Supporting Information

A supplementary physical model of supercapacitor to reveal the mechanism of voltage recovery phenomenon

EXPERIMENTAL

Materials and Method

Potassium hydroxide (KOH, 90%) was purchased from Sigma-Aldrich Co. Ltd. Biochar electrodes were prepared by carbonization (see our before works), then cut to 2×1.5 cm². Metal plates were stainless steel with 4×4 cm². The cells were made with two electrodes, one separator and electrolytes.

Characterization

All of experiments were carried out using electrochemical measurement unit (Autolab PGSTAT302N) with two electrodes system.

![Graph](image_url)

Fig. S1 The plots of voltage recovery, cell made by pine biochar (20×15×2 mm³), electrolyte is 4 M KOH
**Discharge process**

\[ P_{12} + P_2 = 0 \text{ V} \]

\[ P = P_{11} + P_{12} + P_2 = P_{11} \]

**Video S1** Schematic animation of discharge process (double click to watch the video)

**Voltage recovery**

**Video S2** Schematic animation of voltage recovery (double click to watch the video)
**Fig. S2** Specific capacitance of pine cell at different current density

**Fig. S3** The voltage recovery of a) metal cells with different separators b) cells made by different thickness of pine biochar
Fig. S4  a) voltage recovery, b) recovery value after different shorting time and c) \( \ln \frac{U_t}{U_0} \) vs. \( t \)