**Supporting Information**

# High Multi-Environmental Mechanical Stability and Adhesive Transparent Ionic Conductive Hydrogels Used as Smart Wearable Devices

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**Table S1.** Composition of the hydrogels.

| Name | TA@BC (wt %) | AA (g) | AMPS (g) | UV initiator (μl) | $H_2O$ (g) | $CaCl_2$ (g) |
|---|---|---|---|---|---|---|
| **P(AA-AMPS)** | 0 | 1.25 | 1.25 | 4 | 10 | 0 |
| **P(AA-AMPS)-TA@$BA_{0.25}$-$Ca^{2+}$** | 0.25 | 1.25 | 1.25 | 4 | 10 | 4.4 |
| **P(AA-AMPS)-TA@$BA_{0.5}$** | 0.5 | 1.25 | 1.25 | 4 | 10 | 0 |
| **P(AA-AMPS)-TA@$BA_{0.5}$-$Ca^{2+}$** | 0.5 | 1.25 | 1.25 | 4 | 10 | 4.4 |
| **P(AA-AMPS)-TA@$BA_1$-$Ca^{2+}$** | 1.0 | 1.25 | 1.25 | 4 | 10 | 4.4 |

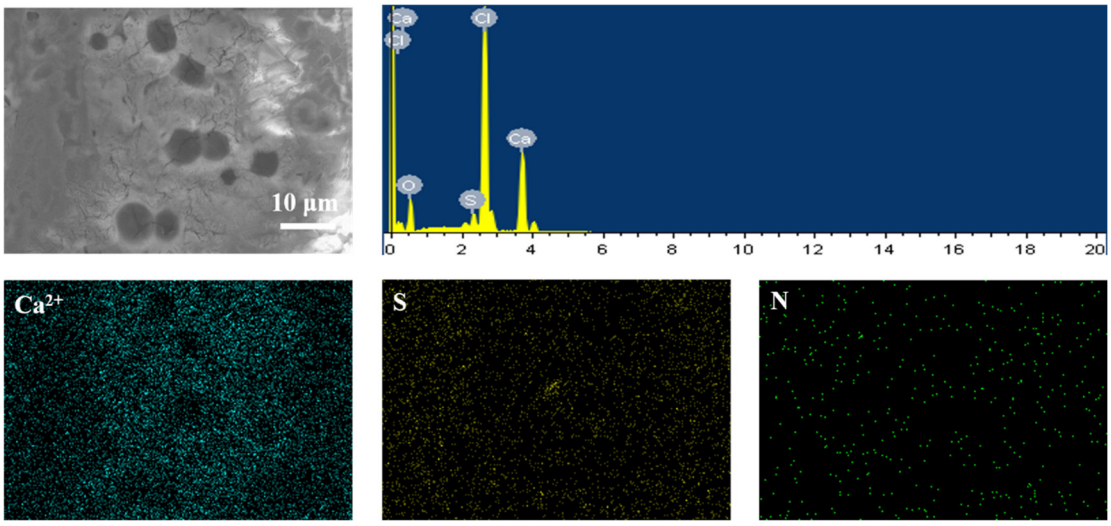


**Figure S1.** EDS images of the surface of the P(AA-AMPS)-TA@BC-$Ca^{2+}$ hydrogel.

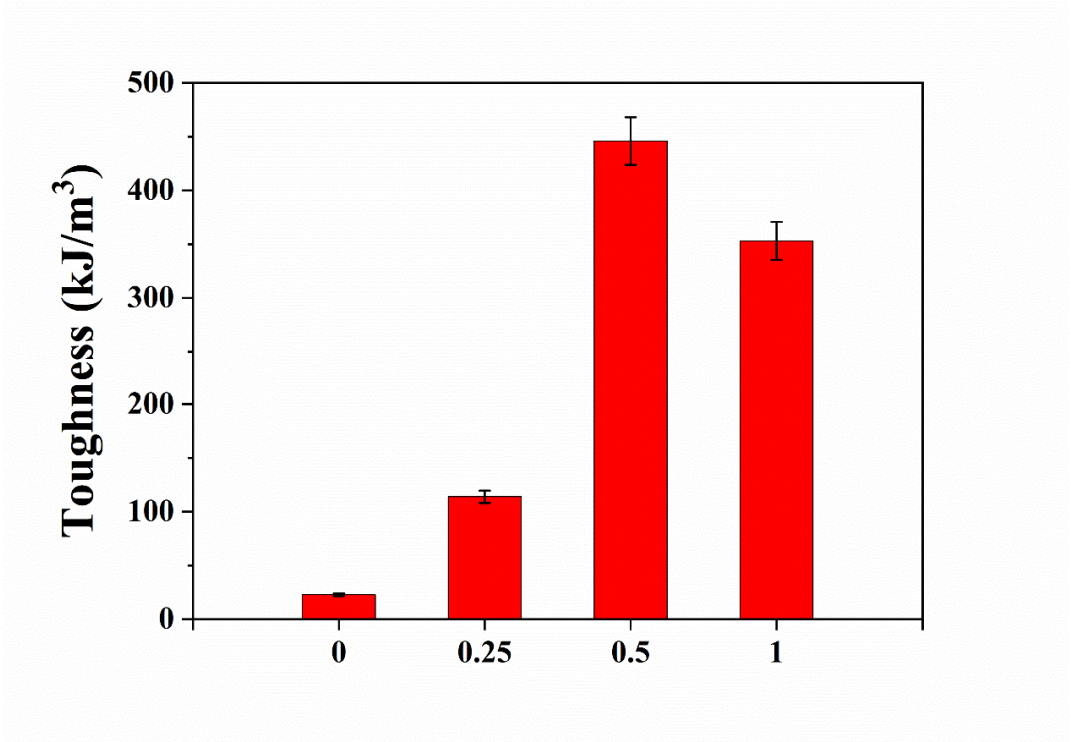


**Figure S2.** Toughness of P(AA-AMPS)-TA@BC-$Ca^{2+}$ hydrogels with different concentrations of TA@BC (0/0.25/0.5/1) (the error bars show the error range of the experiment).

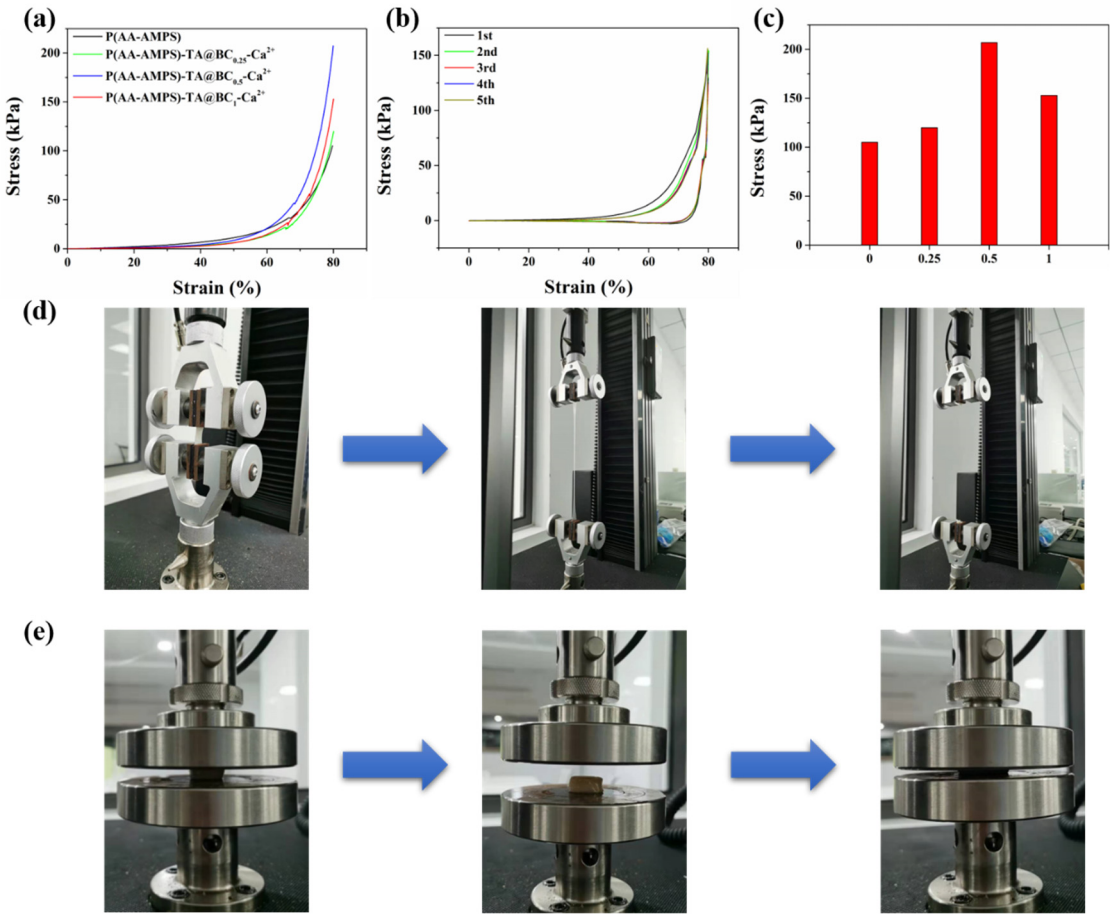


**Figure S3**. (**a**) Compressive stress-strain curves of P(AA-AMPS)-TA@BC-$Ca^{2+}$ hydrogels with different concentrations of TA@BC; (**b**) Curves of compression-release cycles (80%, 5 cycles) of P(AA-AMPS)-TA@$BC_{0.5}$-$Ca^{2+}$ hydrogel; (**c**) Compression stress-strain histogram of P(AA-AMPS), P(AA-AMPS)-TA@$BC_{0.5}$, P(AA-AMPS)-TA@$BC_{0.5}$-$Ca^{2+}$ hydrogel; (**d**) Diagram of the stretching process; (e) Diagram of compression process.

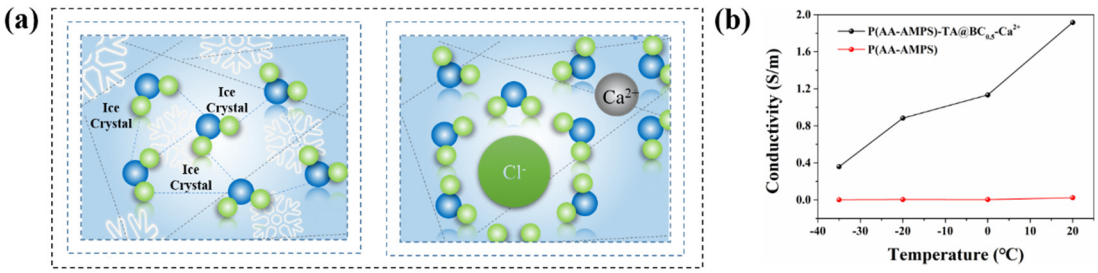


**Figure S4**. Mechanism of anti-freezing and moisturizing and electrical conductivity of hydrogel. (**a**) The interaction between $Ca^{2+}$/$Cl^-$ ions and water molecules in $CaCl_2$ solution and the principle diagram of antifreeze and moisture retention (the unlabeled blue spheres represent oxygen atoms and the green spheres represent hydrogen atoms); (**b**) Electrical conductivity of P(AA-AMPS) and P(AA-AMPS)-TA@$BC_{0.5}$-$Ca^{2+}$ hydrogels at different temperatures.

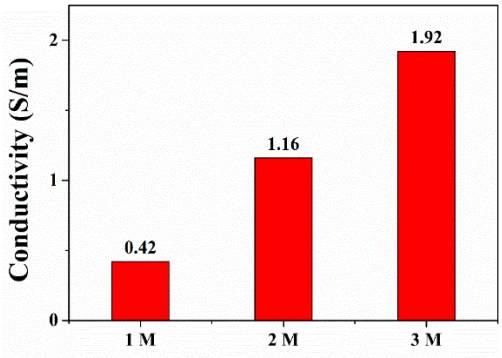


**Figure S5**. Hydrogel conductivity with diverse ion concentration

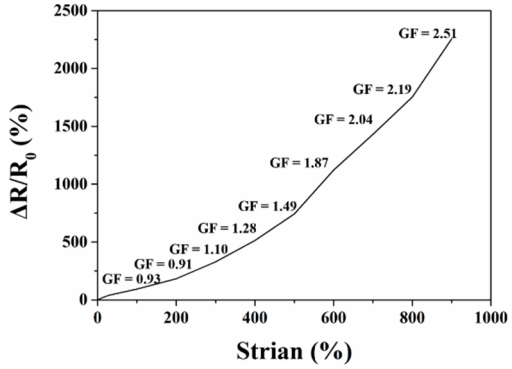


**Figure S6.** The RRC value and GF value of P(AA-AMPS)-TA@$BC_{0.5}$-$Ca^{2+}$ hydrogel in strain from 2.5% to 900%.

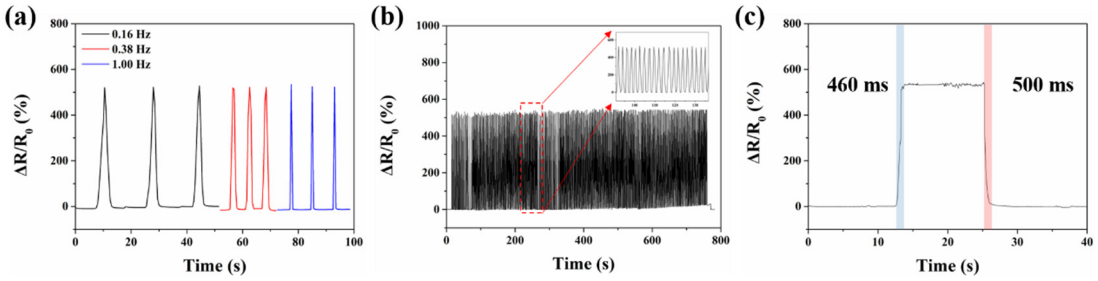


**Figure S7**. (**a**) Response frequency of P(AA-AMPS)-TA@$BC_{0.5}$-$Ca^{2+}$ sensor. (**b**) RRC of P(AA-AMPS)-TA@$BC_{0.5}$-$Ca^{2+}$ sensor elongated to a strain of 400% for 300 cycles under stretching mode. (**c**) Response and recovery time of P(AA-AMPS)-TA@$BC_{0.5}$-$Ca^{2+}$ strip under the 400% strain.