Electronic Supplementary Information (ESI)

Phonic Braille recognition system based on self-powered sensor with self-healing ability, temperature resistance, and stretchability

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Experimental section

Raw materials

Tris(2-aminoethyl)amine (TAEA, 98.0%), and terephthalaldehyde (TPA, 98.0%) were purchased from TCI. Poly(propylene glycol)bis(2-aminopropyl ether) (PEA, M_n = 2000), potassium iodide (KI, 99.5%), acrylamide (AAm, 99.0%), potassium persulfate (KPS, 99.99%), N,N,N',N'-tetramethylethylenediamine (TEMED, 99.0%), and glycerol (99.0%) were purchased from Aladdin. Synthetic hectorite clay (Laponite XLS) was purchased from BYK Ltd. Sylgard 184 was purchased from Dow Corning. All chemical reagents were used as received without further purification.

Synthesis of Polyazomethine

PEA (2 g, 1 mmol) and TAEA (225 μL, 1.5 mmol) were mixed in 3 mL of anhydrous DMF. After TPA (0.44 g, 3.25 mmol) was dissolved in 3 mL of DMF, the solution was slowly dropped into the above mixture under constant stirring. The solution was transferred to a Teflon mold and sealed at room temperature for 2 h. Then the sample was put into an oven at 50 °C for 48 h, and 60 °C for 24 h, followed by drying at 60 °C under a vacuum oven for 24 h.

Synthesis of Organohydrogel

Firstly, the PAAm-Clay hydrogel was synthesized. Briefly, Laponite XLS (1 g) was dissolved in deionized water (6 ml). AAm (1 g) was added to the solution with stirring for 0.5 h, followed by adding 1 mL of KPS aqueous solution (0.015 g mL^{-1}) and 20 μL

of TEMED to initiate the polymerization. Secondly, KI (3 g) was dissolved in glycerol (10 g) to form KI-Gly solution. The PAAm-Clay hydrogel was immersed in the KI-Gly solution to perform the solvent displacement. After 12 h, the PAAm-Clay-KI organohydrogel nanocomposite was obtained and taken out from the solution.

Fabrication of Self-powered Sensor

PAAm-Clay-KI organohydrogel and PAZ were cut into proper dimensions using a blade. A PAAm-Clay-KI film was sandwiched by two PAZ films to fabricate the device, with metal wires connecting to the organohydrogel.

Design of Braille recognition system

To convert the electrical signal of the self-powered Braille recognition sensor to the audio signal, the circuit was designed as follows. The six pixels of the Braille recognition sensor were named S1 to S6 which were connected to the LM358 signal amplifier module, and then connected to the STM32F103RCT6 microcontroller (MCU). The MCU was connected to the MP3 audio player module, with a microSD card pre-loaded with 26 English letters audio. The audio speaker was connected to the MP3 audio player module. The voltage outputs of the sensors could be recognized as high-low-level by the MCU. The MCU identified which sensor triggered the response through the method of IO interrupt response. According to the combinatorial logic coding of the alphabet, the MCU controlled MP3 to play the appropriate English letter audio.

Characterization of materials and devices

The infrared thermal images were recorded by a Fluke Ti25 infrared camera. According to the standard of ISO37-4, an Instron E1000 all-electric dynamic test instrument was utilized to perform the mechanical tensile tests with a stretching rate of 20 mm min^{-1}. A source meter (Keithley 2450) was used to record the basic *I-V* curves and the resistance change of the device under the applied voltage. The relative resistance change was calculated by $\Delta R/R_0$ (%) = $(R - R_0)/R_0 \times 100\%$, in which R_0 refers to the initial resistance and R means the resistance after deformation. The alternating-current impedance was conducted on an electrochemical workstation (CHI650E). The open-circuit voltage, short-circuit current, and transferred charge of TENGs were measured by using an oscilloscope (LeCroy 62Xs), a low-noise current preamplifier (Stanford Research System SR570), and an electrometer (Keithley 6514), respectively.

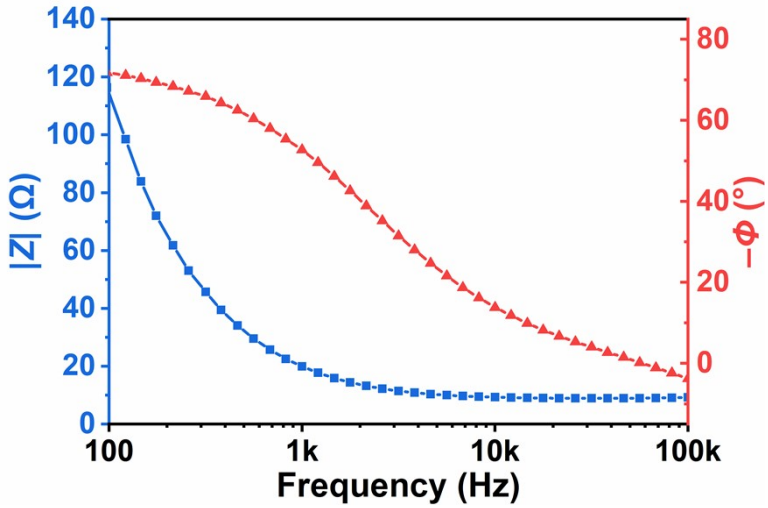

Fig. S1 Plots of impedance magnitude (|*Z*|, blue line) and negative phase angle (−ϕ, red line) versus testing frequency for the PAAm-Clay-KI organohydrogel.

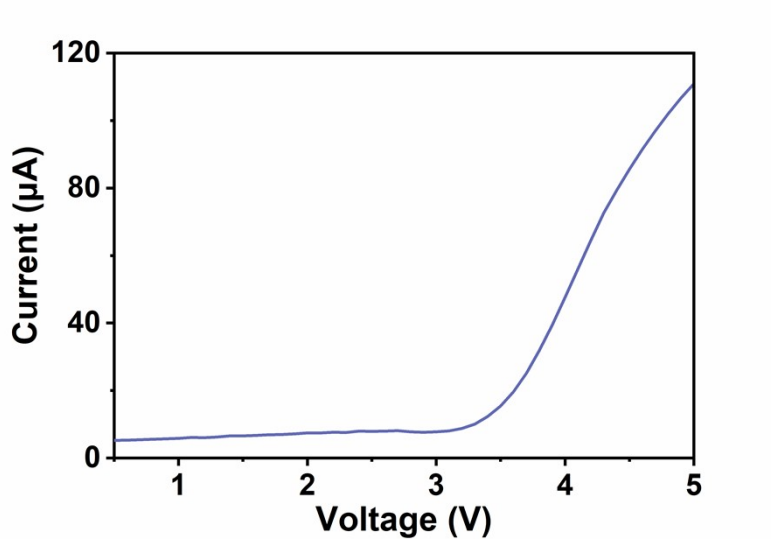

Fig. S2 Basic *I-V* curves of the PAAm-Clay-KI organohydrogel.

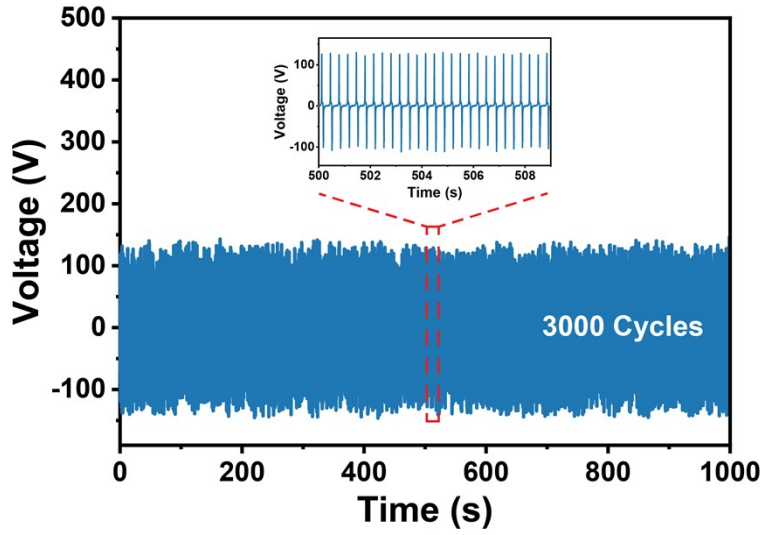

Fig. S3 Open-circuit voltage of the self-powered sensor during 3000 contact-separation cycles.