

## **Supplementary Material**

### **Electrospinning Ultrafine Graphene Nanofibers for Flexible Sensors**

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## 1. Fiber Diameter Control Model

Key Assumptions:

1. Geometry: All GO sheets are rectangular.
2. Density Homogeneity: Polymer and GO share identical density.
3. Compact packing: Soft GO sheets can fold and form a compact packing without pores.

Mathematical Derivation:

The cross-sectional area occupied by GO sheets equals the product of the fiber's cross-sectional area and GO mass fraction ( $w$ ):

$$N_s L t = \frac{\pi}{4} w D^2 \#(1)$$

where  $N_s$  is the number of GO sheets,  $D$  is fiber diameter.

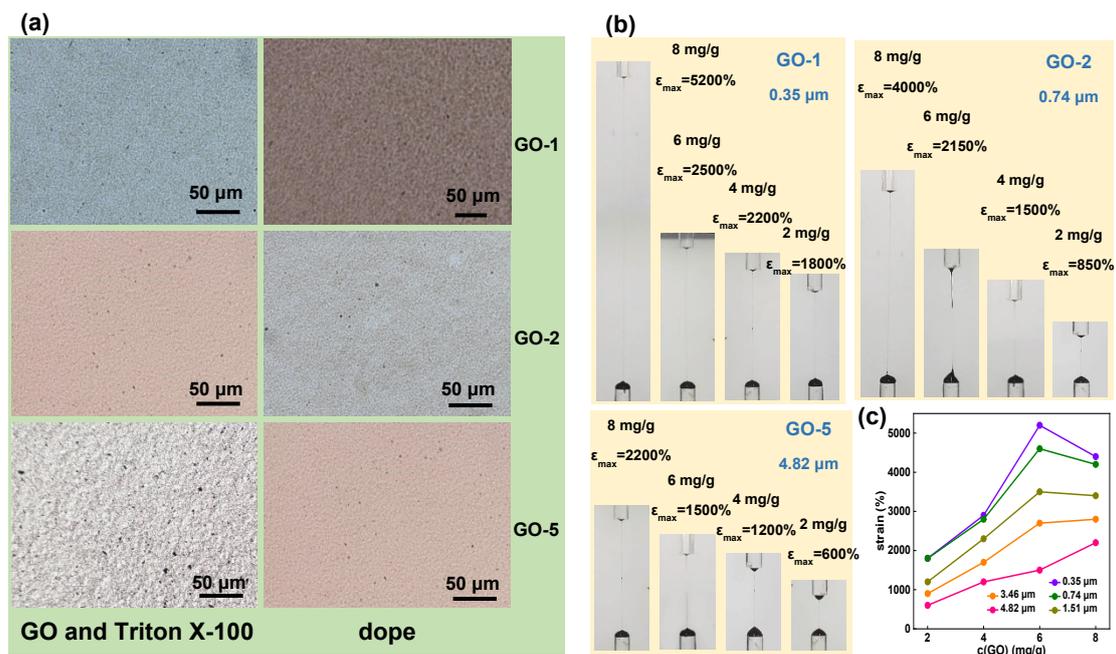
Ultimate Fineness Condition:

At the minimum dope concentration ( $C \rightarrow 0$ ), GO sheets separate and curl into Archimedean spirals, and become discontinuous along the fiber axis. This yields the theoretical minimum diameter ( $D_{\min}$ ):

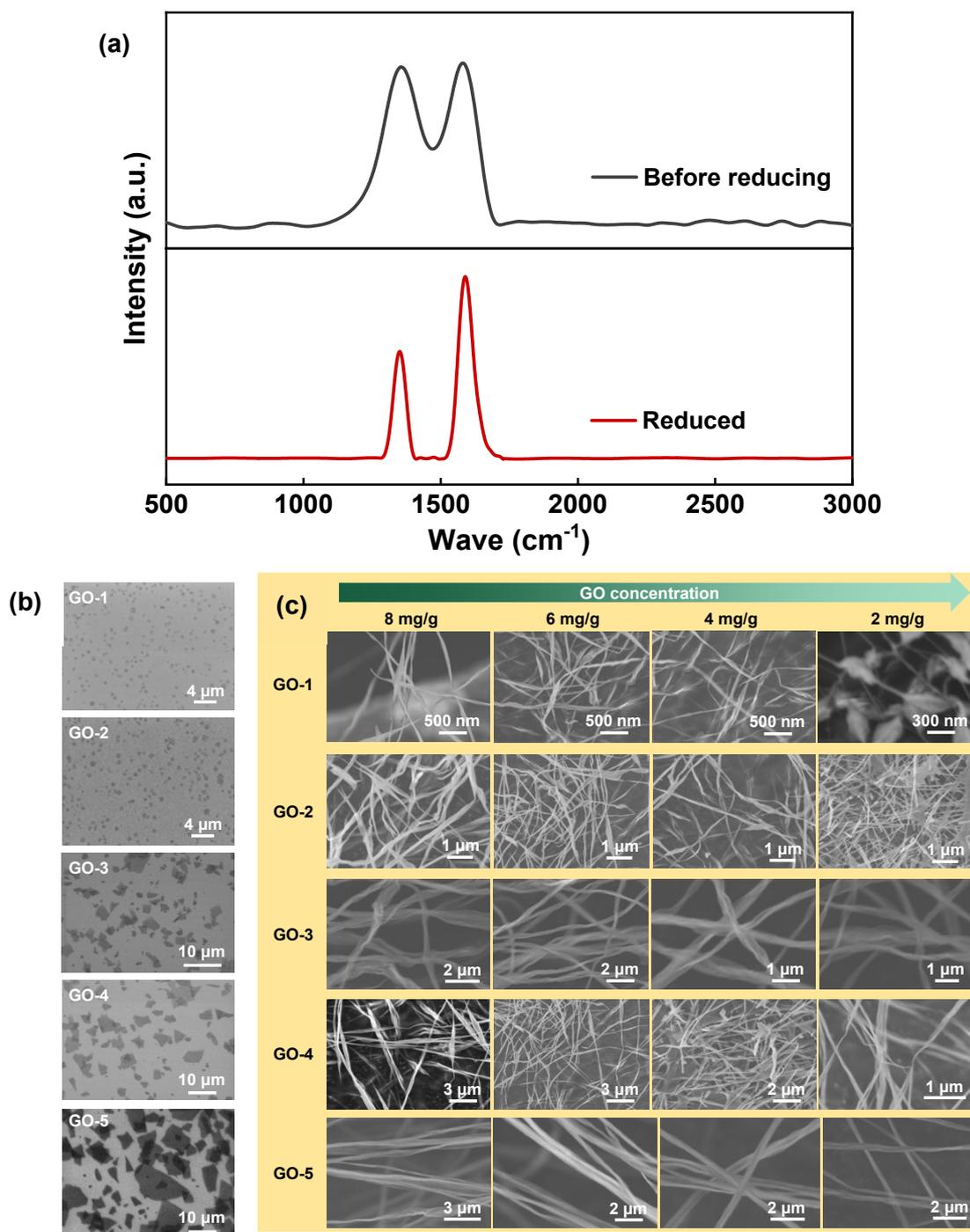
$$L t = \frac{\pi}{4} w D_{\min}^2 \#(2)$$

Experimentally,  $D_{\min}$  is extrapolated from the linear fit of  $D^2$  and  $C$ .

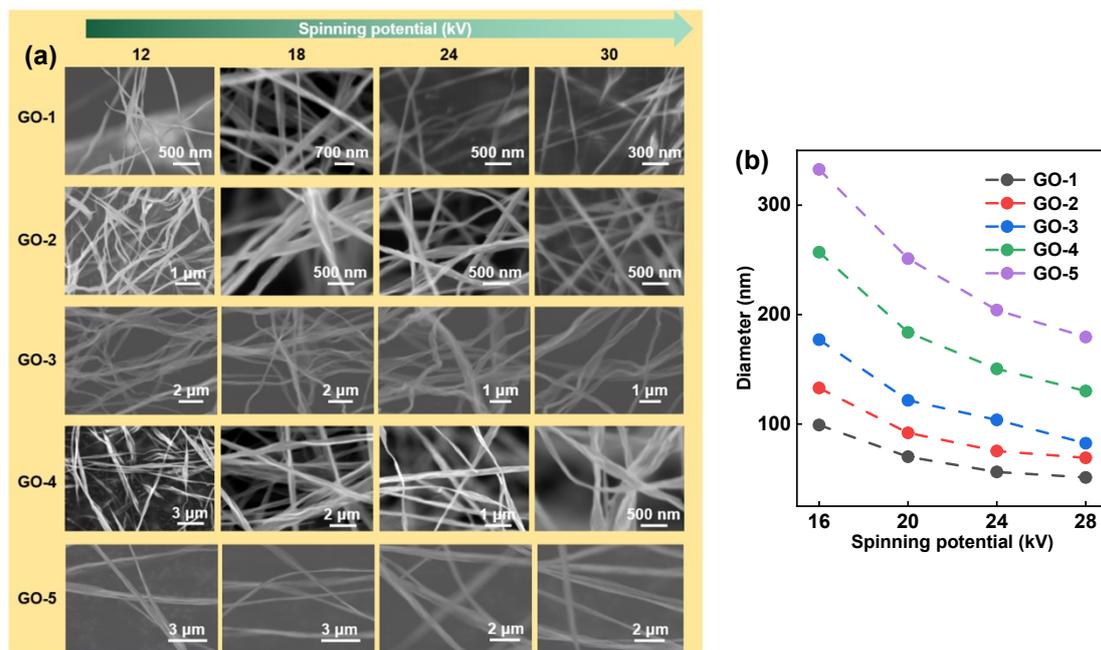
$$D^2 = kC + b \Rightarrow D_{\min} = \sqrt{b} \#(3)$$



**Figure S1.** (a) Optical images of mixing dope. (b) Photographs of strain test of GO-n dopes. (c) Straining ability as a function of GO size and concentration.

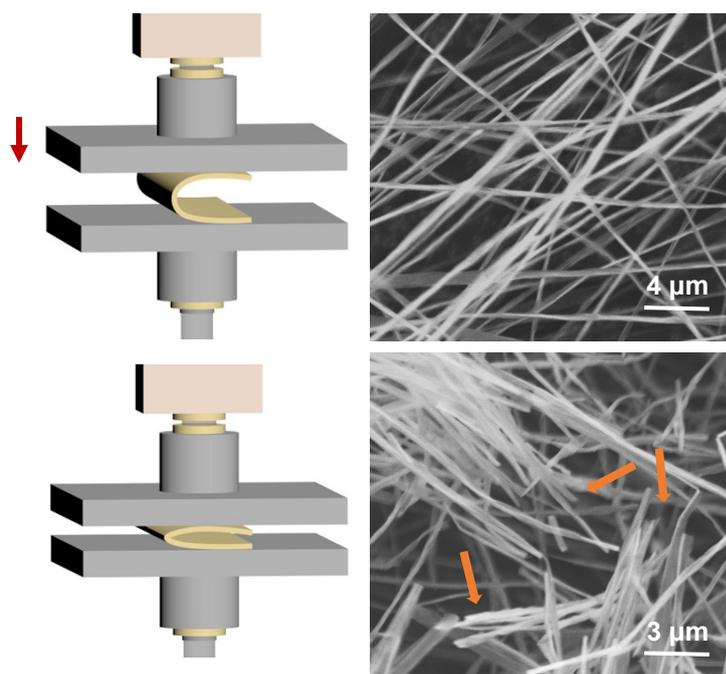


**Figure S2.** (a) Raman spectra of fabric before/after 1200 °C annealing. (b) SEM images of different GO sheets. (c) SEM images of nanofibers prepared from different GO 1-5 with different size and concentrations.

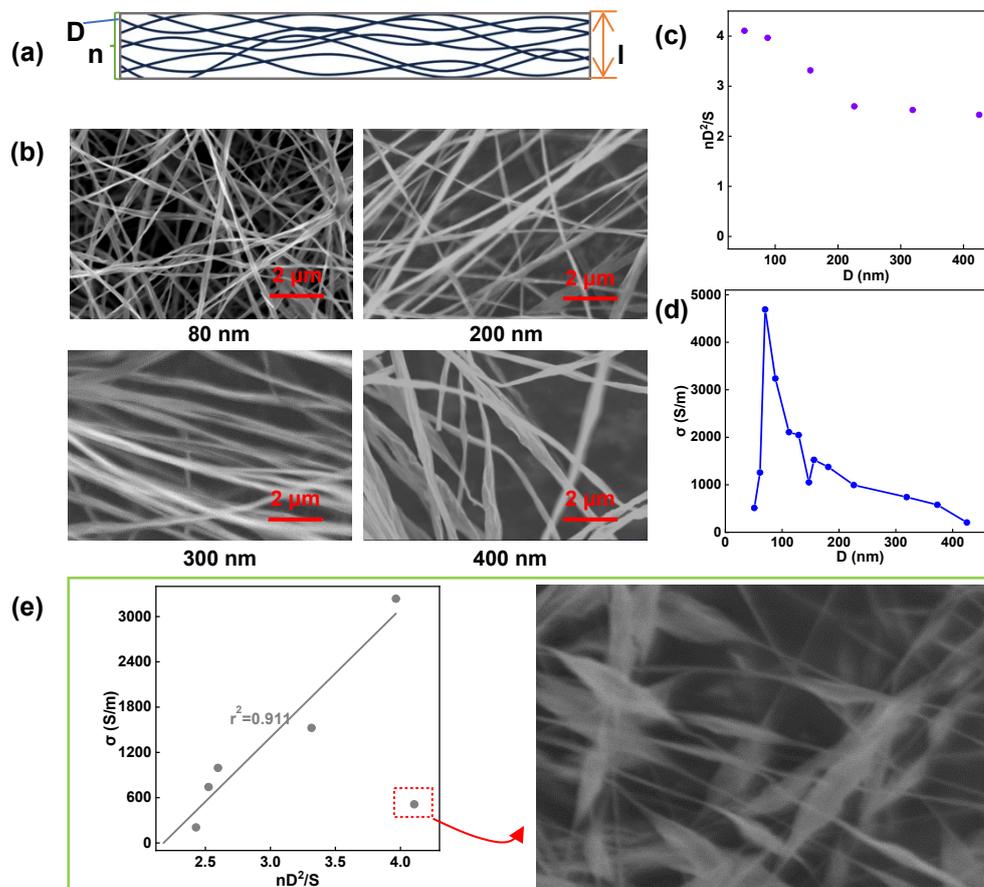


**Figure S3.** (a) SEM images of nanofibers prepared from different GO 1-5 with different spinning potential.

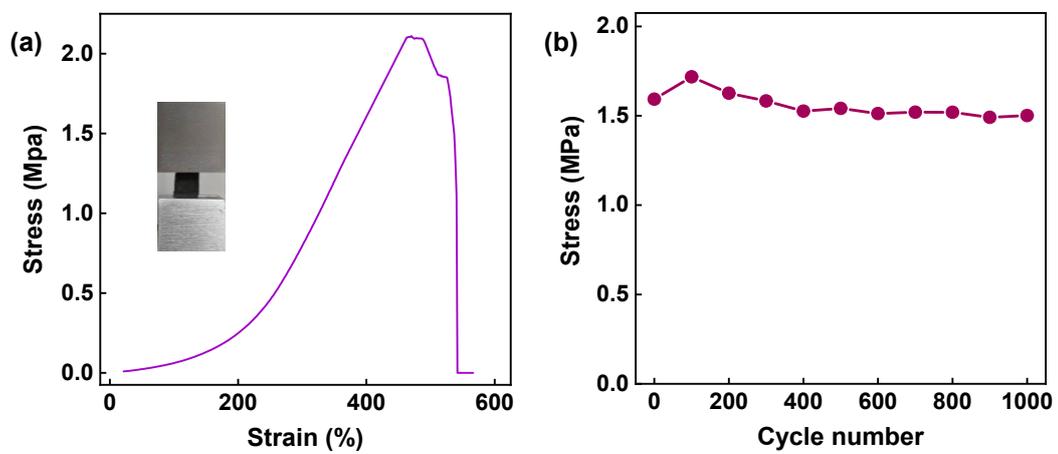
(b) The relationship between spinning potential and  $D$ .



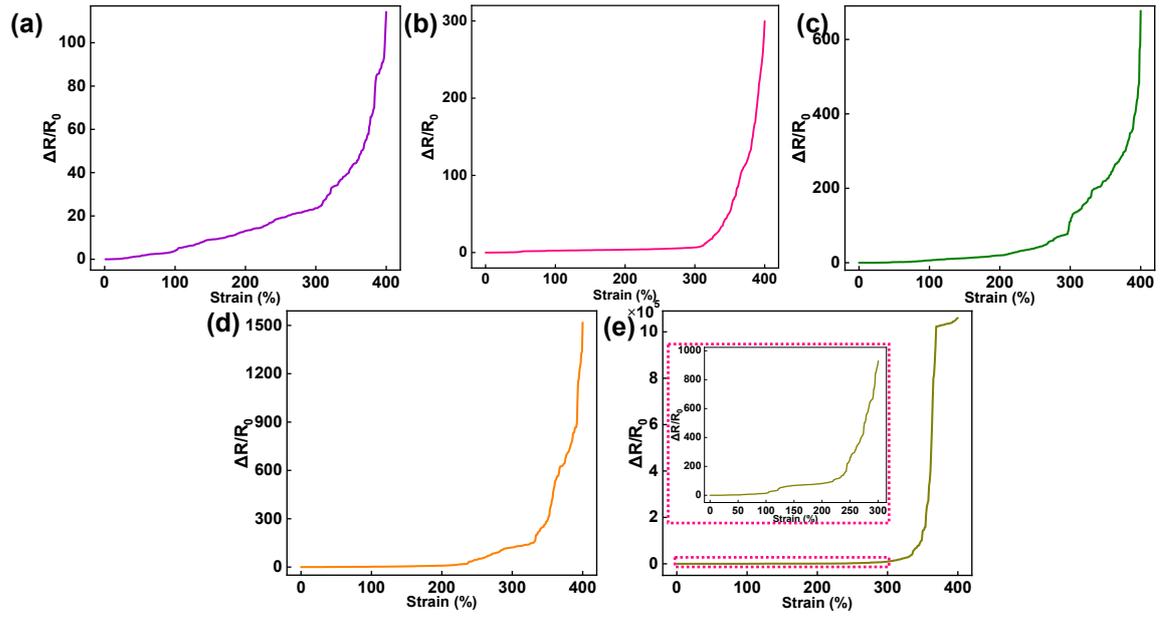
**Figure S4.** SEM images of GNFF before/after severe folding.



**Figure S5.** The effect of conductivity on fiber diameter. (a) Simplified model for calculating the electrical conductivity of non-woven fabrics. (b) SEM image of non-woven fabric. (c)  $nD^2/S$  varies with  $D$ . (d) Conductivity varies with GO size and GO concentration. (e) Linear fitting of  $nD^2/S$  with  $\sigma$ . The deviation from the linear relation is caused by the discontinuity of fibers.



**Figure S6.** Mechanical property of fabrics. (a) Stress-strain curve. (b) Cyclic stability.



**Figure S7.** Relationship between the relative resistance change and strain. The corresponding  $L$  is (a)  $4.82 \mu\text{m}$ ; (b)  $3.46 \mu\text{m}$ ; (c)  $1.51 \mu\text{m}$ ; (d)  $0.74 \mu\text{m}$ ; (e)  $0.35 \mu\text{m}$ .

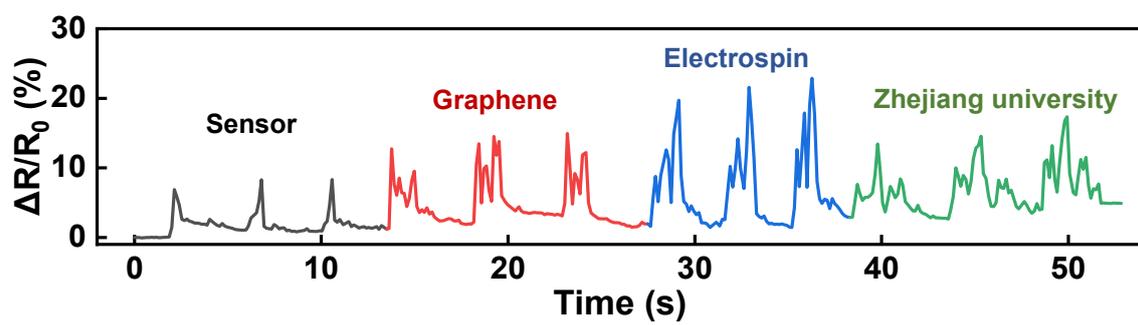
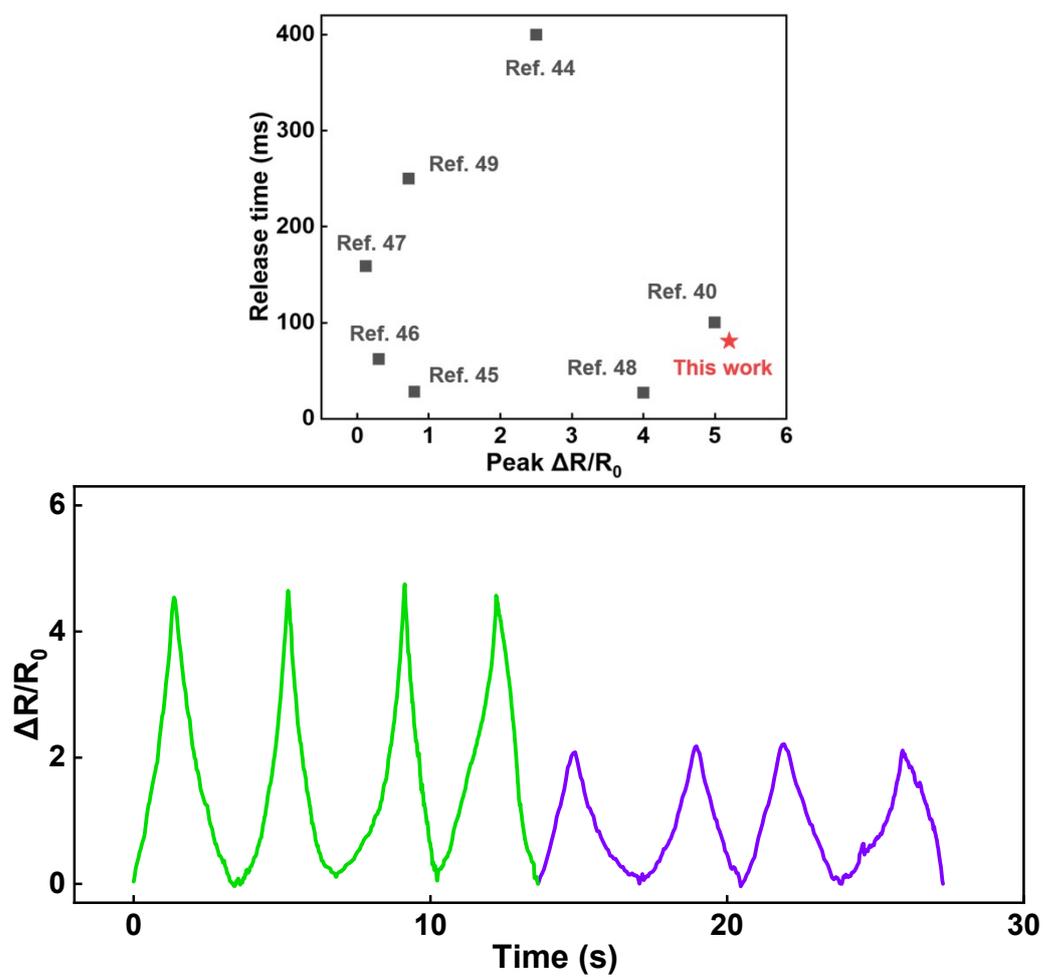
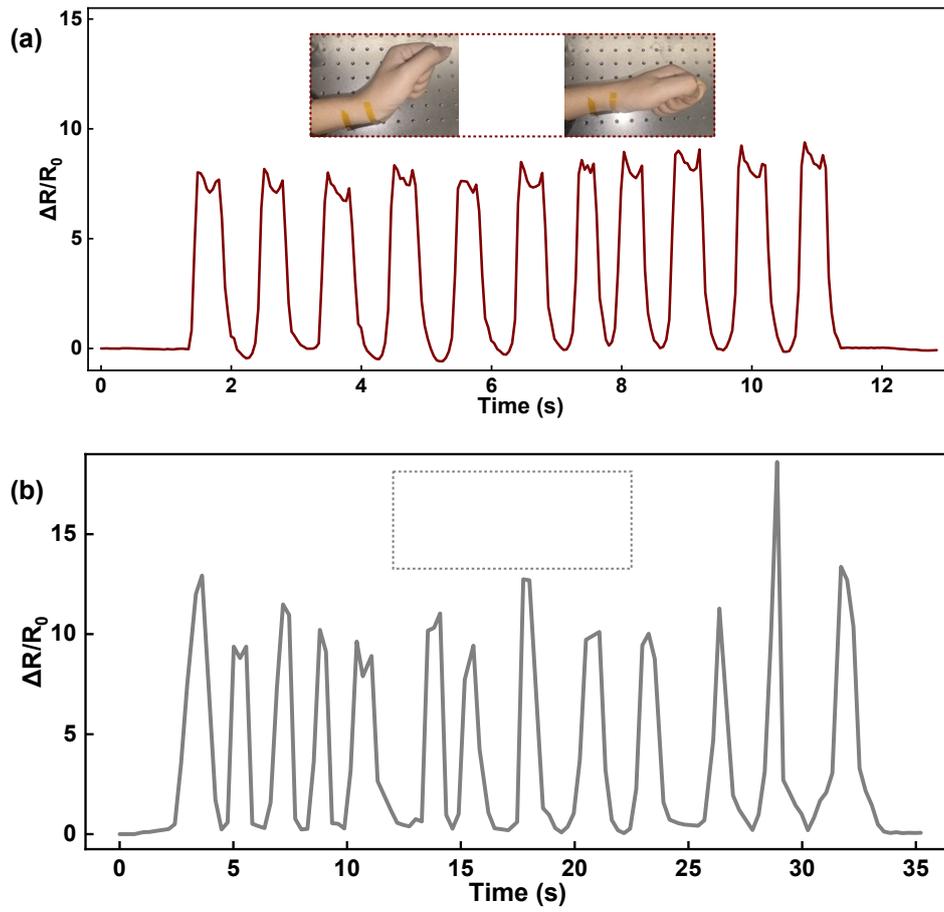


Figure S8. Response signal of strain sensor in word recognition.



**Figure S9.** (a) Comparison of release time and peak resistance of ultra-fine GNFF flexible sensor with other sensors. (b) Response signal of finger bending test in underwater environment.



**Figure S10.** Resistance variation of strain sensor in monitoring (a) wrist; (b) knee motion.

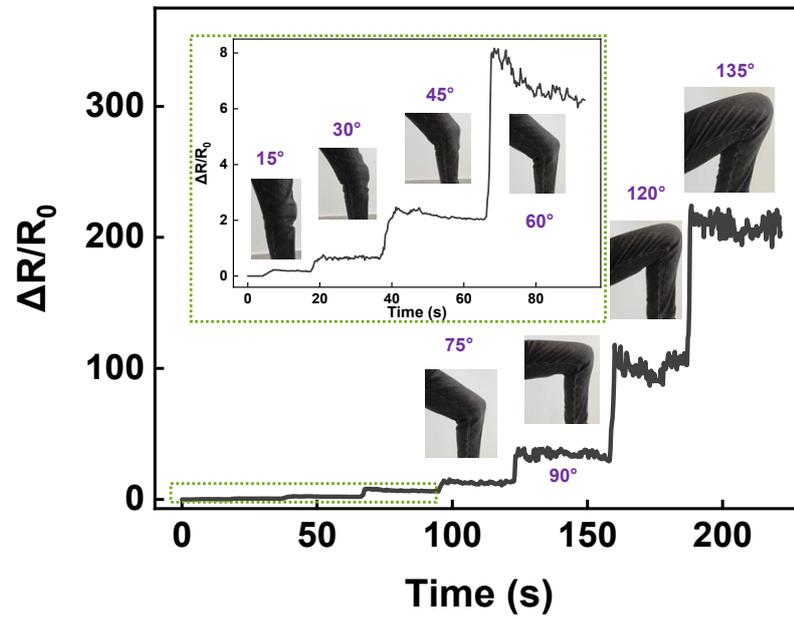


Figure S11. Resistance variation of strain sensor in monitoring different bending states of leg.