

**High-Performance Multi-Component Synergistic Hydrogel
Electrolyte with Enhanced Ion Transport for Flexible Zinc-Air
Batteries and Wearable Sensors**

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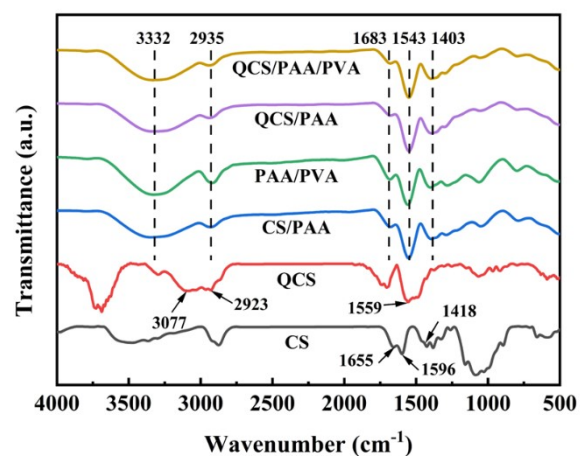


Fig. S1. Infrared spectra of chitosan, quaternary ammonium chitosan, and four hydrogels.

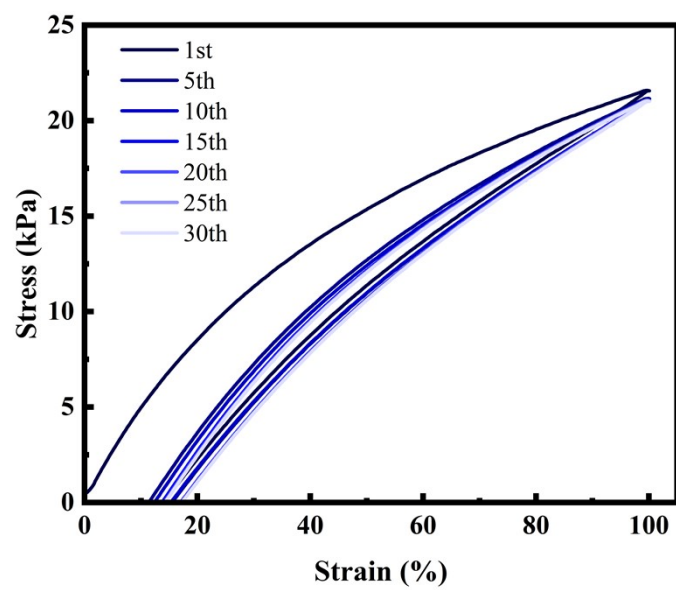


Fig. S2. Cyclic tensile load-unload curve of QCS/PAA/PVA hydrogel

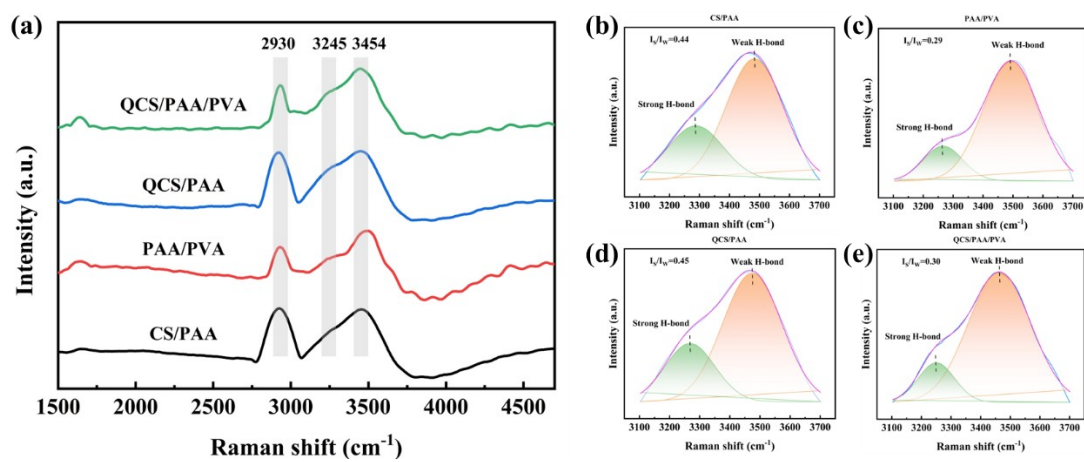


Fig. S3. Raman spectra of four hydrogels (a) and peak comparison charts (b-e).

Table S1 The properties comparison of solid battery equipped with different gel electrolytes

Electrolyte	Power density (mW cm ⁻²)	Potential(V)	Cyclic Stability (h)	Current density (mA cm ⁻²)	Zinc foil thickness (mm)	Ionic Conductivity (mS cm ⁻¹)	Reference
QCS/PAA/PV A-T	164	1.413	78	5	0.5	324.76	This work
QSPI@HEC	80	1.54	71	10	—	24	1
Agar-PVA/GO	123.7	1.1	5.8	0.5	0.2	75	2
PVAA- Cellulose	74	1.41	54	3	0.3	123	3
CCNF-PDIL	135	1.46	240	2	0.3	286.5	4
ICNF/WCNF	126	1.43	310	2	0.5	175	5
PCG	128	1.39	30	2	0.2	13	6
PVA-Lecithin	58		46	3	0.3	82	7
PANA-O3DG- TMG	130.5	1.558	230	1	—	173.9	8
MXene/Zn- LDH- array@PVA	92.3	1.37	50	3	0.3	55.3	9

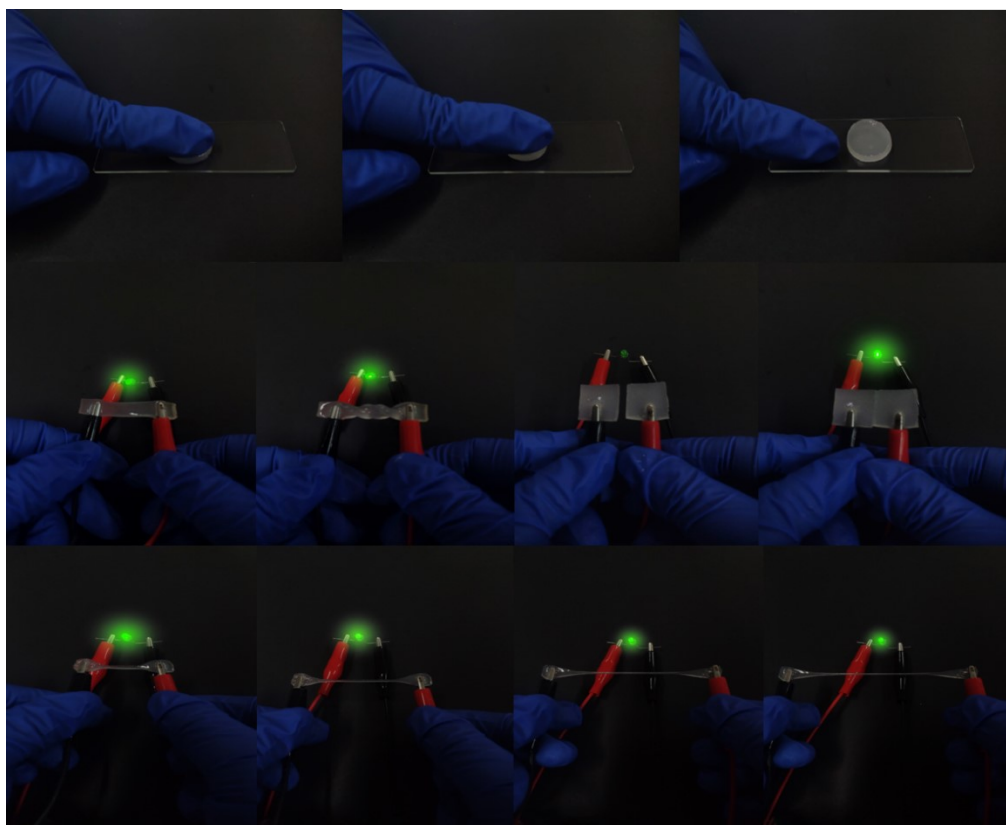


Fig. S4. Compression and rebound of QCS/PAA/PVA-T hydrogel, and lighting up an LED bulb during bending, docking, and stretching.

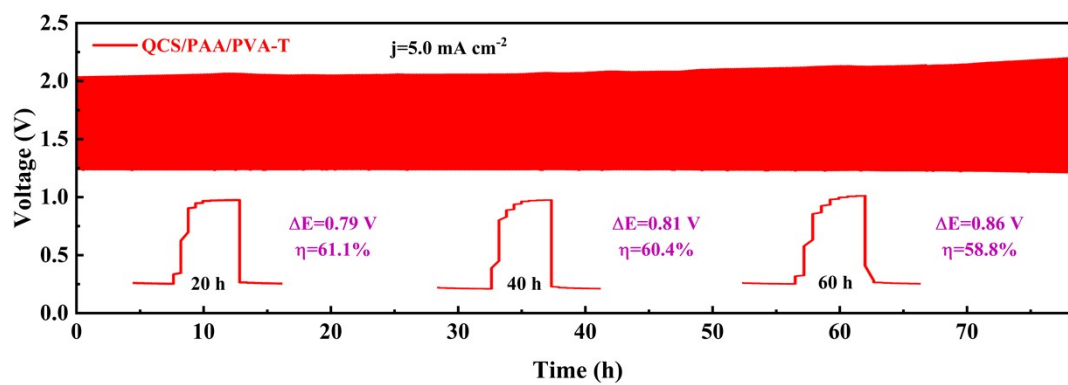


Fig. S5. Cycling stability of QCS/PAA/PVA-T flexible zinc-air battery at a current density of 5 mA cm^{-2} .

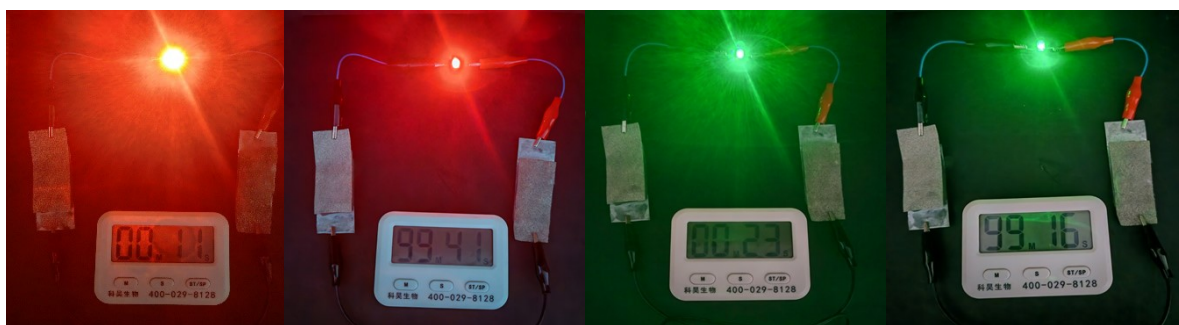


Fig. S6. Two flexible zinc-air batteries in series lighting an LED.

Table.S2 The core sensing performance comparison of various hydrogel-based strain sensors

Material System	Testing Scope(%)	Cyclic Stability(s)/strain(%)	Gauge Factor	Reference
QCS/PAA/PVA	0% ~ 630%	>4000 / 100%	7.416	This work
Heterogeneous Hydrogel	0% ~ 260%	5000	6.15	10
	PAM/PVA/SC	0% ~ 400%	12000 / 50%	2.17
A ₅ M _{1.5} PC	0% ~ 400%	—	1.307	12
Guar gum/acrylic acid/MXene@AgNPs	0 ~ 300%	—	6.4	13
MXene/PAA-CS	0% ~ 500%	—	11.66 ± 0.93	14

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