Supplementary Information

Ultrahigh-Surface-Area Hierarchical Porous Carbon from Chitosan: Acetic Acid Mediated Efficient Synthesis and Its Application in Superior Supercapacitor

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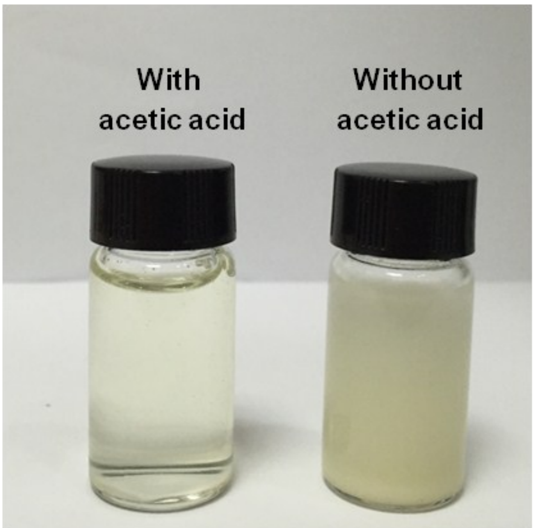

Fig. S1 Photographs of the chitosan aqueous solution obtained with (left) and without (right) the addition of acetic acid.

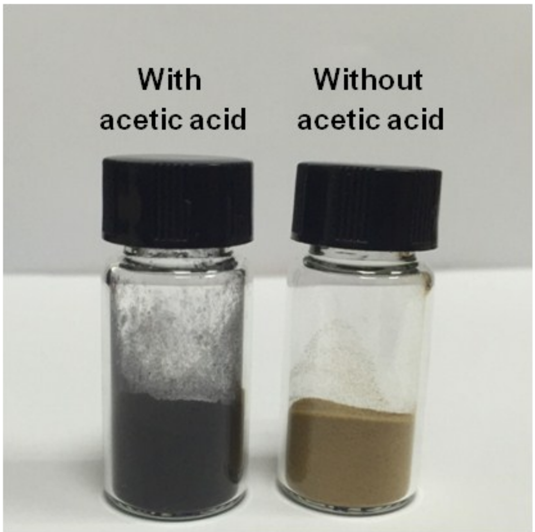

Fig. S2 Photographs of the hydrochar obtained with (left) and without (right) the addition of acetic acid.

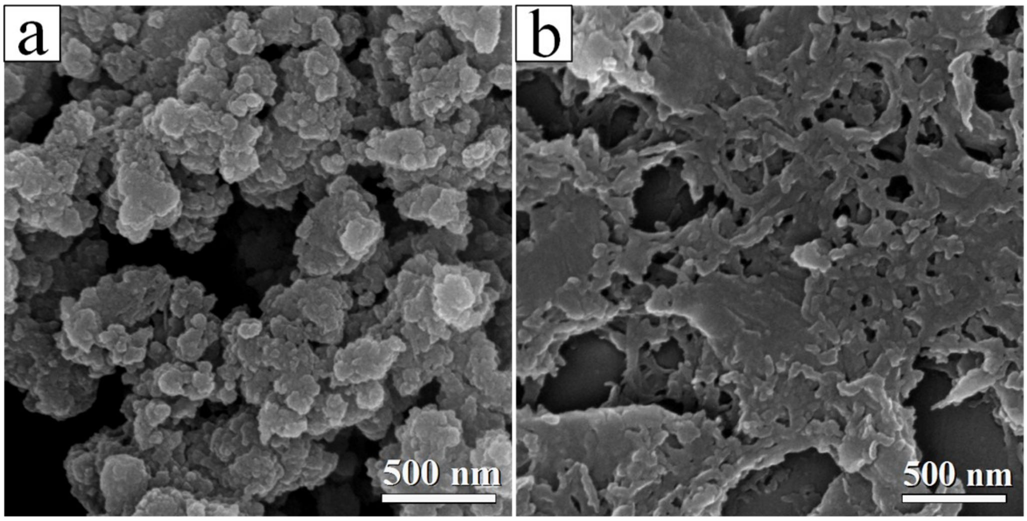

Fig. S3 SEM images of the hydrochars obtained (a) with and (b) without the addition of acetic acid.

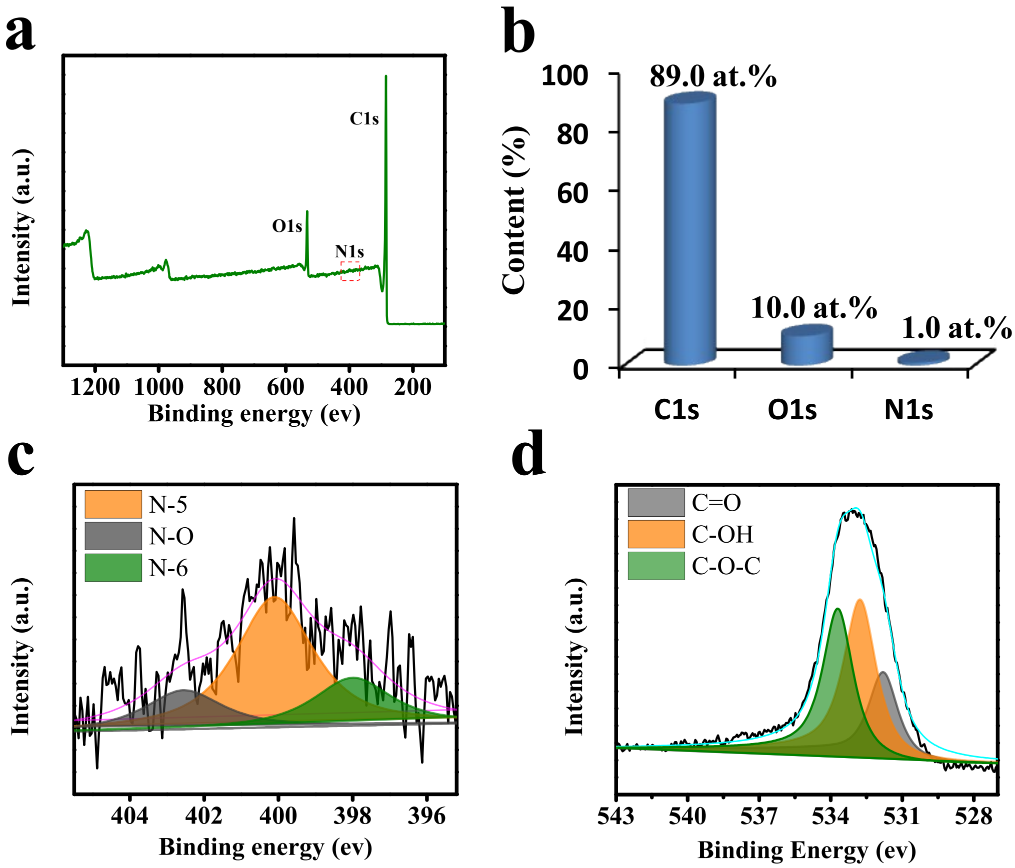

Fig. S4 (a) XPS spectrum, (b) elemental content information, (c) high-resolution N 1s spectrum of the C-HPC and (d) high-resolution O 1s spectrum.

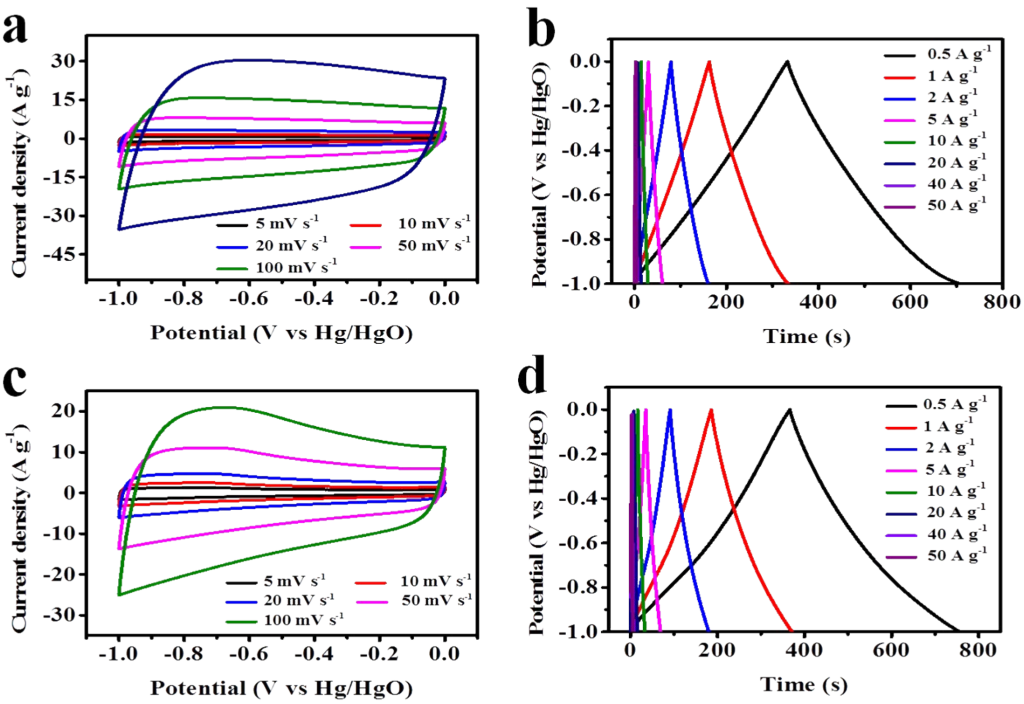

Fig. S5 (a) CV and (b) GCD curves of YP-50. (c) CV and (d) GCD curves of control sample.

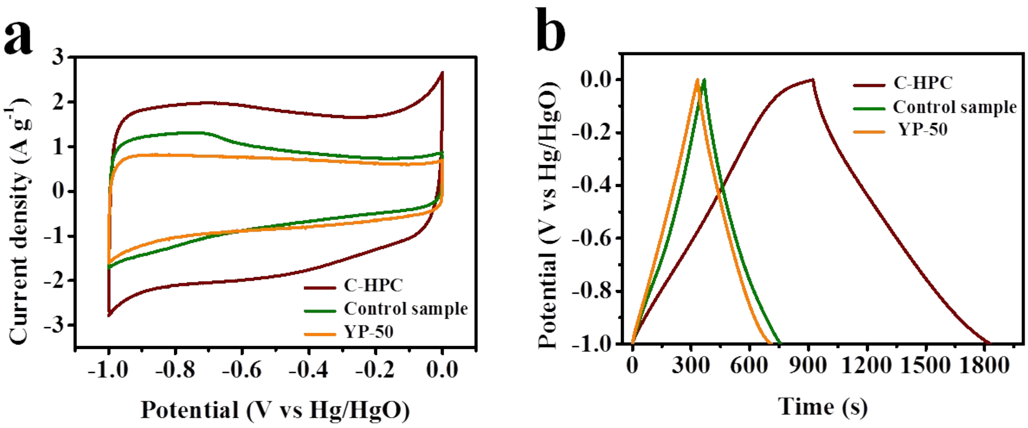

Fig. S6 Comparisons of (a) the CV curves obtained at a sweep rate of 5 mV s^{-1} and (b) the GCD curves obtained at a current density of 0.5 A g^{-1} for C-HPC, the control sample and YP-50.

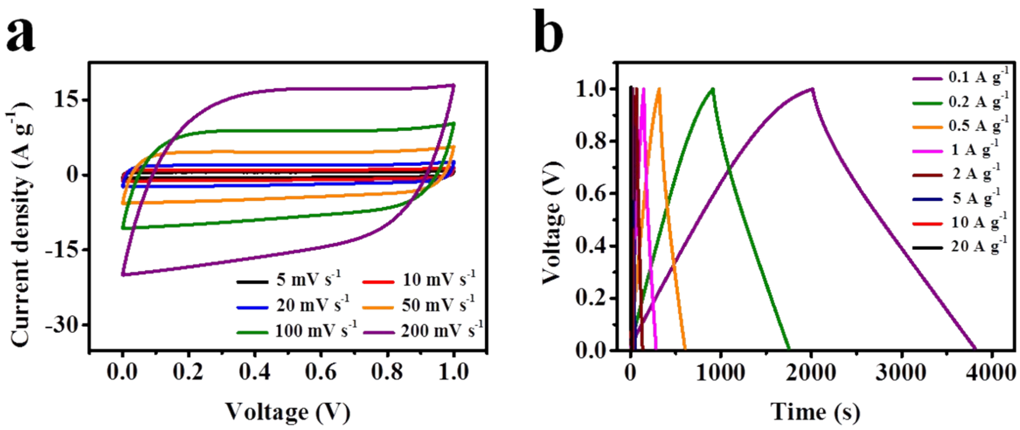

Fig. S7 (a) CV curves at different sweep rates and (b) GCD curves at different current densities of C-HPC-based coin-type symmetrical supercapacitors by using 6 M KOH aqueous solution as electrolyte.

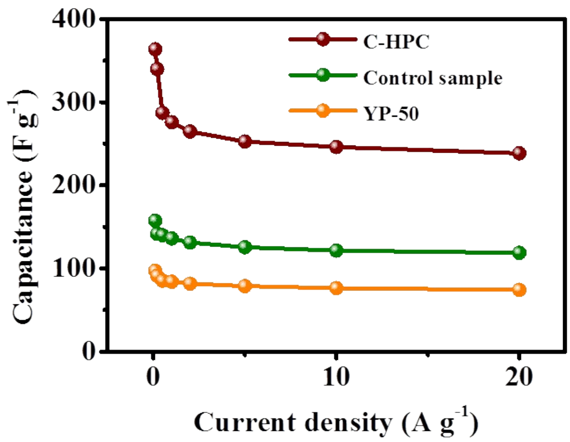

Fig. S8 (a) Specific capacitances of C-HPC, control sample and YP-50 tested in coin-type symmetrical supercapacitors by using 6 M KOH aqueous solution as electrolyte at different current densities.

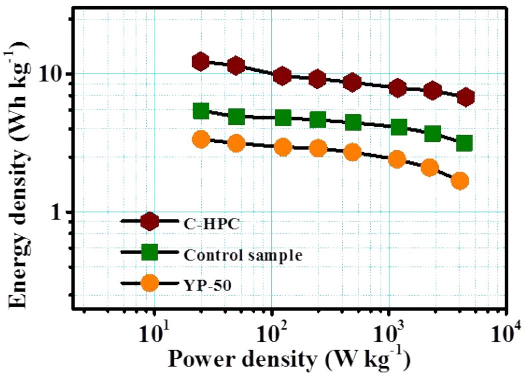

Fig. S9 Ragone plots of coin-type symmetrical supercapacitors for C-HPC, control sample and YP-50 by using 6 M KOH aqueous solution as electrolyte.

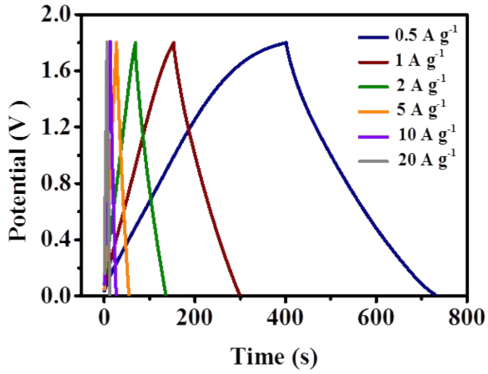

Fig. S10 (a) GCD curves of C-HPC at various current densities obtained in coin-type symmetrical supercapacitors by using 1 M Na_2SO_4 aqueous solution as electrolyte.

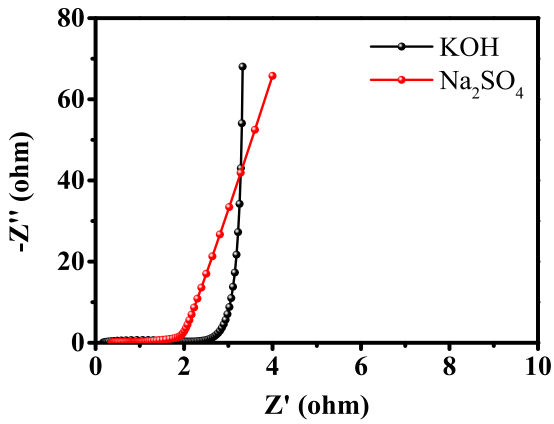

Fig. S11 Nyquist plots of the C-HPC coin-type symmetrical supercapacitors by using 6 M KOH aqueous solution and 1 M Na_2SO_4 aqueous solution as electrolyte.

Table S1 Summary BET surface areas, total pore volumes, activating agents and experience conditions for the reported porous carbons derived from chitosan.

Refer. Number	Pore structure	S_{BET} (m^2 g^{-1})	V_t (cm^3 g^{-1})	Activation Agent	Carbonization Temperature	Source
This work	**Hierarchical porous structure**	**3532**	**1.64**	**KOH**	**800**	**Chitosan**
1	Hierarchical porous structure	1013	0.58	K_2CO_3	800	Chitosan
2	Hierarchical porous structure	2435	1.09	KOH	800	Chitosan
3	Micro/meso-porous structure	2616	1.28	KOH	900	Chitosan
3	Micro/meso-porous structure	3330	2.20	KOH	1000	Chitosan
4	Hierarchical porous structure	1511	-	KOH	700	Chitosan and graphene
5	Hierarchical porous structure	1582	1.23	$ZnCl_2$	700	Chitosan
6	Micro/meso-porous structure	1567	0.48	$ZnCl_2$	900	Chitosan
7	Micro/meso-porous structure	1054	0.45	CO_2	900	Chitosan
8	Hierarchical porous structure	1785	0.54	$ZnCl_2$	700	Chitosan
9	Microporous structure	440		Na_2CO_3	600	Chitosan
10	Hierarchical porous structure	692	3.02	-	900	Chitosan and graphene
10	Hierarchical porous structure	472	1.94	-	900	Chitosan
11	Micro/meso-porous carbon	1510	1.32	-	900	Chitosan
12	Hierarchical porous structure	1956	1.48	$Zn(NO_3)_2\cdot 6H_2O$	800	Chitosan
13	Hierarchical porous structure	2169	0.99	KOH	800	Chitosan
14	Micro/meso-porous structure	2807	-	KOH	750	Chitosan
14	Micro/meso-porous structure	2397	-	KOH	850	Chitosan

Table S2 Summary of BET surface areas, activation method and activation agent for the reported hierarchal porous carbons derived from different precursors.

Refer. Number	S_{BET} (m^2 g^{-1})	Activation Method	Activation Agent	Biomass
This work	**3532**	**Chemical**	**KOH**	**Chitosan**
15	2250	Chemical	$ZnCl_2$+$FeCl_3$	Moringa oleifera stems
16	2312	Chemical	KOH	Moringa oleifera branches
17	2252	Chemical	KOH	Gelatin
18	2968	Chemical	KOH	Pumpkin
19	1930	Chemical	KOH	Peanut skin
20	2396	Chemical	KOH	Peanut shell
21	2839	Chemical	KOH	Sewage sludge
22	598	Chemical	KOH	Glucosamine hydrochloride
23	1962	Chemical	NaOH	Paulownia sawdust
24	2218	Chemical	KOH	Lignin
25	1260	Chemical	KOH	Sawdust
25	1850	Chemical	KOH	Sawdust
26	898	Physical	NH_3	Typha orientalis
27	1103	Chemical	KOH	Fungus
28	1363	Chemical	KOH	Almond shell
29	2585	Chemical	KOH	Sunflower seed shell
30	2342	Chemical	KOH	Potato starch
31	2160	Chemical	$ZnCl_2$+KCl	Glucose
32	2457	Chemical	KOH	Cellulose

32	2273	Chemical	KOH	Starch
33	3251	Chemical	KOH	Starch
34	1510	Chemical	KOH	Starch
35	2316	Chemical	KOH	Wheat straw
36	2157	Chemical	KOH	Pig bone
37	2273	Chemical	KOH	Fish scale
38	1273	Chemical	KOH	Cherry stones
39	416	Chemical	KOH	Waste news paper
40	2405	Chemical	KOH	Enteromorpha prolifera
40	1204	Chemical	KOH	Enteromorpha prolifera
41	2106	Chemical	KOH	Fermented rice
42	1413	Chemical	KOH	Bamboo
43	169	Chemical	KOH	Bamboo
44	2073	Chemical	KOH	Algae
45	2855	Chemical	KOH	Silk
46	2496	Chemical	$ZnCl_2$+$FeCl_3$	Silk
47	2454	Chemical	KOH	Silk fibroin
48	2490	Chemical	KOH	Bluestem
48	1616	Chemical	NaOH	Bluestem
48	552	Chemical	$NaHCO_3$	Bluestem
49	2111	Chemical	KOH	Coffee grounds
50	1758	Chemical	KOH	Artemia cyst shell
51	491	Chemical	H_3PO_4	Bacterial cellulose
52	3270	Chemical	KOH	Seaweed
52	2170	Chemical	KOH	Seaweed
53	3054	Chemical	KOH	Corncob
54	1776	Chemical	KOH	Willow catkins

55	1589	Chemical	KOH	Willow catkins
56	1586	Chemical	KOH	Willow catkins
57	1929	Chemical	KOH	Olive pits
58	1081	Chemical	KOH	Shiitake mushroom
58	2988	Chemical	H_3PO_4+KOH	Shiitake mushroom
58	1315	Chemical	H_3PO_4	Shiitake mushroom
59	3398	Chemical	KOH	Bean dregs
59	2555	Chemical	KOH	Bean dregs
60	2130	Chemical	H_3PO_4	Soybean residue
61	580	Chemical	KOH	Soybean
62	1124	Physical	Air	Grape seed
63	3350	Chemical	KOH	Sisal fiber
64	2140	Chemical	KOH	Cornstalks
65	2296	Chemical	KOH	Bagasse
66	1154	Chemical	KOH	Plane tree
67	2821	Chemical+Physical	KOH+CO_2	Fir wood
32	2331	Chemical	KOH	Wood
32	2967	Chemical	KOH	Wood
68	1750	Physical	Steam	Wood
68	1579	Chemical	$ZnCl_2$	Wood
69	1926	Physical	Steam	Coconut shell
70	1356	Chemical	KOH	Coconut shell
71	1028	Physical	Air	Coconut shell
72	1652	Chemical+Physical	$ZnCl_2$+CO_2	Coconut shell

73	1026	Chemical+Physical	$KOH+CO_2$	Coconut shell
74	1874	Chemical	$ZnCl_2+FeCl_3$	Coconut shell
75	1266	Chemical	$ZnCl_2$	Coconut shell
76	2841	Chemical	KOH	Tea leaves
77	1409	Chemical	K_2CO_3+KOH	Fallen leaves
78	1395	Chemical	K_2CO_3	Reed black liquor
79	1217	Chemical	K_2CO_3	Reed black liquor
80	2710	Chemical	KOH	Rice husk
80	2304	Chemical	KOH	Rice husk
81	176	Chemical	H_3PO_4	Rice husk
81	1295	Chemical	H_3PO_4	Rice husk
82	162	Chemical	H_3PO_4	Rice husk
68	1930	Chemical	KOH	Rice husk
68	1886	Chemical	NaOH	Rice husk
83	2287	Chemical	KOH	Hemp bast fiber
84	721	Chemical	$ZnCl_2$	Spider silk
85	1212	Chemical	KOH	Broussonetia papyrifera
86	1230	Chemical	KOH	Neem dead leaves
87	2646	Chemical	KOH	Black liquor

Table S3 Summary of BET surface areas corrensponding activation method and conditions for porous carbons derived from different precursors.

Refer. Number	S_{BET} ($m^2\ g^{-1}$)	Activation Tempreture (^oC)	Activation Agent	Carbon Source/ Activation Agent	Source
This work	**3532**	**800**	**KOH**	**3:1**	**Chitosan**
88	2582	900	KOH	10:1	Graphene
64	3200	750	KOH	10:1	Cornstalks
89	3100	800	KOH	9:1	Graphene
90	3247	900	KOH	7:1	Phenolic resin
91	3023	900	KOH	6:1	Polystyrene
92	2224	800	KOH	6:1	Olive pits
93	2896	800	NaOH	6:1	Rice hull
63	3350	900	KOH	5:1	Sisal fibers
48	2490	820	KOH	5:1	Big bluestem grass
94	3304	800	KOH	4:1	Rice husk
95	3404	800	KOH	4:1	Celtuce leaves
76	2841	800	KOH	4:1	Waste tea-leaves
32	2973	800	KOH	4:1	Eucalyptus wood sawdust
53	3054	850	KOH	4:1	Corncobs
45	2854	800	KOH	4:1	Silk cocoons
33	3251	800	KOH	4:1	Porous starch

Table S4 The contents of C, H and N of the chitosan, hydrochar without use of acetic acid and hydrochar with used of acetic acid.

Samples	C (%)	N (%)	H (%)
Chitosan	40.3	7.4	7.8
Hydrochar without use of acetic acid	42.2	7.8	7.5
Hydrochar with use of acetic acid	61.9	5.5	5.1

Table S5 Comparision of the electrochemical performance for representative carbons.

Samples	Refer. Number	Current Density (A g^{-1})	Capacitance (F g^{-1})		Current Density (A g^{-1})	Capacitance (F g^{-1})	
			Ref.	This work (C-HPC)		Ref.	This work (C-HPC)
Mesoporous carbon	96	0.5	225	**455**	20	165	**332**
Ordered mesoporous carbon/graphene aerogel	97	0.5	197	**455**	10	140	**341**
Nitrogen-doped graphene	98	0.5	250	**455**	20	180	**333**
Carbon nanospheres	99	0.5	140	**455**	2	110	**380**
Carbon nanocages	100	0.5	220	**455**	50	155	**318**
Microporous carbon nanosheets	101	0.5	210	**455**	50	160	**318**
Porous carbon nanosheets	102	0.5	250	**455**	20	130	**333**
Carbon nanosheets	103	0.5	257	**455**	50	200	**318**
Ordered mesoporous carbon	104	1	292	**407**	50	185	**318**
Hierarchical porous carbon	105	0.5	318	**455**	50	189	**318**
Nitrogen-doped porous carbon nanofibers	106	1	202	**407**	20	175	**333**
Nanoporous carbon spheres	107	0.5	405	**455**	50	268	**318**
Porous carbon nanosheets	15	0.5	283	**455**	50	204	**318**
Hierarchical porous carbons	16	0.5	355	**455**	50	230	**318**
Carbon microtubes	54	1	292	**407**	10	244	**341**
YP-50	This work	0.5	189	**455**	50	144	**318**

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