Supporting information

Magnetic Field Assisted Fabrication of Asymmetric Hydrogels for Complex Shape Deformable Actuators

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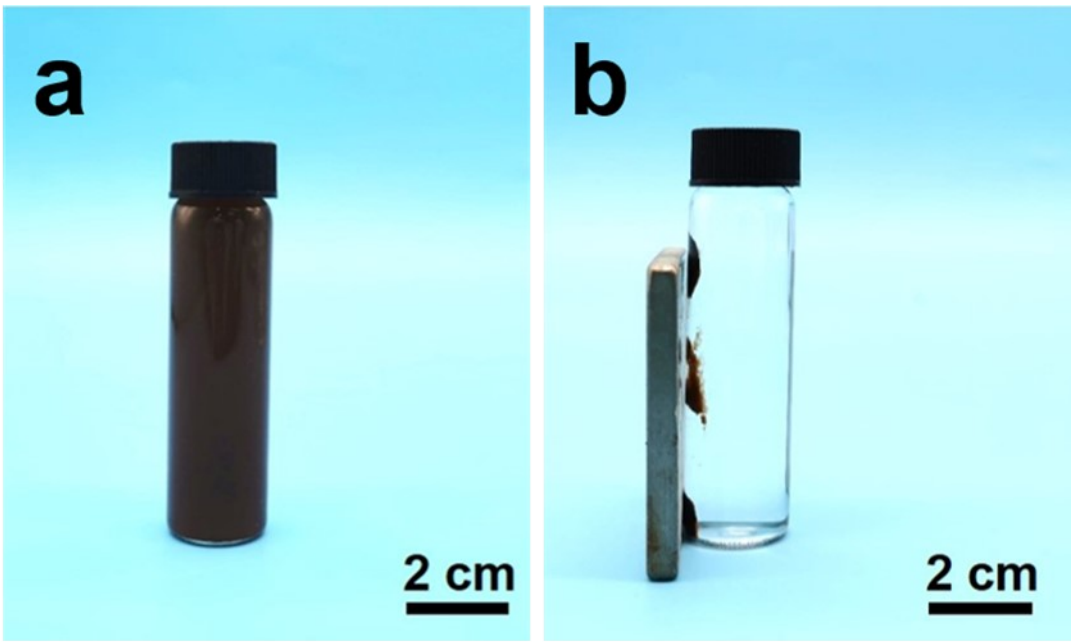

Figure S1. Photographs of Fe_3O_4@TCNC suspension after standing for 24 h (a) and attracting with magnets for 2 min (b).

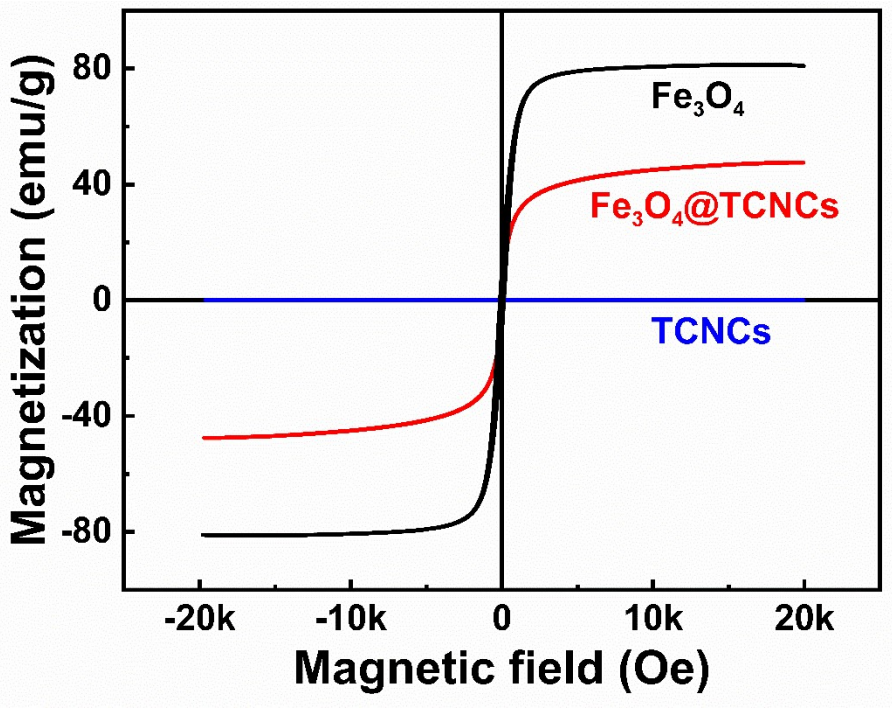

Figure S2. Magnetic hysteresis loops of Fe_3O_4 nanoparticles, Fe_3O_4@TCNCs, and TCNCs.

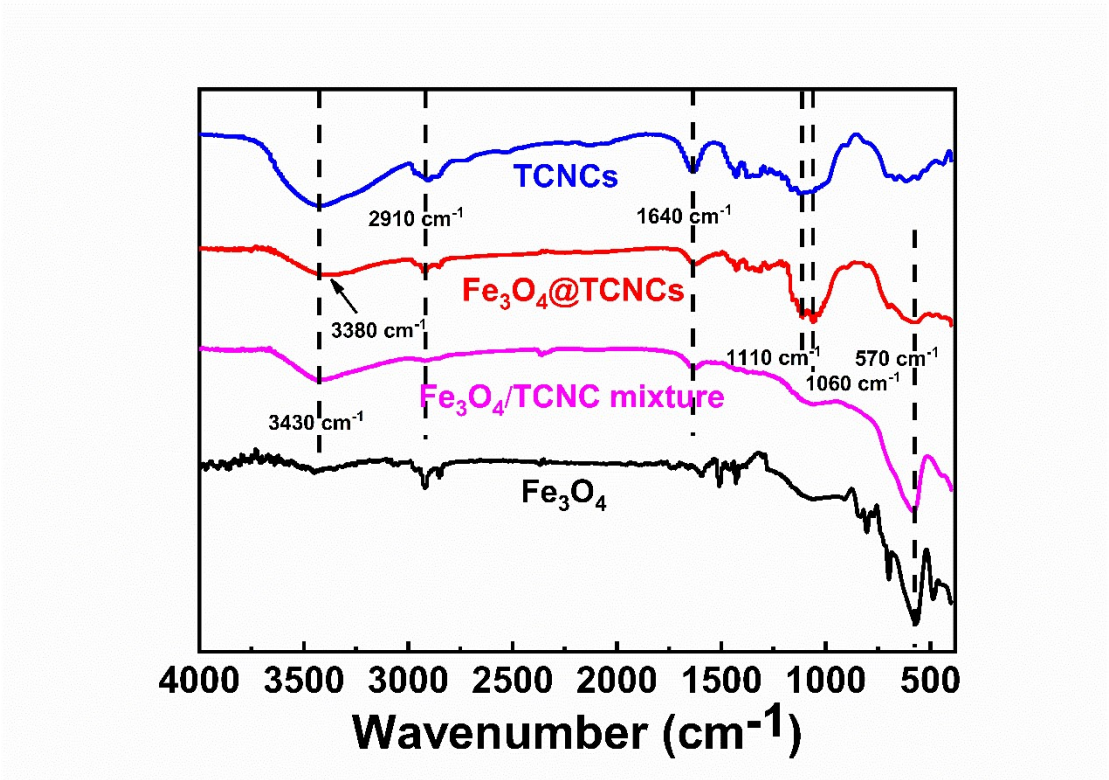

Figure S3. FTIR spectra of TCNCs, Fe_3O_4@TCNCs, Fe_3O_4/TCNC mixture, and Fe_3O_4 powder.

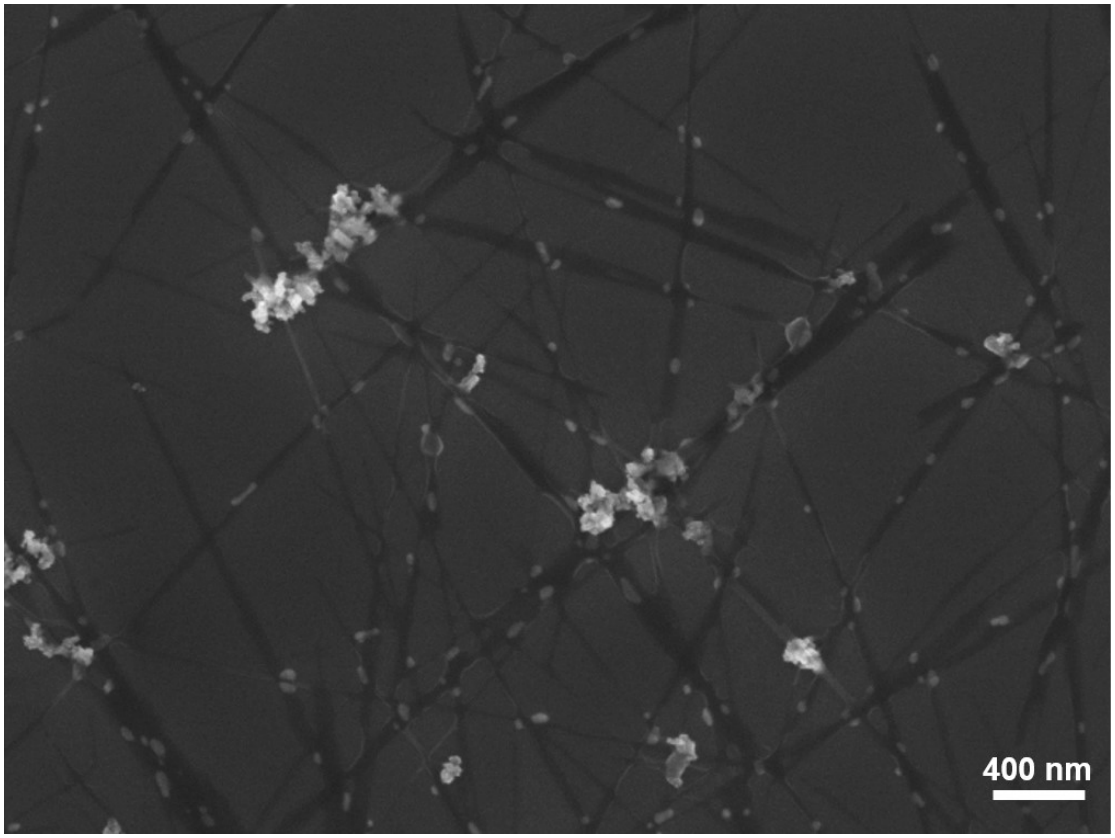

Figure S4. The SEM image of Fe_3O_4@TCNCs composite particles.

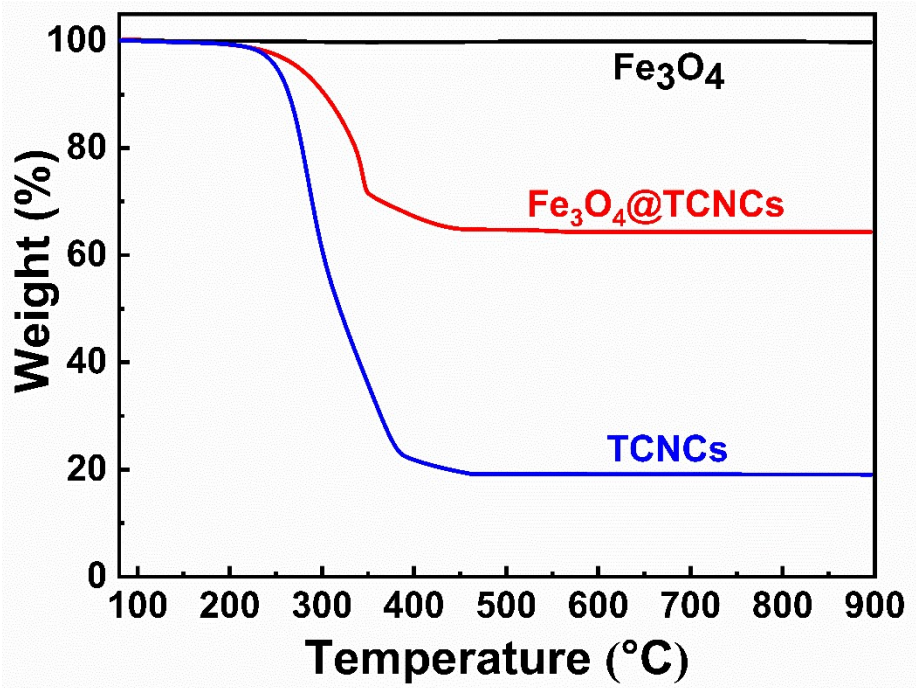

Figure S5. Thermal gravimetric curves of Fe_3O_4, Fe_3O_4@TCNCs, TCNCs under the N_2 atmosphere.

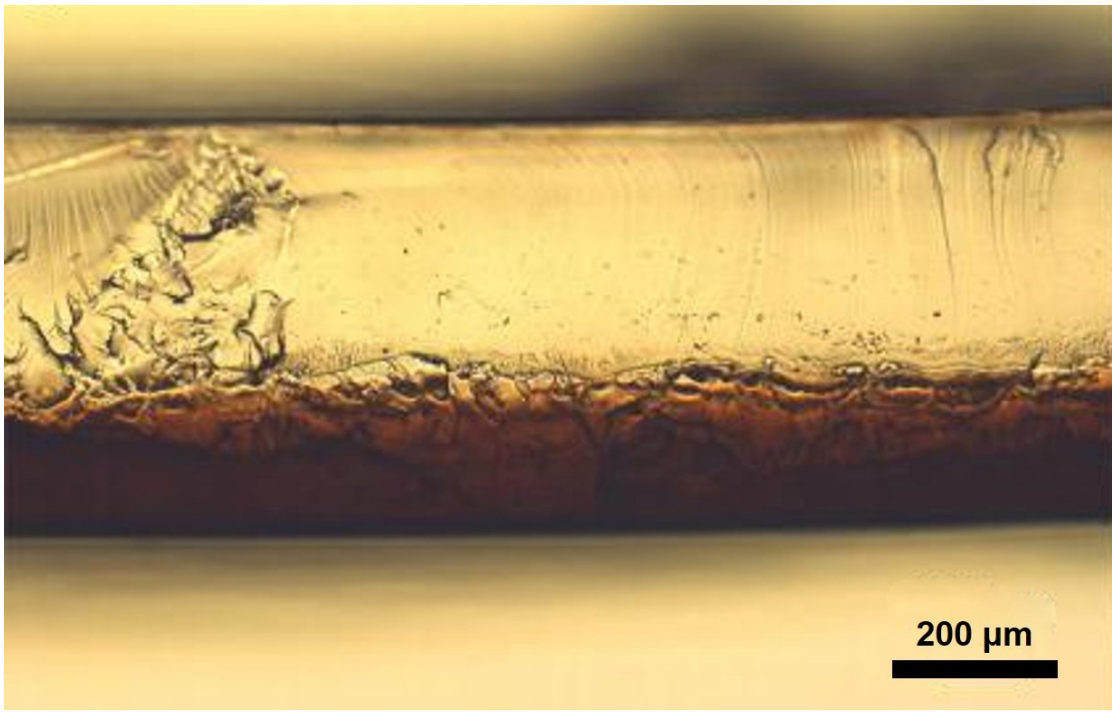

Figure S6. Optical image of the cross-section of asymmetric hydrogel.

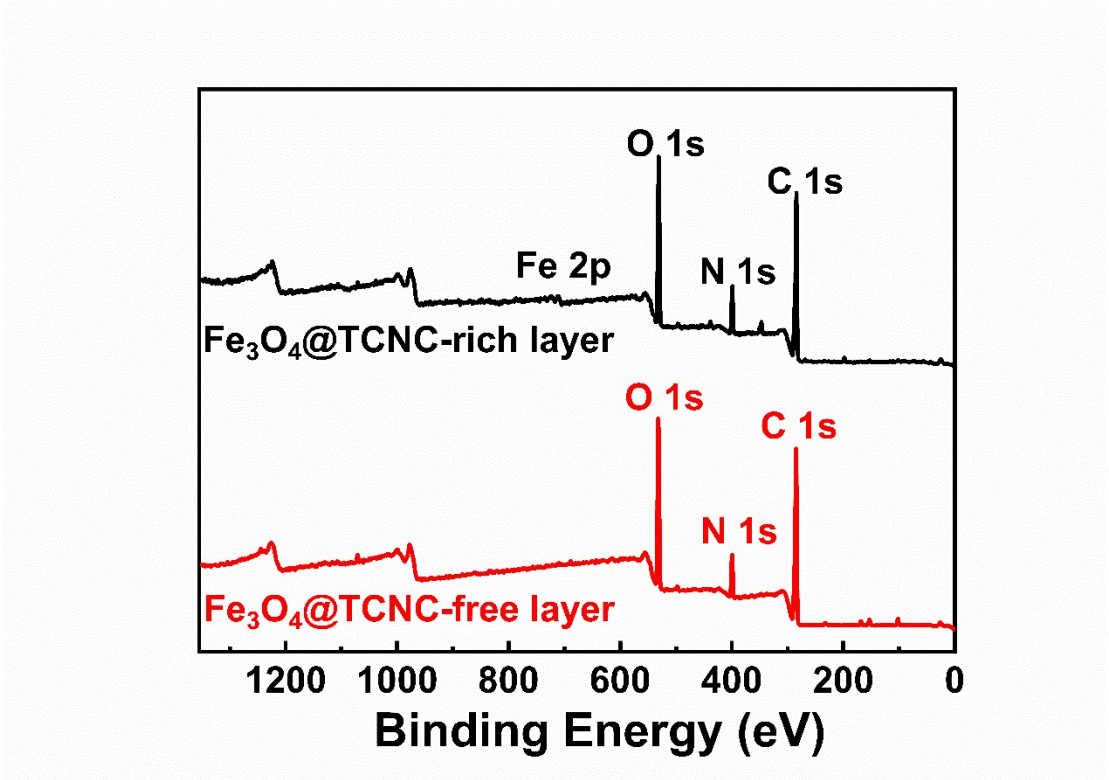

Figure S7. XPS spectra of Fe_3O_4@TCNC-rich layer and Fe_3O_4@TCNC-free layer of the asymmetric hydrogel.

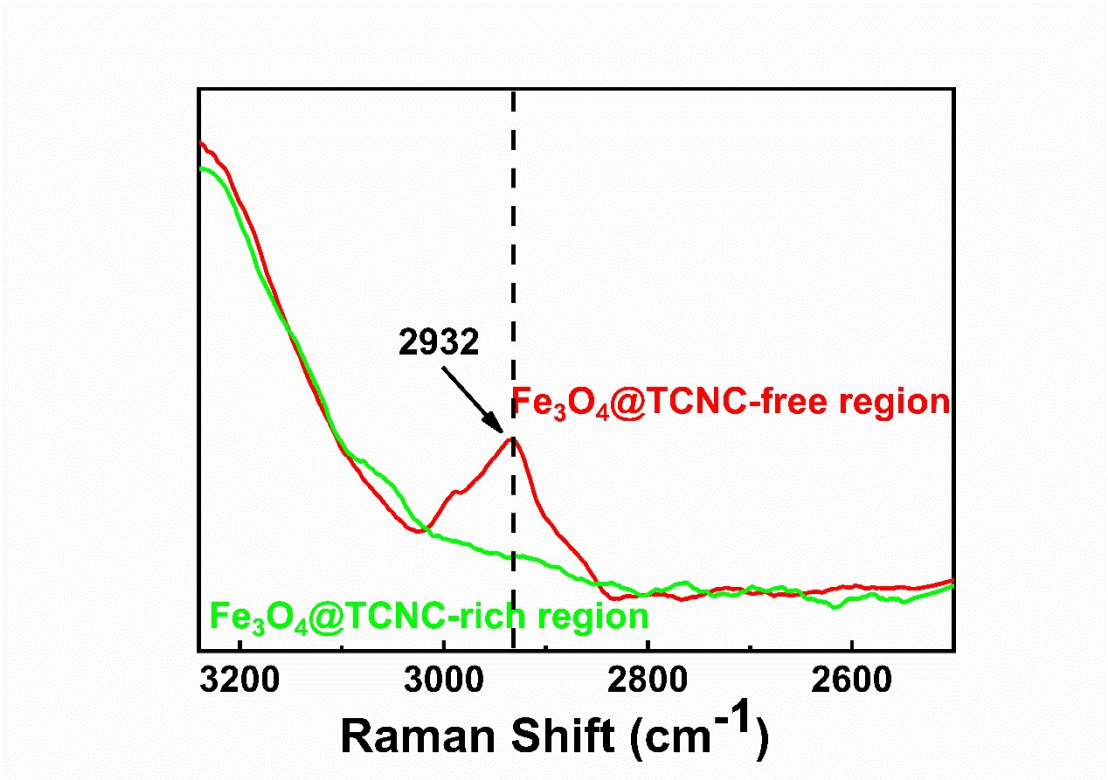

Figure S8. Raman spectra of Fe_3O_4@TCNC-rich region and Fe_3O_4@TCNC-free region of the asymmetric hydrogel.

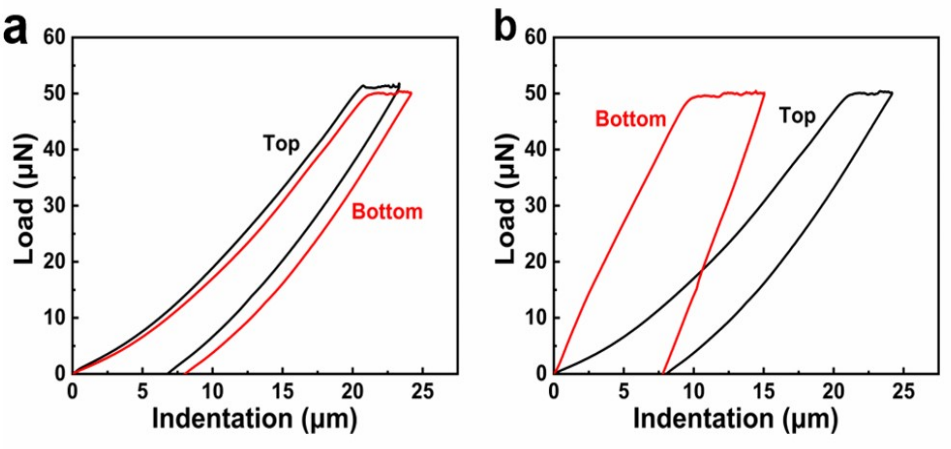

Figure S9. Nanoindentation curves for the top and bottom surfaces of isotropic hydrogel (a) and asymmetric hydrogel (b).

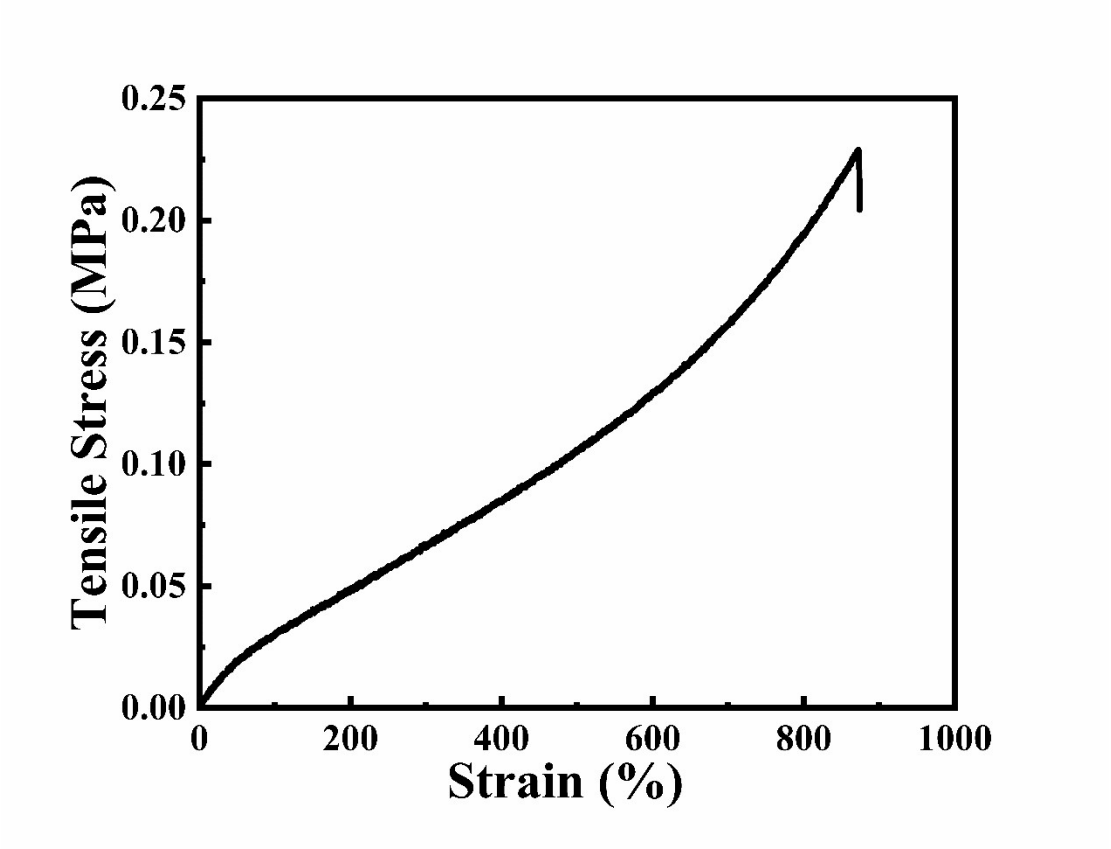

Figure S10. Tensile stress-strain curve of the hydrogel actuator.

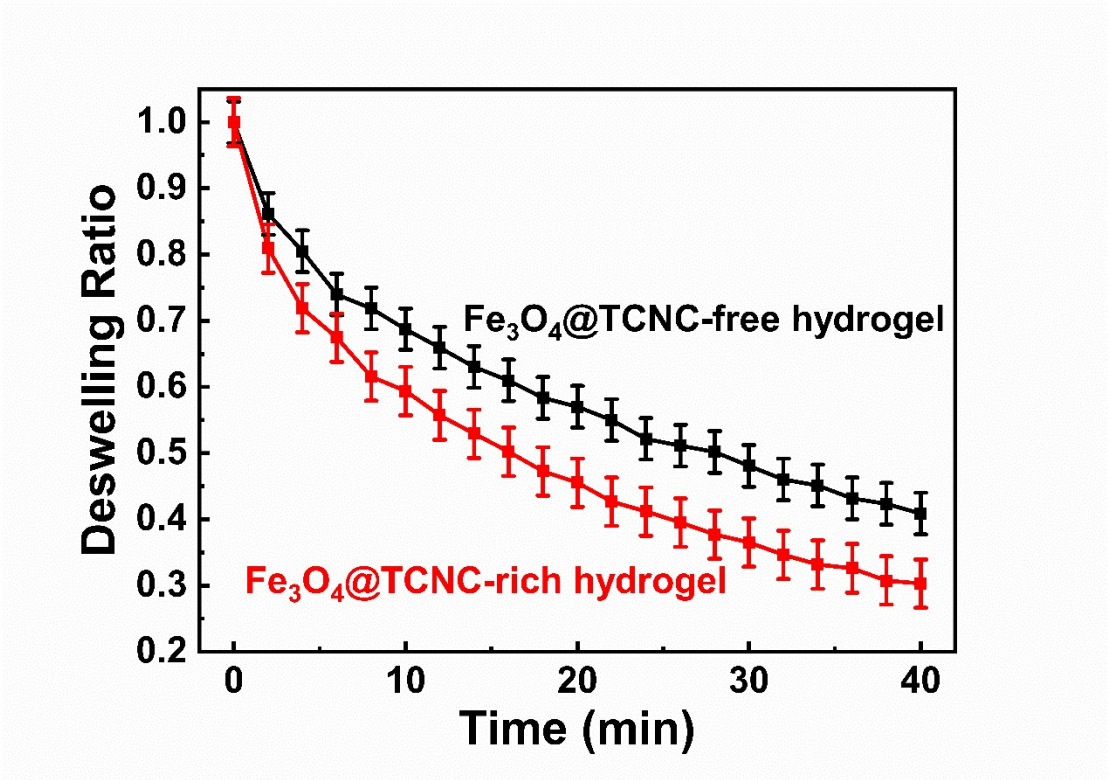

Figure S11. Deswelling kinetic curves of Fe_3O_4@TCNC-rich and Fe_3O_4@TCNC-free hydrogels.

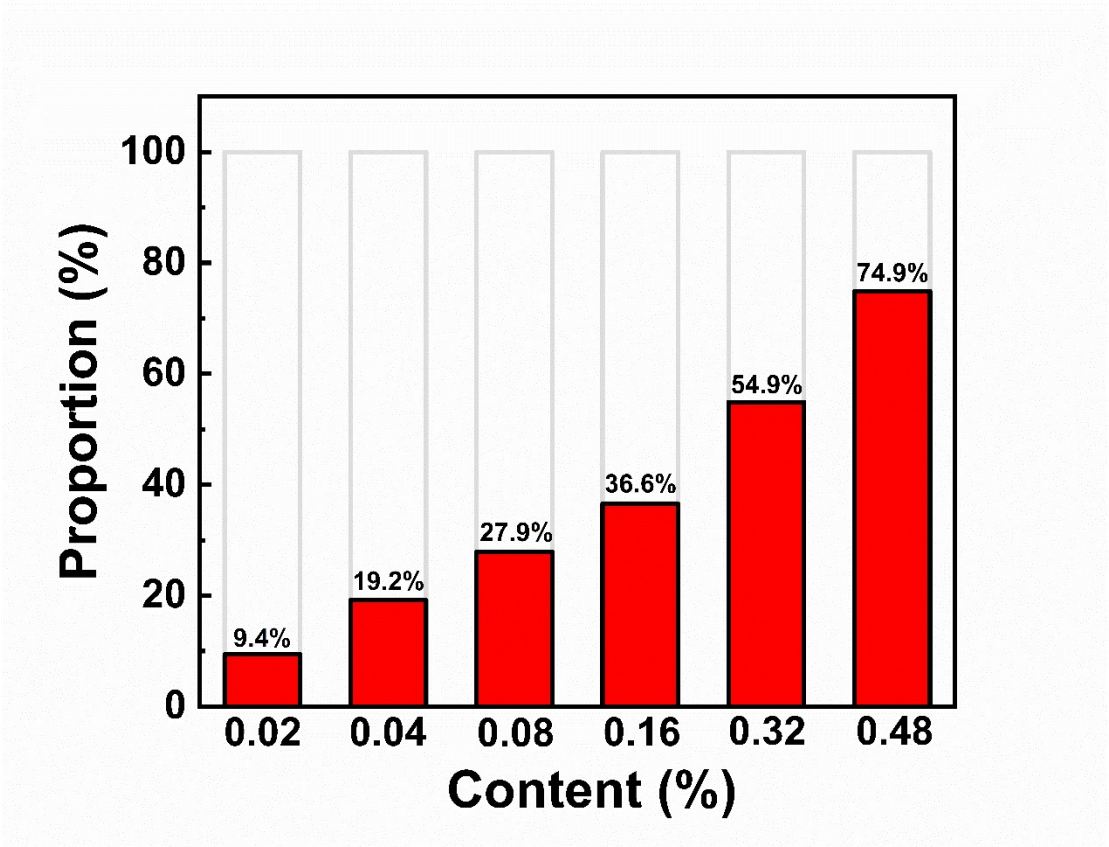

Figure S12. The thickness proportion of Fe_3O_4@TCNC-rich layer on the cross-section of hydrogels.

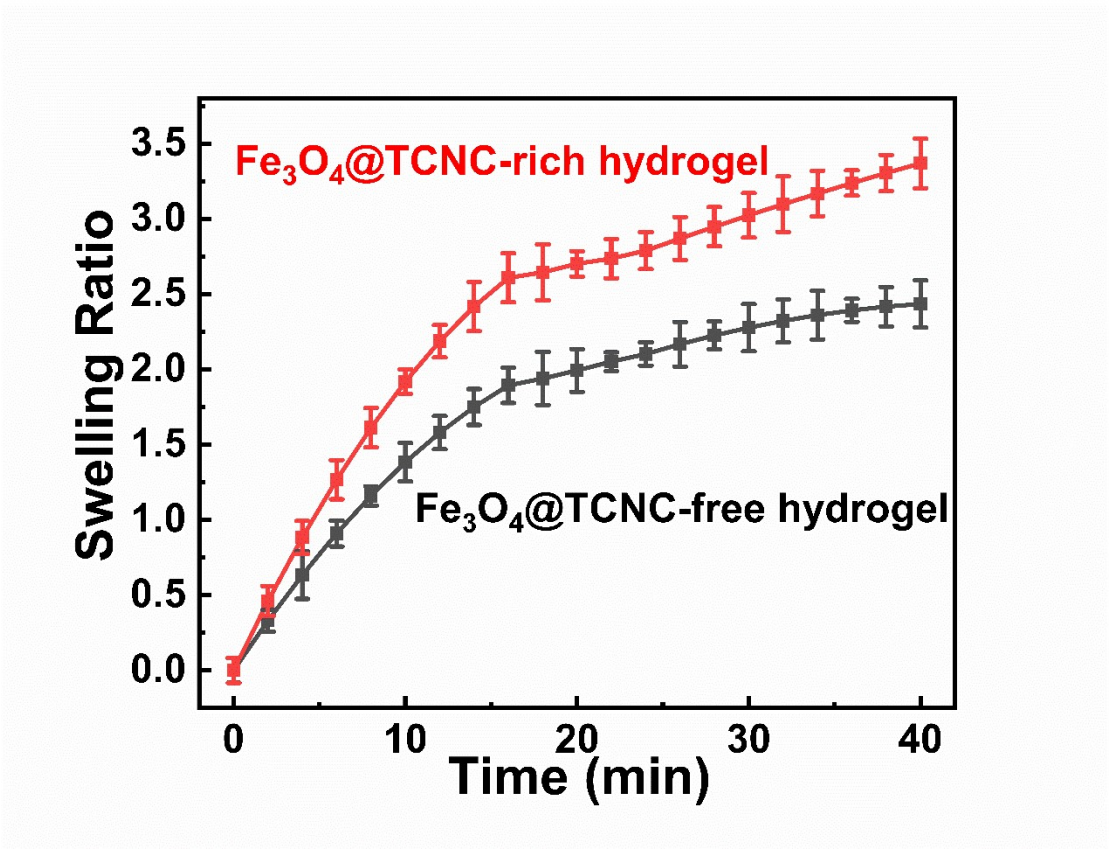

Figure S13. Swelling kinetic curves of Fe_3O_4@TCNC-rich and Fe_3O_4@TCNC-free hydrogels.

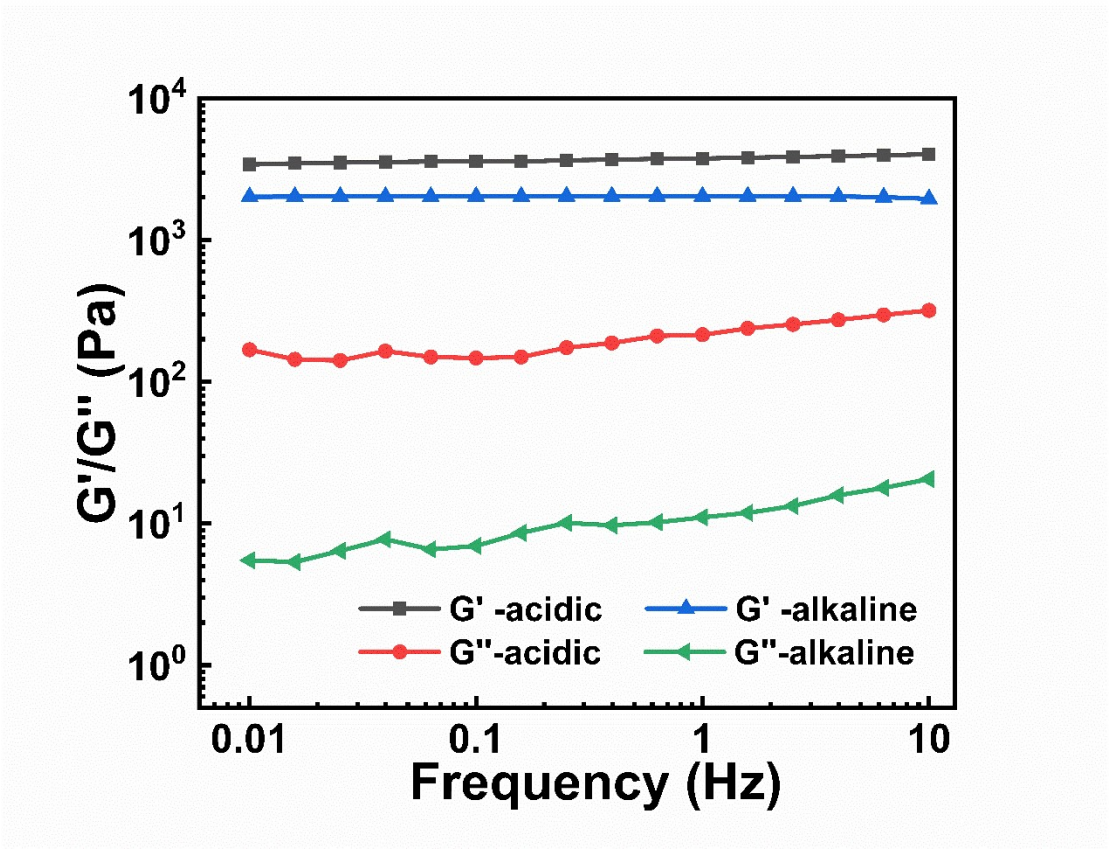

Figure S14. Elastic modulus (G′) and loss modulus (G″) of hydrogel as a function of frequency.