Supporting information

Cobalt nanoparticles encapsulated in nitrogen-doped carbon as a bifunctional catalyst for water electrolysis

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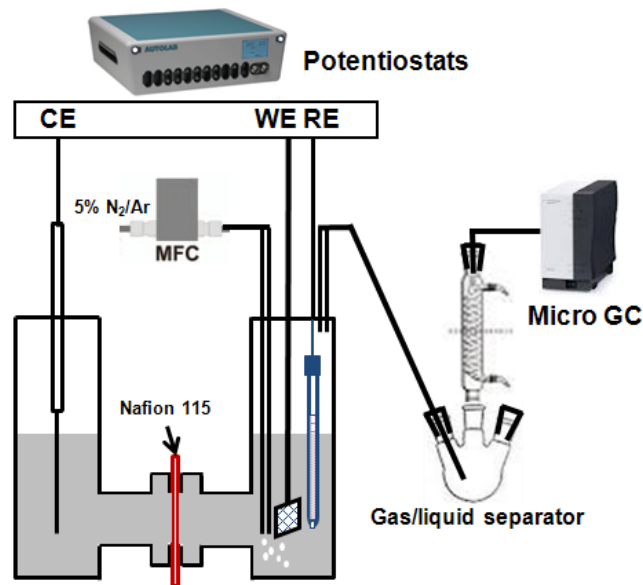
Scheme S1 Schematic diagram for detecting the hydrogen and oxygen evolution on the Co@N-C electrode in an H shape cell.
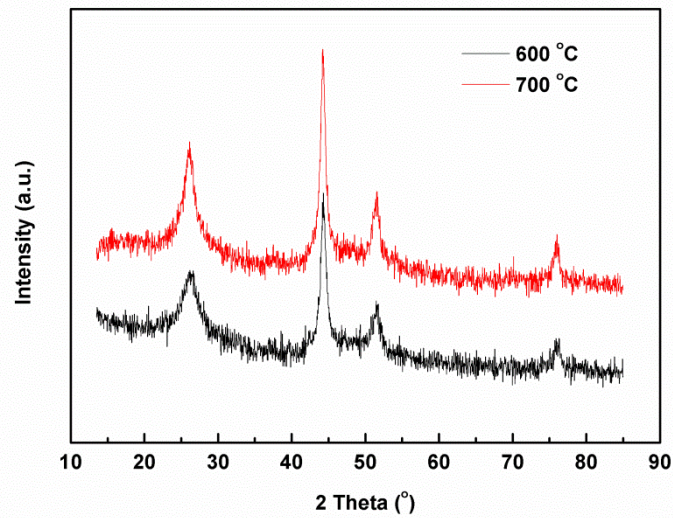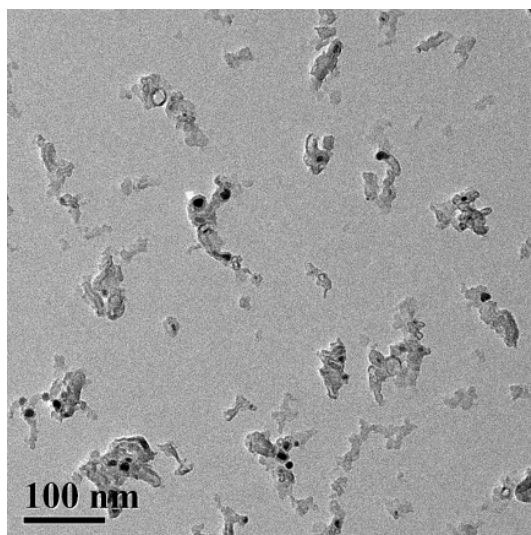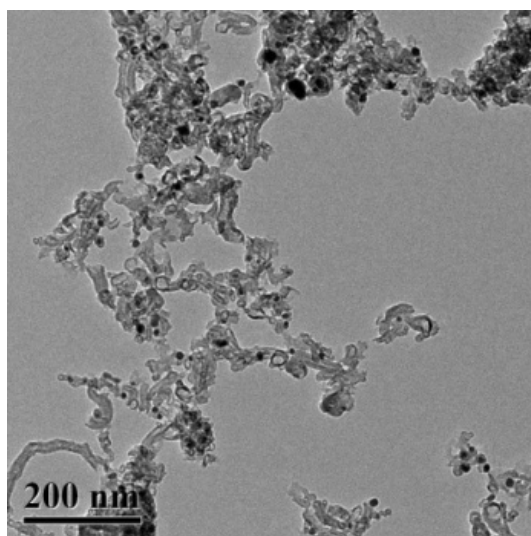

Fig. S1 XRD patterns of Co@N-C pyrolyzed at 600 °C and 700 °C, followed with acid-leaching.

(a)

(b)

Fig. S2 TEM images of Co@N-C pyrolyzed at 600 ^{o}C (a) and 700 ^{o}C (b) followed with acid-leaching.
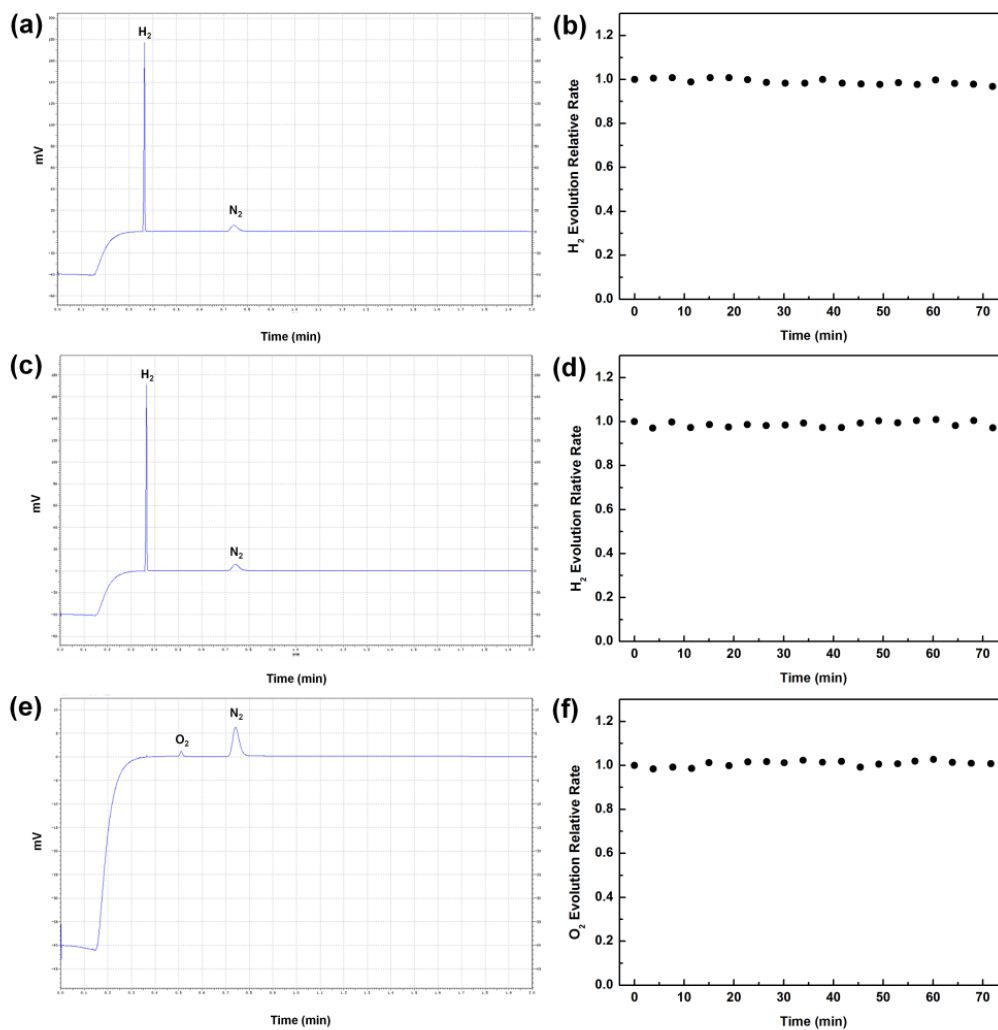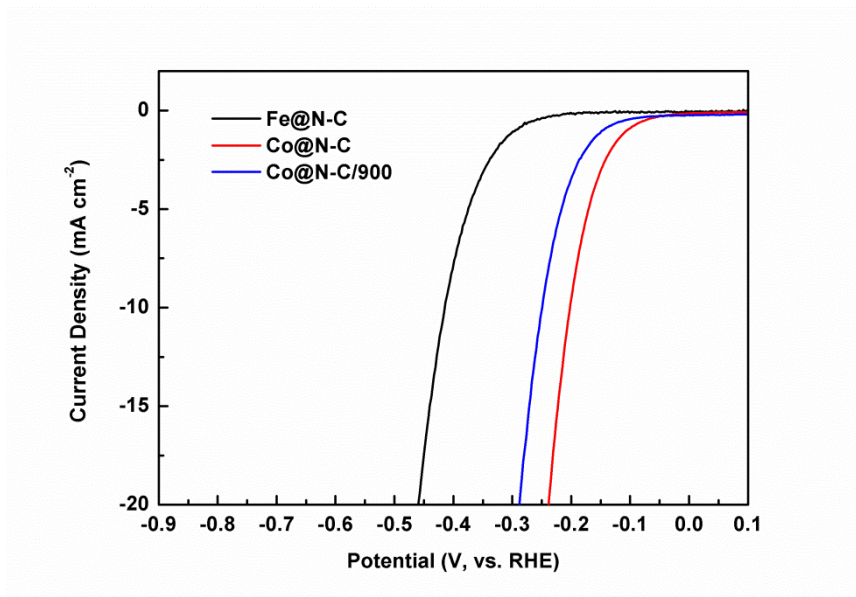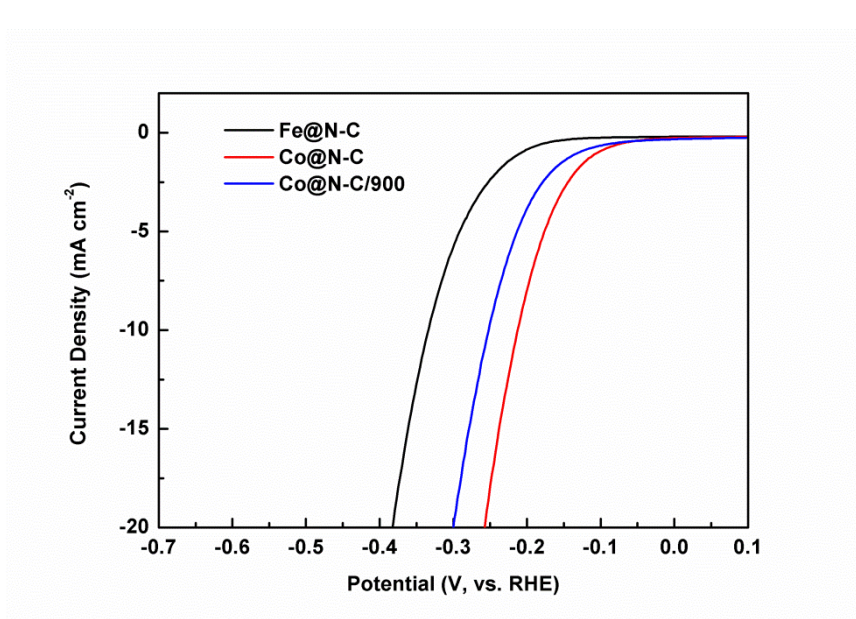
Fig. S3 The GC spectra and H₂ evolution relative rate on the Co@N-C electrode with the electrolysis time in 1 M HClO₄ (a), (b) and 1 M KOH solution (c), (d). The GC spectra and O₂ evolution relative rate on the Co@N-C electrode with the electrolysis time in 1 M KOH solution (e), (f).

(a)

(b)

Fig. S4 HER activities of Fe@N-C, Co@N-C and Co@N-C/900 in 1 M $HClO_4$ (a)
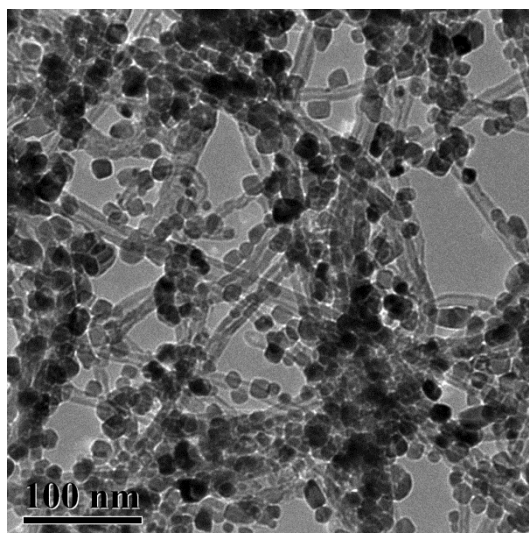
and 1 M KOH (b) solutions.

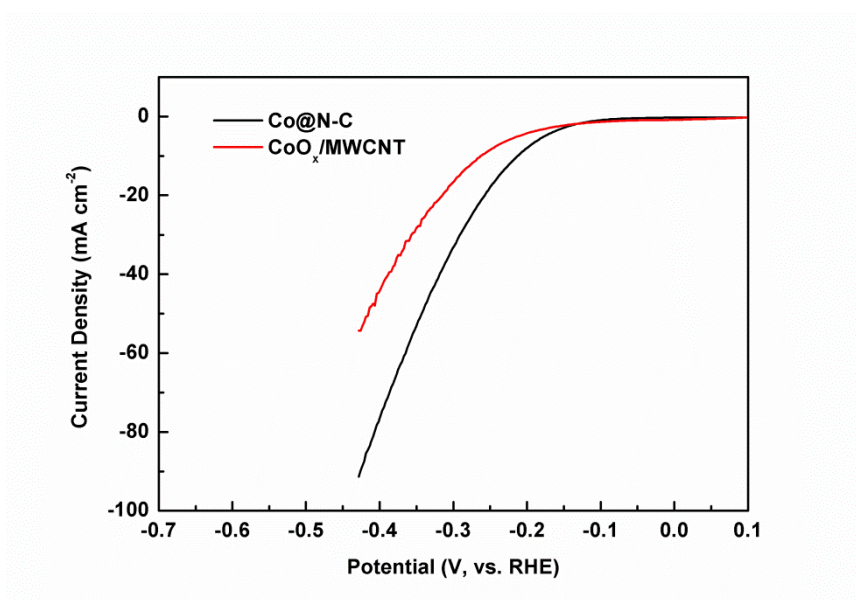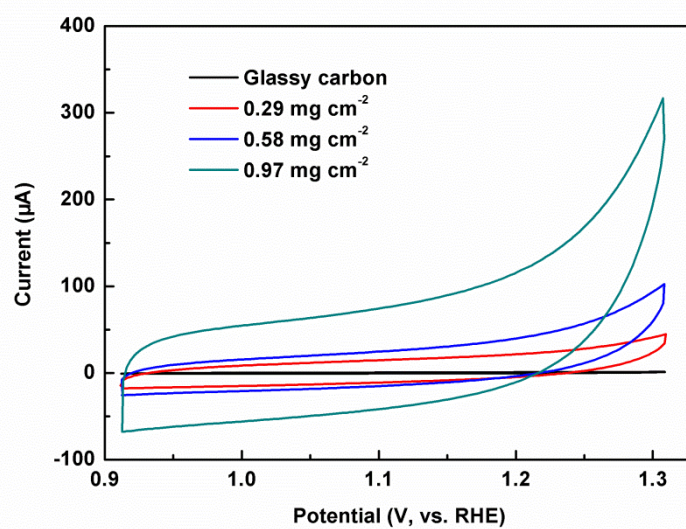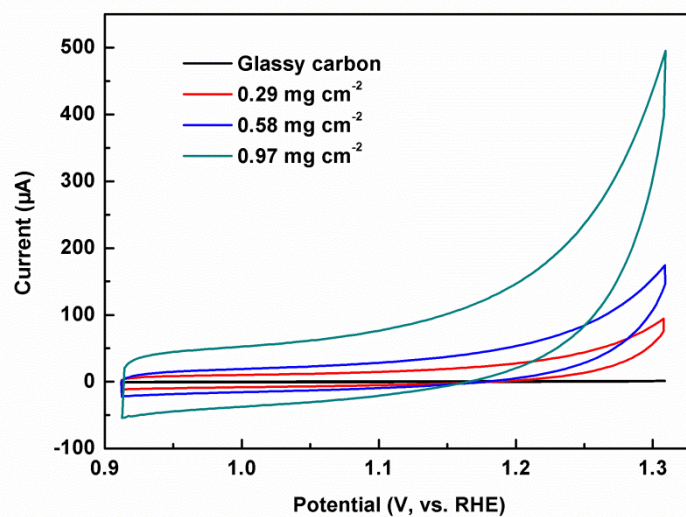Fig. S5 TEM image of CoO$_x$/MWCNT.

Fig. S6 HER activities of Co@N-C and CoO$_x$/MWCNT in 1M KOH solution.

(a)

(b)

Fig. S7 Cyclic voltammetries of Fe@N-C (a) and Co@N-C (b) with different loadings on the glassy carbon electrode. (scan rate: 10 mV s-1, electrolyte solution: 1 M KOH solution, 25 °C)
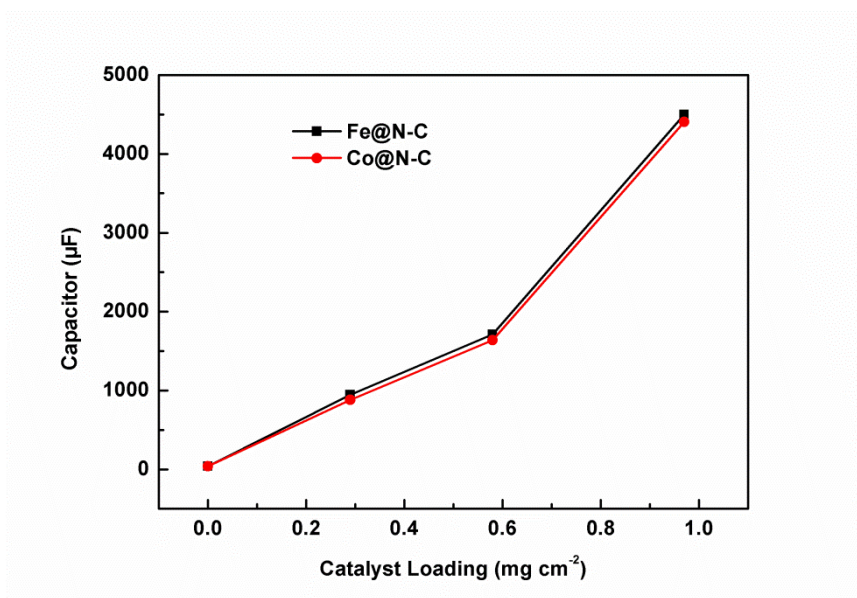
Fig. S8 The relationship between the capacitor and catalyst loading of Fe@N-C and Co@N-C.

Table S1. Summary of representative non-precious-metal HER catalysts in acidic medium

Catalyst	$[H^+]$ concentration (mol L^{-1})	Overpotential (V, at 10 mA cm^{-2})	Reference
Co@N-C	1	0.20	This work
MoS$_2$/Au	1	0.22	[36]
MoS$_2$/Graphene	1	0.16	[37]
O-doped MoS$_2$	1	0.19	[38]
Defect-rich MoS$_2$	1	0.19	[39]
Ni$_2$P	1	0.14	[40]
Cu$_2$MoS$_4$	1	0.30	[41]
CoP$_2$/CNTs	1	0.13	[42]
Co/N-doped CNTs	1	0.26	[22]

Table S2. Summary of representative non-precious-metal HER catalysts in alkaline medium

Catalyst	$[OH^-]$ concentration (mol L^{-1})	Overpotential (V, at 10 mA cm^{-2})	Reference
Co@N-C	1	0.21	This work
Ni$_3$S$_2$/MWCNTs	1	0.48	[44]
Ni$_2$P	1	0.23	[45]
MoB	1	0.22	[46]
Mo$_2$C	1	0.19	[46]
Cu/Ni	1	0.26	[47]
Co/N-doped CNTs	1	0.37	[22]

Table S3. Summary of representative non-precious-metal OER catalysts in alkaline medium

Catalyst	[OH⁻] concentration (mol L⁻¹)	Overpotential (V, at 10 mV cm⁻²)	Reference
Co@N-C	1	0.40	This work
Mn_2O_3	1	0.45	[48]
$Zn_xCo_{3-x}O_4$	1	0.35	[49]
$La_{0.8}Sr_{0.2}CoO_3$	1	0.46	[50]
$Co(CO_3)_{0.5}(OH)\cdot0.11H_2O$	1	0.47	[51]
Nitrogen-doped carbon	0.1	0.38	[8]