Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information

Freestanding porous carbon membrane deriving from alginic acid/poly(ionic liquid) complex and its high-performance HER electrocatalysis

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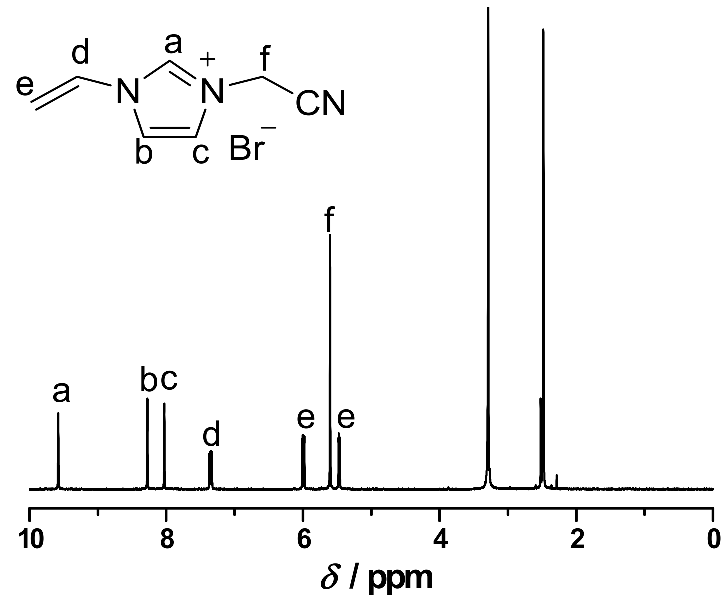

Figure S1. ^{1}H NMR spectrum (400 MHz) of 3-cyanomethyl-1-vinylimidazolium bromide (CMVIm-Br) in DMSO-d^{6} at 25 °C.

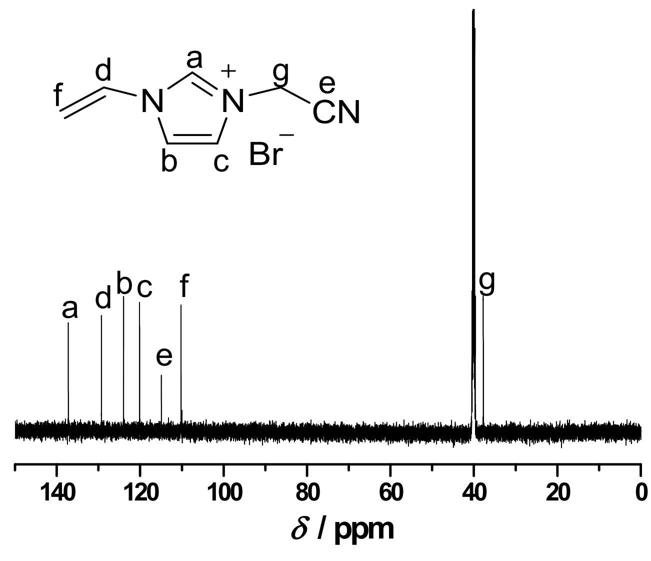

Figure S2. ^{13}C NMR spectrum (100 MHz) of 3-cyanomethyl-1-vinylimidazolium bromide (CMVIm-Br) in DMSO-d^{6} at 25 °C.

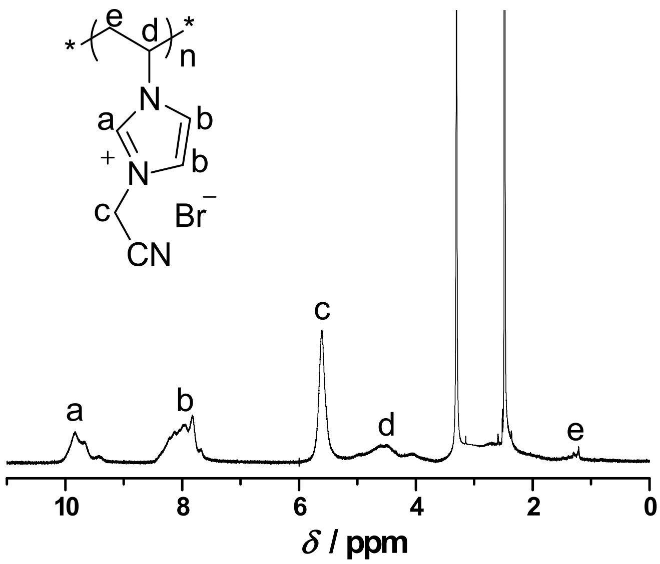

Figure S3. ^{1}H NMR spectrum (400 MHz) of poly(3-cyanomethyl-1-vinylimidazolium bromide) (PIL-Br) in DMSO-d^6 at 25 °C.

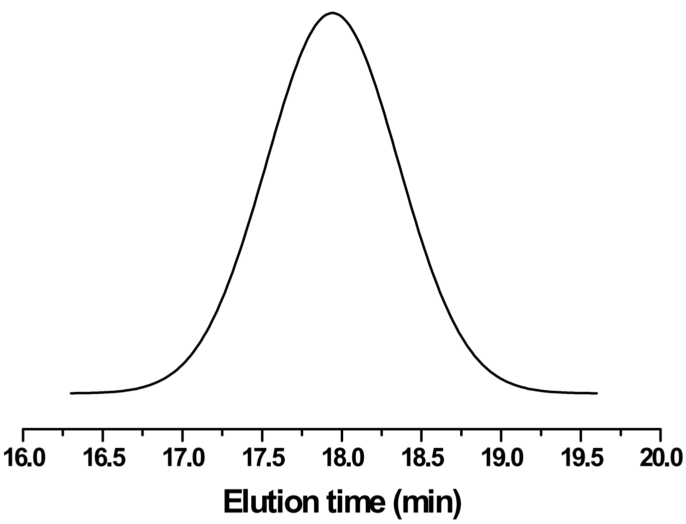

Figure S4. GPC trace of poly(3-cyanomethyl-1-vinylimidazolium bromide).

Table S1 Element content of carbon materias deriving from different precursors.

Sample	C	N	O	S
PC-AA	94.44	0	2.29	2.72
PC-PIL	86.89	5.43	5.33	1.42
NSPC-5	92.17	2.03	3.14	2.25
NSPC-7	91.34	2.48	3.37	2.18
NSPC-9	90.23	2.87	3.85	2.05

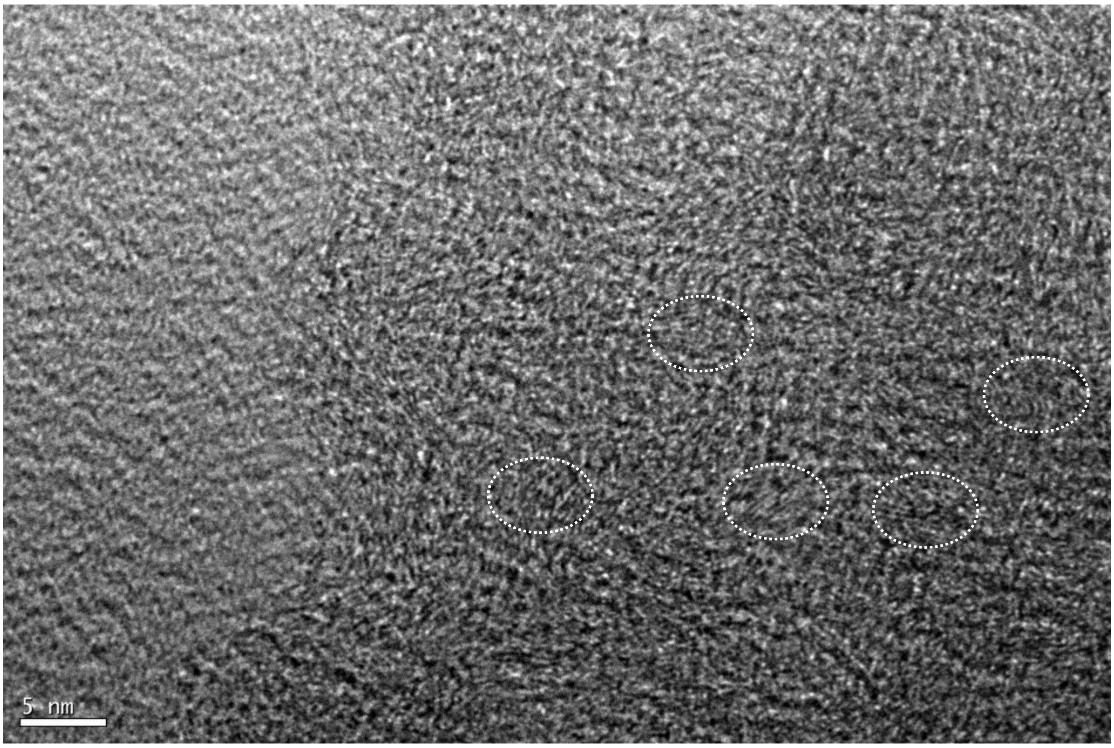

Figure S5 HRTEM image of NSPC-9.

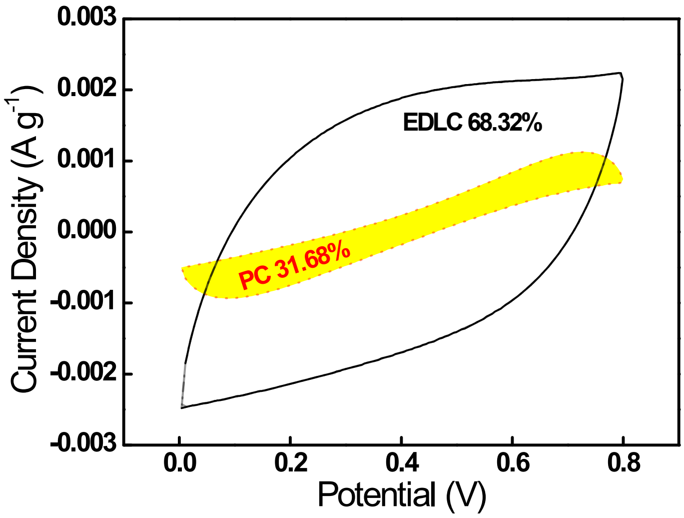

Figure S6 Illustrations of the capacitance contribution of NSPC-9 with potential window 0−0.8 V at 100 mV s^{-1} analyzed by the Dunn method. The blank region outlines the current density from EDLC.

Table S2 Specific capacitance of porous carbon material in this work, in comparison with some representative results from recent publications.

Electrode material	Specific Capacitance	Scan rate or current density	Electrolyte	reference
Carbon-G-A	202.7 F g^{-1}	1.0 A g^{-1}	6.0 M KOH	S1
GA/NMC-95%	377 F g^{-1}	0.2 A g^{-1}	1.0 M H_2SO_4	S2
OMCs	277 F g^{-1}	0.5 mV s^{-1}	1.0 M H_2SO_4	S3
PCNS-2	283 F g^{-1}	0.5 A g^{-1}	6.0 M KOH	S4
PZCC	133 F g^{-1}	10 A g^{-1}	6.0 M KOH	S5
C-900	210 F g^{-1}	1.0 A g^{-1}	6.0 M KOH	S6
NHGCSs	306 F g^{-1}	0.1 A g^{-1}	2.0 M H_2SO_4	S7
NPC800	230 F g^{-1}	0.5 A g^{-1}	5.0 M KOH	S8
HPBC	329 F g^{-1}	0.5 A g^{-1}	6.0 M KOH	S9
CN-BC	302 F g^{-1}	0.5 A g^{-1}	6.0 M KOH	S10
a-PMMA/BC-850	266 F g^{-1}	0.5 A g^{-1}	1.0 M H_2SO_4	S11
NG	289 F g^{-1}	0.2 A g^{-1}	6.0 M KOH	S12
N-CNFs-900.	202 F g^{-1}	1.0 A g^{-1}	6.0 M KOH	S13
MCM-30-2.0	289 F g^{-1}	1.0 A g^{-1}	6.0 M KOH	S14
NSPC-9	969.4 F g^{-1} 357.6 F g^{-1}	0.1 A g^{-1} 1.0 A g^{-1}	0.5 M H_2SO_4	**This work**

Table S3 HER performance of NSPC-9 in this work, in comparison with the results of some representative carbon-based and non-noble electrocatalysts from recent publications.

Catalyst	**Electrolyte**	**Overpotential at $j = 10$ mA cm^{-2} (mV)**	**Tafel slope (mV dec^{-1})**	**Ref.**
C_3N_4/FTO	0.1 M PBS 0.1 M KOH	250 100	/	*S15*
C_3N_4@NG	0.5 M H_2SO_4 0.1 M KOH	240 >600	51.5 /	S16
g-C_3N_4 nanoribbon-G	0.5 M H_2SO_4	207	54	S17
C_3N_4	0.1 M PBS 0.1 M KOH	600 (at $j = 0.8$ mA cm^{-2}) 300 (at $j = 0.8$ mA cm^{-2})	120	S18
MPSA/GO-1000	0.5 M H_2SO_4 0.1 M KOH	210 (at $j = 30$ mA cm^{-2}) 470	/ /	S19
N,P-graphene-1	0.5 M H_2SO_4 0.1 M KOH	420 >600	/ /	S20
SNCTs	0.5 M H_2SO_4	76 (at $\boldsymbol{j} = 0.2$ mA cm^{-2})	126	S21
N,S co-doped graphene 500C	0.5 M H_2SO_4	276	81	S22
SHG	0.1 M KOH	310	112	S23
N-G	0.1 M KOH	510	*157*	S24
NiMoNx/C	0.1 M $HClO_4$	/	35.9	S25
Co-NRCNTs	0.5 M H_2SO_4 0.1 M KOH	260 >400	69 /	S26
1T-MoS_2 nanosheets	0.5 M H_2SO_4	>200	41-46	S27
Exfoliated WS_2 nanosheets	0.5 M H_2SO_4	210 mV	60	S28
Exfoliated MoS_2 nanosheets	0.5 M H_2SO_4	195	54	S29
CoOx@CN	0.5 M H_2SO_4	232	115	S30
Monolayer MoS_2 supported by NPG	0.5 M H_2SO_4	226	46	S31
NSPC-1000	0.5 M H_2SO_4	**146** **(80, after activating)**	64	***This work***

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