Al^{3+}-crosslinked transparent ionic conductive PAA-lysine hydrogels toward flexible high-sensitivity electrochemical sensors

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Table S1：Fabrication formula of poly (acrylic acid) (PAA) hydrogel and poly (acrylic acid)-lysine-aluminum ion (PAA-Lys-Al^{3+}) hydrogels with fixed $AlCl_3$ content and varied lysine contents.

Sample	AA(g)	Lys(g)	$AlCl_3$(g)	KPS(g)	H_2O(mL)
PAA	3	0	0	0.06	10
0Lys	3	0	0.16	0.06	10
0.05Lys	3	0.05	0.16	0.06	10
0.1Lys	3	0.1	0.16	0.06	10
0.15Lys	3	0.15	0.16	0.06	10
0.2Lys	3	0.2	0.16	0.06	10
0.25Lys	3	0.25	0.16	0.06	10
0.3Lys	3	0.3	0.16	0.06	10
0.35Lys	3	0.35	0.16	0.06	10
0.4Lys	3	0.4	0.16	0.06	10

Table S2：Fabrication formula of poly(acrylic acid)-lysine-aluminum ion (PAA-Lys-Al^{3+}) hydrogels with fixed lysine content and varied $AlCl_3$ contents.

Sample	AA(g)	Lys(g)	$AlCl_3$(g)	KPS(g)	H_2O(mL)
0Al	3	0.3	0	0.06	10
0.04Al	3	0.3	0.04	0.06	10
0.08Al	3	0.3	0.08	0.06	10
0.12Al	3	0.3	0.12	0.06	10
0.16Al	3	0.3	0.16	0.06	10
0.2Al	3	0.3	0.2	0.06	10
0.3Al	3	0.3	0.3	0.06	10

Table S3: Hysteresis value (kJ/m³) of the PAA-Lys-Al hydrogel under cyclic stretching at different stretch ratios (100%–700%) with a stretching rate of 100 mm/min.

Stretch ratio	**100%**	**200%**	**300%**	**400%**	**500%**	**600%**	**700%**
Hysteresis (kJ/m^3)	**0.84**	**3.31**	**5.96**	**8.45**	**10.76**	**14.12**	**17.98**

Table S4: Hysteresis ratio (%) of the PAA-Lys-Al hydrogel under cyclic stretching at different stretch ratios (100%–700%) with a stretching rate of 100 mm/min.

Stretch ratio	**100%**	**200%**	**300%**	**400%**	**500%**	**600%**	**700%**
Hysteresis ratio (%)	**11.2**	**14.8**	**15.4**	**14.7**	**14.6**	**14.3**	**14.5**

Figures:

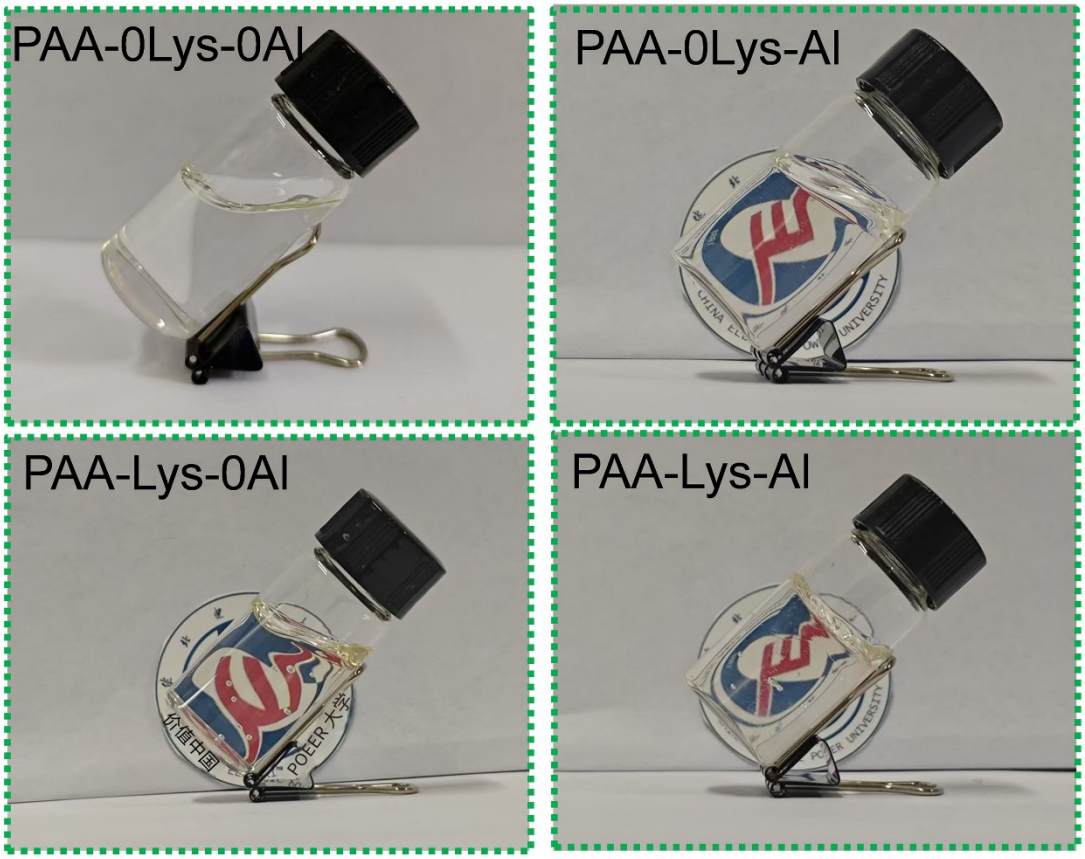


Figure S1. Photographs of four PAA-based samples (PAA-0Lys-0Al, PAA-0Lys-Al, PAA-Lys-0Al, PAA-Lys-Al) in the vial inversion test. PAA-0Lys-0Al, PAA-0Lys-Al and PAA-Lys-0Al exhibit fluidity to varying degrees, demonstrating that both lysine and Al^{3+} are required to construct a stable crosslinked hydrogel network.

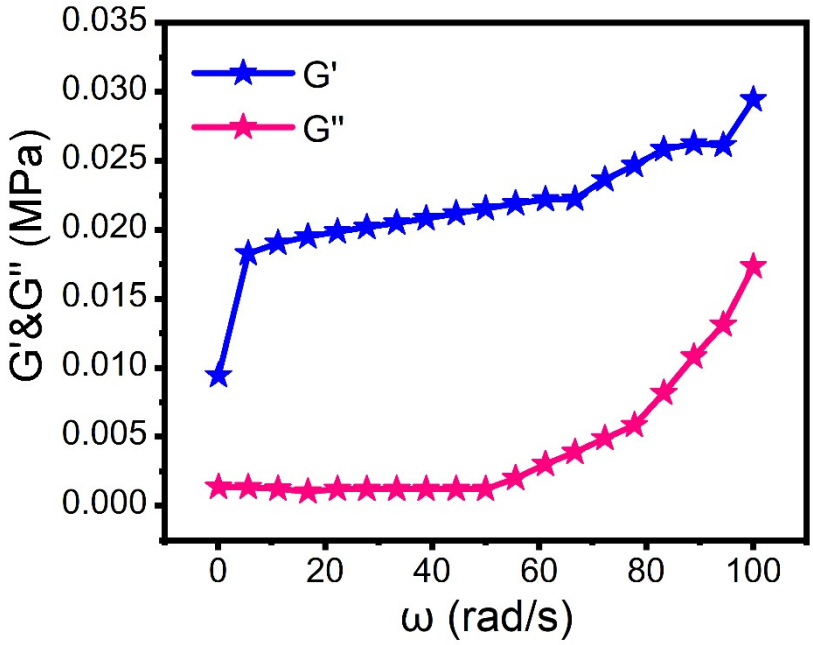


Figure S2. Storage modulus (G') and loss modulus (G") of PAA-Lys-Al hydrogel from oscillatory frequency sweep at a strain amplitude of 10%.

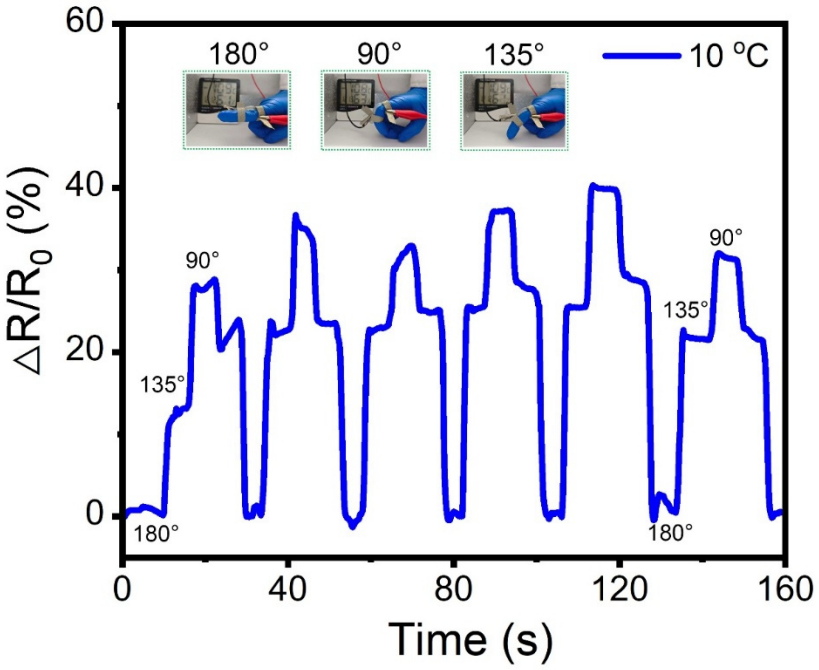


Figure S3. Gradient electrical sensing response of the hydrogel sensor during five finger-bending cycles (180° → 135° → 90°) at −10 °C. Insets are real-time photographs of the finger at different bending angles.

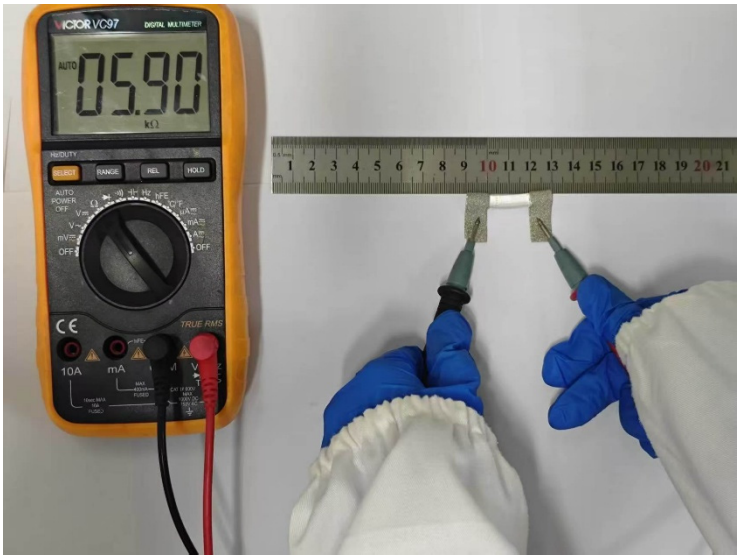


Figure S4. Photograph showing two-probe resistance testing of PAA-Lys-Al hydrogel by a VICTOR VC97 multimeter.