# Supplementary Information

# Mechanically robust gluconate-regulated polydopamine-polyacrylamide hydrogel with exceptional adhesion

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**Material testing**

The tensile and compressive mechanical properties of the hydrogels were evaluated using an electronic universal machine (ZQ-990LB, ZhiQu Co. Ltd., China). Specimens with dimensions of 4 mm in width and 5 mm in thickness were tested at a loading rate of 30 mm/min, with a gauge length of 25 mm between the fixtures.

The hydrogels were subjected to cyclic tensile loading by applying strain up to 300% followed by complete unloading until the force returned to zero. This loading-unloading cycle was repeated to evaluate the hydrogel's elastic recovery and hysteresis behavior.

The hydrogels were cyclically loaded under compression to 50% strain and subsequently unloaded until the applied force reached zero. This loading-unloading process was repeated to characterize the compressive recovery and energy dissipation properties of the hydrogels.

The hydrogels were subjected to cyclic compression testing under progressively increasing strain levels of 10%, 20%, 30%, 40%, 50%, 60%, and 70%. For each strain level, the samples were loaded to the specified deformation and subsequently unloaded until the compressive force returned to zero, enabling systematic evaluation of strain-dependent mechanical resilience and hysteresis behavior.

Dumbbell-shaped hydrogel specimens were adhered to various substrates (metal, glass, and polymer) and subjected to lap shear testing to evaluate their interfacial adhesion strength. The experiments quantitatively assessed the hydrogel's adhesive effectiveness across different surface chemistries and rigidities.

The ionic conductivity of hydrogels was measured using the EmStat 4S HR electrochemical workstation (PalmSens, Netherlands).

**Table S1**. Compositions of the prepared hydrogels.

| Glucose salt | PAM (g) | PDA/PAM (wt%) | BIS/PAM (wt%) | APS/PAM (wt%) | $H_2O$ (mL) |
|---|---|---|---|---|---|
| 0.025mZnG<br>0.05mZnG<br>0.075mZnG<br>0.1mZnG | 4 | 0.4 | 0.5 | 10 | 20 |
| 0.025mMgG | 4 | 0.4 | 0.5 | 10 | 20 |
| 0.025mNaG | 4 | 0.4 | 0.5 | 10 | 20 |
| 0.025mKG | 4 | 0.4 | 0.5 | 10 | 20 |

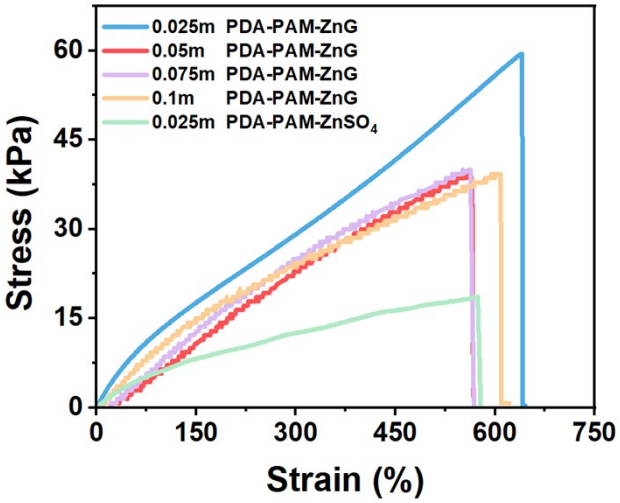


**Fig. S1.** Tensile stress-strain curves of PDA-PAM-ZnG hydrogels with varying concentrations of ZnG.

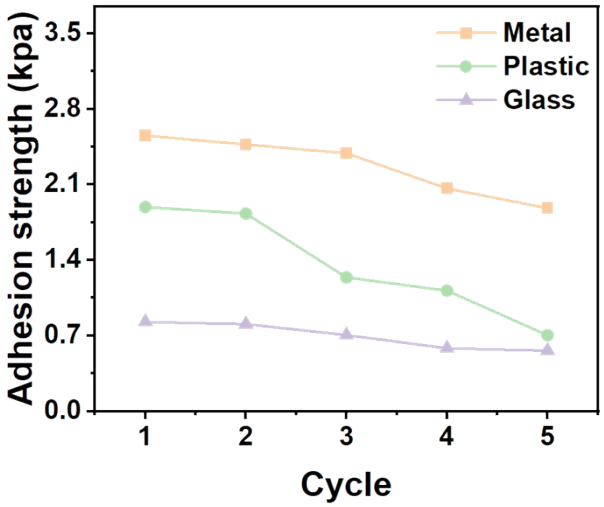


**Fig. S2.** Cyclic adhesive shear strength of PDA-PAM-ZnG hydrogels on metal, plastic, and glass substrates.