Supporting Information

Cobalt/Titanium Nitride@N-doped Carbon Hybrid for Enhanced Electrocatalytic Hydrogen Evolution and Supercapacitance

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Table S1 the content molar ratio of Ti and Co in the Co-TiN@NG-x/CC from ICP results.

n_{Ti}: n_{Co}	Co-TiN@NG-1/CC	Co-TiN@NG-2/CC	Co-TiN@NG-4/CC	Co-TiN@NG-8/CC
Theoretical result	1:1	2:1	4:1	8:1
ICP result	1.05:1	2.03:1	4.05:1	8.06:1

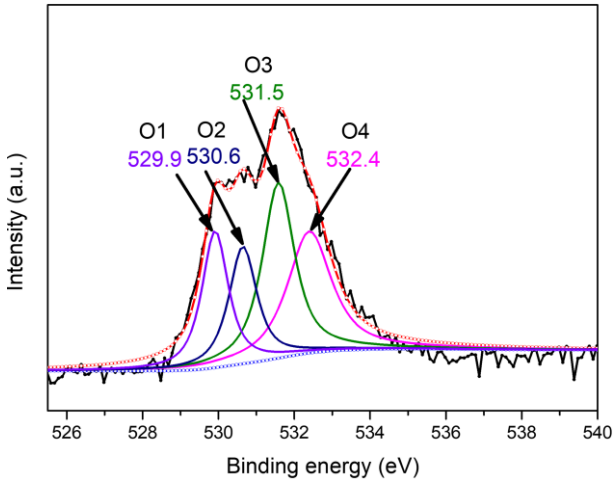

Fig. S1 XPS spectra of O 1s species on the surface of Co-TiN@NG-2/CC.

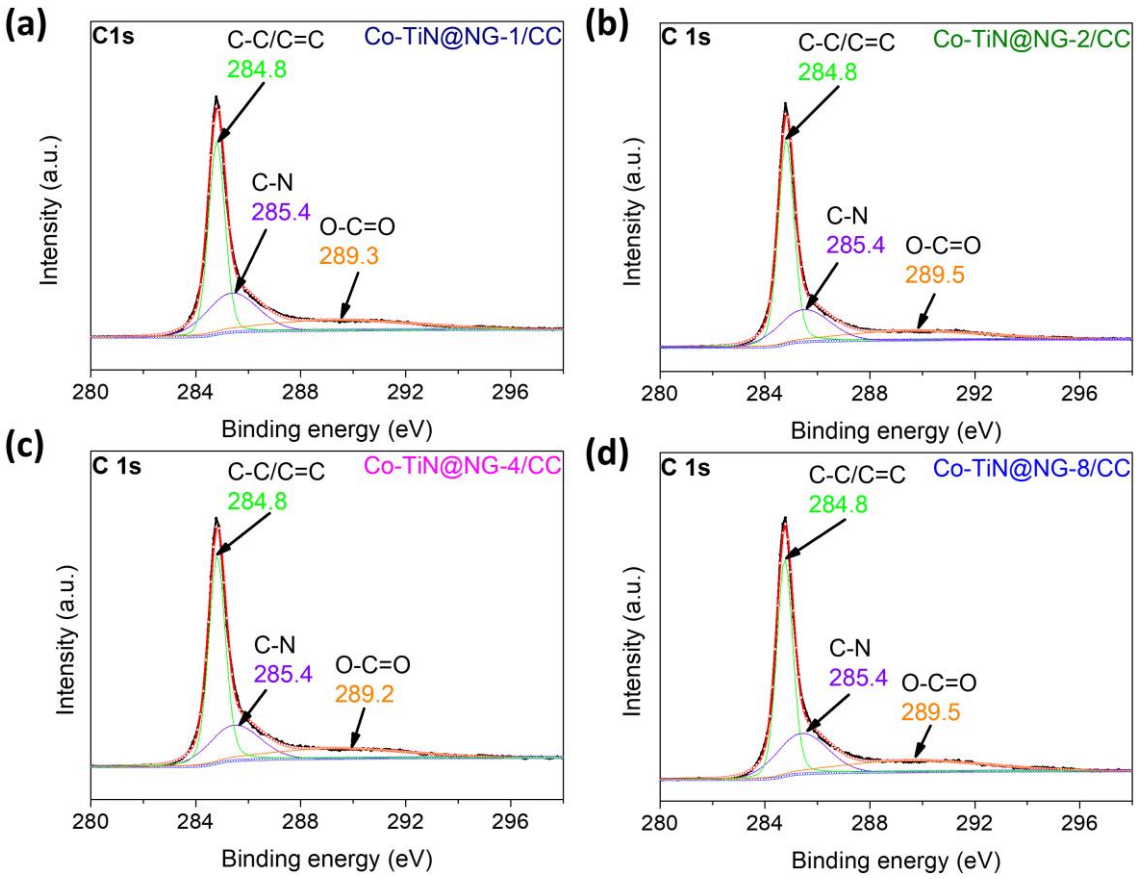

Fig. S2 High-resolution XPS spectra of C 1s of (a) Co-TiN@NG-1/CC, (b) Co-TiN@NG-2/CC, (c) Co-TiN@NG-4/CC and (d) Co-TiN@NG-8/CC

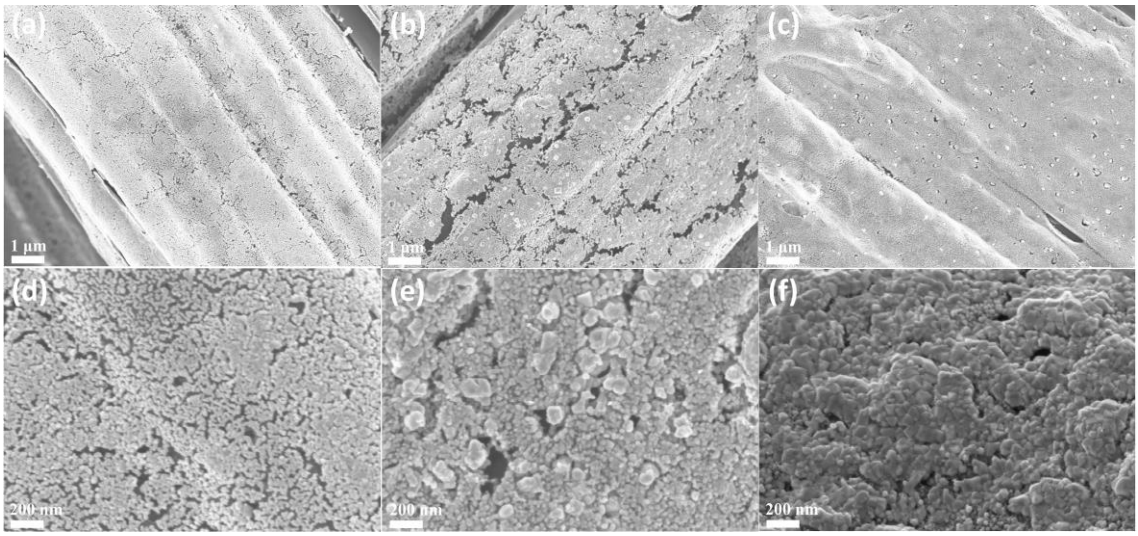

Fig. S3 FESEM images for (a) Co-TiN@NG-8/CC, (b) Co-TiN@NG-4/CC and (c) Co-TiN@NG-1/CC in low magnification, and (d) Co-TiN@NG-8/CC, (e) Co-TiN@NG-4/CC and (f) Co-TiN@NG-1/CC in high magnification.

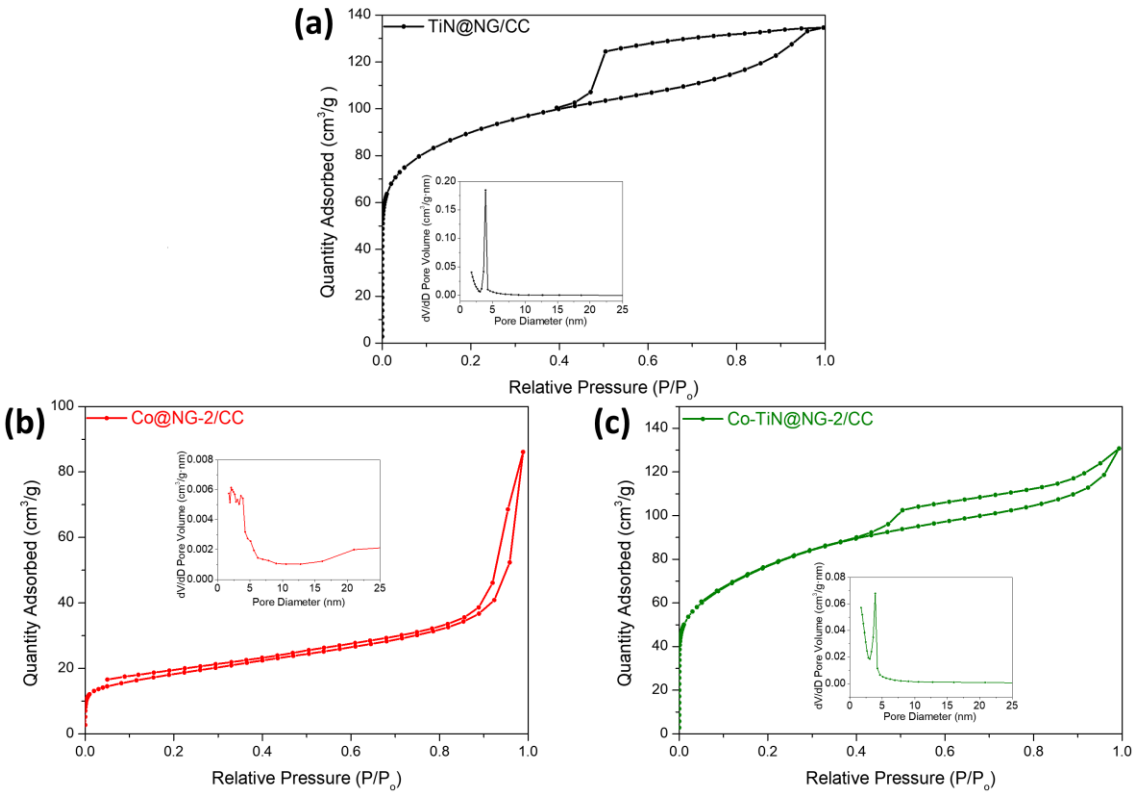

Fig. S4 N_2 adsorption/desorption isotherms and (inset) corresponding pore size distributions of (a) TiN@NG/CC, (b) Co@NG-2/CC and (c) Co-TiN@NG-2/CC

Table S2 Comparisons of HER electrocatalytic activity of Co-TiN with recently reported noble metal-free catalysts under alkaline conditions.

Catalyst	Substrate	Overpotential at 10 mA/cm^{-2} (mV)	Stability Time/CV cycles	Electrolyte	Reference
Co-TiN@NG-2/CC	**CC**	**208**	**24 h/1000 cycles**	**1 M KOH**	**This work**
$MoS_2/MoSe_2$	GCE	235	3 h	1 M KOH	4
Co-BDC/MoS_2	GCE	248	15 h/2000 cycles	1 M KOH	5
$Ni(OH)_2/MoS_2$	GCE	227	1000 cycles	1 M KOH	6
$CoSe_2/MoSe_2$	GCE	218	1000 cycles	1 M KOH	7
$MoSe_2@Ni_{0.85}Se$	NF	117	20 h/1000 cycles	1 M KOH	8
Ni-Mo_xC	GCE	183	24 h/1000	1 M KOH	9

			cycles		
Fe-Ni_3C	GCE	292	10 h/1000 cycles	1 M KOH	10
Co_2P/WC@C	GCE	180	12 h/1000 cycles	1 M KOH	11
Fe_3C-Mo_2C/NC HNFs	GCE	180	-	1 M KOH	12
WC@CNS	NF	220	5 h	0.1 M KOH	13
TaC@CNS	NF	250	-	0.1 M KOH	13
NbC@CNS	NF	240	-	0.1 M KOH	13
$Co_{1.11}Te_2$/C	GCE	178	20 h/1000 cycles	1 M KOH	14

Table S3 Mass activity (MA) and turnover frequency (TOF) of HER electrocatalysts in 1 M KOH.

Catalysts	**Mass activity ($mA \cdot mg^{-1}$)**	**TOF (s^{-1})**
TiN@NG/CC	1.64	0.00049
Co@NG/CC	1.48	0.00044
Co-TiN@NG-8/CC	4.06	0.0012
Co-TiN@NG-4/CC	5.12	0.0015
Co-TiN@NG-2/CC	5.95	0.0018
Co-TiN@NG-1/CC	3.78	0.0011

Table S4 Fitting results of Nyquist plots for all the samples.

Sample	R_s **(Ω)**	R_{ct} **(Ω)**
TiN@NG/CC	2.568	139.3
Co@NG/CC	2.664	20.07
Co-TiN@NG-8/CC	2.377	4.999
Co-TiN@NG-4/CC	2.474	4.837
Co-TiN@NG-2/CC	2.289	3.4
Co-TiN@NG-8/CC	3.736	5.583

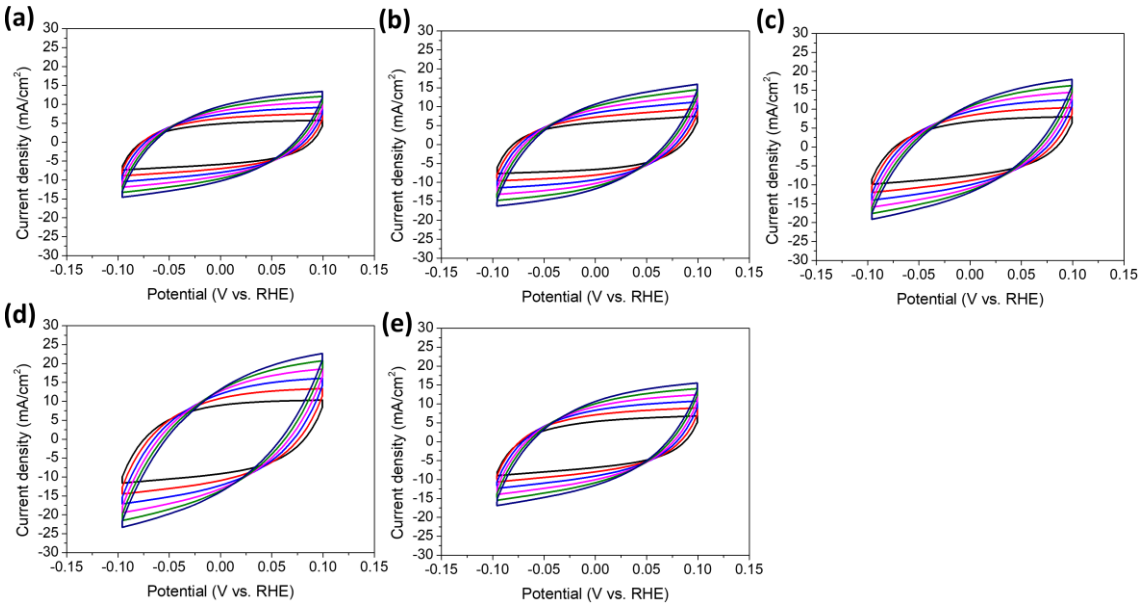

Fig. S5 CV curves at various scan rates for the determination of C_{dl} for sample (a) TiN@NG/CC, (b) Co-TiN@NG-8/CC, (c) Co-TiN@NG-4/CC (d) Co-TiN@NG-2/CC and (e) Co-TiN@NG-1/CC.

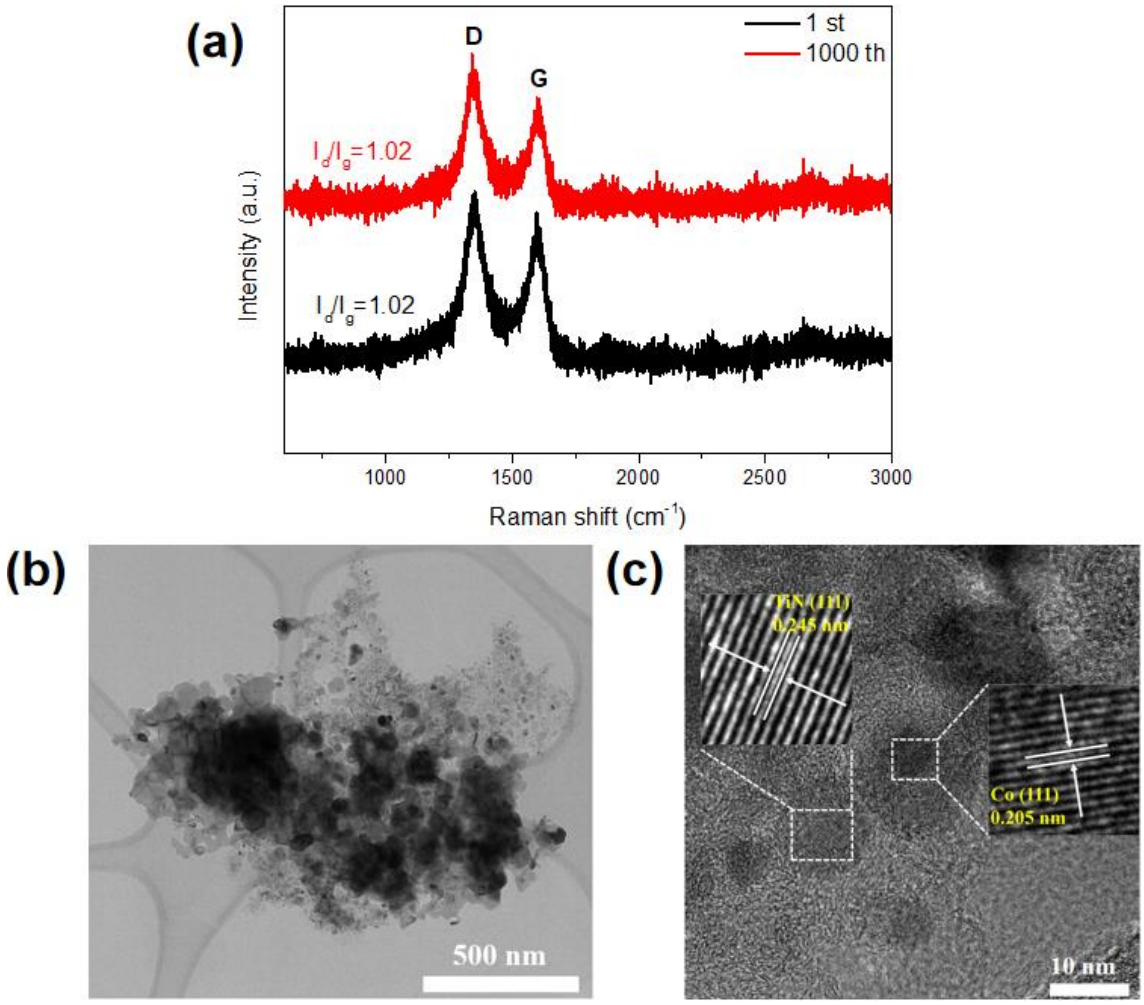

Fig. S6 (a) Raman spectra, (b) TEM image and (c) HRTEM image of Co-TiN@NG-2/CC catalyst after the continuous scanning test.

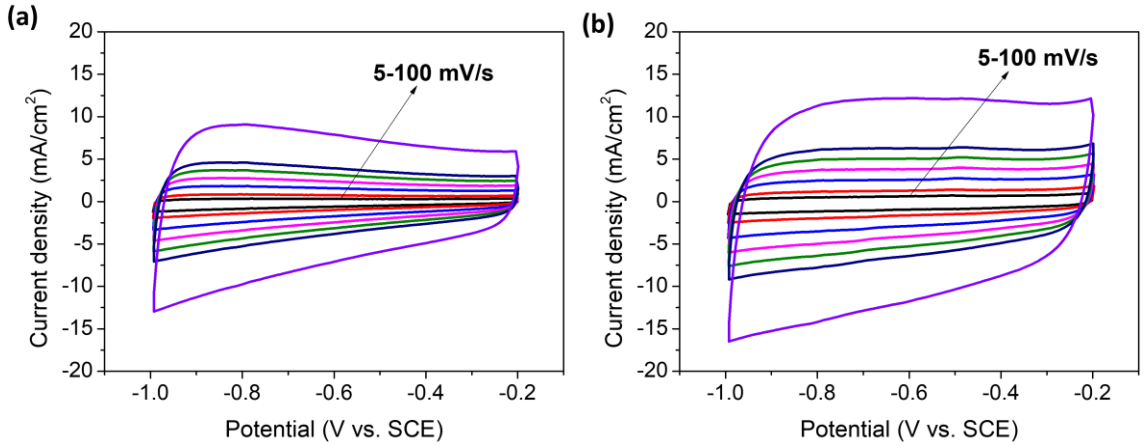

Fig. S7 CV curves of (a) TiN@NG/CC and (b) Co-TiN@NG-2/CC at different scanning rates from 5 to 100 mV/s.

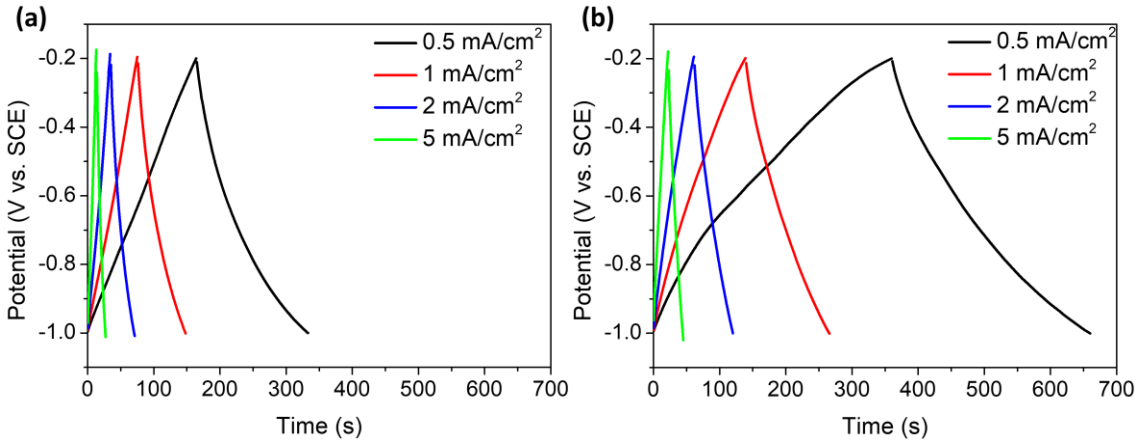

Fig. S8 GCD curves of (a) TiN@NG/CC and (b) Co-TiN@NG-2/CC at different current densities from 0.5 to 5 mA/cm^2 in 1 M KOH.

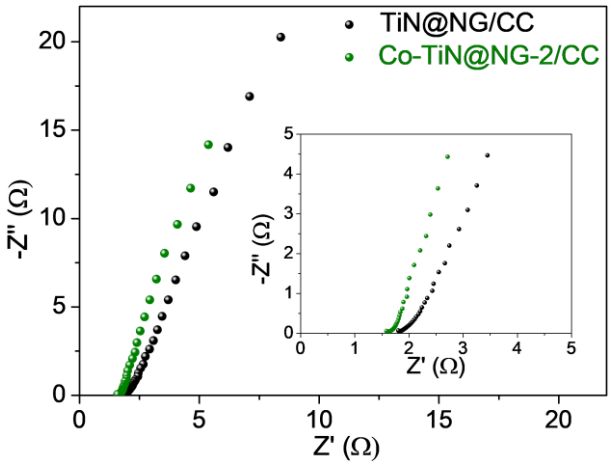

Fig. S9 EIS test of TiN@NG/CC and Co-TiN@NG-2/CC at an opencircuit potential in 1 M KOH.

Table S5 Comparison the capacitance performance of Co-TiN with other metal nitrides that have been reported recently.

Electrodes	**Potential Range**	**Electrolyte**	**Capacitance**	**Reference**
Co-TiN@NG-2/CC	**-1.0 to -0.2 V (Vs. SCE)**	**1.0 M KOH**	**88.5 F/g (148.6 mF/cm^2) at 2 mA/cm^2**	**This work**
Si@Ti@TiN thin film array	0 to 0.8 V (Vs. Ag/AgCl)	0.5 M H_2SO_4	43.8 mF/cm^2 at 1.0 mA/cm^2	6
TiN	−0.8 to 0.2 V	2.0 M KOH	38.5 F/g at 40 mV/s	7

	(Vs. SCE)			
TiN/CNT	−0.6 to 0.25 V (Vs. SCE)	7.5 M KOH	89.96 F/g at 10 mV/s	8
MoN_x/TiN NTA	-1.2 to -0.6 V (Vs. SCE)	1.0 M LiOH	121.50 mF/cm^2 at 0.3 mA/cm^2	9
TiN@C	−1 to 0 V (Vs. SCE)	1.0 M KOH	11.15 mF/cm^2 at 10 mV/s	10
TiN/C	−1.2 to 0.4 V (Vs. SCE)	1.0 M KOH	102.6 F/g at 1 A/g	11
TiN/C	−1.0 to 0 V (Vs. SCE)	1.0 M KOH	159.0 F/g at 0.5 A/g	12
Nb_4N_5@NC	0 to 0.6 V (Vs. Ag/AgCl)	1.0 M KOH	243.6 mF/cm^2 at 0.5 mA/cm^2	13
GaN	-0.5 to 0.4 V (Vs. Hg/Hg_2SO_4)	1.0 M H_2SO_4	24 F/g at 0.5 mA/cm^2	14
CrN	0 to 0.8 V (Vs. Ag/AgCl)	0.5 M H_2SO_4	12.8 mF/cm^2 at 1 mA/cm^2	15