Support information

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Electrochemical characterization of the device

The electrochemical properties of the FSCs including cyclic voltammetry (CV), linear sweep voltammetry (LSV), galvanostatic charge-discharge (GCD), and impedance spectra (EIS) were tested by an electrochemical workstation (CHI660E, CH Instruments, Inc.). Cyclic stability was tested by a battery test system (CT2001A, Wuhan LAND Electronics CO., LTD). The specific capacitance (C_{sp}) of the FSC was calculated from the GCD curve according to the formulas below:

$$C = \frac{2I\Delta t}{m\Delta U} \quad (1)$$

where I is the discharge current (A), Δt is the discharge time (s), m is the mass of an electrode (g), and ΔU is the potential window (V).

Mechanical property and rheological measurement

The compression test was performed on the hydrogels using a texture analyzer (Texture Pro CT V1.6, Brookfield Engineering Labs. Inc.). The cylindrical hydrogels with a radius of 10.13 mm and a thickness of 20 mm, were tested by a compression speed of 0.50 mm s^{-1}. And the mechanical anti-fatigue behavior of the hydrogel was evaluated by a cycling compression test with a speed of 0.50 mm s^{-1}, and a target strain of 50% for 100 times. The rheological properties of hydrogels were tested by Anton Paar model MCR 302 rheometer at room temperature. The oscillation frequency sweep was tested at a constant strain amplitude of 0.1%, the oscillation strain amplitude sweep was tested at a constant frequency of 10 rad s^{-1}, and the cyclic step-strain oscillation sweep was tested between 0.1% and 930% strain. All the tests were performed on the hydrogels with a diameter of 25 mm and thickness of 2 mm.

Electrochemical Measurements

The hydrogels were prepared into rectangle specimens, and the resistance (R) was tested by the electrochemical workstation (AUT86925, AUTOLAB) using the four-probe method. Then the ionic conductivity was calculated according to the following equation:

$$\sigma = \frac{D}{R \times S} \quad (2)$$

where σ is the ionic conductivity D (cm) is the distance between two probes, Z (Ω) is the resistance of the specimen, and S (cm^2) is the cross-sectional area of the sample.

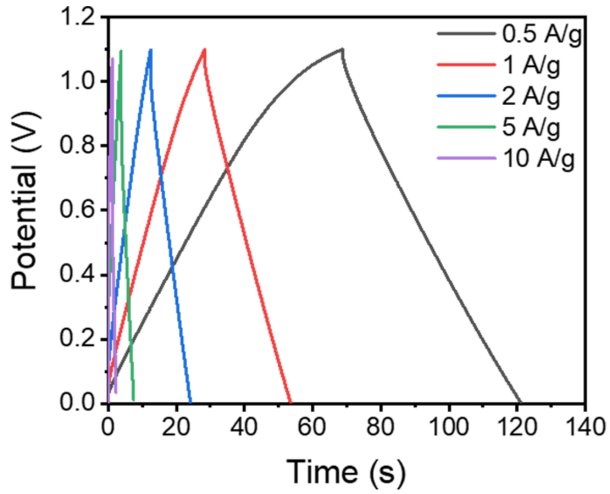

Fig. S1 GCD curves of the in-situ device P(AM-co-DMC)/CMC-KCl at a current density ranging from 0.5 to 10 A g^{-1}.

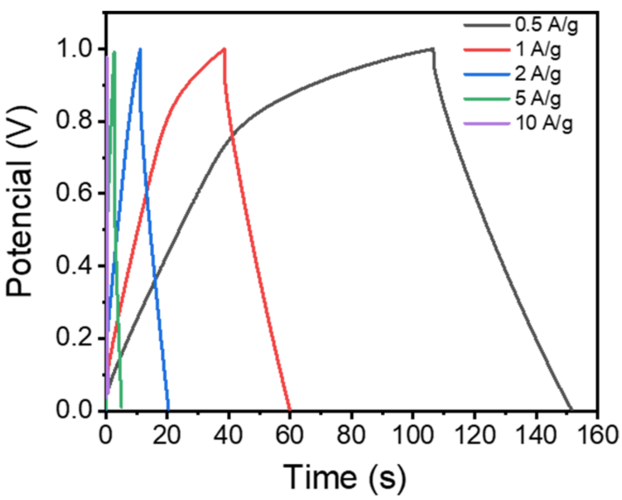

Fig. S2 GCD curves of the in-situ device PAM/CMC-NaCl at a current density ranging from 0.5 to 10 A g^{-1}.

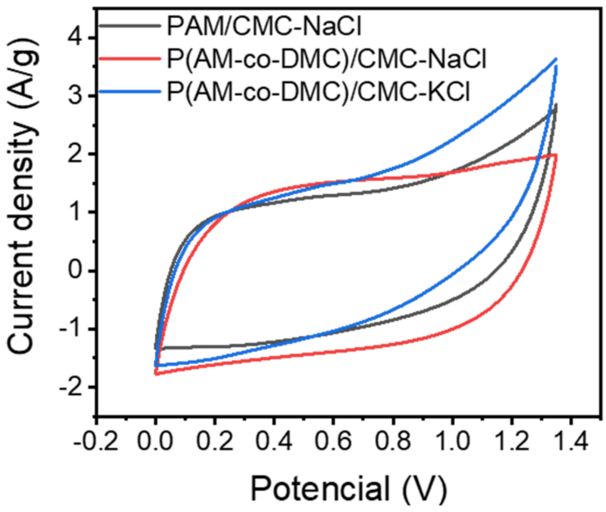

Fig. S3 CV curves at 50 mV s^{-1} of in-situ devices with different electrolytes.

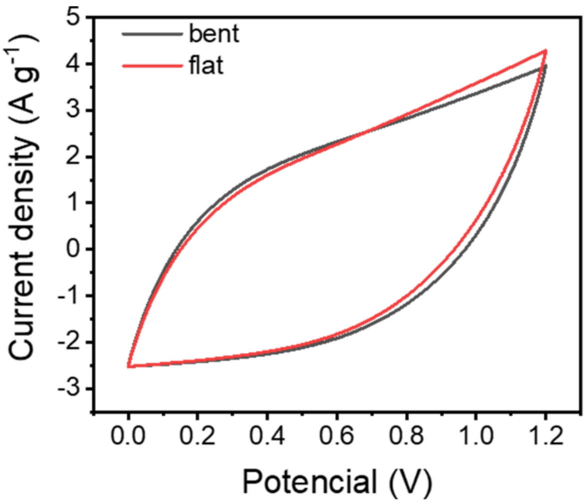

Fig. S4 CV curves of the in-situ devices in different states.

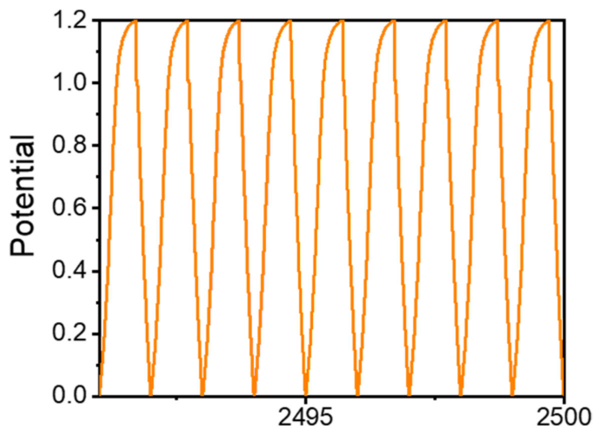

Fig. S5. The 2491st to 2500th charge/discharge curves.