

Highly Tough, Fatigue-Resistant, Low Hysteresis Hybrid Hydrogel with Hierarchical Cross-Linked Structure for Wearable Strain Sensor

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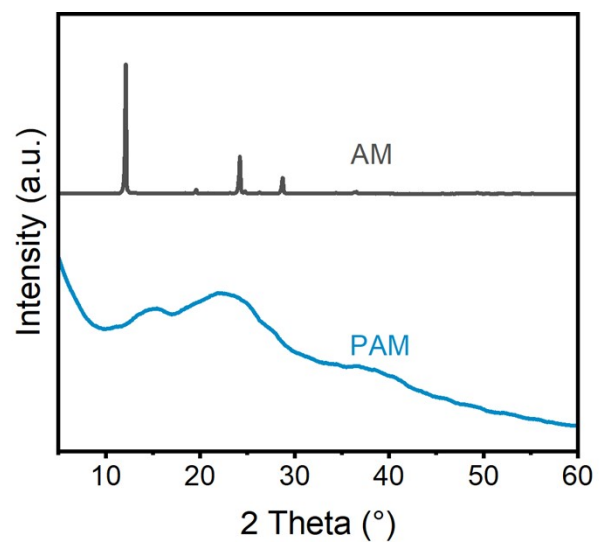


Fig. S1. XRD patterns of pure AM monomer and PAM.

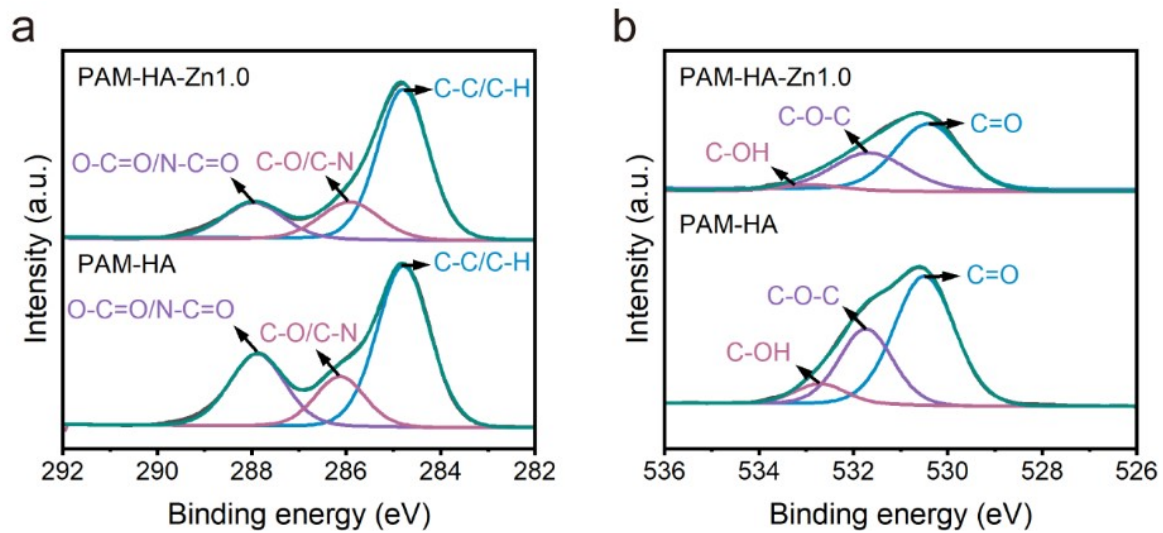


Fig. S2. XPS spectra of (a) C 1s and (b) O 1s for PAM-HA and PAM-HA-Zn1.0 hydrogels.

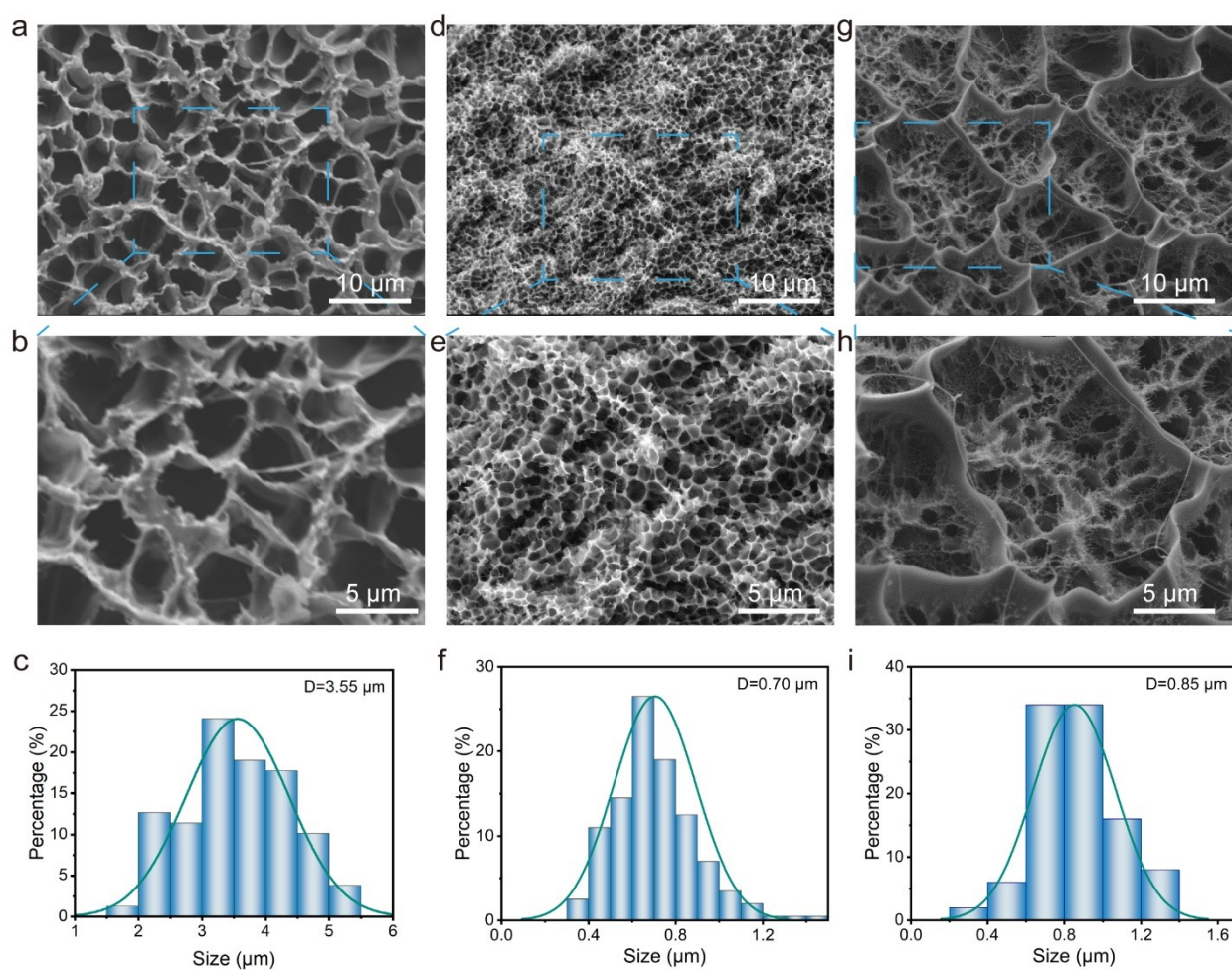


Fig. S3. SEM images and aperture distribution map of (a, b and c) PAM, (d, e and f) PAM-HA and (g, h and i) PAM-HA-Zn1.0 hydrogels.

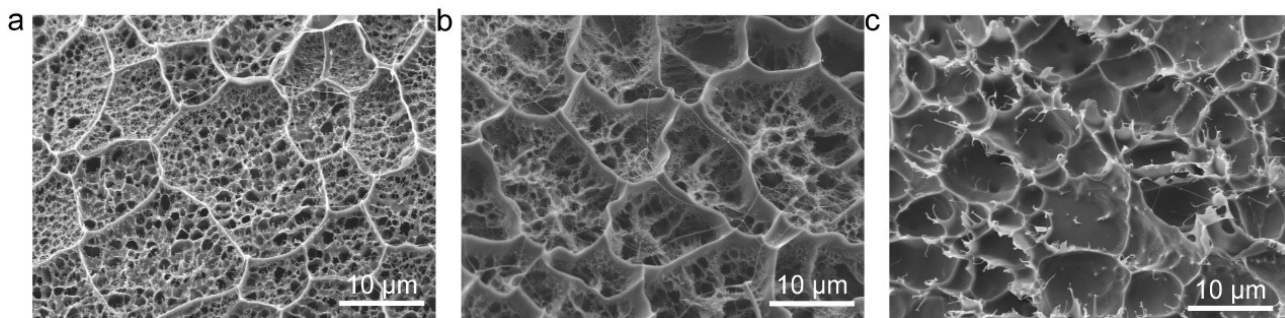


Fig. S4. SEM images of PAM-HA-Zn hydrogel with different ZnCl_2 content. (a) PAM-HA-Zn0.5. (b) PAM-HA-Zn1.0. (c) PAM-HA-Zn2.0.

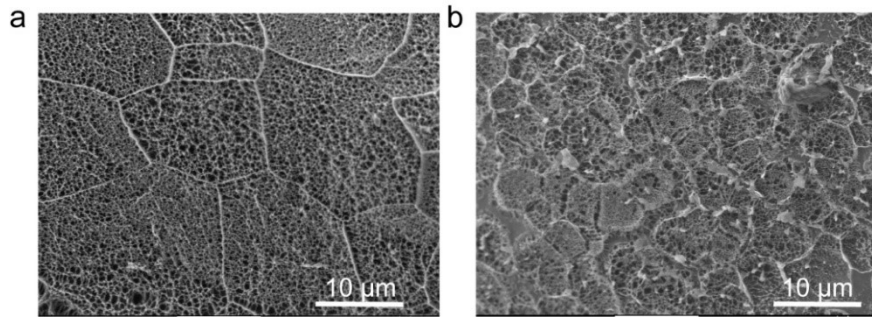


Fig. S5. The SEM images of PAM-HA-Zn1.0 hydrogels after 100 loading-unloading cycles at strain of (a) 100% and (b) 1000%.

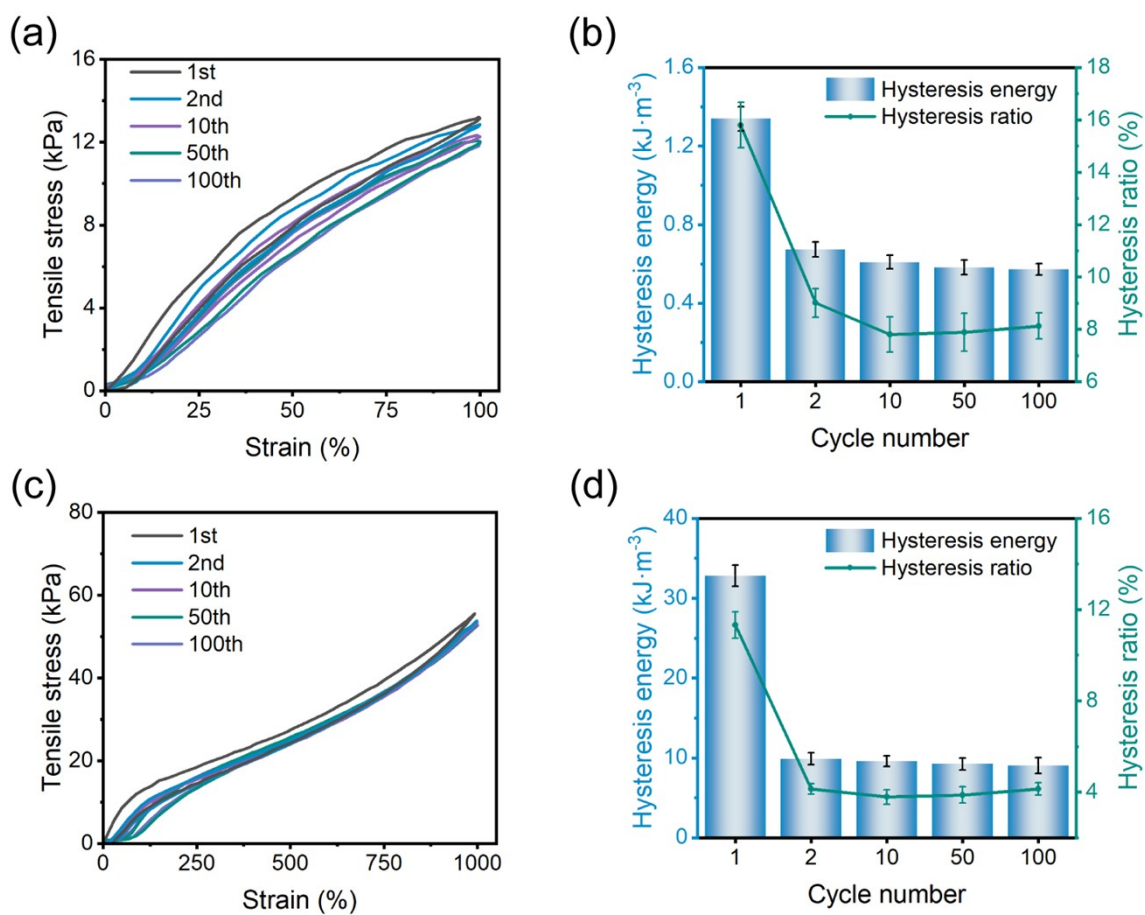


Fig. S6. (a) One hundred successive loading-unloading curves and (b) the corresponding hysteresis energy and hysteresis ratio of the PAM-HA-Zn1.0 hydrogel at strains of 100%. (c) One hundred successive loading-unloading curves and (d) the corresponding hysteresis energy and hysteresis ratio of the PAM-HA-Zn1.0 hydrogel at strains of 1000%.

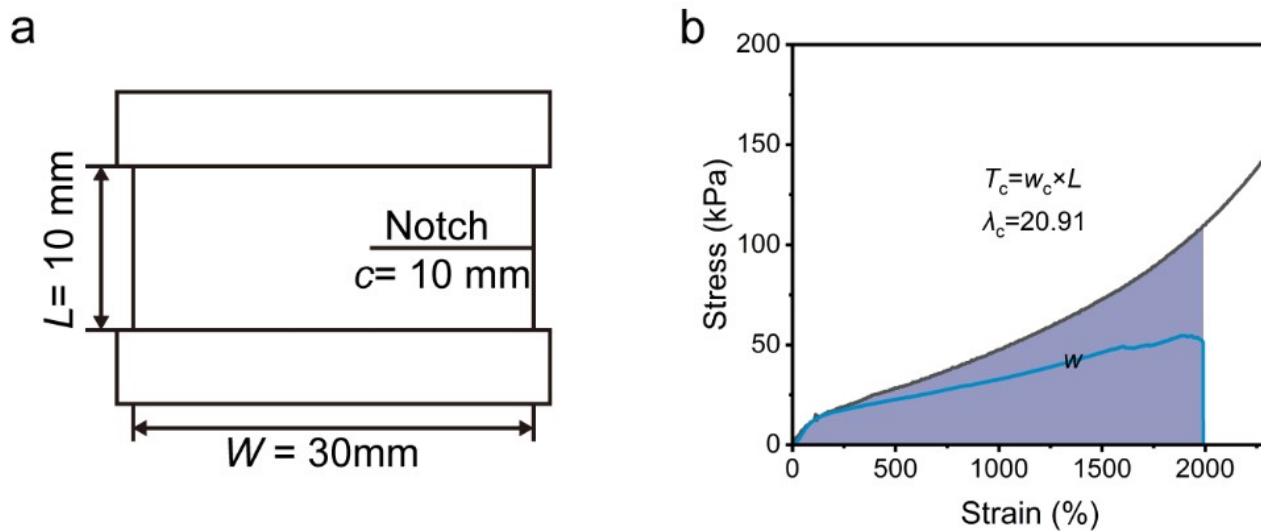


Fig. S7. (a) Measurement of fracture energy with the pure shear experiment and (b) tensile stress-strain curves of the notched sample and unnotched sample of PAM-HA-Zn1.0 hydrogel.

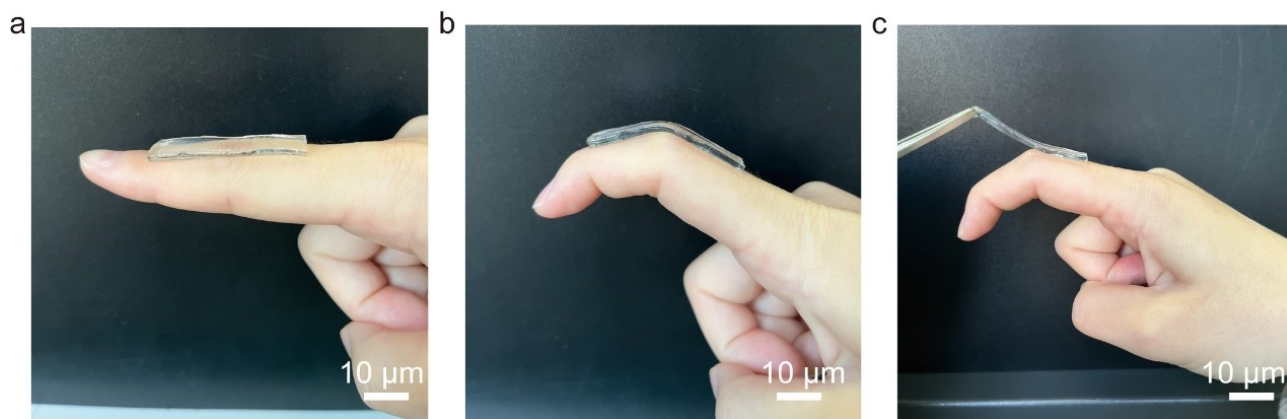


Fig. S8. Diagram of the PAM-HA-Zn1.0 hydrogel adhering to the human hand and the absence of any residue after being removed.

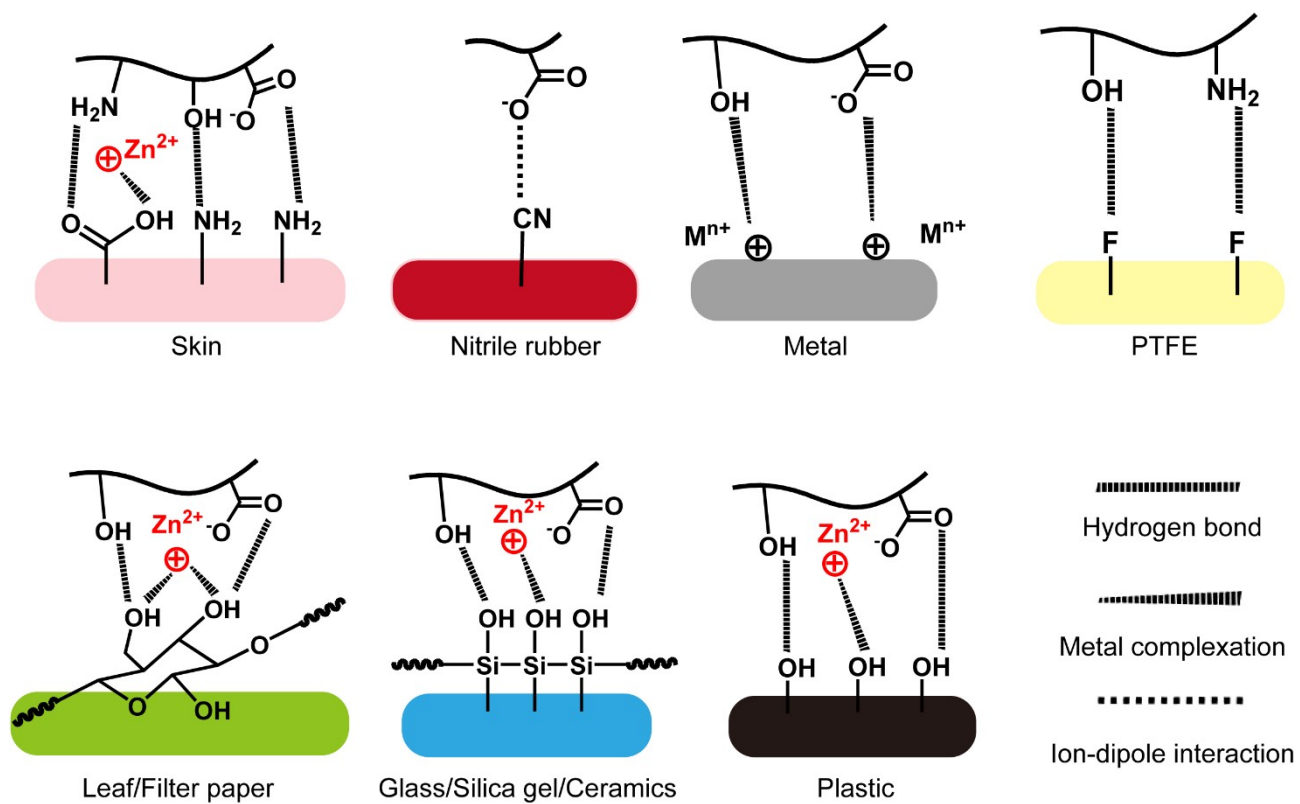


Fig. S9. Schematic diagram for the adhesion mechanism of PAM-HA-Zn1.0 hydrogel to various substrates.

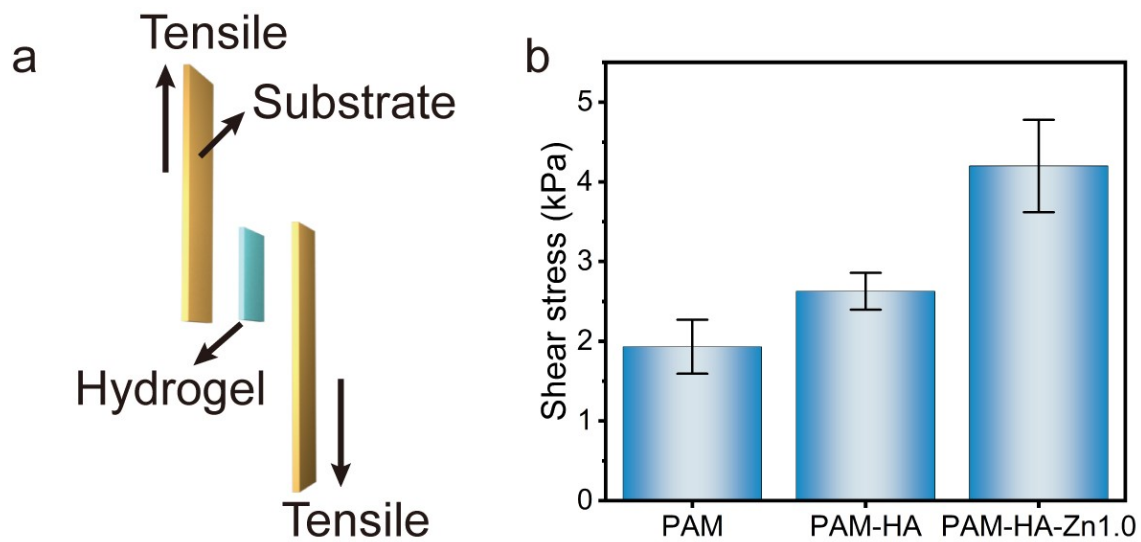


Fig. S10. (a) Schematic diagram for the adhesion measurements of hydrogels. (b) The adhesion strength of PAM, PAM-HA, PAM-HA-Zn1.0 hydrogel to porcine skin.

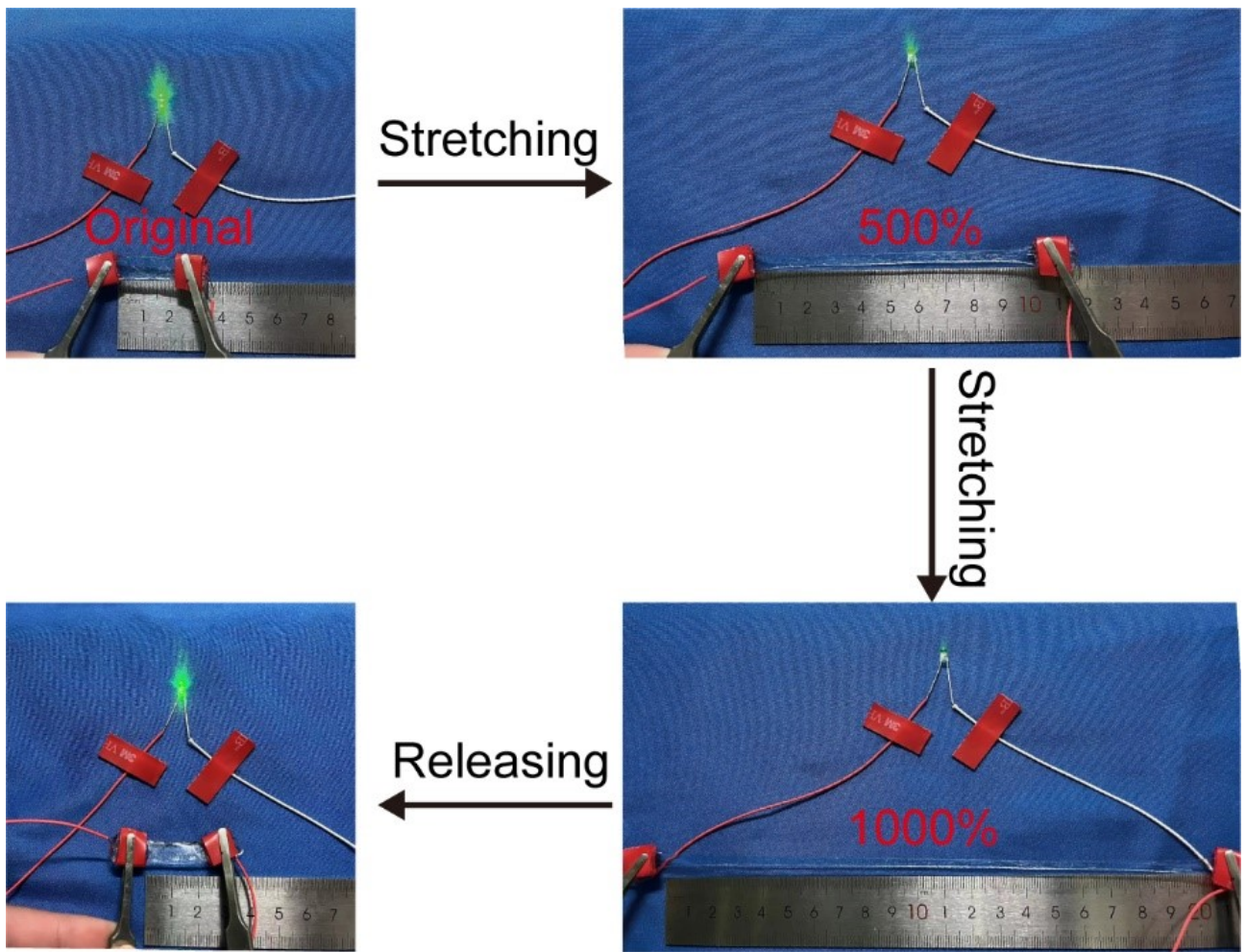


Fig. S11. Change in LED brightness with different strain of PAM-HA-Zn hydrogel connected in the electric circuit

Composition of the hydrogels. The composition of PAM hydrogel and PAM-HA hydrogel was shown in Table S1. The hydrogels with different contents of Zn^{2+} were named PAM-HA- Zn_x in Table S1, where x represented the mass of $ZnCl_2$ as a percentage of the total mass of HA and AM.

Table S1. Composition of the hydrogels.

Name	AAM(g)	HA(g)	APS(g)	MBA(g)	$ZnCl_2$ (g)	Water(g)
PAM	2.0	0	0.01	0.001	0	8.0
PAM-HA	1.6	0.4	0.008	0.0008	0	8.0
PAM-HA- $Zn_{0.5}$	1.6	0.4	0.008	0.0008	0.01	8.0
PAM-HA- $Zn_{1.0}$	1.6	0.4	0.008	0.0008	0.02	8.0
PAM-HA- $Zn_{2.0}$	1.6	0.4	0.008	0.0008	0.04	8.0

Table S2. Comparison of our work and recently reported gels.

Name	Elongation at break (%)	Toughness (MJ m ⁻³)	Reference
PAM-HA-Zn1.0	3040	3.07	This work
PAM/PBA-IL3/CNF2	1810	2.65	[S1]
MCP hydrogel	1100	0.21	[S2]
PAM-oxCNTs hydrogel	1074	2.29	[S3]
PAAm-Ferritin hydrogel	1400	0.62	[S4]
P(AA-MEA)-Graphene hydrogel	1300	1.95	[S5]
Mxene-PVA hydrogel	1200	0.04	[S6]
Fe-SL-g-PAA hydrogel	1680	0.59	[S7]
PACG-M	918	0.59	[S8]
AVN hydrogel	2333	~ 1.5	[S9]

Notes and references

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