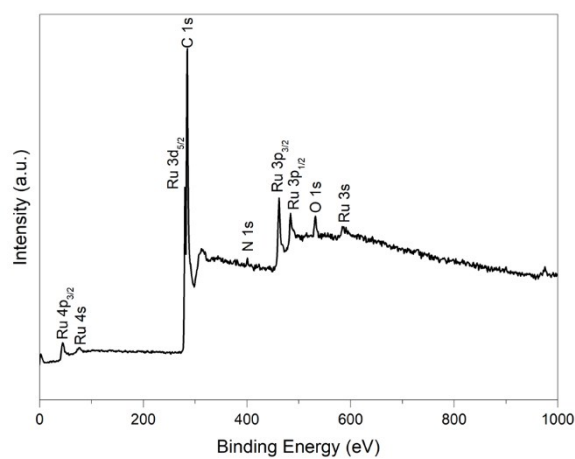


Fig. S3 XPS survey spectra of the Ru/NC-0.01.

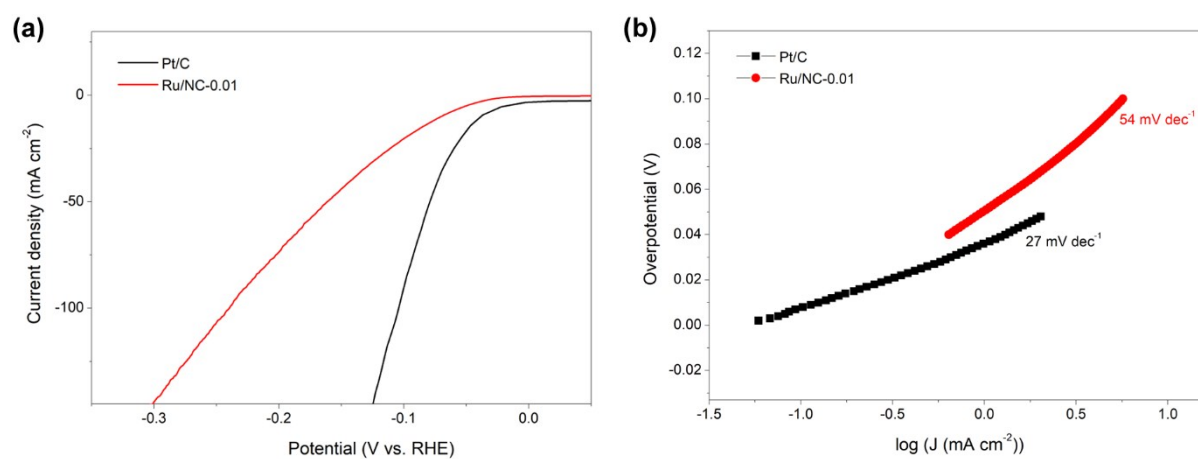


Fig. S4 (a) Polarization curves and (b) corresponding Tafel plots of Ru/NC-0.01 and Pt/C in 0.5 M H₂SO₄.

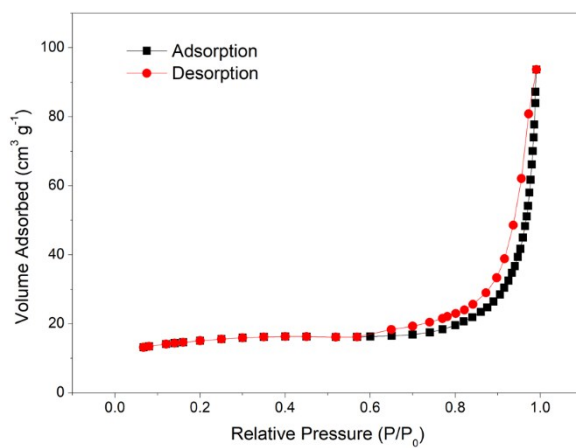


Fig. S5 Nitrogen adsorption isotherms of the Ru/NC-0.01.

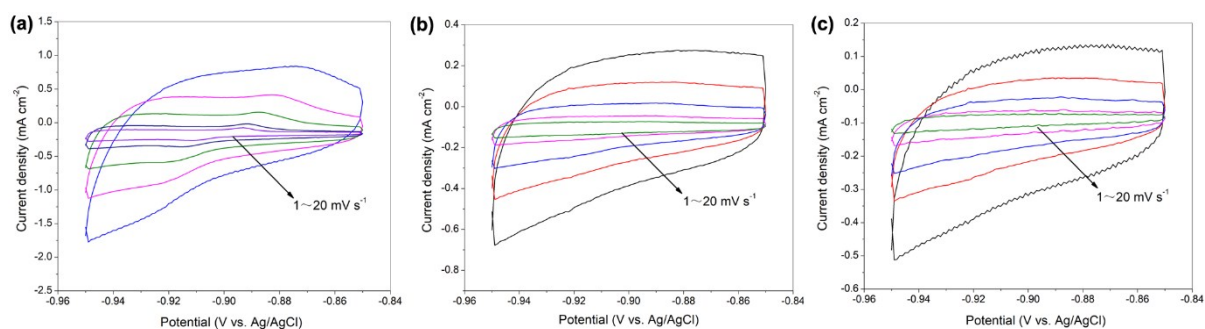


Fig. S6 CVs of Ru/NC-0.01, Ru/NC-0.05 and Ru/NC-0.1 in 1 M KOH.

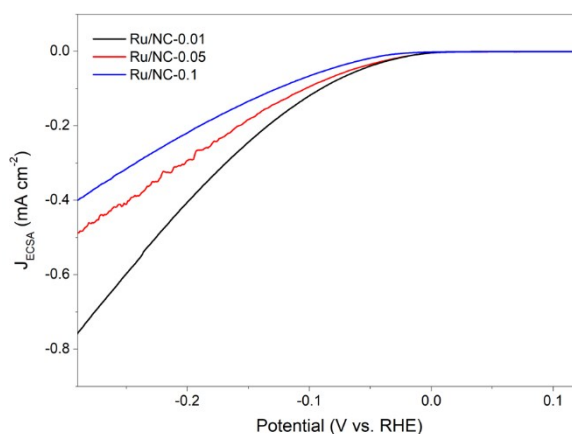


Fig. S7 Polarization curves of Ru/NC-0.01, Ru/NC-0.05 and Ru/NC-0.1 normalized by ECSA in 1 M KOH.

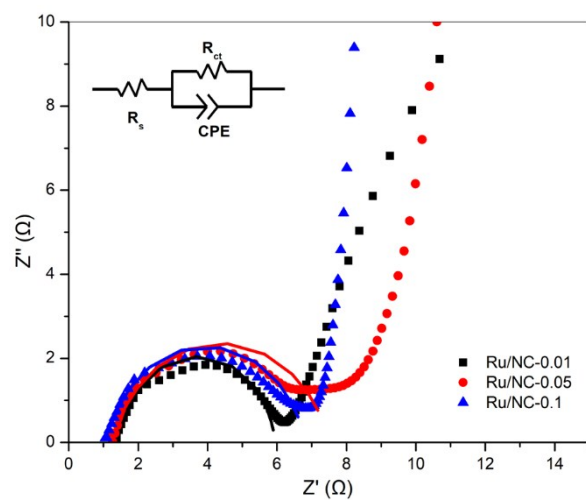


Fig. S8 Fitted Nyquist curves of the Ru/NC using CPE model.

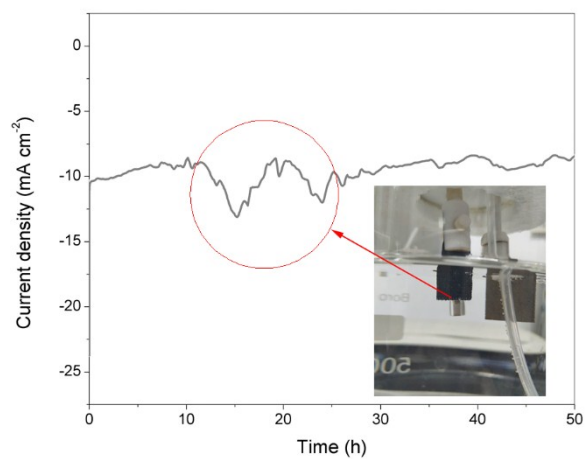


Fig. S9 Chronoamperometric response of the Ru/NC-0.01 at a constant overpotential of 40 mV over 50 h.

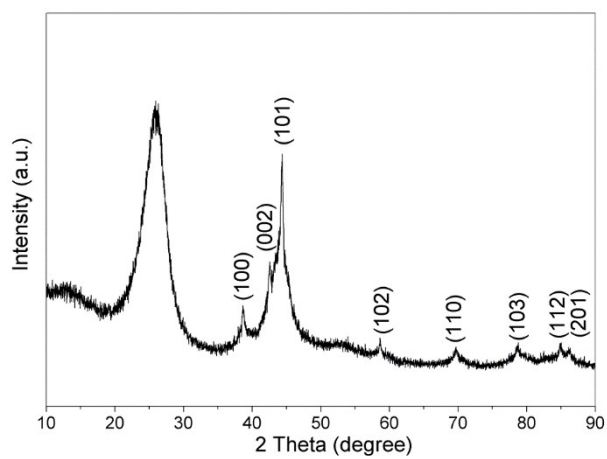


Fig. S10 XRD pattern of the Ru/NC-0.01 after CA test over 50 h.

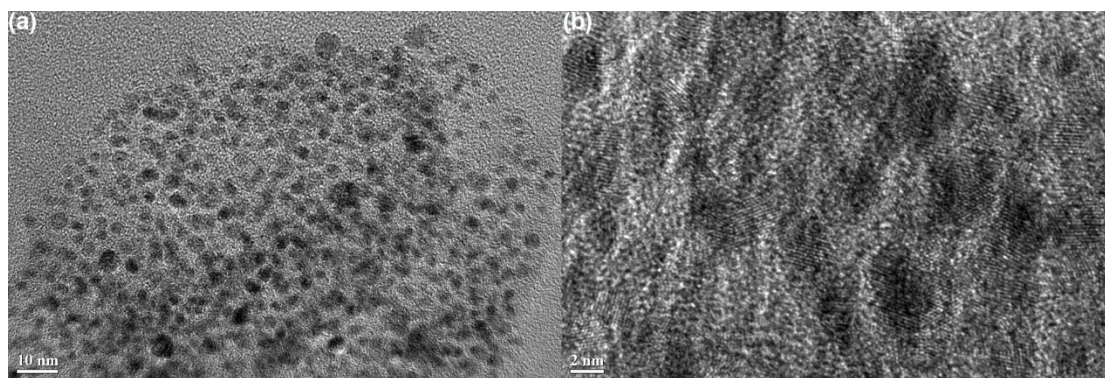


Fig. S11 (a) TEM and (b) HRTEM images of the Ru/NC-0.01 after CA test over 50 h.

Table S1. Comparison of the HER performance for different Ru-based electrocatalysts.

Electrocatalysts	Electrolyte	η (mV) at 10 mA cm ⁻²	Tafel (mV dec ⁻¹)	TOF (s ⁻¹)	Ref.
Ru@GnP	1 M KOH	22	28	/	4(2)
	0.5 M H ₂ SO ₄	13	30	/	
Ru NP/C	1 M KOH	7	19	0.39 at 40 mV	4(6)
Ru/C ₃ N ₄ /C	0.1 M KOH	79	62	4.2 at 100 mV	9
RuCo@NC	1 M KOH	28	31	/	10
Ru/CoP	1 M KOH	23	37	7.26 at 100 mV	11
	0.5 M H ₂ SO ₄	11	31	10.95 at 100 mV	
Ru@C ₂ N	1 M KOH	17	38	0.75 at 25 mV	12
	0.5 M H ₂ SO ₄	13.5	30	0.67 at 25 mV	
Ru@CN	1 M KOH	32	53	/	13
	0.5 M H ₂ SO ₄	126	92	/	
Ru@NC	1 M KOH	26	36	10.8 at 100 mV	14(6)
Ru/PN	0.5 M H ₂ SO ₄	24	38	1.67 at 25 mV	14(7)
RuAu	1 M KOH	24	37	2.18 at 50 mV	14(8)
Ru/NC	0.5 M H ₂ SO ₄	71	54	1.7 at 25 mV	This work
	1 M KOH	17	32	10.2 at 100 mV	

Table S2. EIS calculation parameters of the Ru/NC based on CPE model.

Sample	Ru/NC-0.01		Ru/NC-0.05		Ru/NC-0.1	
Element	Value	Error(%)	Value	Error(%)	Value	Error(%)
R _s (Ω)	1.475	5.673	1.252	12.655	1.096	10.171
R _{ct} (Ω)	4.461	4.191	6.256	6.3376	5.721	4.5415
CPE-T (Ω)	1.3072E-6	50.545	6.5606E-6	73.941	4.1917E-6	57.792
CPE-P (Ω)	0.94463	4.1859	0.82141	7.2187	0.85704	5.3465