Supporting Information

Salt-Responsive Polyampholyte-based Hydrogel Actuators with Gradient Porous Structure

Experimental section

Synthesis of 2-ureidoethyl methacrylate

2-ureidoethyl methacrylate (UM) was synthesized according to a previous work.[1] Briefly, 30% aqueous solution of ammonia (7.8 g) was added into a three-necked flask with a dropping funnel, reflux condenser and a stirrer. The solution was cooled to 10 °C and 7.75 g 2-isocyanatoethyl methacrylate was added. Along with the reaction proceeded, white crystals precipitated and the crystals was washed with acetone and dried under vacuum. 8.5 g UM (white powder, yield: 90%) was finally obtained.

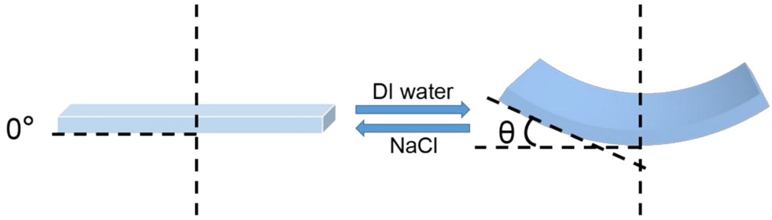

Figure S1. Definition of bending angle and final angle. The angle of the strip in the sodium chloride solution is defined as 0°.

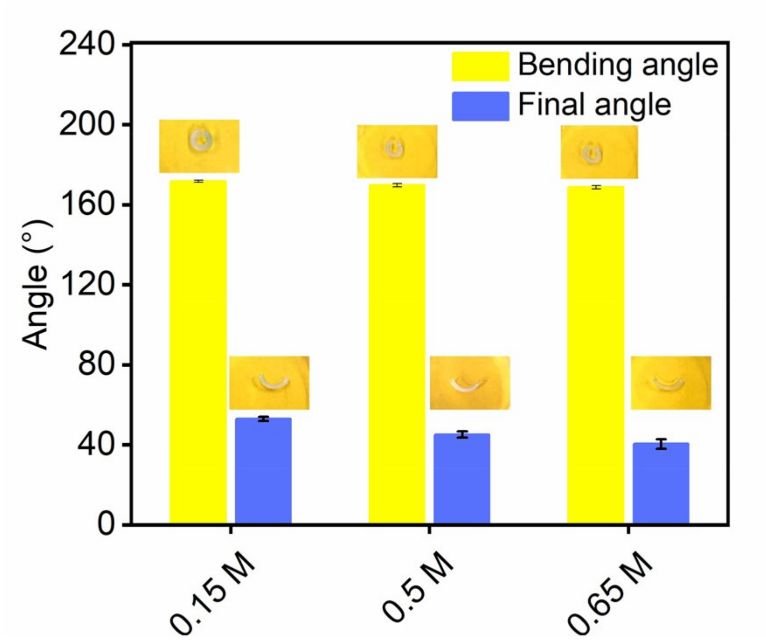

Figure S2. The bending angle and final angle of actuators in the NaCl solutions with low concentrations (0.15 M and 0.65 M NaCl represent normal saline and seawater, respectively).

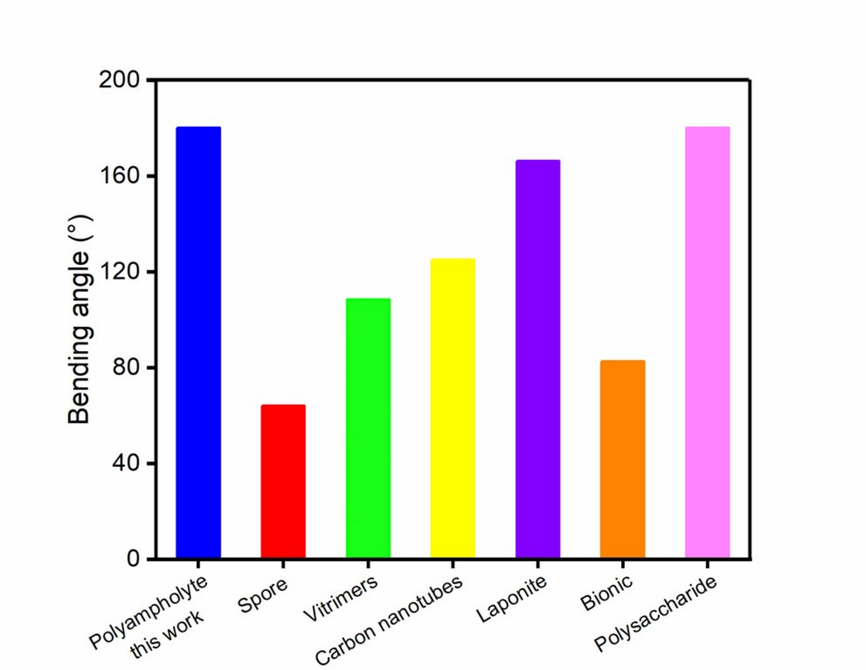

Figure S3. Comparison of bending angle between the hydrogel actuator and other systems, the details are shown in Table S1.

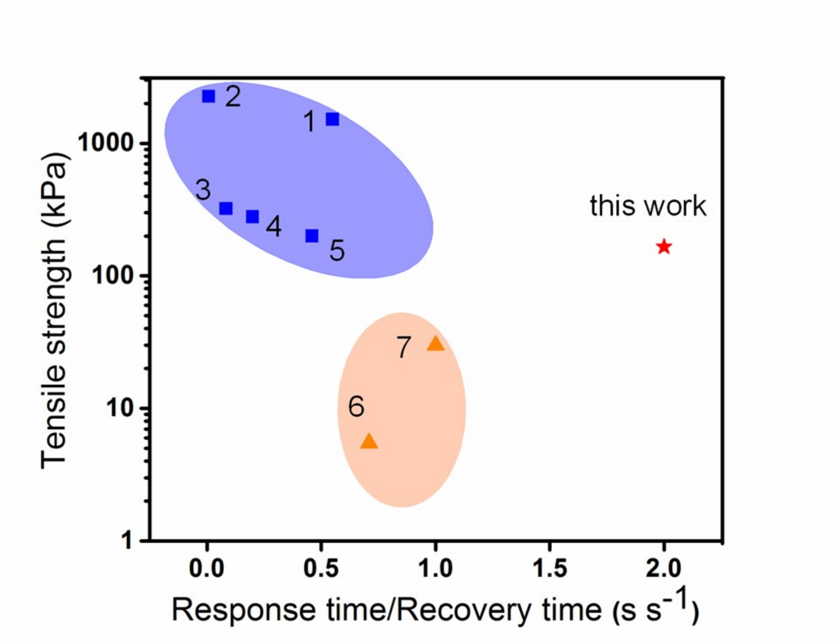

Figure S4. Comparison of tensile strength and response/recovery time ratio between the hydrogel actuator and other hydrogel actuators (No. 1−7).

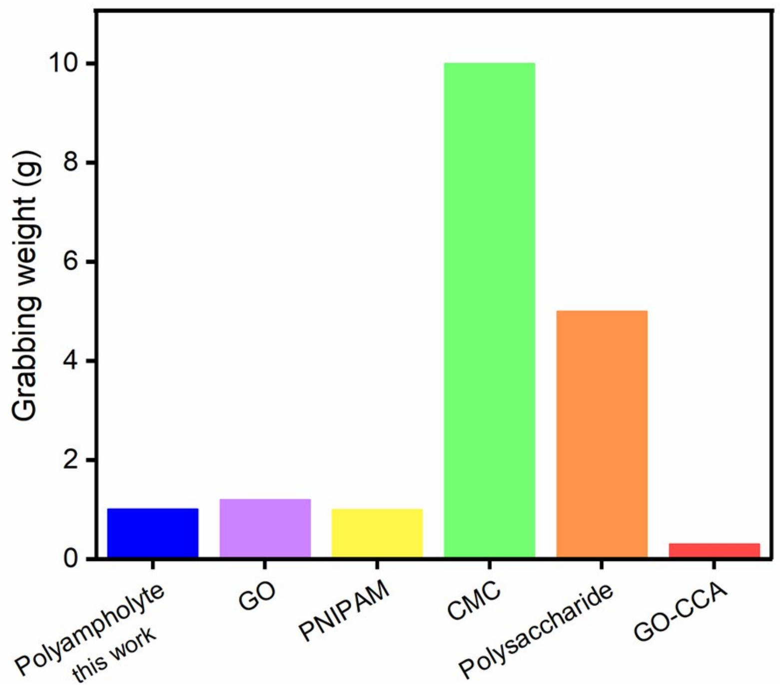

Figure S5. Comparison of grabbing weight between the polyampholyte-based gripper and GO[14], PNIPAM[15], CMC[16], Polysaccharide[17], GO-CCA[18] systems.

Table S1. Data collection for Figure S3. Hydrogel actuators with different bending angle, response time and bending rate are considered.

Materials	Bending angle (°)	Response time (s)	Bending rate (°/s)	Ref.
Polyampholyte	180.0	3600	0.05	This work
Spore	64.1	40	1.60	[2]
Vitrimers	108.4	600	0.18	[3]
Carbon nanotubes	125.0	4800	0.02	[4]
Laponite	166.3	120	1.38	[5]
Bionic	82.6	480	0.17	[6]
Polysaccharide	180.0	15	12	[7]

Table S2. Data collection for Figure S4. Hydrogel actuators with different tensile strength and response/recovery time ratio are considered.

Materials	Tensile strength (kPa)	Response/Recovery time ratio	Number	Ref.
P(NaSS-*co*-DMAEA-Q)	165	2	This work	This work
P(AAc-*co*-NIPAm)	1520	5.5×10^{-1}	1	[8]
CS/SA	2260	8.0×10^{-3}	2	[7]
Al-alginate/PNIPAM	322	8.3×10^{-2}	3	[9]
PNIPAM/Laponite	280	2.0×10^{-1}	4	[10]
TiO_2/AM/NIPAM	200	4.6×10^{-1}	5	[11]
P(Fc-*co*-*β*-CD-AAm)	6	7.1×10^{-1}	6	[12]
P(NIPAM)/P(VBIPS)	30	1	7	[13]

Movie S1. The shape deformation process of the gradient P(NaSS-*co*-DMAEA-Q) hydrogel actuator in deionized (DI) water.

Movie S2. The shape recovery process of the gradient P(NaSS-*co*-DMAEA-Q) hydrogel actuator in NaCl solution.

Movie S3. The grabbing-releasing process of the underwater gripper in DI water and NaCl solution.

References

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