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Electronic Supplementary Information

Integrated cross-section interface engineering and surface encapsulating strategy: a high-response, waterproof, and low-cost paper-based bending strain sensor

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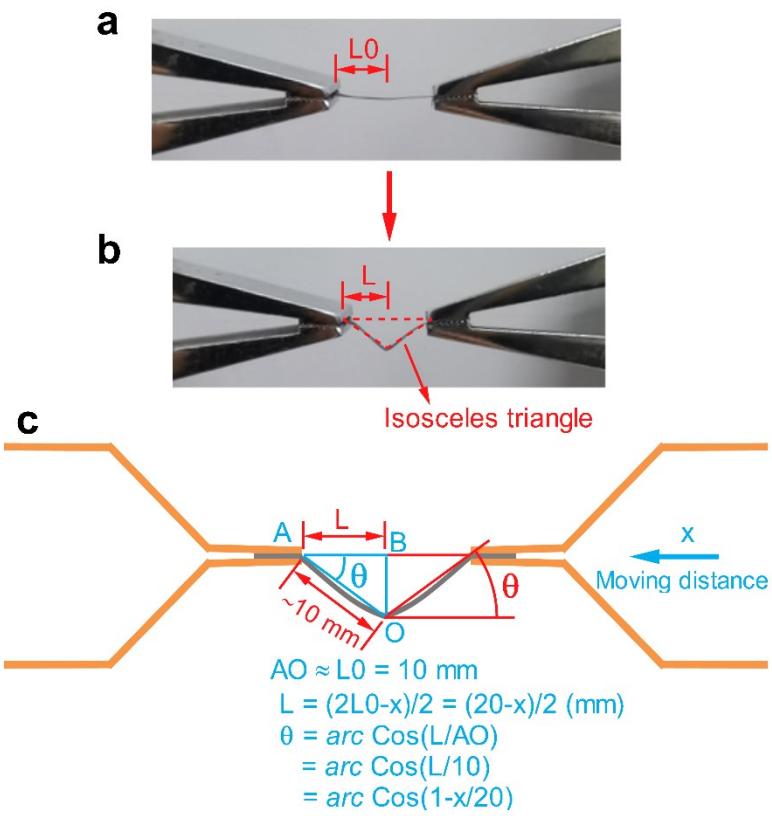

Fig. S1 Optical photographs of the PBS sensor before (a) and after (b) bending in cross-section view. (c) Schematic diagram of the PBS sensor under bending state in cross-section view.

Table S1 Bending angles used in the test of the PBS sensor under different moving distances

Moving distance (x, mm)	Bending angle (θ, °)
0	0
0.625	14.4
1.25	20.4
1.5	22.3
2.5	29.0
3.75	35.7
5	41.4
7.5	51.3
10	60.0
12.5	68.0
15	75.5
19	87.1

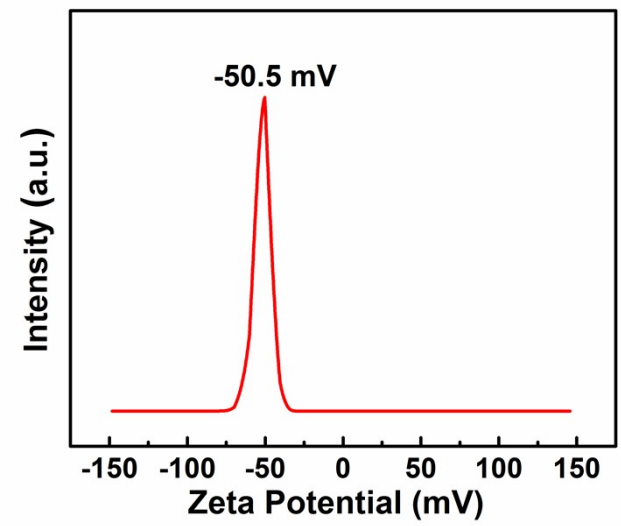

Fig. S2 Zeta potential of the carbon ink.

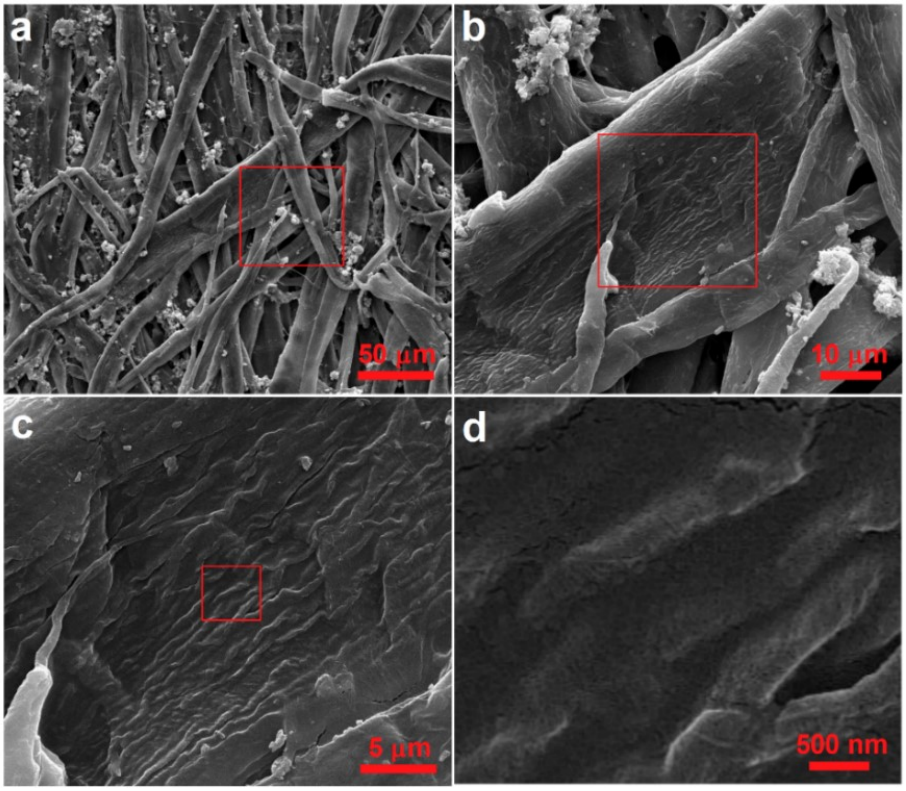

Fig. S3 (a–d) Surface SEM images of the bare paper at different magnifications.

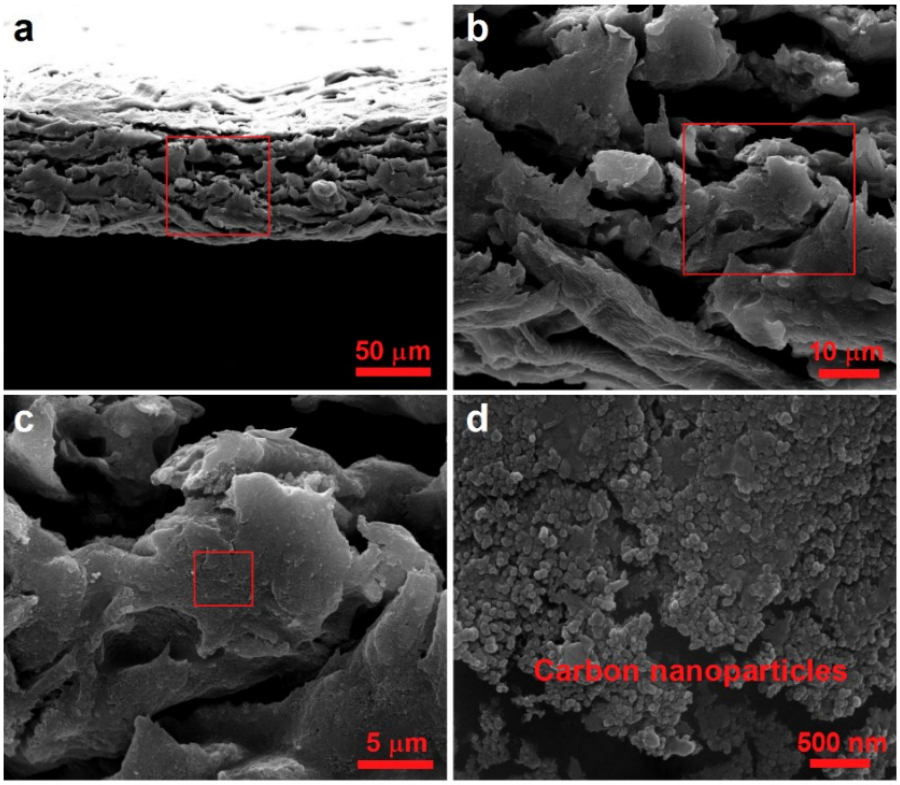

Fig. S4 (a–d) Cross-section SEM images of the paper with carbon ink at different magnifications.

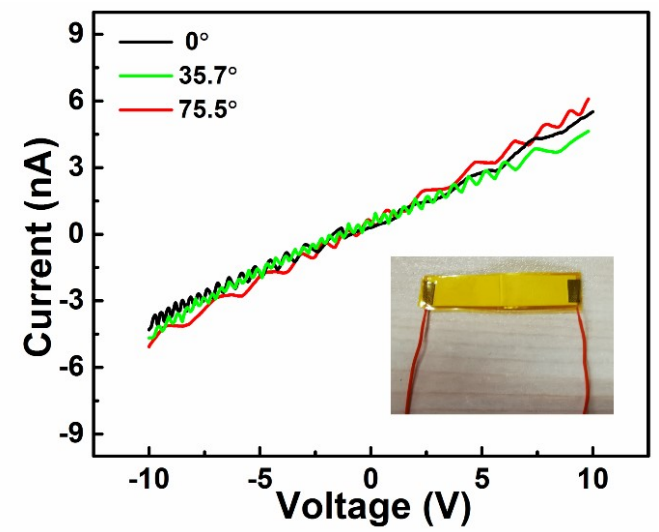

Fig. S5 I−V curves of the sensor based on bare paper at different bending strain angles.

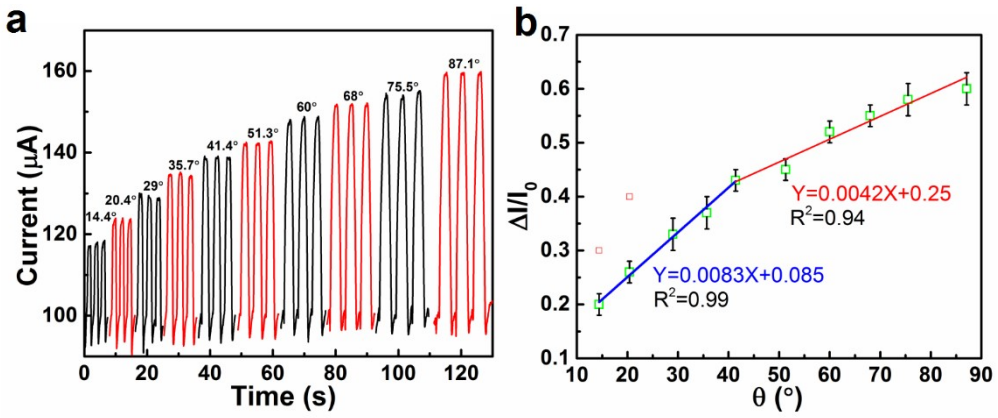

Fig. S6 (a) Response and recovery curves of the PBS sensor without gap to increased bending strain angles (14.4−87.1°) at bending and unbending states. (b) Response of the PBS sensor without gap at different bending strain angles, and corresponding linear fitting lines.

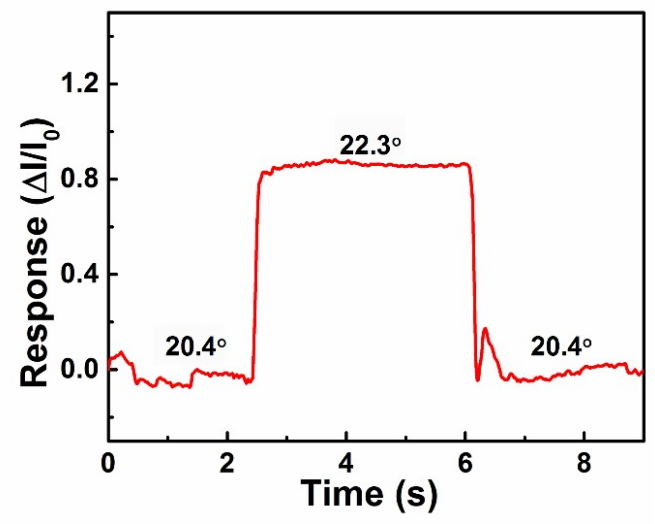

Fig. S7 Response curve with the bending angle increasing from 20.4° to 22.3°.

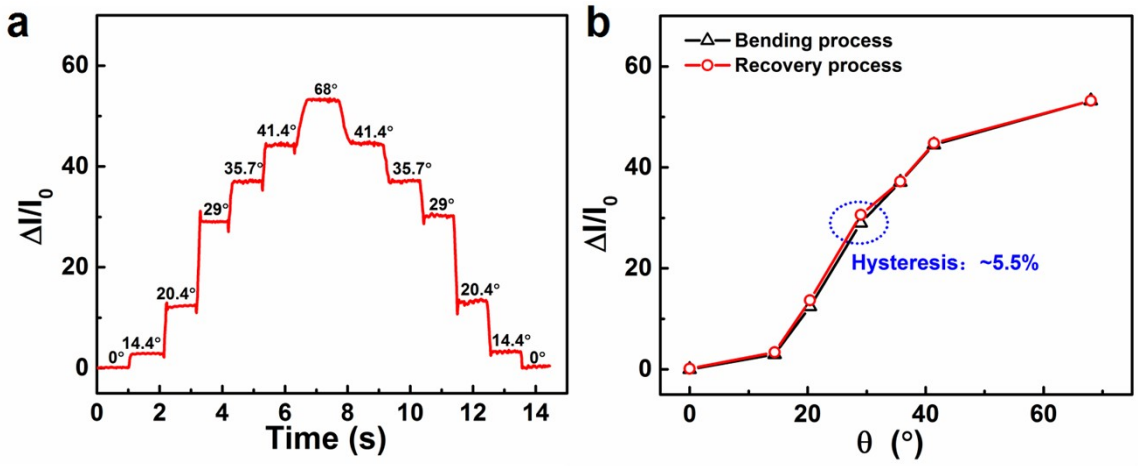

Fig. S8 (a) Real-time response curve of the sensor in bending and recovery processes. (b) Response values of the sensor at different bending angles in the process of bending and recovery. According to the hysteresis definition of the sensor, the maximum response difference appears at 29°, and the hysteresis is about 5%.

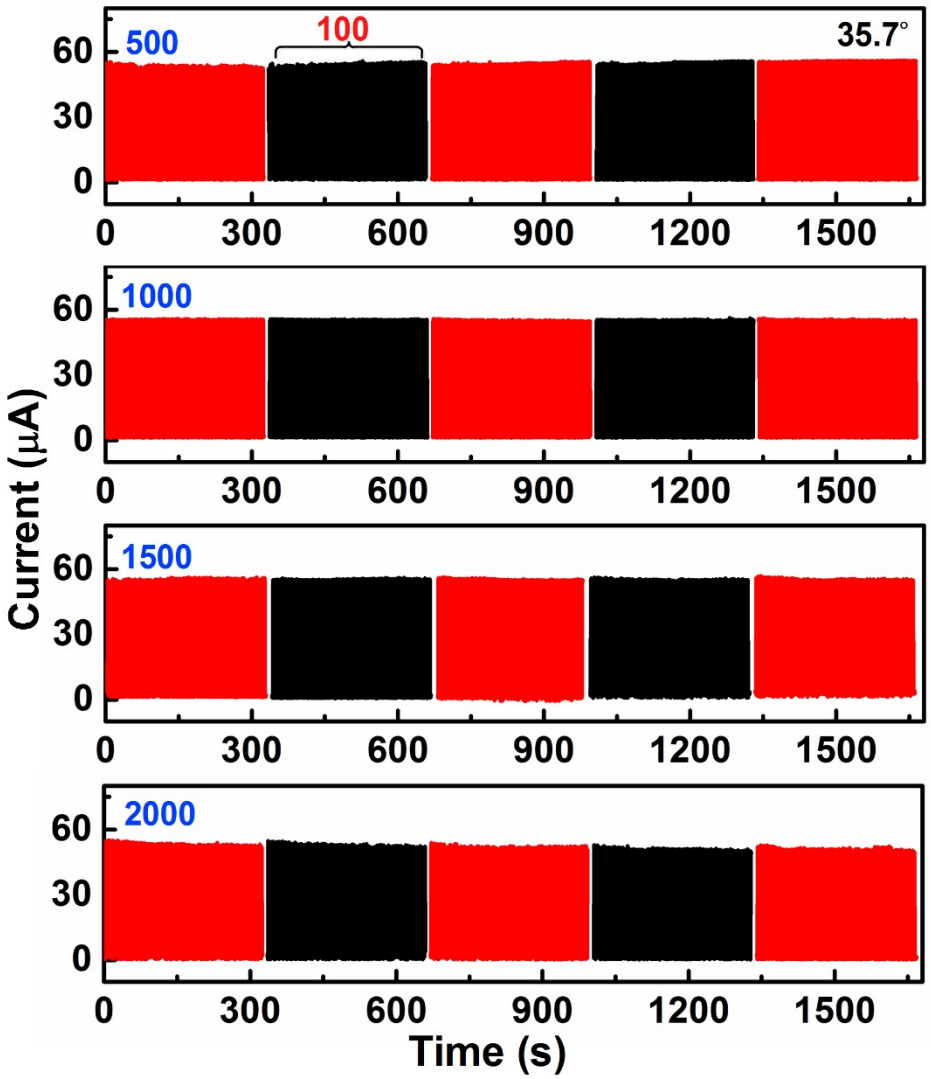

Fig. S9 Current change curves of the PBS sensor during 1–2000 cycles under 35.7°. Due to the limited storage depth of the Keithley 4200-SCS (only 4000 data can be recorded in one test), 100 cyclic response is recorded in each test and 20 tests are conducted. The total response cycles are 2000 times.

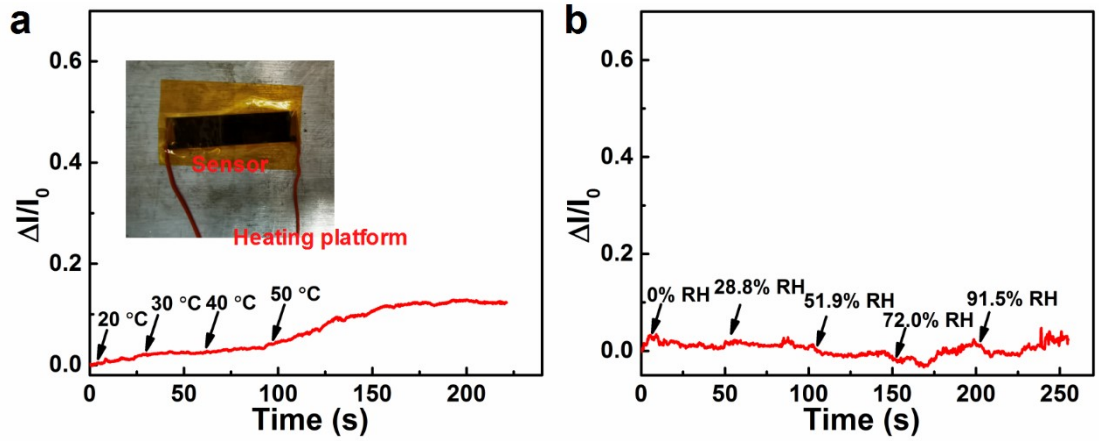

Fig. S10 Real-time response curves of the sensor to the increased (a) temperature and (b) RH. Different temperatures are generated by the heating platform.

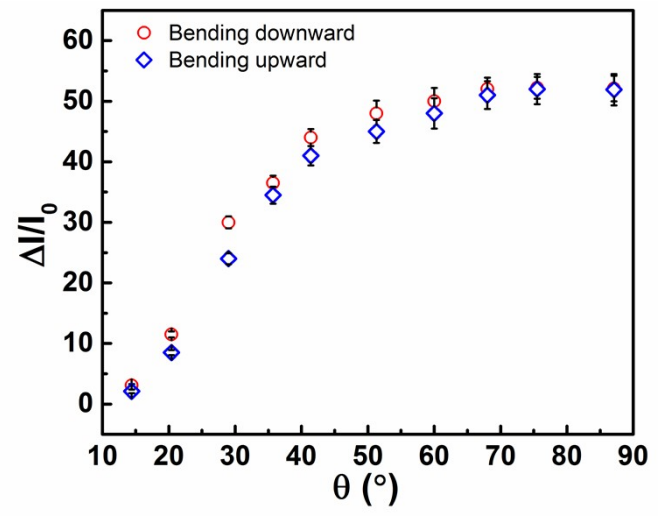

Fig. S11 Response values of the PBS sensor under bending downward and upward at different bending strain angles.

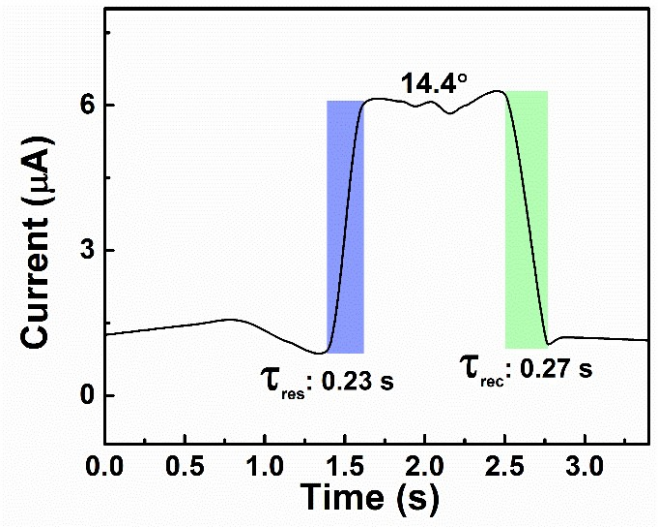

Fig. S12 Enlarged response and recovery curve of Fig. 3b at the bending angle of 14.4°.

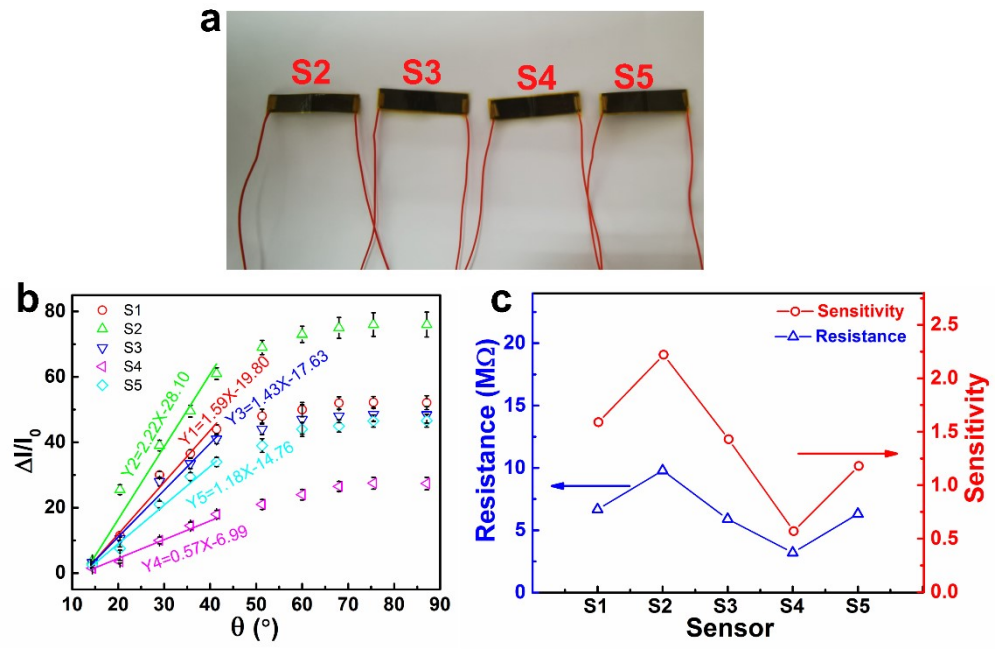

Fig. S13 (a) Optical photograph of four additional PB sensors. (b) Response values of five PBS sensors (S1 is the performance of the original sensor in Fig. 3, and S2, S3, S4 and S5 are the performance of the supplementary sensors) at different bending strain angles, and corresponding linear fitting lines. (c) The initial resistance (flat state) of the five PBS sensors and their sensitivity (14.4−41.4°).

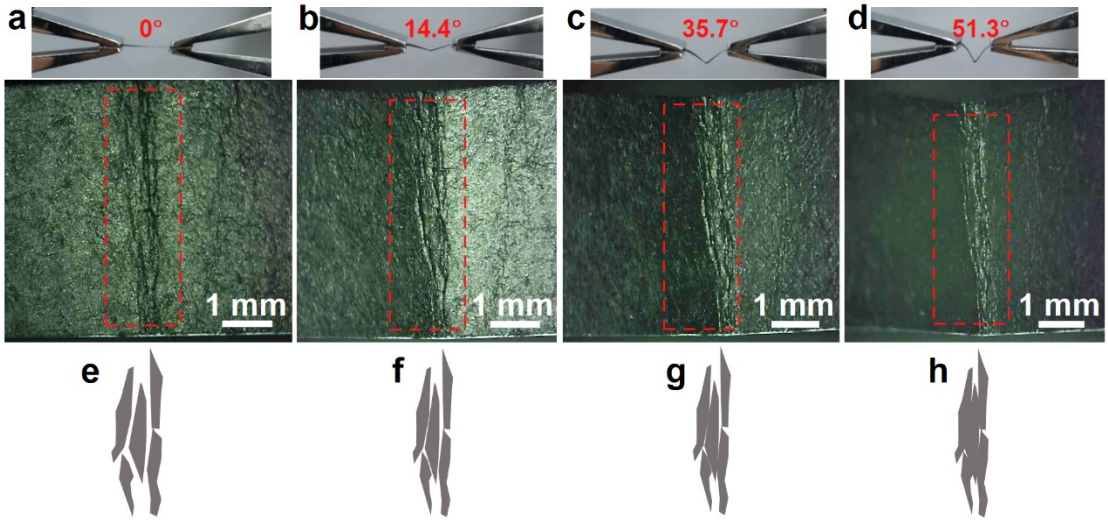

Fig. S14 Bending strain sensing mechanism of the PBS sensor without gap. (a−d) Optical photographs of the sensor at different bending strain angles. (e−h) Corresponding schematic illustrations of surface at different bending strain angles.

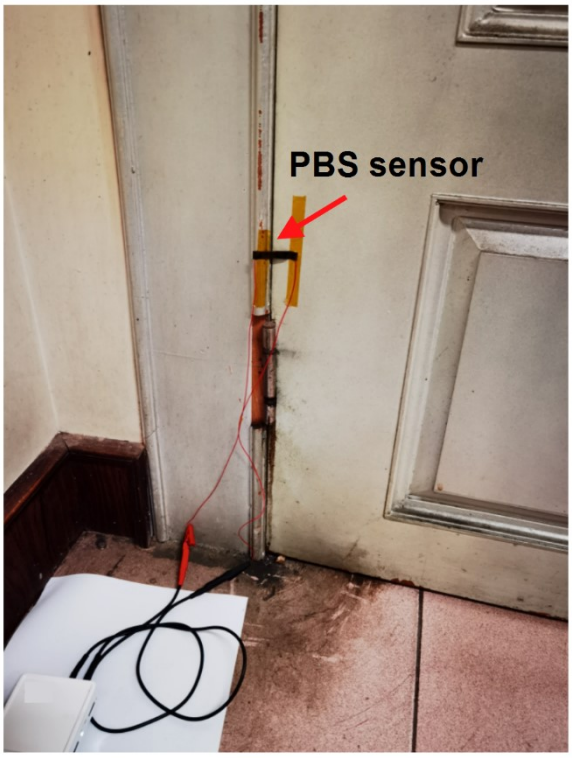

Fig. S15 Optical photograph of the PBS sensors attached to the back of the door.

Supplementary Video Captions

Video S1. Response curve of the PBS sensor under bending downward and upward.

Video S2. Response curve of the PBS sensor in air and water.

Video S3. Demonstration of the PBS sensor for monitoring door.

Video S4. Response curve of the PBS sensor in the smartphone at different state of the door.