Electronic Supplementary Material (ESI) for Green Chemistry.
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Preparation of Macroscopic Robust Carbon-Fiber Monolith from Filamentous Fungi and Its Application in Li-S Batteries

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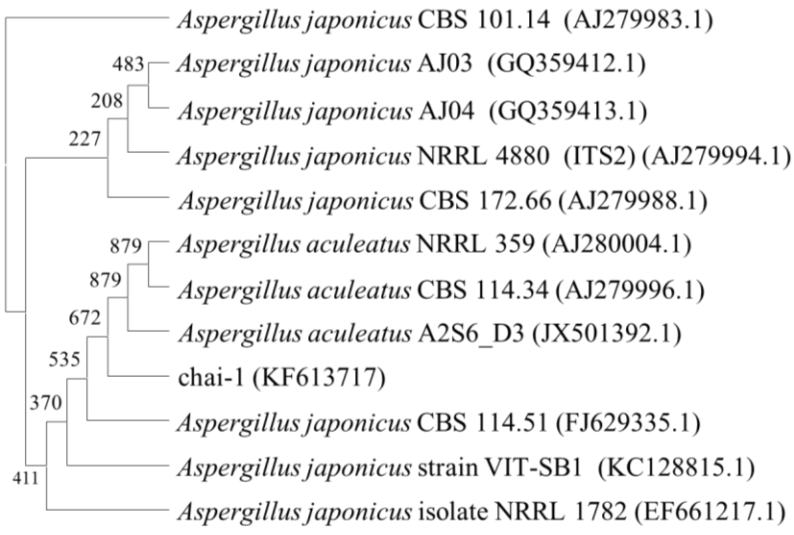
Electronic Suppementary Information

ESI-1. Isolation and Identification of the Fungi “chai-1”.

colonial morphology

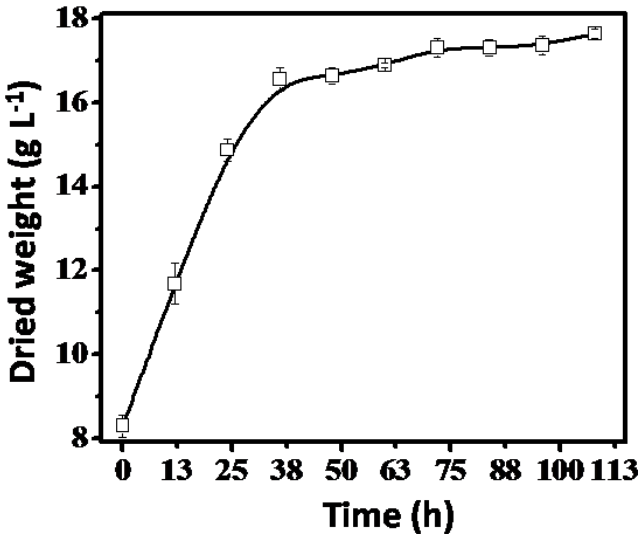


phylogenetic tree

The fungi used in present research was named “chai-1”. Colonial morphology of strain chai-1 is shown in the above image. This fungi strain was isolated from the root of *Taxus chinensis* according to our previous procedure.[1] ITS sequence-generated phylogenetic tree shows the relationships of chai-1 with its close relatives. The number at the branch nodes is bootstrap values based on 1000 re-samplings. Accession numbers of other bacterial isolates are shown in brackets. According to the Blast and phylogenetic analysis, strain “chai-1” belonged to the genus *Aspergillus aculeatus*.

[1] K. Liu, X. Ding, B. Deng, W. Chen, *J. Ind. Microbiol. Biotechnol.*, **2009**, *36*, 1171.

ESI-2. Microbe Growth Curve.



The fungi pellets in the fluid medium were inoculated into new fluid medium (inoculum size 5 %) and incubated at 37 ^{o}C with shaking rate 175 rpm. The sample was withdrawn at every 12 h interval, which was dried in flowing-air at 80 ^{o}C to determine the dry weight. The growth curve of *Aspergillus aculeatus* "chai-1" is shown above. According to the growth curve, all the thallus used in this experiment was collected after cultured for three days.

ESI-3. Separation and qualitative analysis of fungi cell wall.

Separation of cell wall. The entire process was conducted below 5 ^{o}C. Fungi (250 mL/8.5 mg mL^{-1}) were captured by vacuum filtration and washed by distilled water. The fungi collected were rapidly frozen by liquild nitrogen, which became very brittle and were grinded into white powders. The powders were added into PBS buffer solution (50 mL/pH 7.8) containing EDTA (0.1 mL/10 mM) and phenylmethanesulfonyl fluoride (PMSF: 0.2 mL/10 mM), which was treated by ultrosonicaiton for 80 times (800 W). The PMSF was added for every one hour. The fluidic substances in the cell wall released into the buffer solution and through centrifugation (1000 g) we can efficiently obtain the cell wall. The cell wall was rinsed and centrifugated unitil the supernate became clean. The cell wall was dispersed in 100 mL of water for futher use.

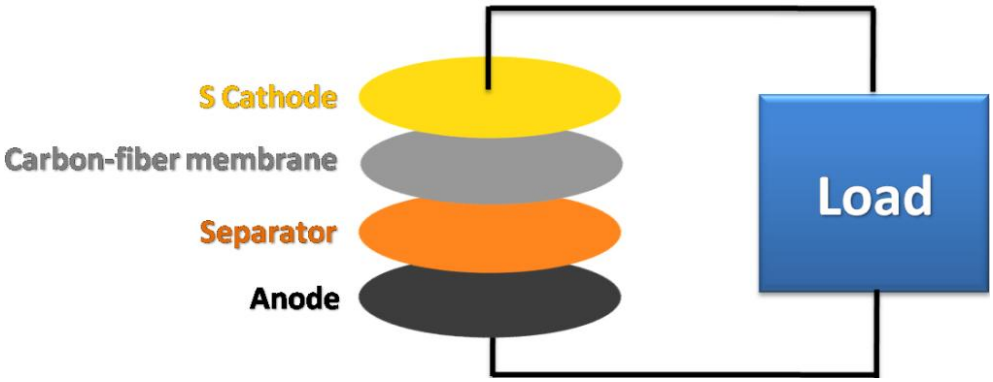
Polysaccharides. The cell wall was added into the 100 mL of NaOH solution (3 M). The suspension solution was refluxed for 2 h and then using concentrated HCl to adjust the pH to ~7. The suspension was centrifugated to obtain the supernant.

2.5 mL of concentrated H_2SO_4 was added into the mixture of 0.05 mL of supernant and 0.95 mL of water. Then, 0.5 mL of phenol (6 wt. %) was added. The solution rapidly turned to orange. This process was used to qualitative detect the polysaccharides. First, the polysaccharides decomposed to monosaccharides by hydrolysis in H_2SO_4, which further transformed to furfural by dehydration. The furfural can readily react with phenol to produce orange compound.

Proteins. Coomassie brilliant blue g-250 is effective to interact with proteins in dilute acid solution and correspondingly its color changes to bright blue. The proteins easily decompose to amino acids by

hydrolysis in acid or base conditions, although PMSF can highly restrict the hydrolysis. As a result, we directly dispersed the fresh cell wall in water by ultrasonication for 10 min without using any other chemical agents. The supernant was collected by centrifugation and based on the visualisation of Coomassie brilliant blue g-250, an obvious bright blue color can be seen.

ESI-4. Configuration of Li-S Batteries.

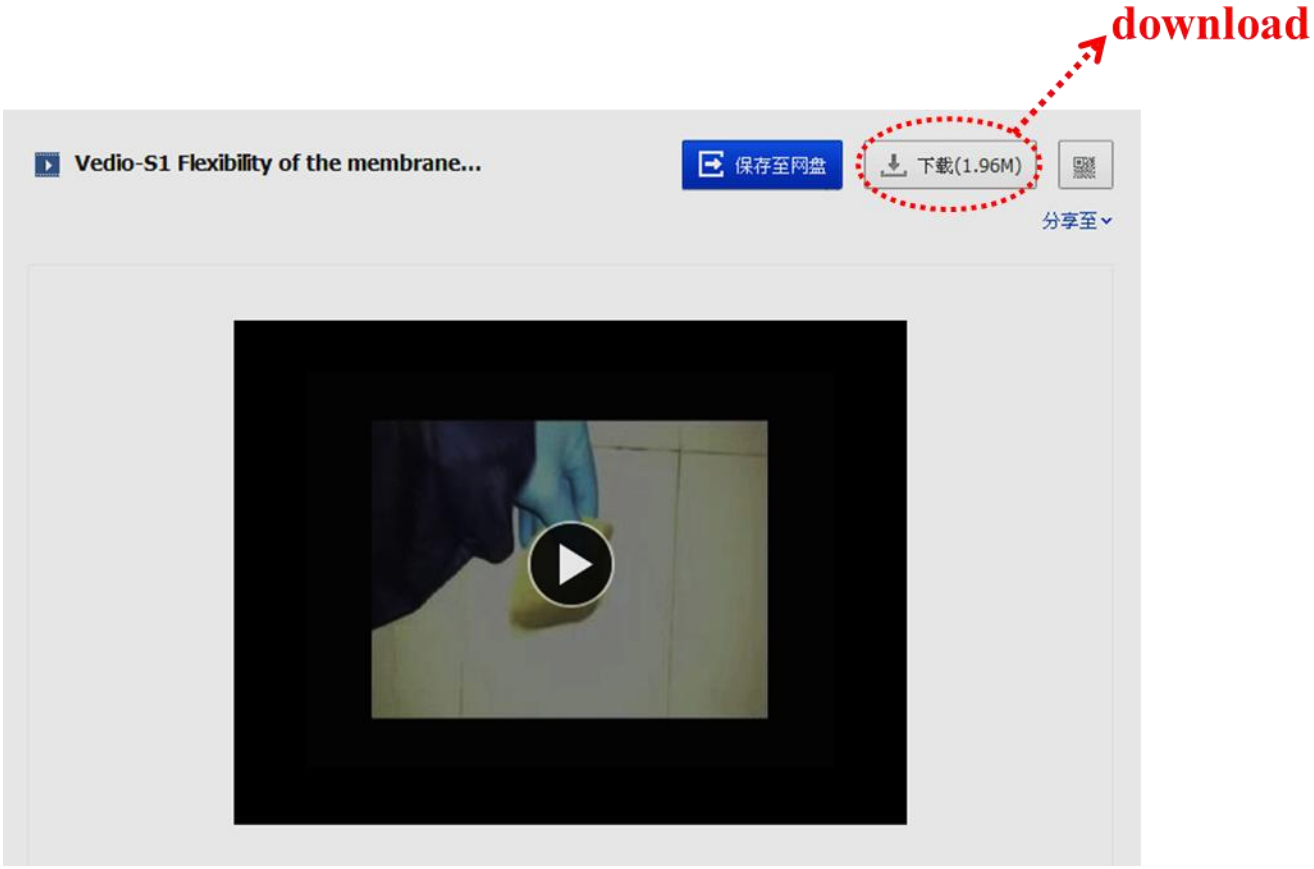


ESI-5. Website of Multimedia.

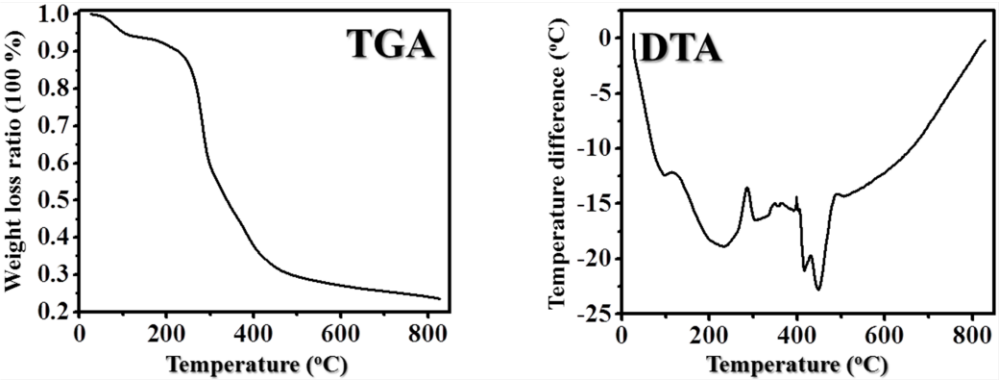
Multimedia displays the flexibility of the wet carbon monolith precursor (website:

http://pan.baidu.com/share/link?shareid=2559388185&uk=2619354716).

This file is free of charge and can be downloaded without registration.



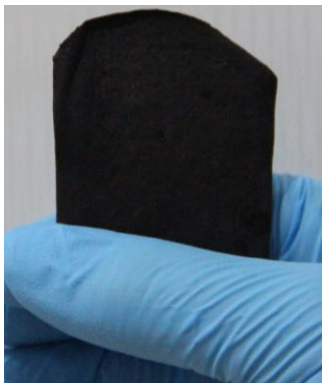
ESI-6. TGA-DTA of Fungi Monolith.

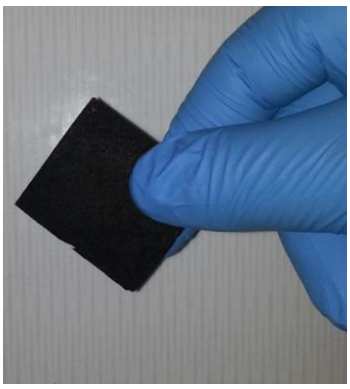


A weight loss stage was found in temperature range of 30-250 ^{o}C, which can be attributed to H_2O evaporation and correspondingly, two endothermic peaks occur in this temperature range. With increasing the temperature to 450 ^{o}C, an obvious weight loss happened. This stage could be due to the complicated degradation and cross-linking reactions, affording the carbonaceous products. According to the DTA curve, these reactions relied on the heat from environment. As further promoting the temperature, the rate of weight loss became slow and no DTA peak can be measured. At 800 ^{o}C, weight ratio was 27.1 wt. %, which was also the char yield.

ESI-7. Carbon Monolith by Carbonization of Another two Fungi.

One of these two fungi was also separated from the root of *Taxus chinensis*. But it is not identified and therefore its temporary name is "Fungi-waiting" here. Another is separated from the moldy potatoes (*Aspergillus niger*). Both of these two fungi can be used to fabricate the carbon monolith.

Fungi-waiting:  

Aspergillus niger:  

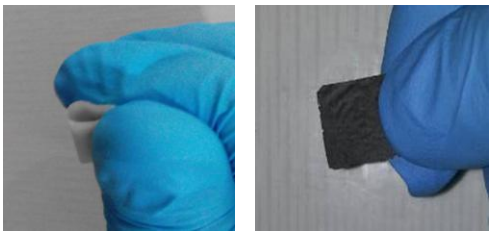
ESI-8. Observation of Fungi by Optical Microscope.

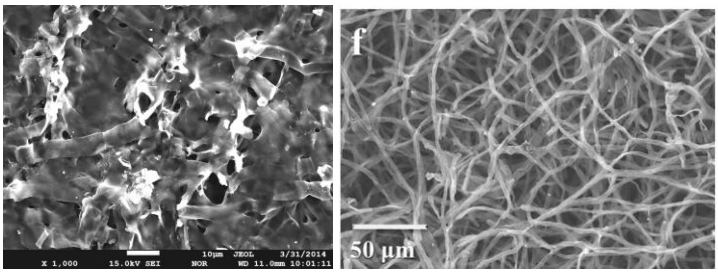
Preparation of lactophenol blue solution: 10 g of carbolic acid was dissovled in 10 mL of distilled water (80 ^{o}C). 10 mL of lactic acid and 20 mL of glycerine were added and finally 0.029 g cotton blue was added.

Morphological observation of fungi: Pure fungi inoculated on CMX culture medium at 28 ^{o}C by inverted culture. The cleaned sterile cover glass was obliquely inserted into the culture medium and the fungi will grow and finally cover the glass. Adding ~6 drops of lactophenol blue solution onto another sterile cover glass, which covered onto the fungi-containing cover glass. The optical microscope was used to observe the morphology.

ESI-9. Carbon Monolith by Carbonization of cell wall.

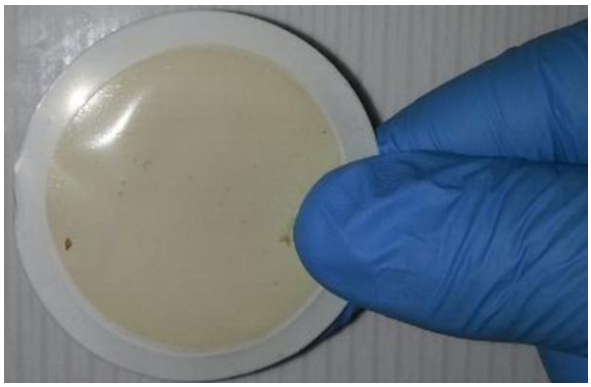
Farbication process: cell wall in ESI-3 was used. 30 mL of suspension was vacuum filtrated. A white film was formed and can be readily peeled off. The white film was dried in flowing air at 80 ^{o}C. The carbonization process is the same to that in the main text in Experimental.



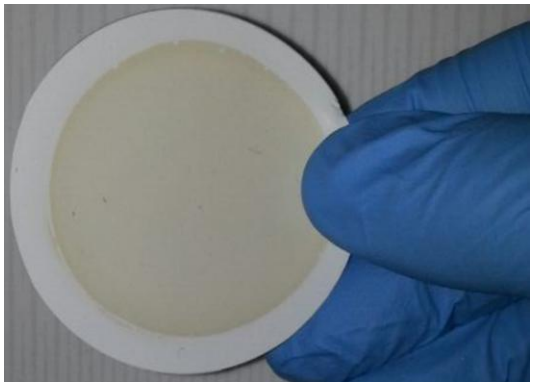


As compared with the Figure 1 in main text (given in the right side here), the carbon membrane from cell wall (left) is very compact.

ESI-10. Monolithic Precursors from Yeast and Bacteria

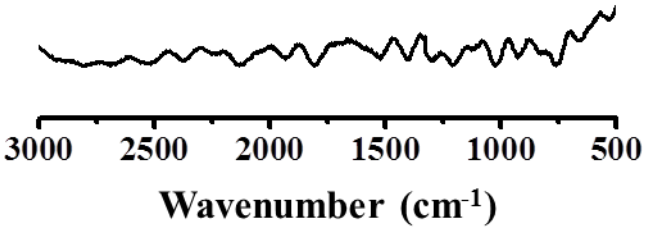


Yeast membrane



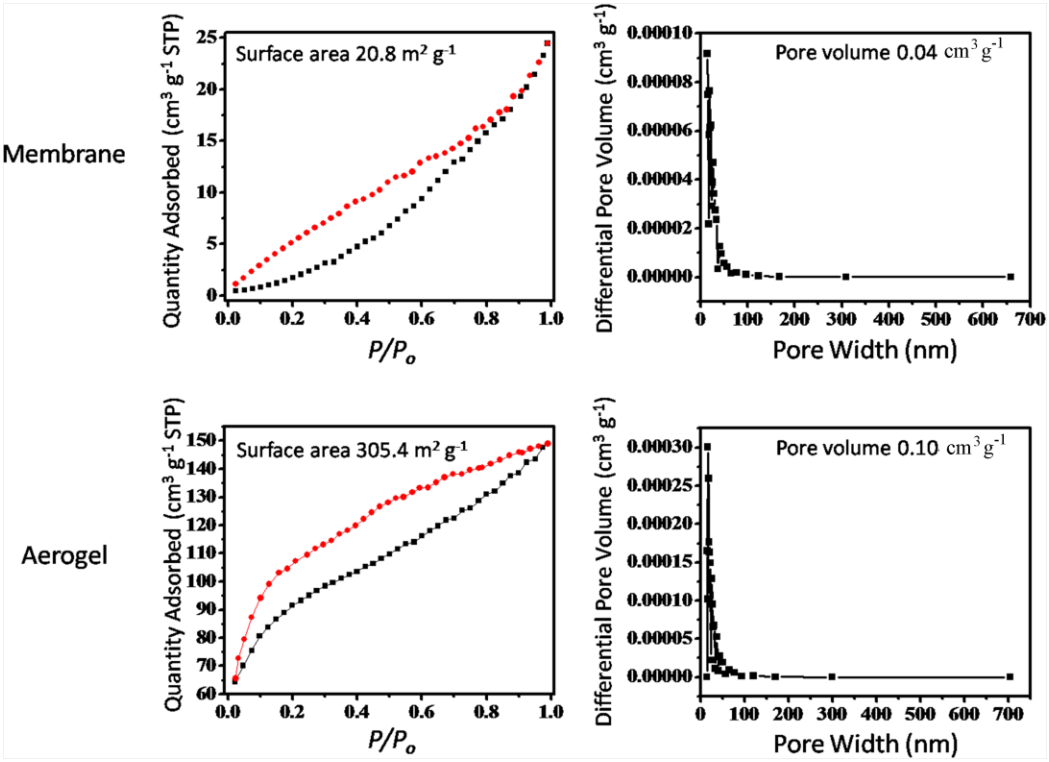
Bacteria membrane

ESI-11. Raman spectrum of fungi monolith.

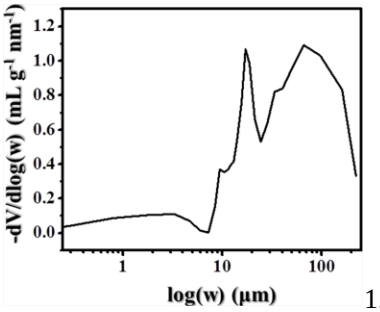


ESI-12. N_2 Adsorption-Desorption Isotherm and Hg intrusion test.

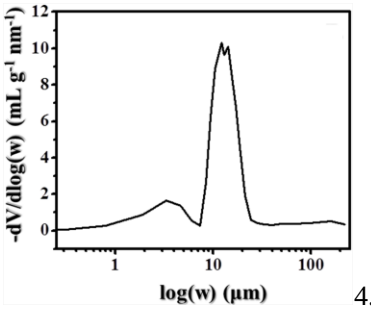
N_2 adsorption-desorption isotherm



Hg intrusion

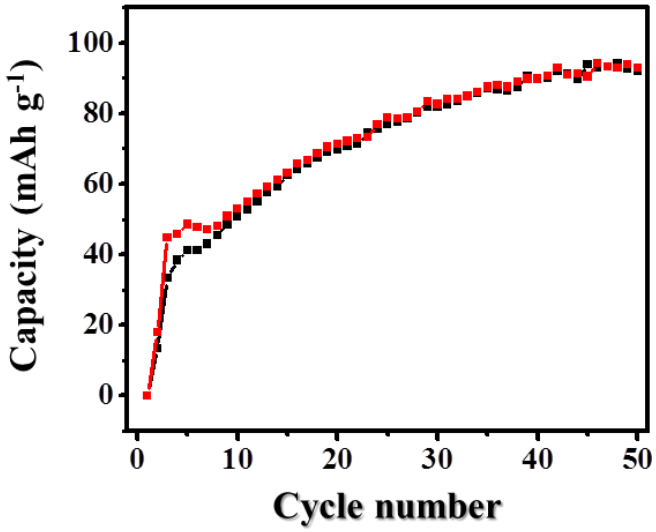
Memrbane: 

1.26 mL g^{-1}

Aerogel: 

4.37 mL g^{-1}

ESI-13. Performance of Li-S Batteries using cell-wall-derived carbon membrane as conductive interlayer.



From the above figure, it is known that the capacity of Li-S batteries is less than 100 mA h g^{-1}. Moreover, the capacity promotes with the increase of cycle number. These are the typical phenomenon that the transportation of Li^+ is inhibited.