Electronic Supplementary Material

Stretchable and conductive lignin hydrogel electrolyte for flexible supercapacitor

2. Experimental

2.1. Preparation of Active Carbon Cloth (ACC) Electrodes

The carbon cloth was first treated with 40 mL of H_2SO_4 and HNO_3. The active carbon cloth was washed with deionized water and then dried for 12 h at 90 °C. Next, an active slurry was prepared by mixing activated carbon, acetylene black and poly(tetrafluoroethylene) (a weight ratio of 8:1:1). Subsequently, certain amount of ethanol was added to prepare the active slurry. The ACC electrodes were prepared by coating the active slurry on the active carbon cloth.

2.2. Assembly of the supercapacitors

The ASH and ACC were cut into rectangular slices with a dimension of 10 × 10 × 2 mm^3 and 12 × 12 × 0.2mm^3, respectively. The supercapacitor was prepared by assembling the ASH and ACC in a sandwich conformation (Fig. S1).

2.3. The measurements of electrochemical performance

Cyclic voltammogram (CV) test was carried out under the voltage window from 0 to 1.5 V with the scan rates from 5 to 100 $mV \cdot s^{-1}$. Electrochemical impedance spectra (EIS) were obtained in a frequency range of 0.01-100000Hz. Galvanostatic charge–discharge (GCD) measurements were carried out under the potential range of 0-1.0 V with different current densities from 0.5 to 10 $A \cdot g^{-1}$. Ionic conductivity (σ, $S \cdot cm^{-1}$) was calculated via the following formula:

$$\sigma = \frac{L}{S \times R_s} \tag{1}$$

where L (cm) is the thickness of the hydrogel electrolyte, S (cm^2) is the area of the electrode and R_s (Ω) is the equivalent series resistance. The specific capacitance (C_g, F·g^{-1}) and double-layer capacitance (C_s, F·cm^{-2}) were calculated with the following equation:

$$C_g = \frac{2I}{m} \cdot \frac{dt}{dv} \tag{2}$$

$$C_s = \frac{2I}{A} \cdot \frac{dt}{dv} \tag{3}$$

where I (A) and m (g) is the discharge current and the weight of active materials, A (cm^2) is the actual area of the active materials on the collector. *dv/dt* represents the slope of the discharge curve. The power density (P, W·Kg^{-1}) and energy density (E, Wh·Kg^{-1}) of the supercapacitor were calculated according to the equations:

$$E = \frac{C(\Delta v)^2}{2 \times 3.6} \tag{4}$$

$$P = \frac{3600E}{\Delta t} \tag{5}$$

Δt(s) represents the discharge time and Δv(V) is the discharge voltage.

3. Results and discussion

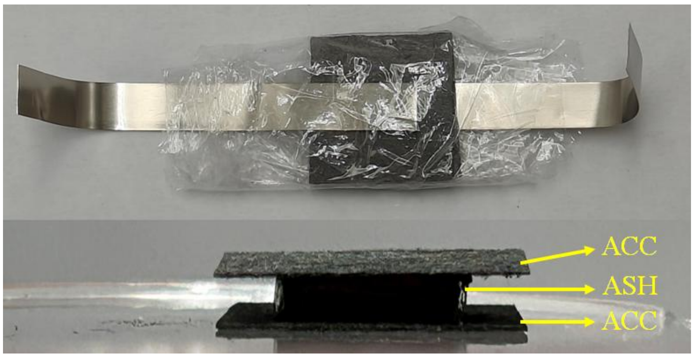

Fig. S1. Pictures about the structural composition of supercapacitor.

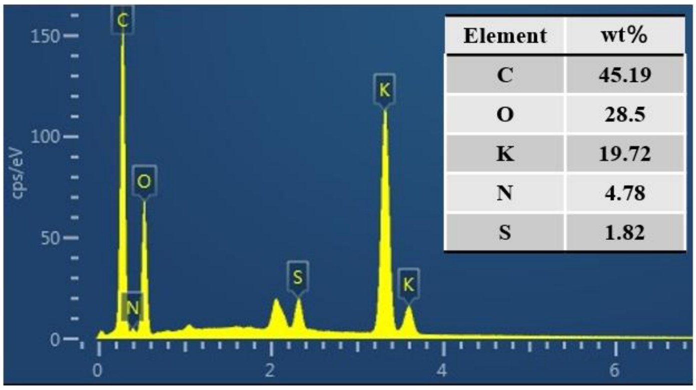

Fig. S2. The element contents of ASH gel electrolyte.

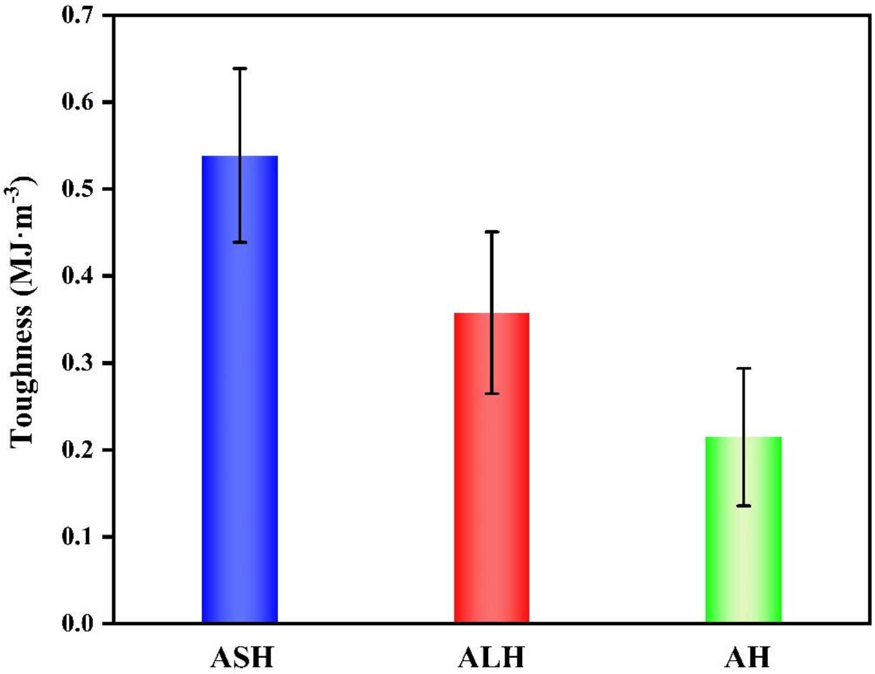

Fig. S3. Toughness of the ASH, ALH and AH.

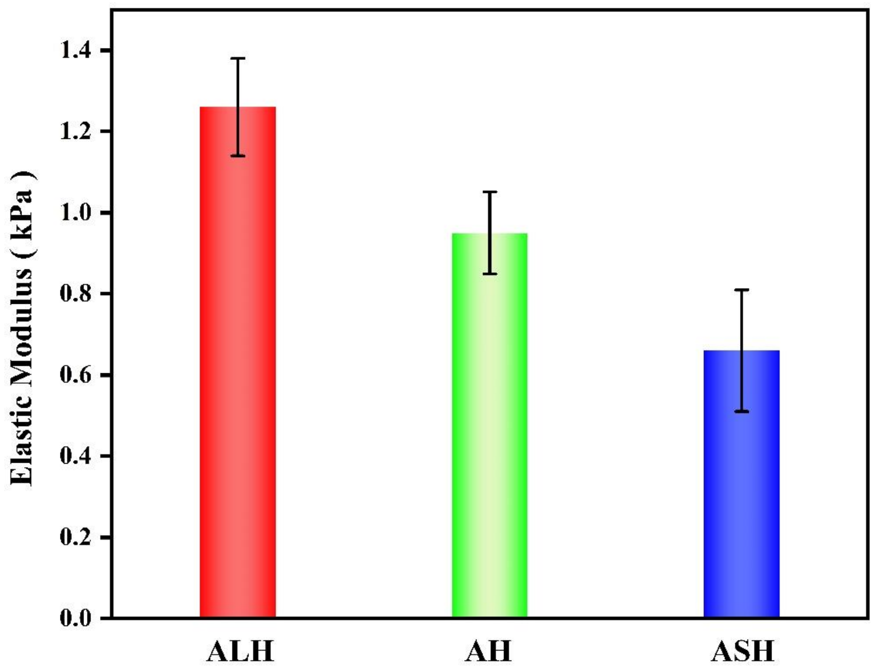

Fig. S4. Elastic modulus of the ASH, ALH and AH.

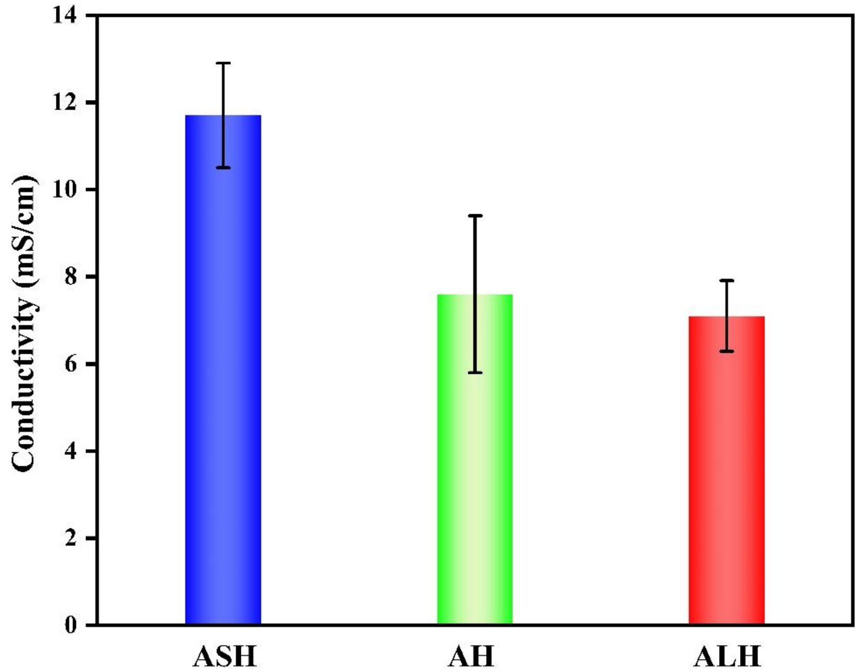

Fig. S5. The ionic conductivity of ASH, ALH and AH.

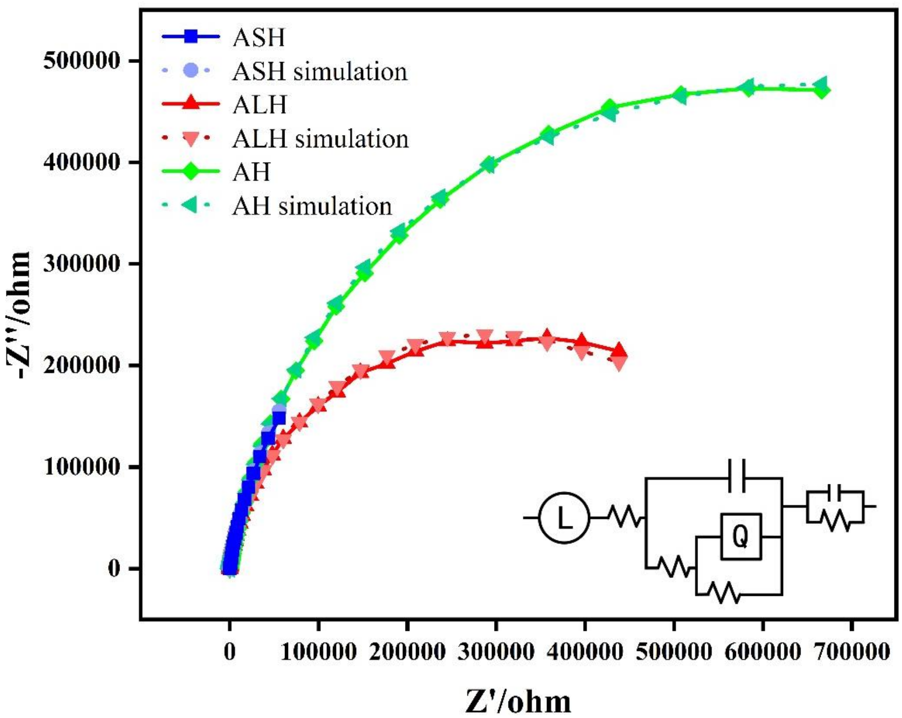

Fig. S6. Simulation results by ZSimDemo software.

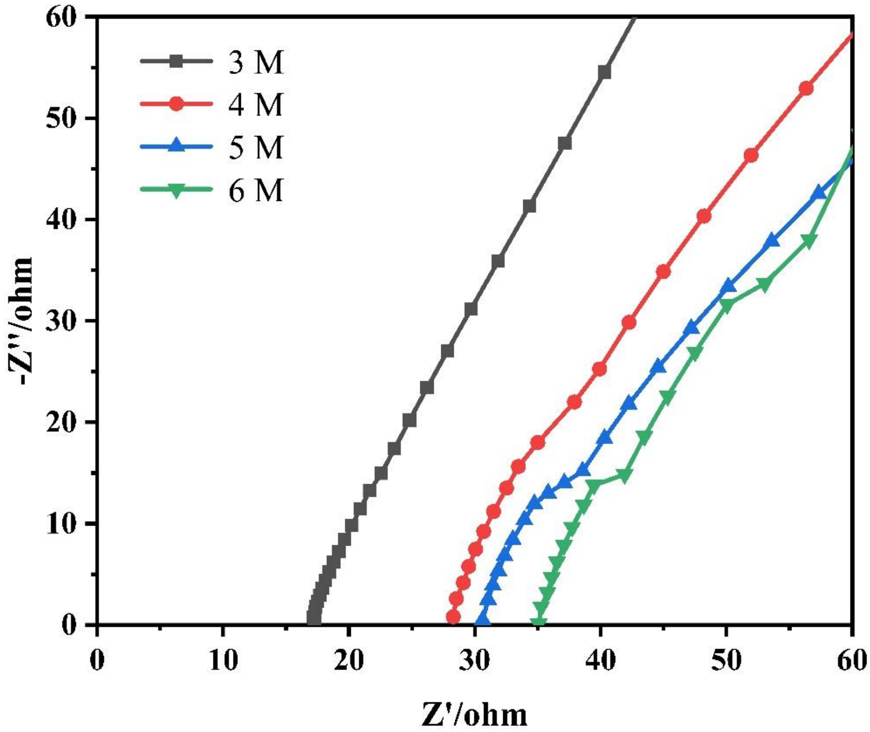

Fig. S7. The effect of different KOH concentrations on the equivalent series resistances of the ASH.