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Supplementary Information

Spinnable Adhesive Functional-Hydrogel Fibers for Sensing and Perception Applications

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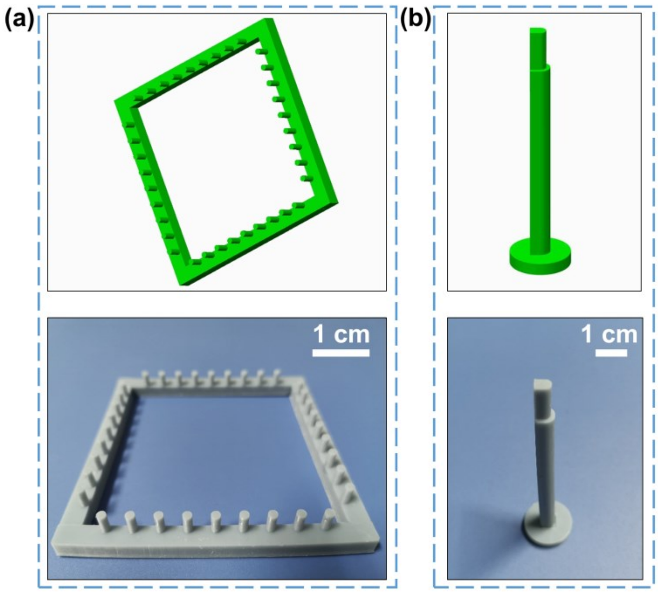

Figure S1 3D model diagram and physical diagram of **(a)** the square frame and **(b)** the pillar for spinning the hydrogel fiber.

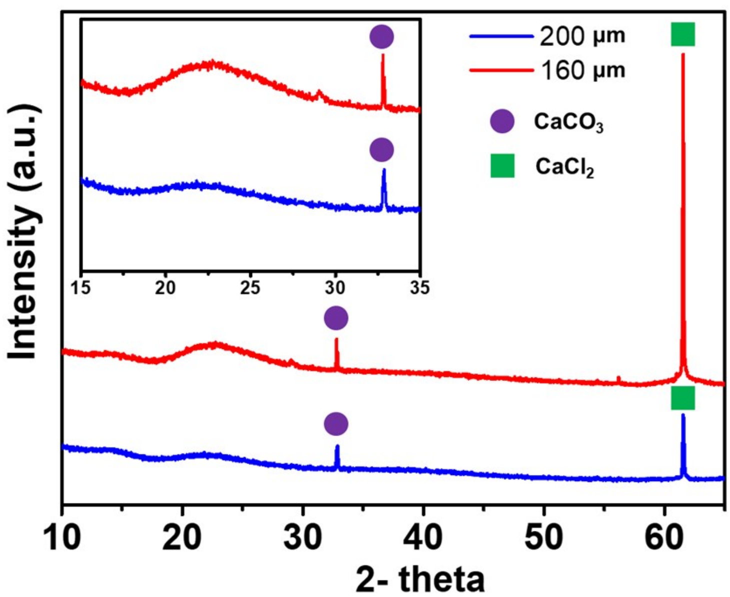

Figure S2 XRD spectra of hydrogel fibers with diameters of 160 μm (red line) and 200 μm (blue line). The green squares symbols represent $CaCl_2$ and the purple circles symbols represent $CaCO_3$.

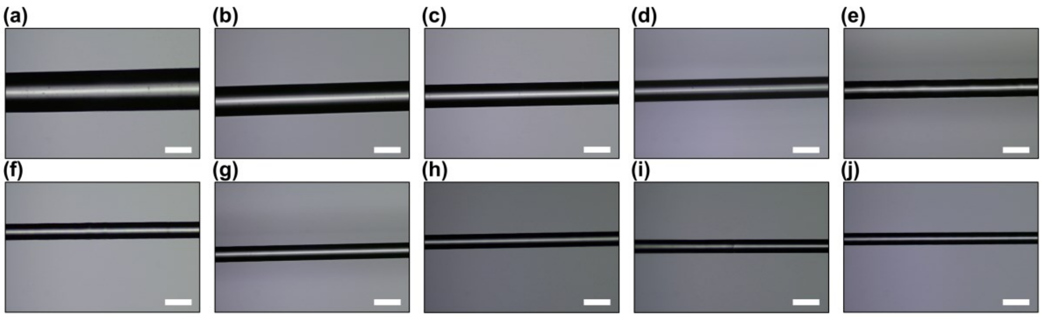

Figure S3 Optical microscope images of the hydrogel fibers in different stretch ratios of **(a)** 10, **(b)** 20, **(c)** 30, **(d)** 40, **(e)** 50, **(f)** 60, **(g)** 70, **(h)** 80, **(i)** 90, **(j)** 100, respectively. The reflective mode is selected during microscope characterization and all scale bars are 200 μm.

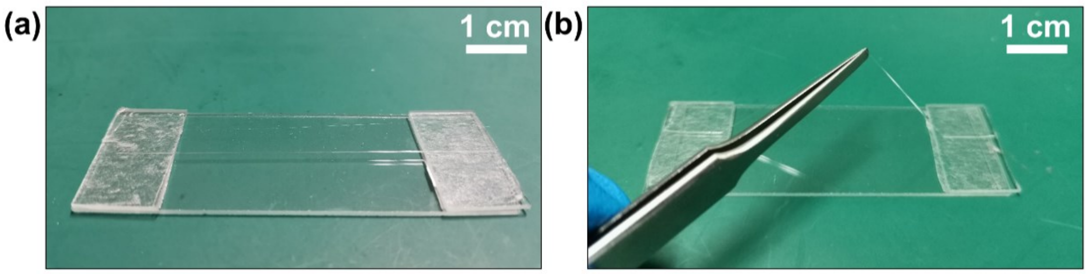

Figure S4 Photos of demonstrating **(a)** hydrogel fibers before freeze-drying **(b)** fibers lyophilized for 48 hours by using a lyophilizer. It can be seen that the fibers are still flexible and cannot be dried.

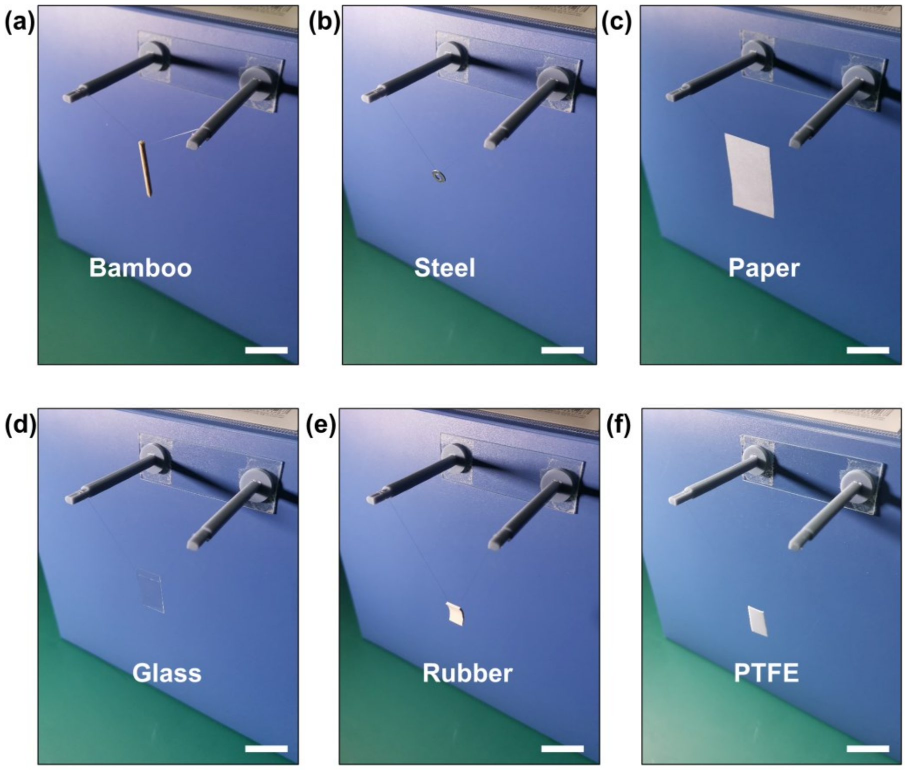

Figure S5 Adhesion tests of the hydrogel fibers (stretch ratio ~ 50) with different materials including **(a)** bamboo, **(b)** steel washer, **(c)** paper, **(d)** glass, **(e)** rubber and **(f)** PTFE. All scale bars are 2 cm.

Detailed calculation procedure for calculating the adhesion strength (σ_S) of the hydrogel fiber to the PP plastic sheet (185 mg) is shown in Equation S1

$$\sigma_s = \frac{F_s}{S} \tag{S1}$$

where F_S is gravity of the PP plastic sheet and S is the contact area between the hydrogel fiber and the PP plastic sheet. So $F_S = mg = 185\times10^{-6} \times 10 = 1.85 \times 10^{-3}$ N, $S = l \times d = 7000 \times 141.67 \times 10^{-12} = 9.9169 \times 10^{-7}$ m^2. And m is the mass of the PP plastic sheet, g is acceleration of gravity, l is contact length between the hydrogel fiber and the PP plastic sheet and d is the diameter of the hydrogel fiber.

Therefore, $\sigma_s = \frac{F_s}{S} = \frac{mg}{ld} = \frac{1.85\times10^{-3}}{9.9169\times10^{-7}} = 1865.50$ Pa

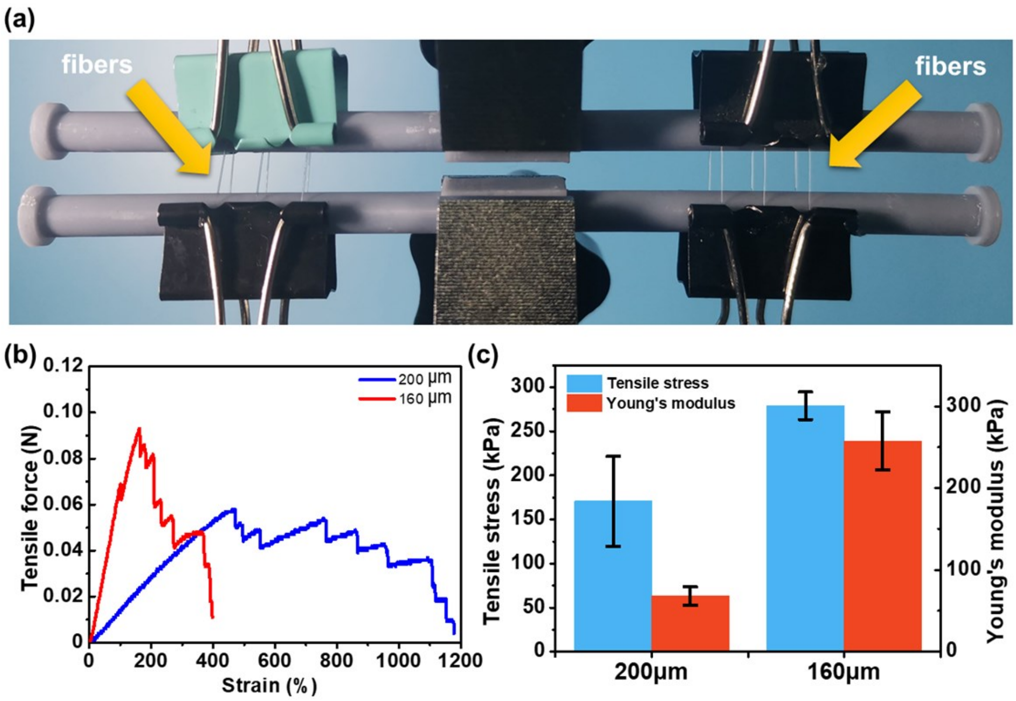

Figure S6 Tensile tests of the hydrogel fibers. **(a)** Photograph of tensile test of the hydrogel fibers. **(b)** Typical tensile force-strain of 12 hydrogel fibers with the diameters of 160 μm and 200 μm. **(c)** Tensile stress and Young's modulus of the hydrogel fiber with the diameters of 160 μm and 200 μm.

And the tensile stress (σ) can be calculated by Equation S2:

$$\sigma = \frac{F}{nS} \tag{S2}$$

Where F is the measured tensile force that corresponds to the point where the first fiber is broken, n is the number of the fibers and S is the cross-sectional area of a single fiber. The Young's modulus (E) of the fibers can be calculated by Equation S3:

$$E = \frac{\sigma}{\varepsilon} \tag{S3}$$

where σ is the tensile stress the fiber, ε is the stress the fiber.

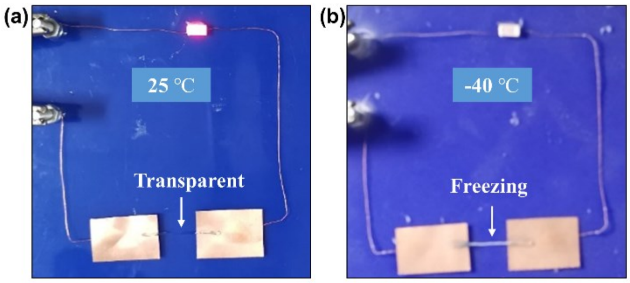

Figure S7 Photos of demonstrating the electrical conductivity of the hydrogel fiber without glycerol at 25 °C and -40 °C. **(a)** The LED light was on at 25 °C, **(b)** the LED light was off at -40 °C because hydrogel fiber without glycerol was frozen and lost its electrical conductivity.

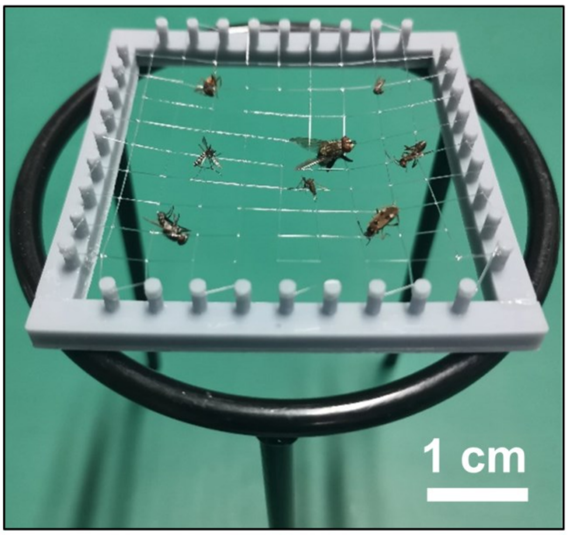

Figure S8 Photograph demonstrating the good adhesiveness of the HFW to different insects.

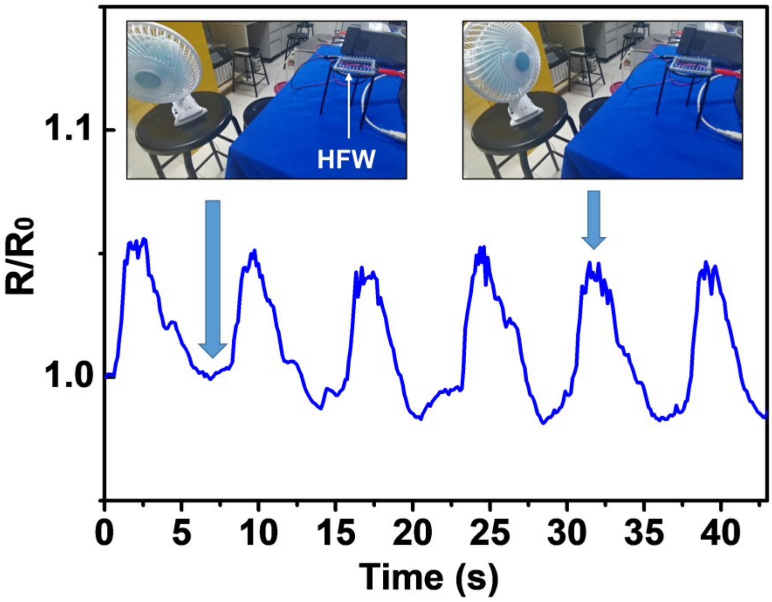

Figure S9 The relative resistance change of the HFW caused by wind from different directions, where the HFW showed good wind-responsiveness.

Detailed calculation procedure about tensile stress (σ_a) of the hydrogel fiber are shown below.

Generally, tensile stress can be calculated by Equation S4,

$$\sigma_a = \frac{F_a}{A} = \frac{4mg}{\pi d'^2} \tag{S4}$$

where F_a is gravity of the clasp, A is cross-sectional area the hydrogel fiber, m is mass of the clasp (maximal m = 107 mg), d' is the length of elongated fiber. The relationship between d' and d is shown in Equation S5,

$$\frac{\pi d'^2 l'^2}{4} = \frac{\pi d^2 l^2}{4} \tag{S5}$$

where d is the initial length of fiber, $d = 141.67\times10^{-6}$ m, l, l' are the initial length and the subsequent length of fiber, respectively.

The relationship between l and l' can be expressed as Equation S6,

$$(l'/2)^2 = (l/2)^2 + h^2 \qquad \text{(S6)}$$

where l' was calculated as 8.73 ×10^{-2} m, d' was calculated as 1.07×10^{-4} m.

Therefore, $\sigma_a = \frac{4mg}{\pi d'^2} = \frac{4 \times 107 \times 10^{-6} \times 10}{\pi \times (1.07 \times 10^{-4})^2} = 118.51 \text{ kPa}$