

# Supporting Information

## **Eggshell protein modified cotton fabric for flexible and sustainable piezoelectric wearable sensors**

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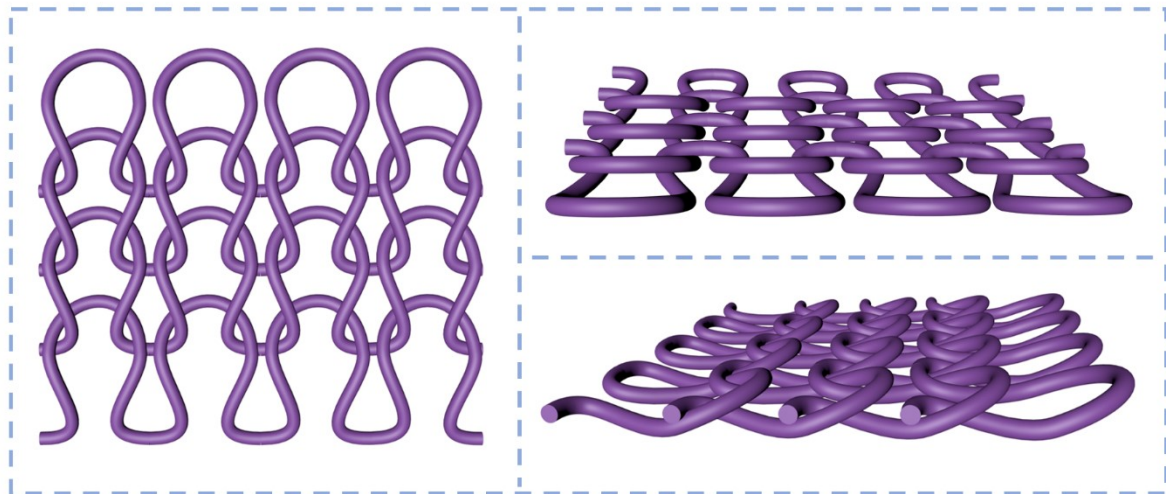
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### Note S1. Calculation of stiffness

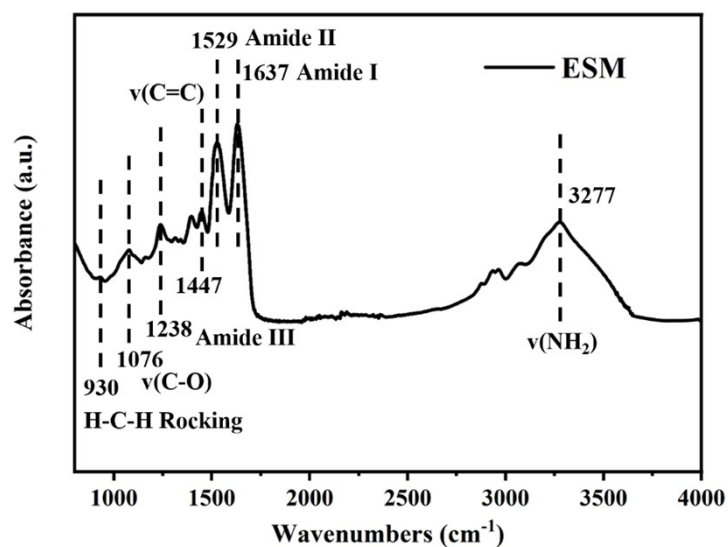
Five samples of 20 cm × 2.5 cm were prepared for each sample respectively. The sample was put on the platform of stiffness tester to test the extension length (L) with bending angle of 41.5 ° from the horizontal direction. The stiffness of all the samples is calculated according to formula (1).

$$G = m \times C^3 \times 10^{-3} \quad (1)$$

where  $G$  is the stiffness of the sample,  $m$  is the gram weight of the sample,  $C$  is the average bending length of the sample, which is 1/2 of the extension length.



**Fig. S1** The 3D rib structure of cotton fabric.

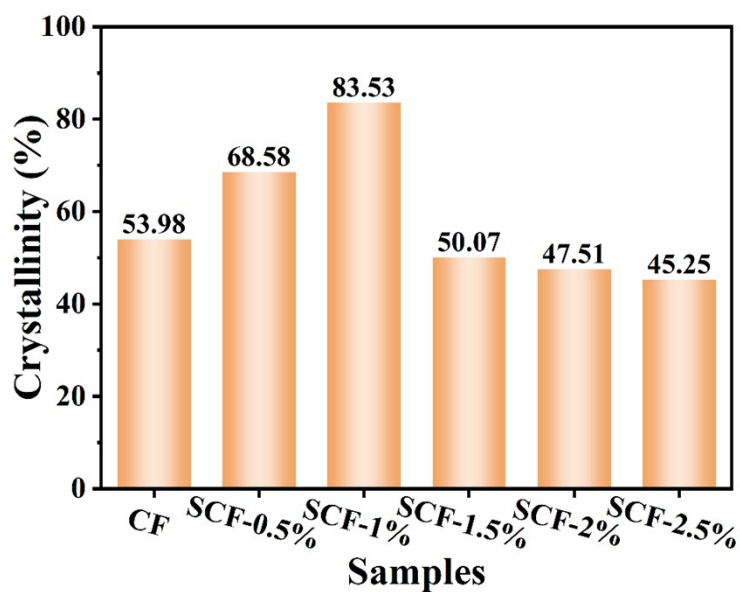


**Fig. S2** FTIR spectra of the ESM.

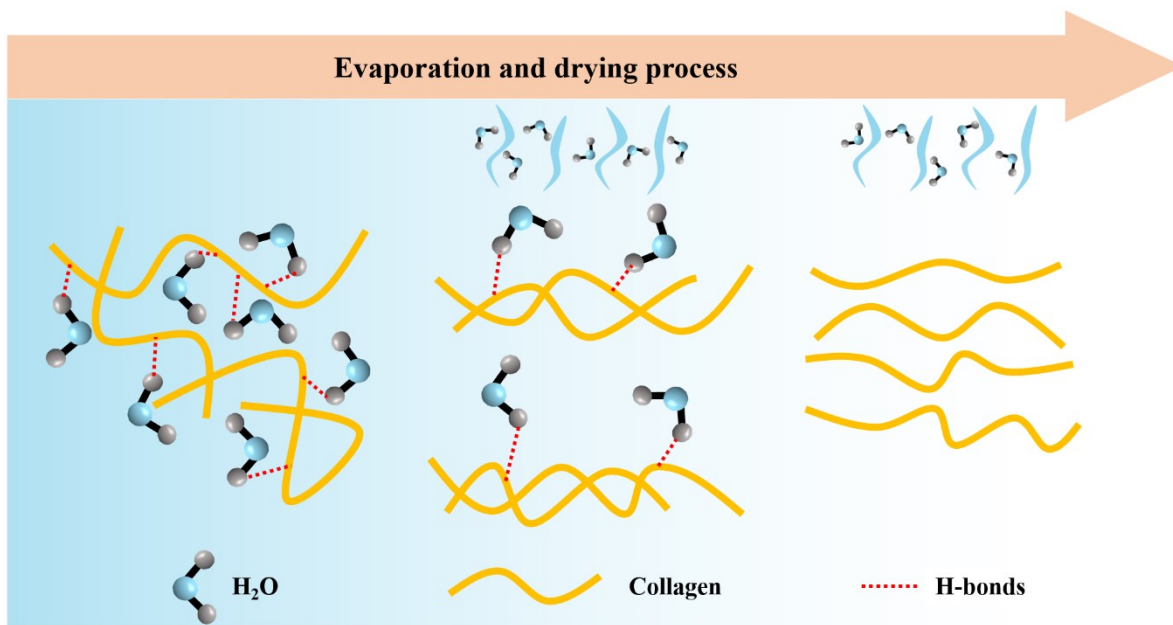
**Note S2. Calculation of crystallinity**

The total degree of the crystallinity ( $x_{c_t}$ ) of the samples is calculated according to formula (2) from XRD patterns using the curve deconvolution method.<sup>1</sup>

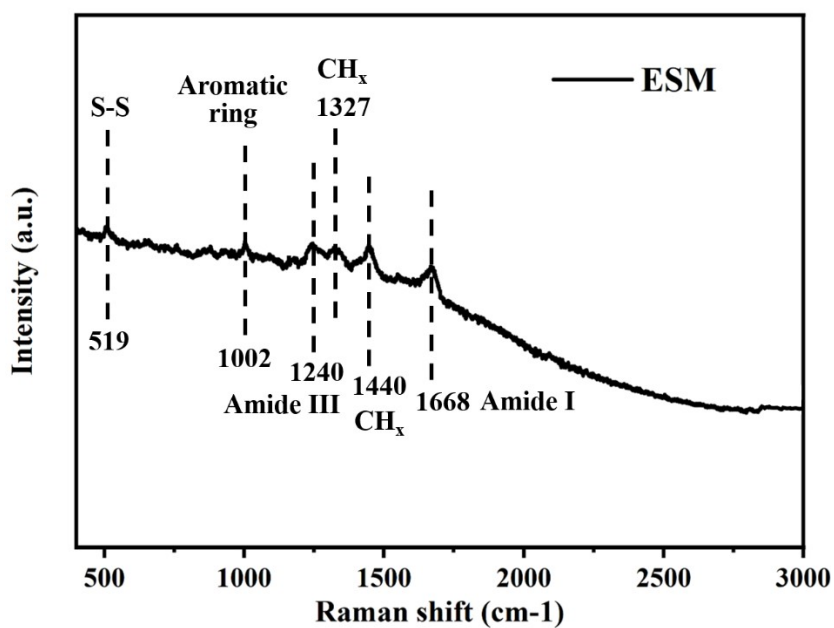
$$x_{c_t} = \frac{\sum A_{crys}}{\sum A_{crys} + \sum A_{amp}} \times 100\% \quad (2)$$



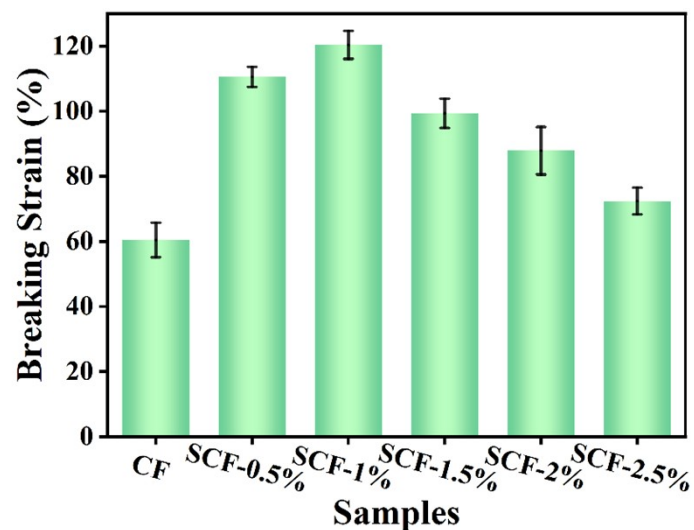
**Fig. S3** Crystallinity of all samples calculated from XRD patterns.



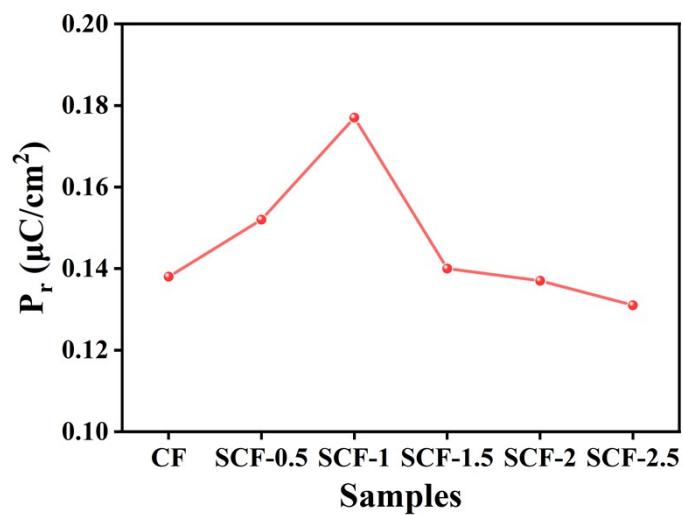
**Fig. S4** Mechanism of reorientation of molecule chains formed by SEP and water molecules during the drying of the composites.



**Fig. S5** Raman spectrum of ESM.



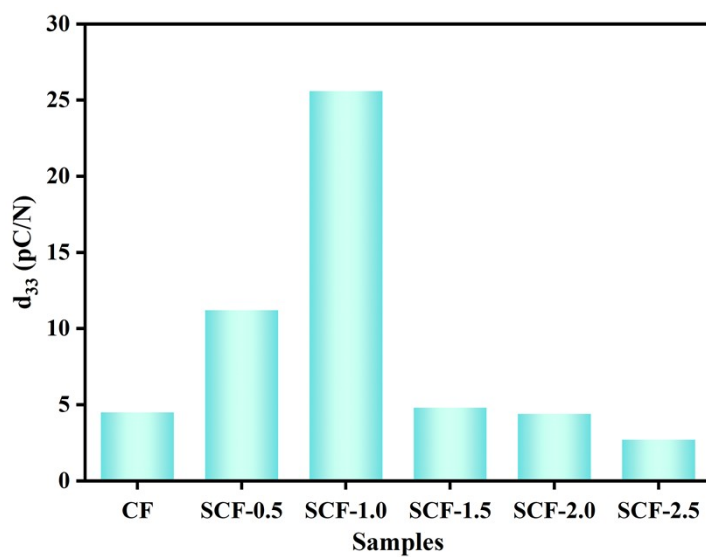
**Fig. S6** Breaking strain of different samples. Mean  $\pm$  SD of three independent experiments were shown (n=3).



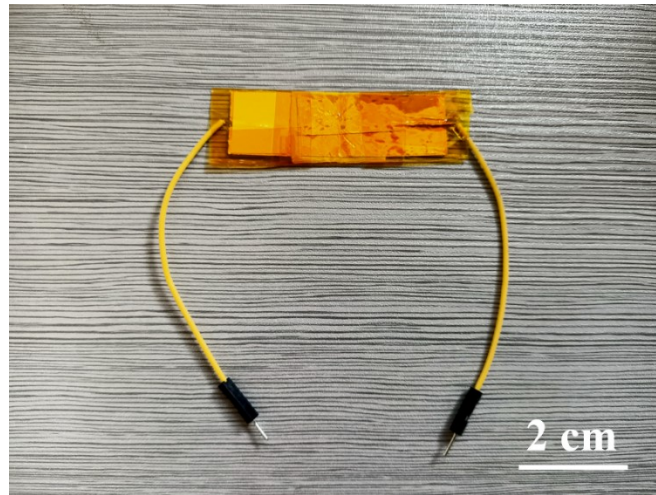
**Fig. S7** Remnant polarization ( $P_r$ ) of pristine cotton fabric and SEP-coated fabrics.



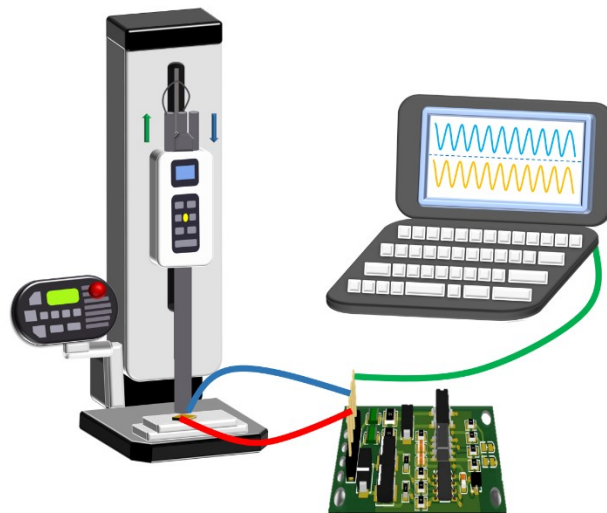
**Fig. S8** Piezoelectric constant ( $d_{33}$ ) of (a) pristine cotton, (b) SCF-0.5, (c) SCF-1.0, (d) SCF-1.5, (e) SCF-2.0 and (f) SCF-2.5 measured by a commercial  $d_{33}$  meter.



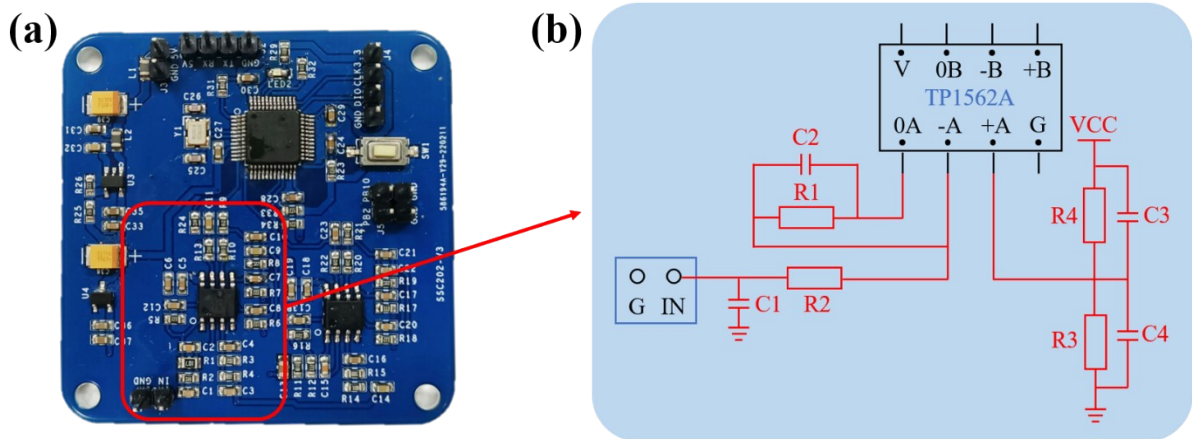
**Fig. S9**  $d_{33}$  of pristine cotton fabric and SEP-coated fabrics.



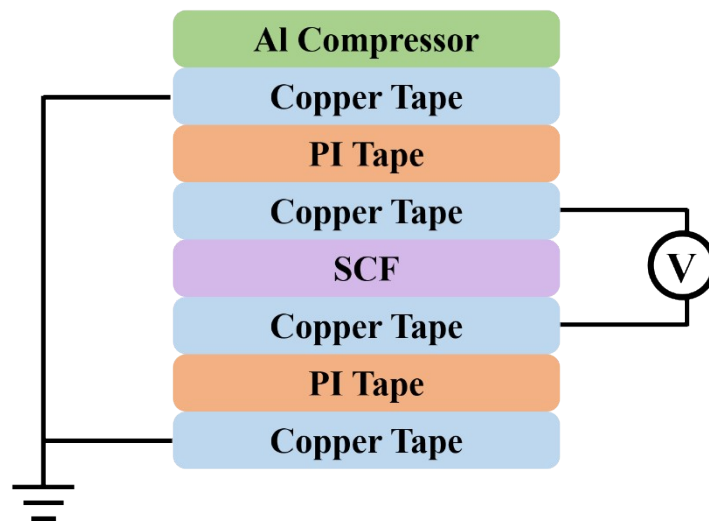
**Fig. S10** Optical image of the as-proposed device.



**Fig. S11** Schematic illustrations of the piezoelectric test device.

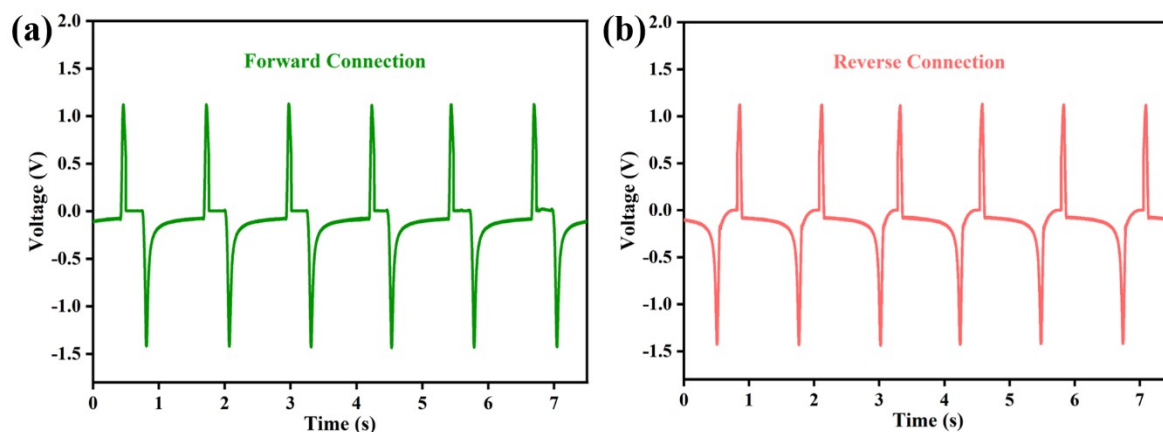


**Fig. S12** (a) The flexible thin-film piezoelectric sensing system. (b) The preamplifier circuit diagram.



**Fig. S13** The test configuration of the sensors to avoid frictional electrical signals.





**Fig. S14** Short-circuit current measurements of the piezoelectric device in the forward connection (a) and the reverse connection (b).

**Table S1.** The tensile stress-strain curves data of pristine cotton fabric and SEP-coated fabrics.

Sample	The maximum tensile stress (%)	Breaking strain (%)	Young's modulus (MPa)
CF	3.98±0.14	60.42±5.32	1.12±0.08
SCF-0.5%	4.94±0.19	110.55±3.15	0.53±0.03
SCF-1%	5.96±0.23	120.37±4.37	0.81±0.04
SCF-1.5%	5.23±0.10	99.36±4.53	0.90±0.06
SCF-2%	4.78±0.12	87.86±7.34	1.61±0.05
SCF-2.5%	4.59±0.27	72.36±4.15	1.98±0.06

## References

- 1 S. K. Karan, R. Bera, S. Paria, A. K. Das, S. Maiti, A. Maitra and B. B. Khatua, *Adv. Energy Mater.*, 2016, **6**, 1601016.