Supporting Information

Metal-Organic Frameworks Derived Nitrogen-Doped Carbon-RhNi Alloys Anchored on Graphene for Highly Efficient Hydrogen Evolution Reaction

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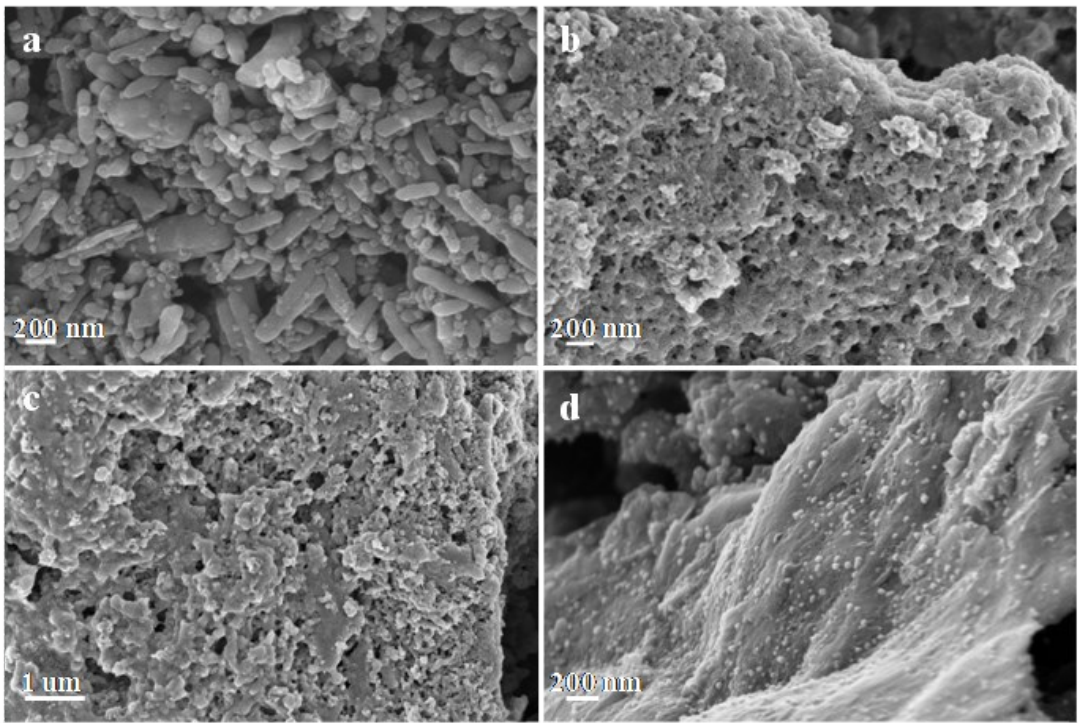

Fig. S1 SEM images of (a) NC-Ni, (b) NC-Rh, (c) NC-RhNi and (d) NC-RhNi/rGO.

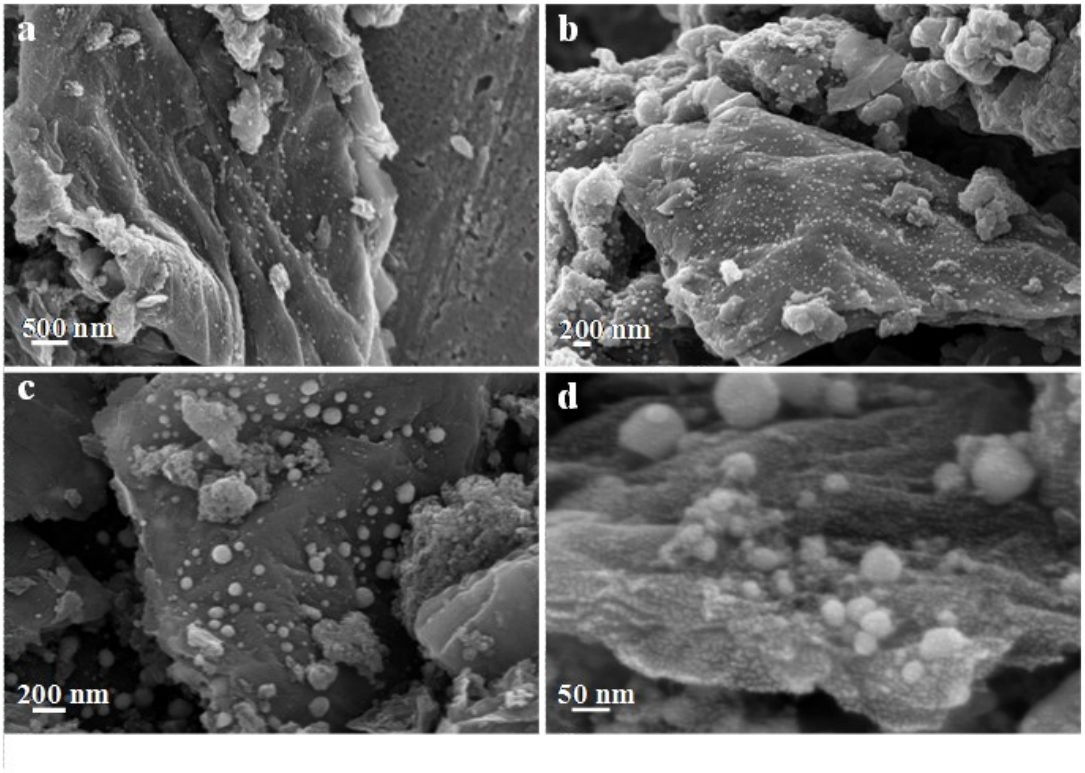

Fig. S2 SEM images of different ratio of Rh and Ni (a) 1:1, (b) 1:2, (c) 1:3 and (d) 2:1.

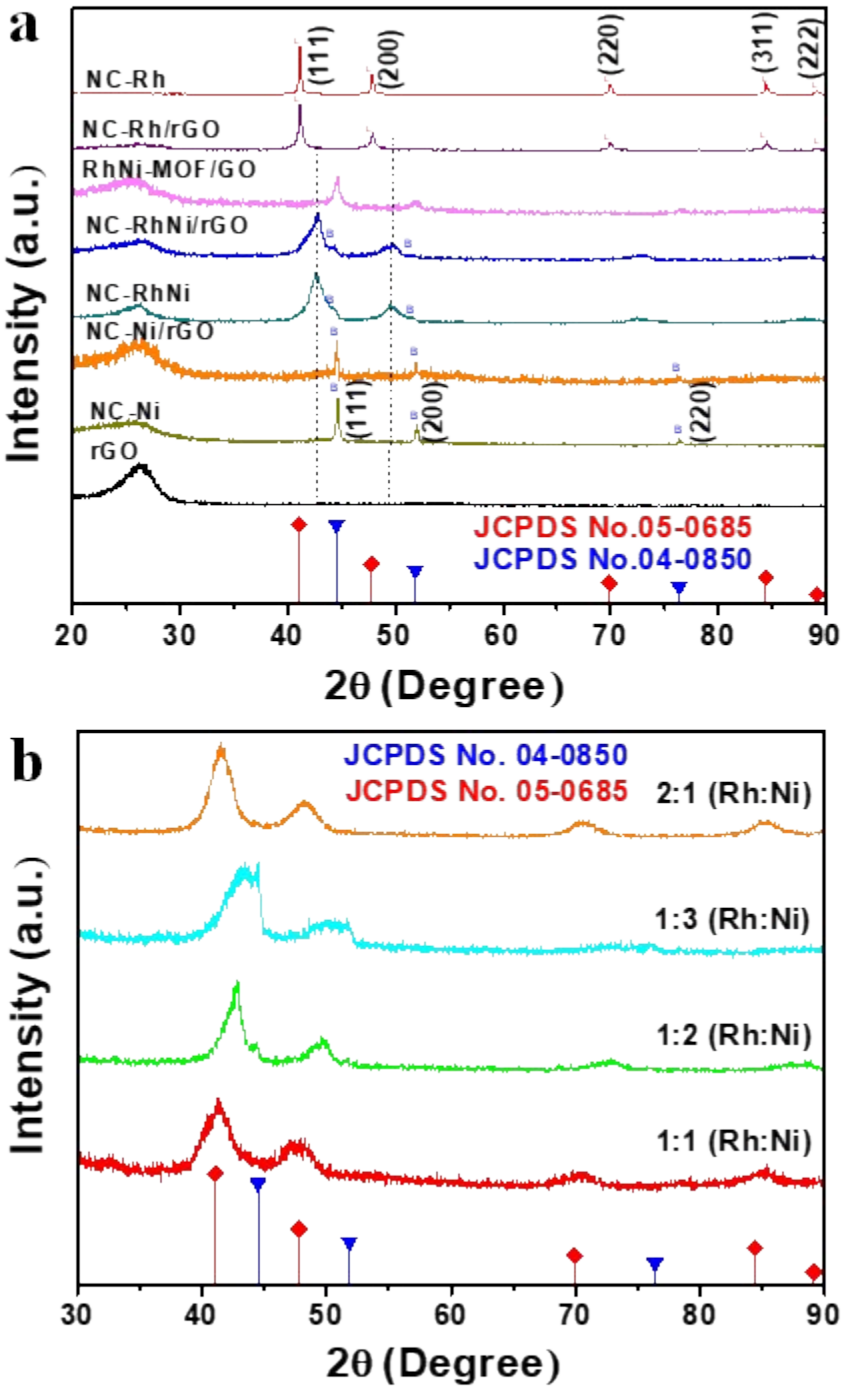

Fig. S3 (a) XRD patterns for rGO, NC-Ni, NC-Ni/rGO, NC-RhNi, NC-RhNi/rGO, RhNi-MOF/GO, NC-Rh/rGO and NC-Rh, (b) XRD patterns of samples with different ratios of Rh to Ni.

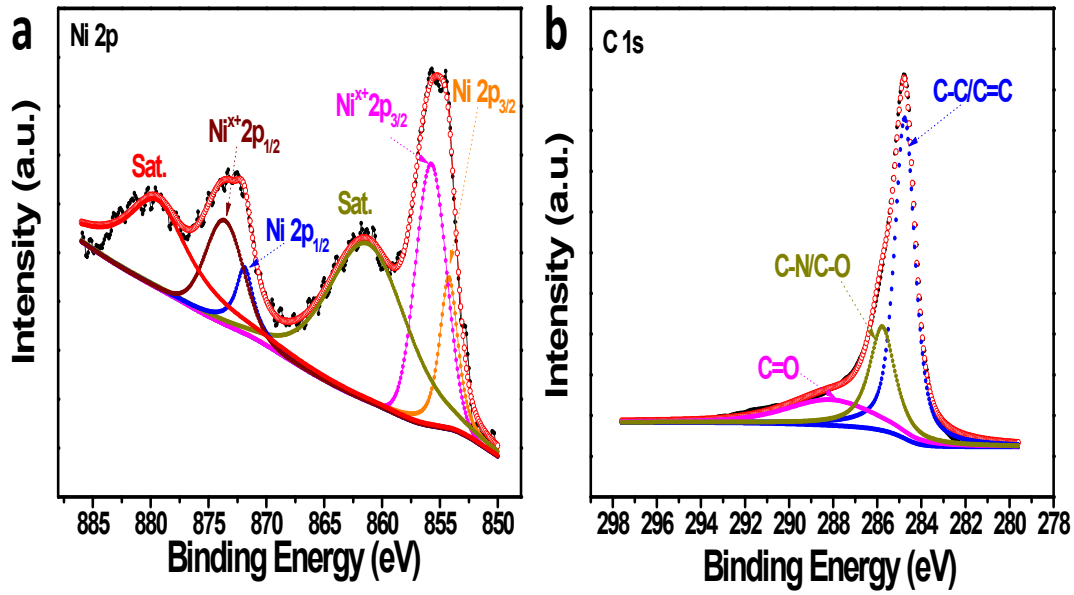

Fig. S4 High-resolution XPS spectra for (a) Ni 2p and (b) C 1s.

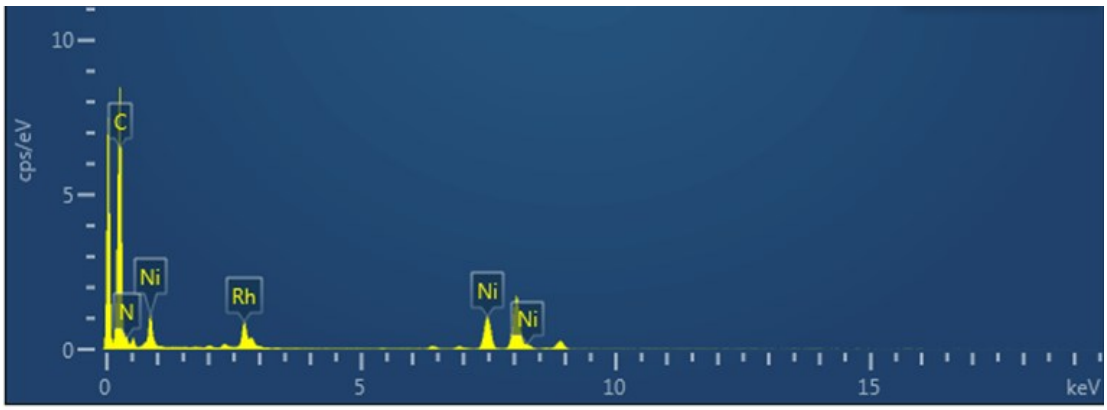

Fig. S5 Energy-dispersive spectroscopic (EDS) pattern of NC-RhNi/rGO.

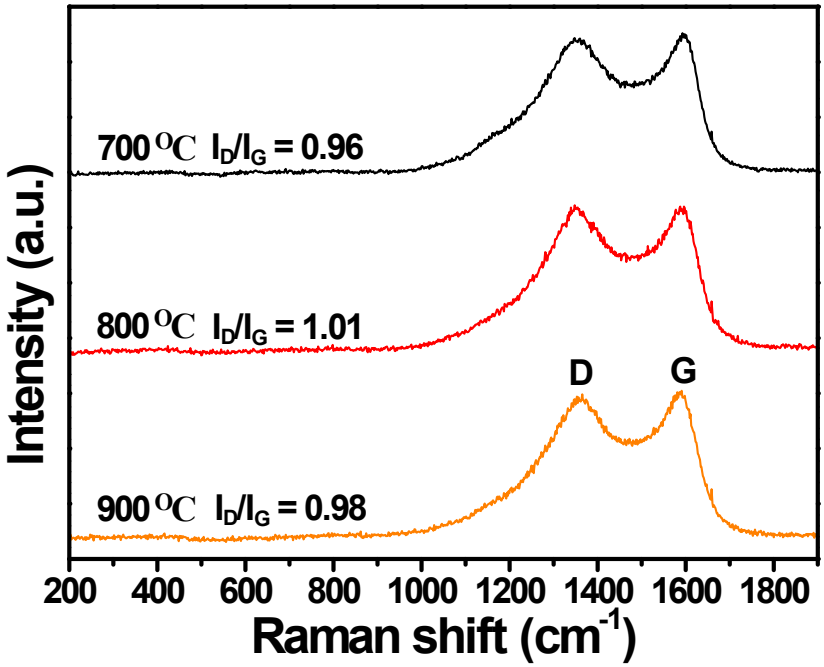

Fig. S6 Raman spectra of the samples calcinated at different temperatures.

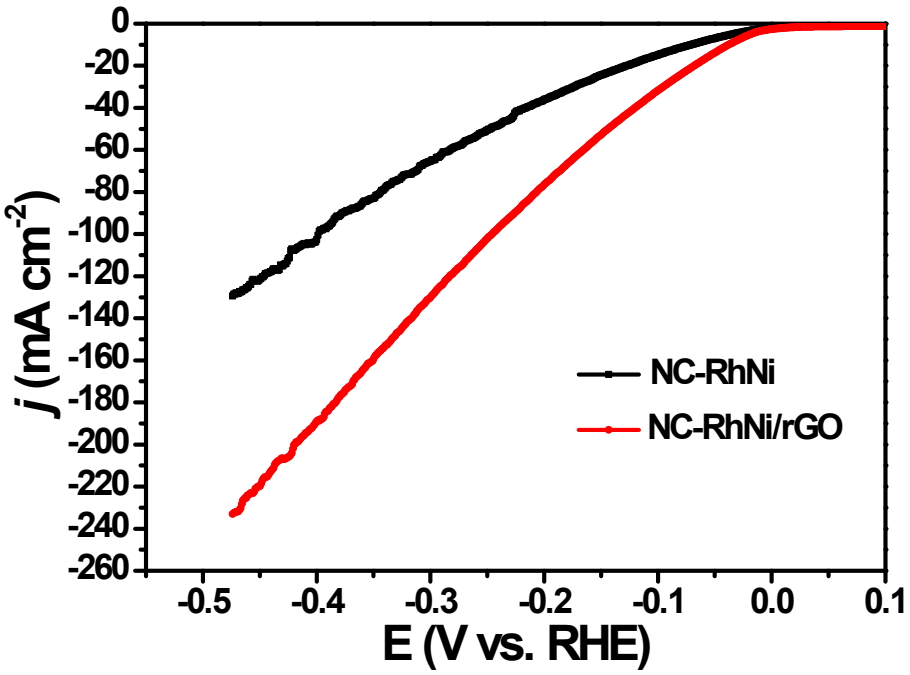

Fig. S7 Linear sweep polarization curves of NC-RhNi and NC-RhNi/rGO obtained in 1.0 M KOH at a scan rate of 5 mV s^{-1}.

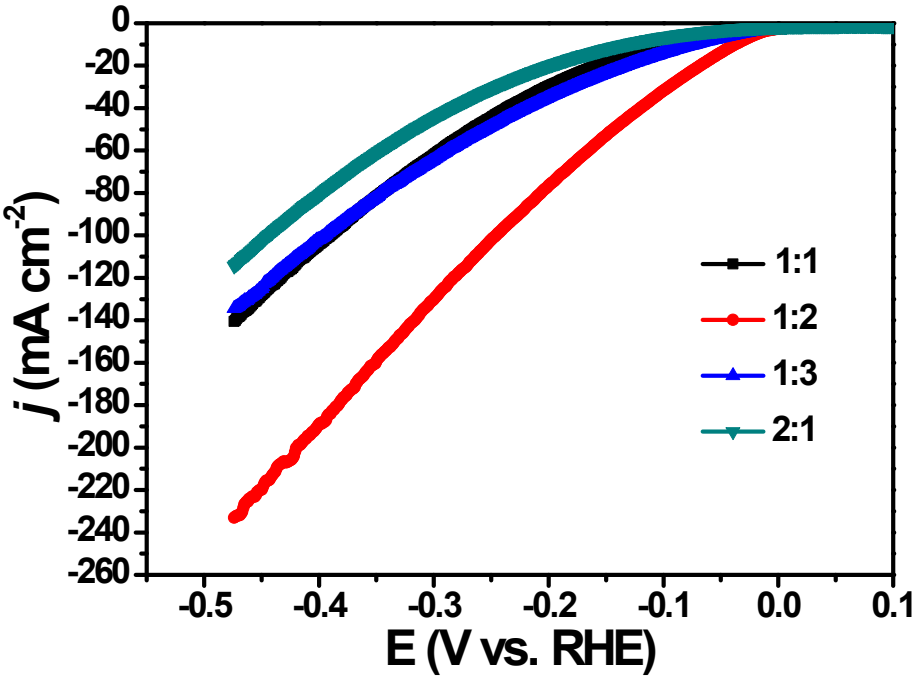

Fig. S8 Linear sweep polarization curves of NC-RhNi/rGO with different rate of Rh to Ni obtained in 1.0 M KOH at a scan rate of 5 mV s^{-1}.

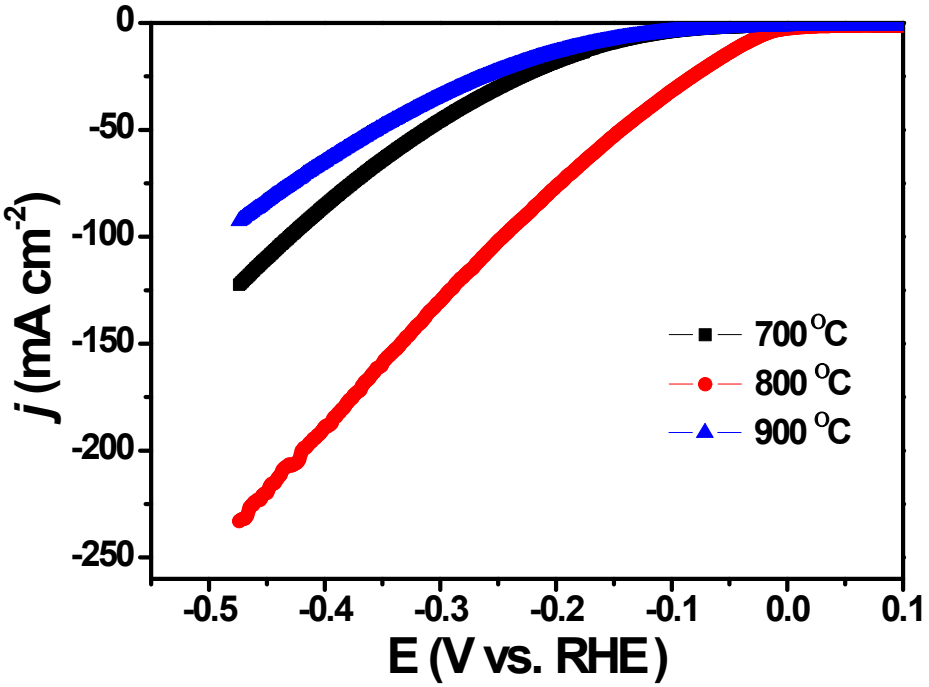

Fig. S9 Linear sweep polarization curves of NC-RhNi/rGO obtained by different calcinate temperatures at a scan rate of 5 mV s^{-1} in 1.0 M KOH.

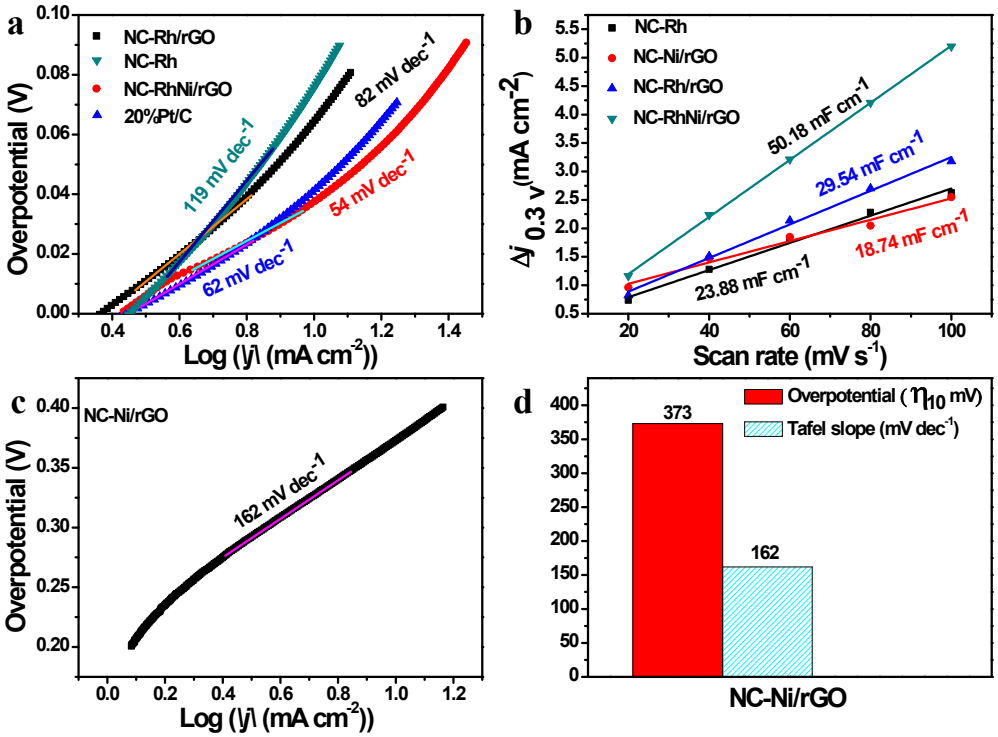

Fig. S10 (a) the corresponding Tafel plots of NC-Rh/rGO, NC-RhNi/rGO, NC-Rh and 20% Pt/C. (b) Estimation of electrochemical double-layer capacitance (C_{dl}) for various electrocatalysts by plotting the difference in current densities at 0.3 V versus RHE for NC-Ni/rGO, NC-RhNi/rGO, NC-Rh/rGO and NC-Rh. (c) The corresponding Tafel plot of NC-Ni/rGO, and (d) Comparison of overpotential at a current density of 10 mA cm^{-2} and Tafel slope of NC-Ni/rGO in 1.0 M KOH.

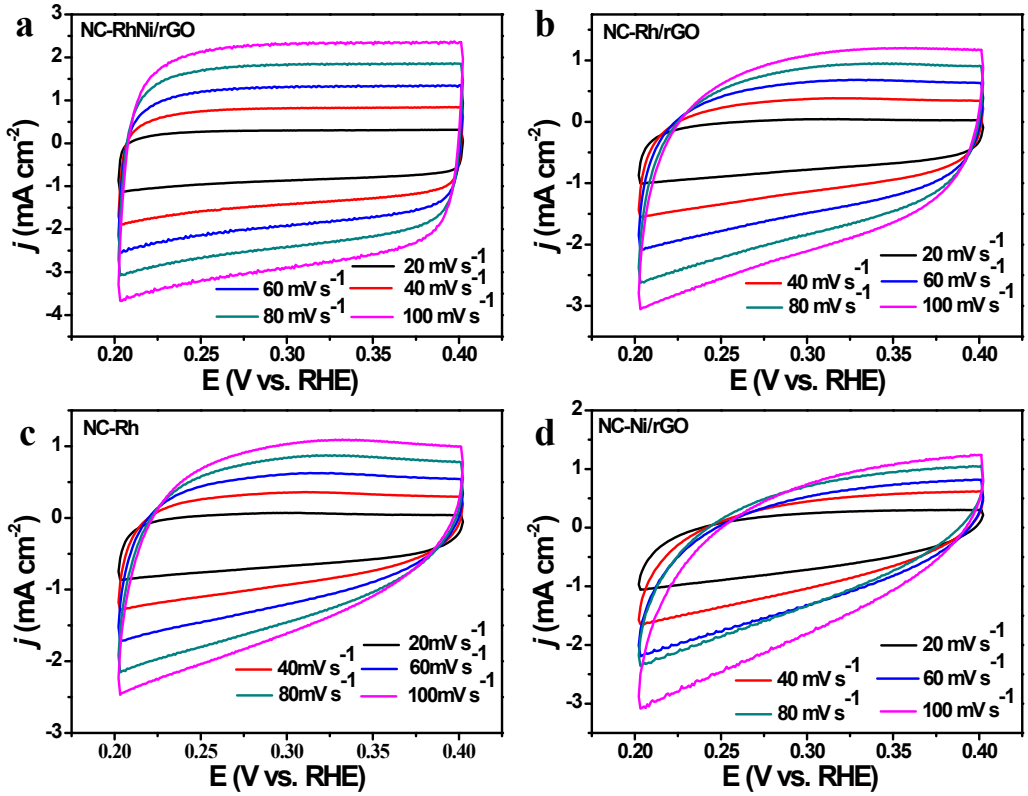

Fig. S11 Cyclic voltammograms (CV) curves of (a) NC-RhNi/rGO, (b) NC-Rh/rGO, (c) NC-Rh, and (d) NC-Ni/rGO in the region of 0.20-0.40V vs. RHE in 1.0 M KOH at various scan rates.

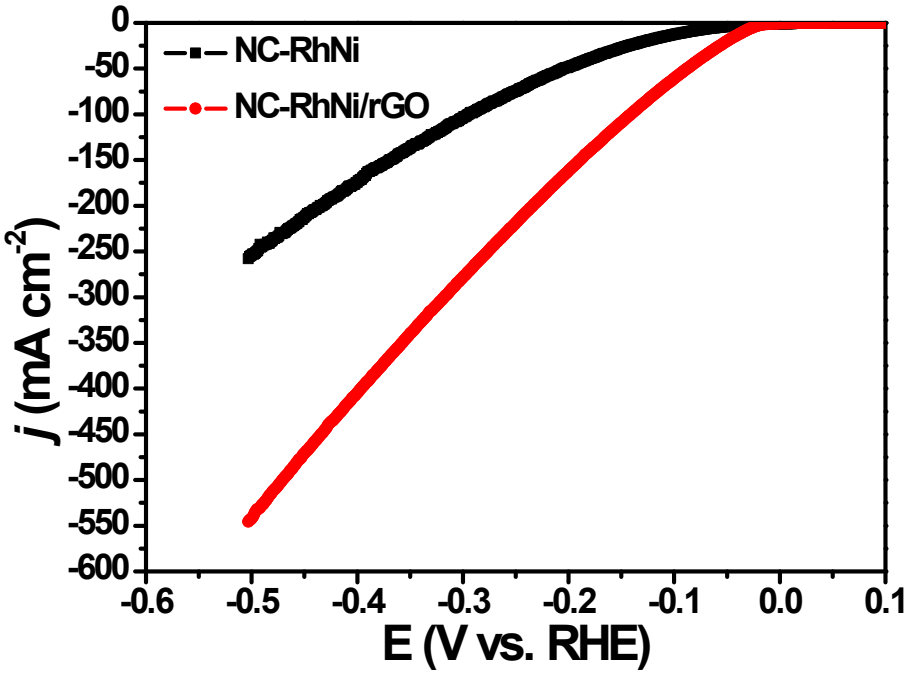

Fig. S12 Linear sweep polarization curves of NC-RhNi/rGO and NC-RhNi obtained in 0.5 M H_2SO_4 at a scan rate of 5 mV s^{-1}.

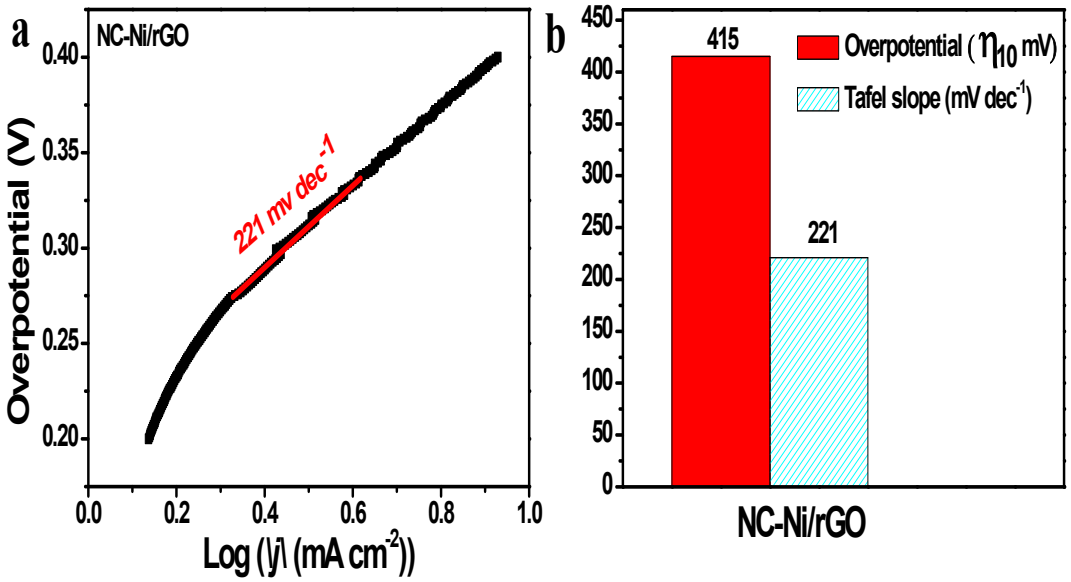

Fig. S13 (a) The corresponding Tafel plot of NC-Ni/rGO and (b) Comparison of overpotential at a current density of 10 mA cm^{-2} and Tafel slope of NC-Ni/rGO in 0.5 M H_2SO_4.

Table S1. The atomic ratio of NC-RhNi/rGO obtained from XPS spectra.

Element	Rh 3d	Ni 2p	C 1s	N 1s	O 1s
NC-RhNi/rGO	0.49%	1.75%	83.92%	5.73%	8.11 %

Table S2. Comparison of HER performance with that of recently reported alloy electrocatalysts.

Electrocatalysts	Electrolyte	η_{10} (mV)	Tafel slope (mV dec^{-1})	References
Cu-Ni nanocages	1 M KOH	140	79	[1]
Ni_xCu_y@NG-NC	1 M KOH	122	84.2	[2]
IrNi@OC	1 M KOH	27	50	[3]
Pt-Ni hetero	1 M KOH	48		[4]
$CoRu_x$@N-C	1 M KOH 0.5 M H_2SO_4	27 94	73 64	[5]
PtRh ANDs	0.5 M H_2SO_4	25	32	[6]
NiRu@N–C	0.5 M H_2SO_4	50	36	[7]
CoNi@NC	0.1 M H_2SO_4	142	105	[8]
NiCu@C	0.5 M H_2SO_4 1 M KOH	48 74	63.2 94.5	[9]
RuAu SAAs	1 M KOH	24	37	[10]
hcp Pt–Ni	1 M KOH	65	78	[11]
NC-RhNi/rGO	1 M KOH 0.5 M H_2SO_4	37 34	54 22	This work

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