Electronic supplementary information

A facilely prepared notch-insensitive nanocomposite organohydrogel based flexible wearable device for long-term outdoor human motion monitoring and recognition

Zhejian He,[1#] Haoqiang Hua,[2#] Zhantao Zou,[1] Lin Shu*,[2] Tao Wang*,[1,3] Weixiang Sun,[1,3] Xiangmin Xu,[2] Zhen Tong,[1]

[1] Research Institute of Materials Science, South China University of Technology, Guangzhou 510640, China.

[2] School of Electronic and Information Engineering, South China University of Technology, Guangzhou 510640, China.

[3] Guangdong Provincial Key Enterprise Laboratory of Novel Polyamide 6 Functional Fiber Materials Research and Application, Jiangmen 529100, China.

*shul@scut.edu.cn (L. Shu), fetwang@scut.edu.cn (T. Wang)

[#] Z. He and H. Hua contributed equally to this work

Supplementary movies

Supplementary movie S1-tensile with 25% notch (4x speed)

Supplementary movie S2-cyclic tensile with 50% notch (20x speed)

Supplementary movie S3-walking

Supplementary movie S4-going downstairs and upstairs

Supplementary movie S5-deep squat

Table S1. The sensor performance of related works

Ref. No.	Sensitivity (Gauge Factor)	Notch insensitivity	Adhesion strength (kPa, on glass)	Anti-freezing (°C)	Action classification & recognition	Assembled device
[6]	3.2 (180%)	/	6.37	-20	Moderate	/
[10]	3.8 (100%)	/	/	-70	Weak	/
[13]	1.4 (220%)	/	5.5	/	Moderate	/
[17]	3 (300%)	/	19.28	/	Weak	/
[18]	2.6 (100%)	/	75	-32	Weak	/
[19]	/	Yes	/	/	Weak	/
[20]	1.5 (500%)	Yes	/	/	Moderate	/
[31]	0.6 (600%)	/	/	/	Weak	/
[43]	2.4 (200%)	/	28	-20	Super	Yes
[55]	1.6 (600%)	Yes	/	/	Moderate	/
This work	4.05 (800%)	Yes	22	-40	Super	Yes

Note: / represents that there is no such property reported in the corresponding work.

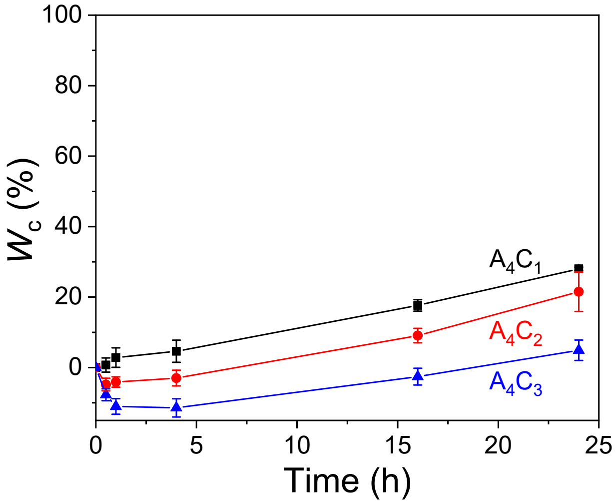


Fig. S1. The weight change percentage W_c of the indicated NC hydrogels during the solvent exchange process in glycerol.

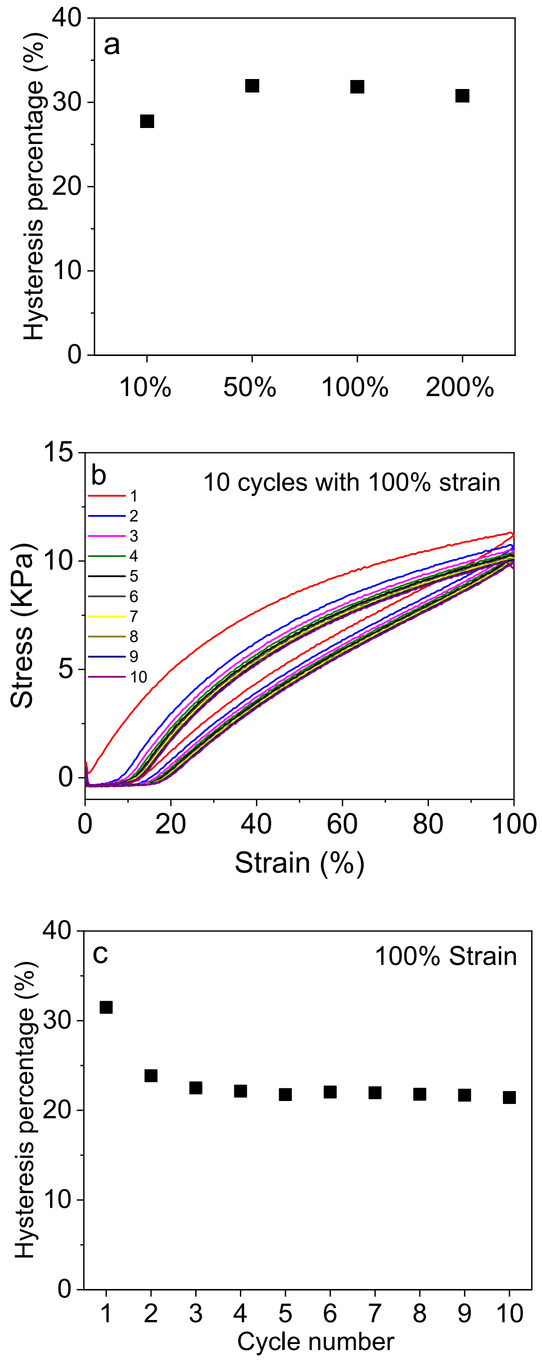


Fig. S2. (a) The hysteresis percentage of the $A_4C_2G_4$ hydrogel during the loading-unloading with indicated tensile strain. (b) 10 continuous cyclic tensile of $A_4C_2G_4$ with the strain of 100%. (c) 10 cyclic loading-unloading tests with the tensile strain of 100%.

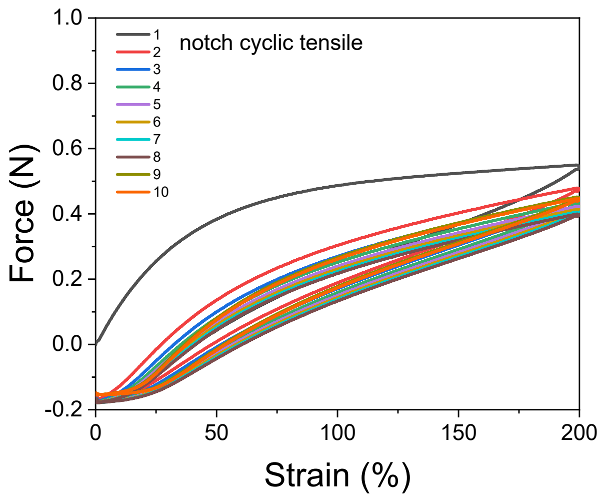


Fig. S3. 10 cyclic loading-unloading tensile tests of the $A_4C_2G_4$ hydrogel with 5 mm edge notch (25% of the sample width).

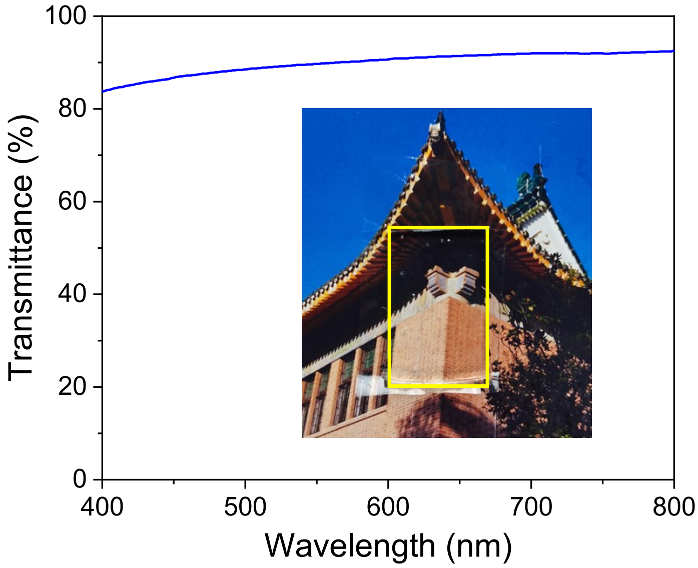


Fig. S4. Transmittance of the $A_4C_2G_4$ hydrogel at the wavelength between 400 and 800 nm, the insert is the corresponding photo of the hydrogel (within the yellow frame) on a picture.

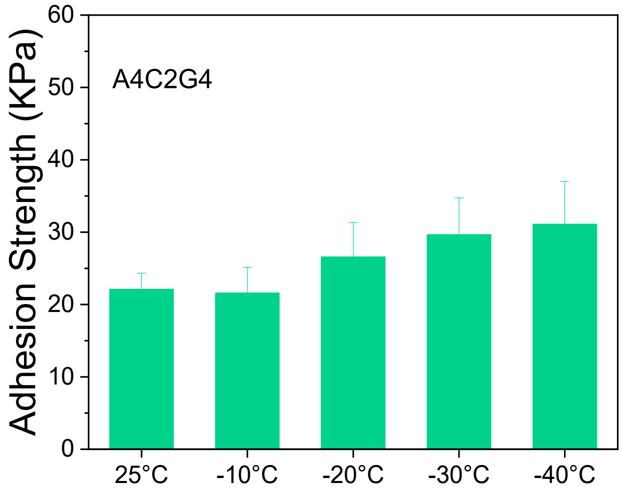


Fig. S5. Adhesive strength of the $A_4C_2G_4$ hydrogel at different temperatures.

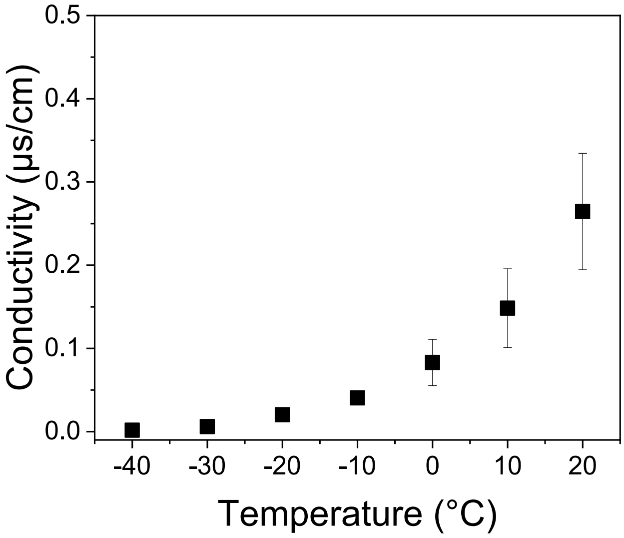


Fig. S6. The conductivity of the $A_4C_2G_4$ hydrogel at different temperatures.

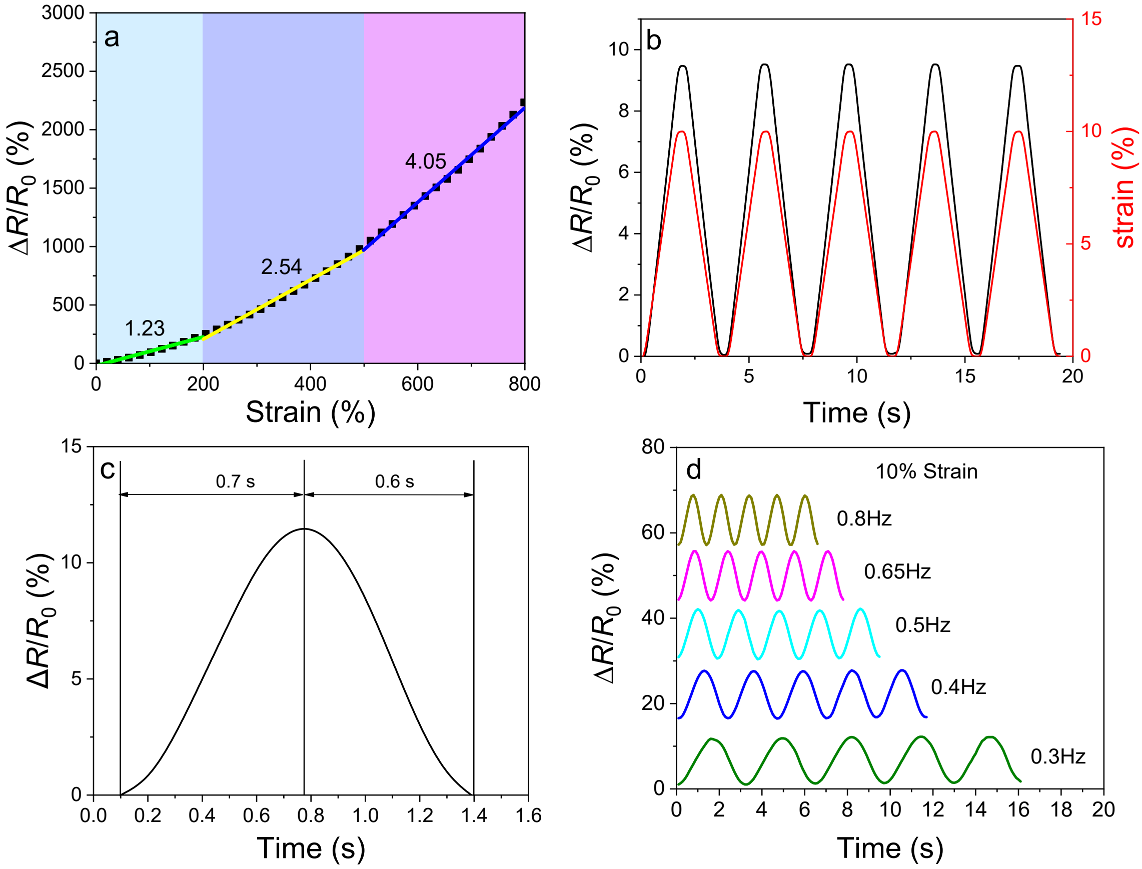
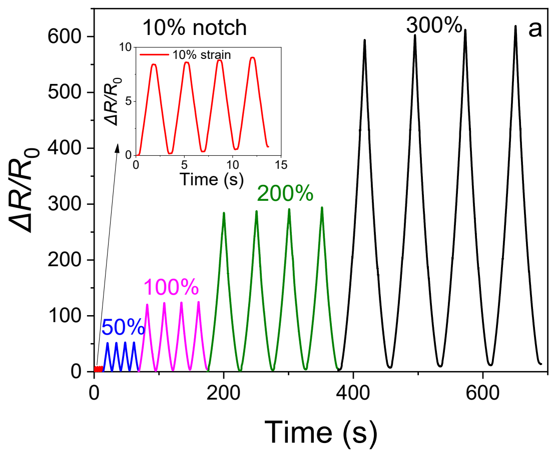


Fig. S7. The strain sensor performances of the $A_4C_2G_4$ hydrogel. (a) The relative resistance change $\Delta R/R_0$ and the gauge factor (GF) values as a function of the tensile strain of 10%. (b) The dependence of strain and $\Delta R/R_0$ to the test time. (c) Response and recovery time of the $A_4C_2G_4$ hydrogel at 10% tensile strain and 0.8 Hz strain rate. (d) $\Delta R/R_0$ at different frequencies with 10% strain.



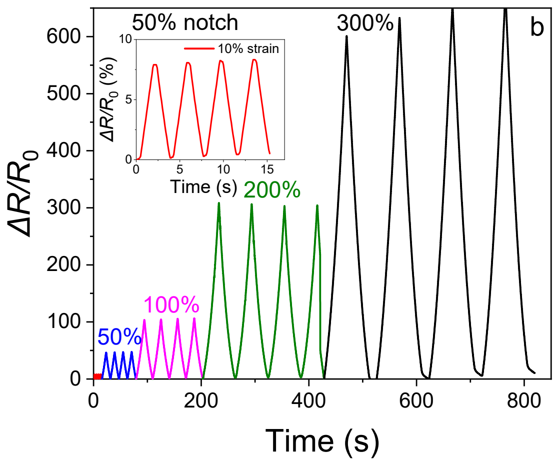


Fig. S8. Typical relative resistance change ($\Delta R/R_0$) of the $A_4C_2G_4$ hydrogel with various notch percentages (a. 25%, b. 75%) at different tensile strains (10%, 50%, 100%, 200%, and 300%).

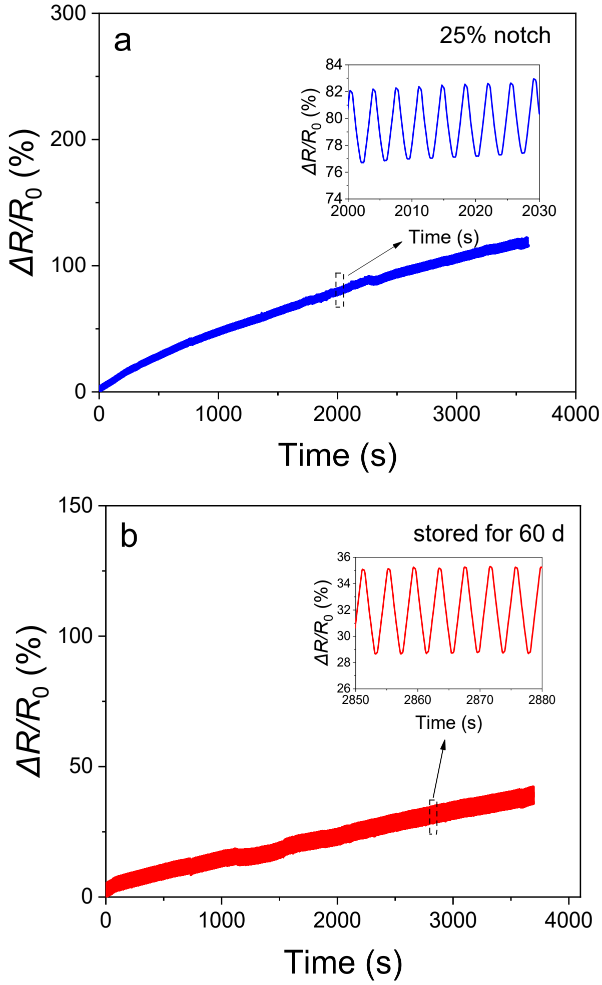


Fig. S9. $\Delta R/R_0$ of the cyclic strain response of the $A_4C_2G_4$ hydrogel sensor at 10% strain. (a) 1000 cycles with 25% notch. (b) 1000 cycles of the hydrogel after being stored for 60 d. Inserts are the enlargement of indicated local data.

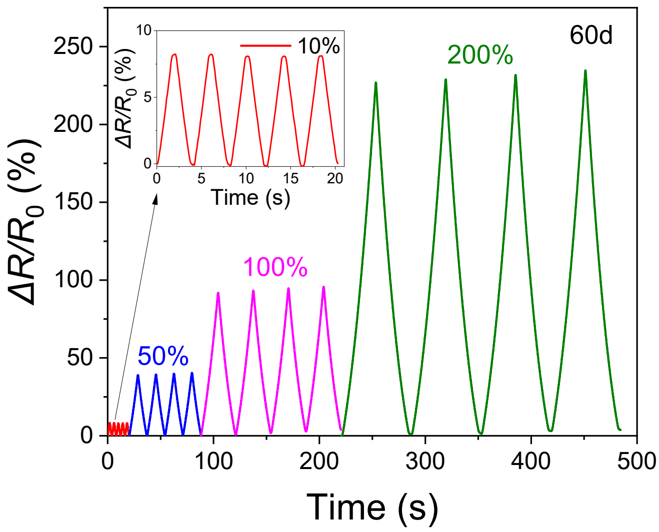


Fig. S10. $\Delta R/R_0$ of the $A_4C_2G_4$ hydrogel at the tensile strain response after 60 d storing.

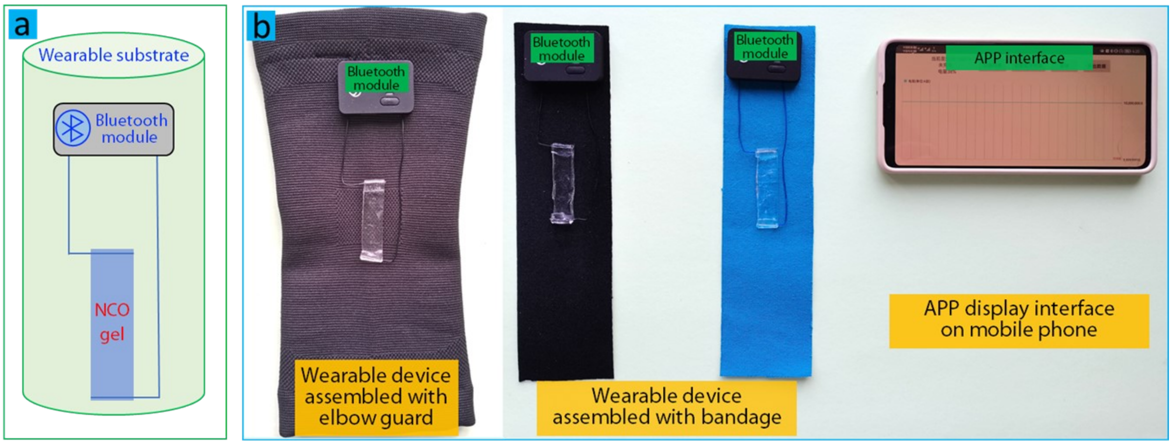


Fig. S11. Schematic illustration (a) and the photos of the wearable device based on the NCO hydrogel and the receiving and display interface on mobile phone (b).

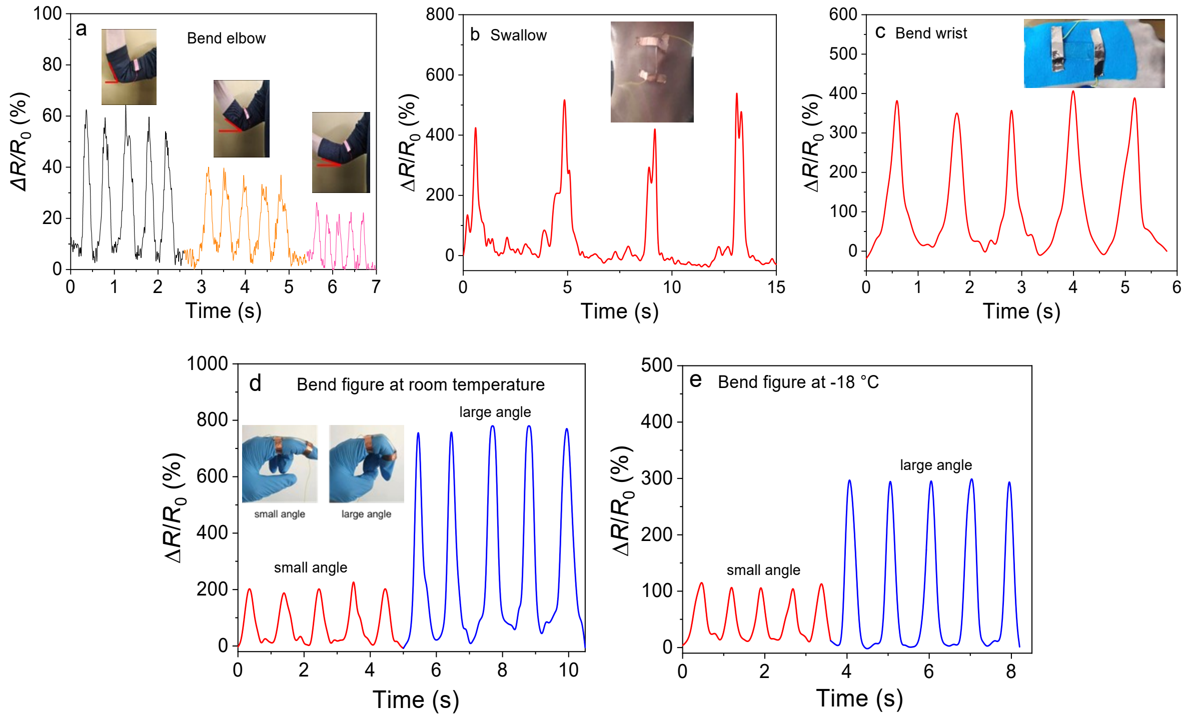


Fig. S12. $\Delta R/R_0$ obtained from the wearable device responses at different motions: (a) bend elbow, (b) swallow, (c) bend wrist, and bend finger at room temperature (d) and at -18 °C (e). Inserts are the corresponding photos.

Note: The hydrogel sensor connected with wireless Bluetooth module were first stored at -18 °C for 4 h, then the hydrogel sensor was attached with figure and actions of bending figure were recorded at this temperature condition. The resistance change of the hydrogel sensor was obtained on the mobile phone.

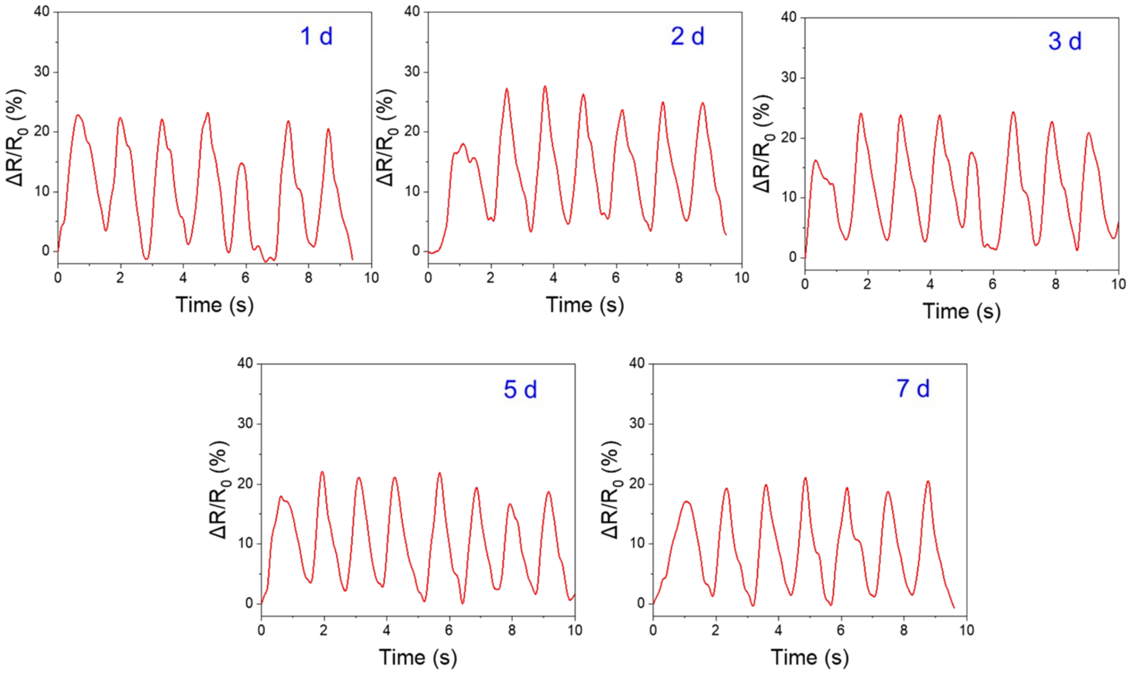


Fig. S13. Part of the signals of going upstairs obtained from the wearable device based on the NCO hydrogel after the device was stored for different time, (a) 1 d, (b) 2 d, (c) 3 d, (d) 5 d and (e) 7 d.