Supporting Information for

Hierarchical porous carbon based on the self-template structure of rice husk for high-performance supercapacitors

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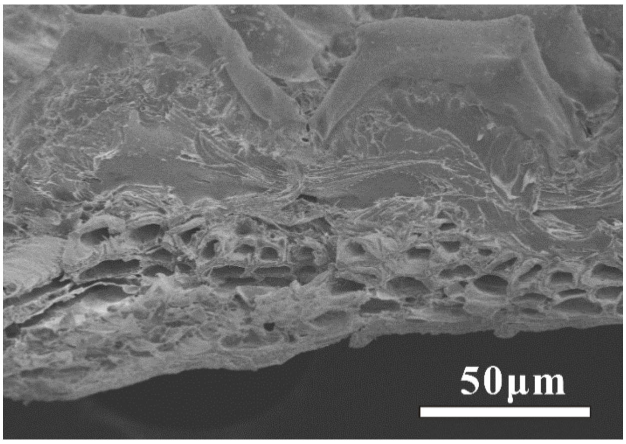

Fig. S1 SEM image of RH cross section

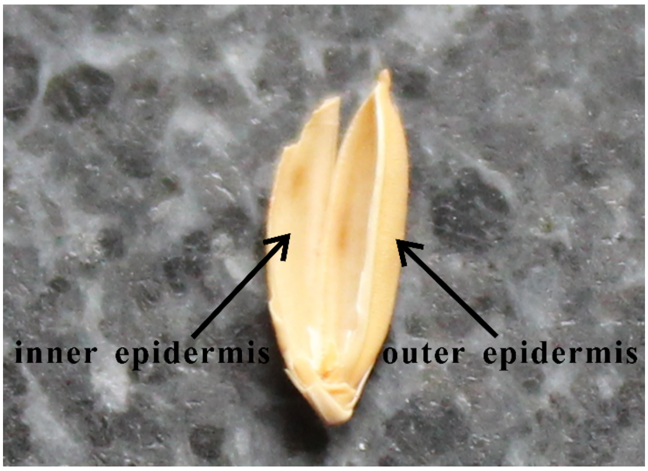

Fig. S2 The digital photograph of RH

Table S1 The porosity properties of the sample

Samples	**S_{BET}/m^2 g^{-1}**	**V_{total}/cm^3 g^{-1}**	**V_{mic}/cm^3 g^{-1}**	**V_{meso}/cm^3 g^{-1}**	**D_{pore}/nm**
RHHPC	2804	1.797	0.476	1.321	2.56
RHC	3263	1.772	1.132	0.640	2.17
Template carbon	247	0.191	0.0233	0.168	3.1
Carbon-silica composite	19	0.0162	0.0037	0.0125	3.4

S_{BET}: Specific surface area determined from the BET method (m^2 g^{-1}).
V_{total}: Total pore volume (cm^3 g^{-1}).
V_{meso}: Mesopore volume (cm^3 g^{-1}).
V_{mic} Micropore volume (cm^3 g^{-1}).
D_{pore}: Average pore diameter (nm).

As shown in Table S1, the specific surface area of the template carbon increased from 19 m^2 g^{-1} of carbon-silica composite to 247 m^2 g^{-1} with removal of silica in carbon- silica composite. When the carbon-silica composite or template carbon was activated by KOH, the specific surface area of obtained product (RHC or RHHPC) was as high as approximately 3000 m^2 g^{-1}. Among them, the specific surface area of RHC was larger than RHHPC due to a large amount of micropores existed in RHC with a high micropore volume. Micropores account for 63.9 % of the total volume, which confirmed the presence of massive micropores in RHC. On the contrary, the RHHPC exhibited a lower micropore volume, which benefited from hierarchical porous structure instead of micropore-dominanted structure in RHHPC. The ratio of micropores was only 26.5%.

Table S2 Summary of oxygen containing functional groups in RHHPC

B.E. (eV)	**530.4**	**531.2**	**531.9**	**532.8**	**533.4**
Species	Quinones	COOH/C(O)O	C=O	C-O	OH
RHHPC	1.45	1.59	2.06	2.08	2.56

The contents of individual oxygen-containing functional groups in RHHPC are listed in Table S2. These surface functional groups provide extraordinary capacitance through Faradaic reactions for high-performance carbon materials, as well as improved electrode wettability because of the increased number of hydrophilic polar sites.

Preparation of RHC

The RH was heated to 500 °C and pyrolyzed for 1 h in a tubular furnace under the protection of nitrogen, then the carbon-silica composite was obtained. The carbon-silica composite was added to KOH solution to obtain the mixture with a KOH-to-carbon-silica composite ratio of 4:1 by weight. Next, the mixture was dried at 110 °C to obtain the KOH-impregnated carbon-silica composite. The KOH-impregnated carbon-silica composite was heated up to 700 °C for 1h in an electrical furnace. The activated mixtures were washed with deionized water until the filtrate became neutral. The sample was finally dried overnight at 100°C.

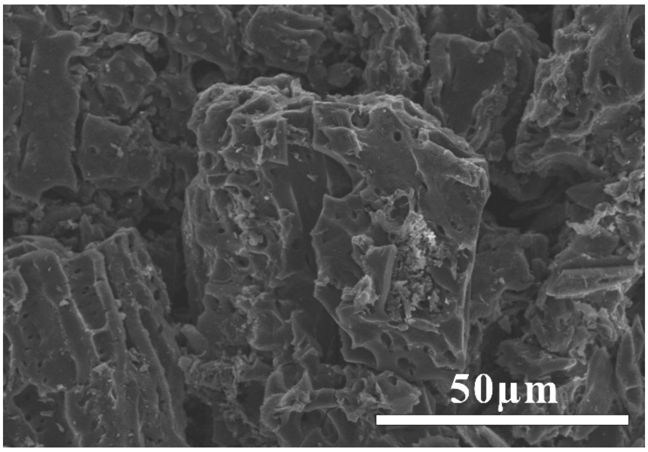

Fig. S3 SEM image of RHC

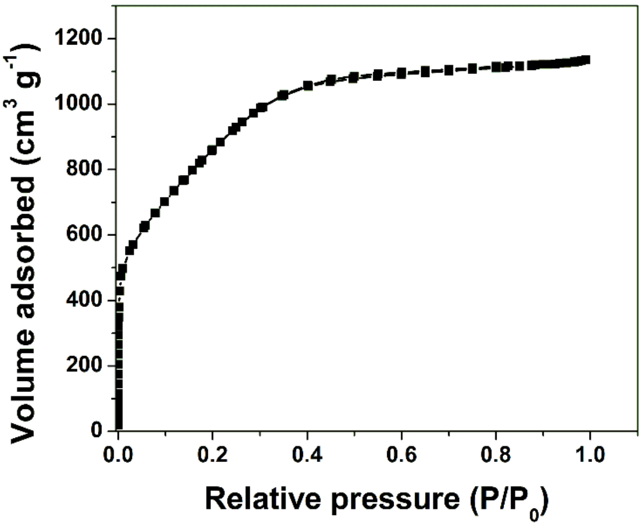

Fig. S4 Nitrogen adsorption–desorption isotherms of RHC

At relatively low pressure, the adsorbed N_2 volume increased steeply. At the higher relative pressures, it give rise to an almost horizontal plateau without hysteresis loop. These indicate that RHC possesses the high microporosity.

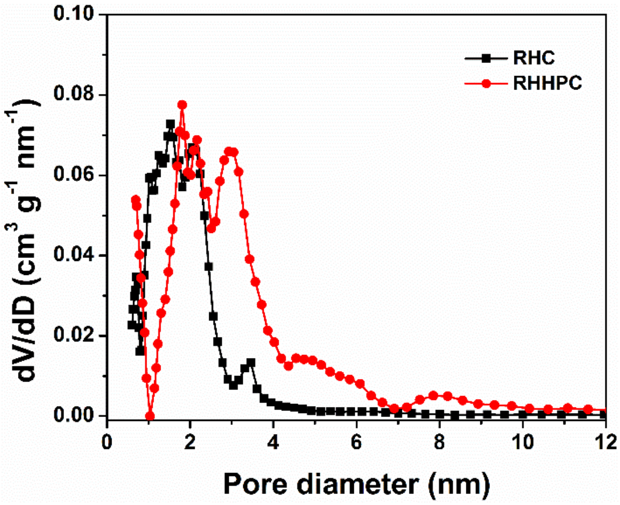

Fig. S5 The pore size distributions of RHHPC and RHC.

The pore size distributions of RHHPC and RHC calculated from the nitrogen desorption branches by DFT analysis are given in Fig. S5. RHHPC display typical hierarchical pore size distribution in a broad range of 0.5-10 nm. It can be clearly observed that the majority of pores of RHPHC are located in the region of mesopores. On the contrary, the RHC exhibits a narrow PSD between 0.5-3 nm, indicating that a large amount of micropores exist in RHC.

Table S3 Comparison of the electrochemical performances of RHHPC and other reported porous carbon materials

Sample	**Capacitance (F g^{-1})**	**Rate capability (%)**	**Electrolyte (mol L^{-1})**	**Ref.**
RHHPC	278 (0.5 A g^{-1})	77.2% (20 A g^{-1})	KOH(6)	This work
chicken feather	278 (1 A g^{-1})	60.07% (10 A g^{-1})	H_2SO_4(1)	[45]
bagasse	142.1 (0.5 A g^{-1})	63.38% (10 A g^{-1})	KOH(6)	[1]
enteromorpha prolifera	275 (0.05 A g^{-1})	76.36% (3 A g^{-1})	KOH(6)	[46]
endothelium corneum gigeriae galli	198 (1 A g^{-1})	72.12%(8 A g^{-1})	KOH(6)	[47]

Table S3 lists comparison of the electrochemical performances of RHHPC and other reported porous carbon materials. The prepared RHHPC from rice husk have higher specific capacitance and better rate capability than reported results based on other biomasses (chicken feather, bagasse, enteromorpha prolifera, endothelium corneum gigeriae galli). These comparative results also prove that the RHHPC is the promising material for supercapacitors.

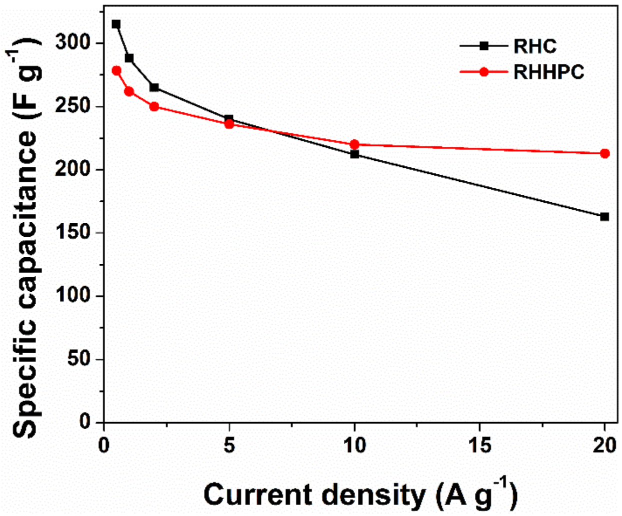

Fig. S6 Relationships between the specific capacitance values and current density for RHC and RHHPC.

Fig. S6 shows the comparison of the specific capacitance of RHC and RHHPC in a large range of current density. RHC has a specific capacitance of 315 F g^{-1} (at the current densities of 0.5 A g^{-1}) which is higher than RHHPC (278 F g^{-1}) due to its high specific surface area. When the current density was increased to 20 A g^{-1}, the specific capacitance of RHC decreased to 163 F g^{-1} with a capacitance retention of *ca.* 50%. In contrast to RHC, RHHPC exhibited a high retention of 77%. The high rate capability of RHHPC was attributed to the high ratio and large size of mesopores in RHPHC.

These comparative results indicate that 3D nano-silica in rice husk is very important to form hierarchical porous structure with high mesoporous ratio. Meanwhile, the hierarchical porous structure of RHHPC is benefit to obtain a good rate capability.

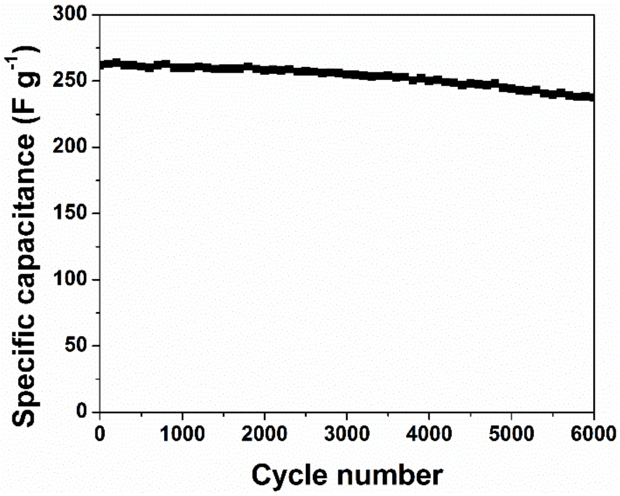

Fig. S7 Galvanostatic charge/discharge cycling stability of RHHPC at a current density of 1 A g^{-1}.

The cycling stability of the RHHPC electrode was tested at 1 A g^{-1} in 6 mol L^{-1} KOH electrolyte. As shown in Fig. S7, the specific capacitance of RHHPC decreased slowly, and about 90.5 % of the initial specific capacitance is retained after 6000 cycles. This demonstrates that the RHHPC has a relatively good long-term stability in KOH electrolyte.