Oxidized alginate linked tough conjoined-network hydrogel with self-healing and conductive properties for strain sensing

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SEM images of the hydrogels

The SEM images of the hydrogel was shown in Fig. S1. The images showed that the hydrogel (1, 2, 3, 5) were porous structures.

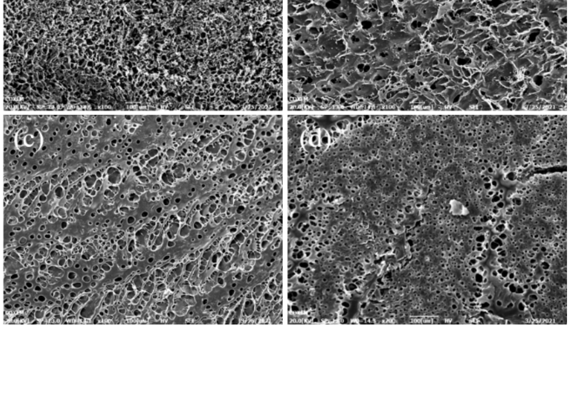

Fig. S1. The SEM images of the hydrogel (1, 2, 3 ,5) corresponding to (a, b, c, d).

Photograph of hydrogel-3

The PAM/ADA hydrogel (hydrogel-3) was soft and adhesive and the hydrogel can not be clip on the mechanical tester, as shown in Fig. S2. The mechanical properties of the hydrogel-3 can not be obtained.

Fig. S2. Image of the hydrogel-3.

Ionic conductivity of the conjoined network hydrogels

The conductivity of the conjoined-network hydrogels was shown in Fig. S3. The PAM hydrogel (hydrogel-1) showed a conductivity of 0.012 S m^{-1}. After introducing the modified polymer of chitosan and alginate, the conductivity of the hydrogel-2 and hydrogel-3 enhanced due to the free ions in the modified chitosan or alginate. The hydrogel-4 and hydrogel-5 showed a higher conductivity compared with the hydrogel-2 and hydrogel-3 because more free ions would presented in the hydrogel with higher concentration of the modified biopolymer.

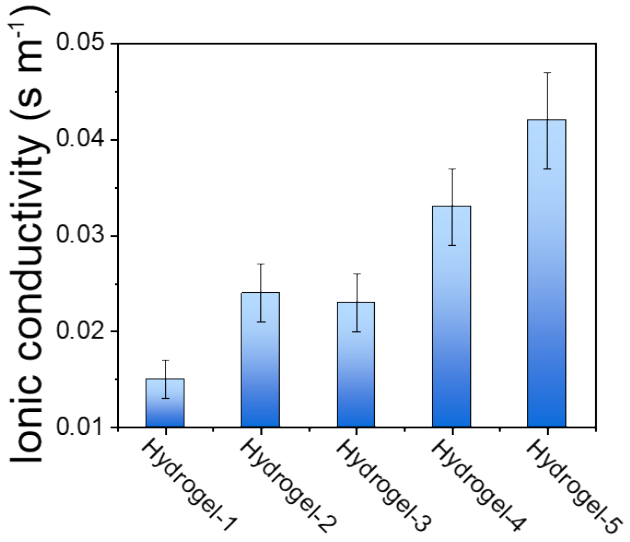

Fig. S3. Ionic conductivity of the hydrogels.

Loading and unloading curve of the hydrogel sensors

The loading and unloading curve of the hydrogel sensors under a strain of 275% was shown in Fig. S4. The relative resistance change of the strain loading is almost consistent with the unloading curve within a strain of 275% which indicated the sensory performance of the hydrogel sensor was reliable.

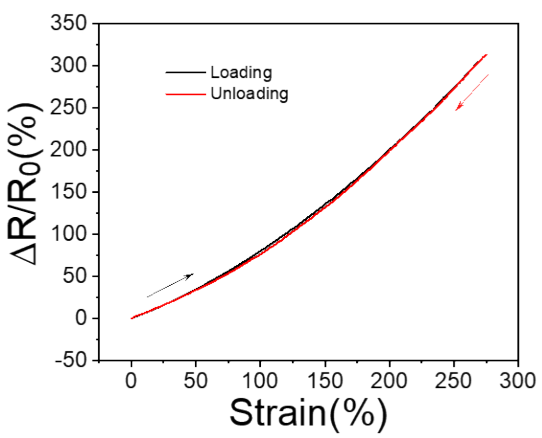

Fig. S4. The relative resistance changes of the hydrogel sensors under a strain of 275%.

Stability of the hydrogel sensor

The hydrogel sensor showed excellent stability. The hydrogel-4 still showed high toughness after storing for six months. As shown in Fig. S5, the hydrogel can resist the puncture by a screwdriver indicating the hydrogel was stable. In addition, the hydrogel can still be used as sensor to detect the signal change. The relative resistance increased along with stretching the hydrogel sensor to a strain of 125% (Fig. S5). The resistance decreased with releasing the hydrogel and the resistance can return to its origin value which suggested high stability of the hydrogel sensor.

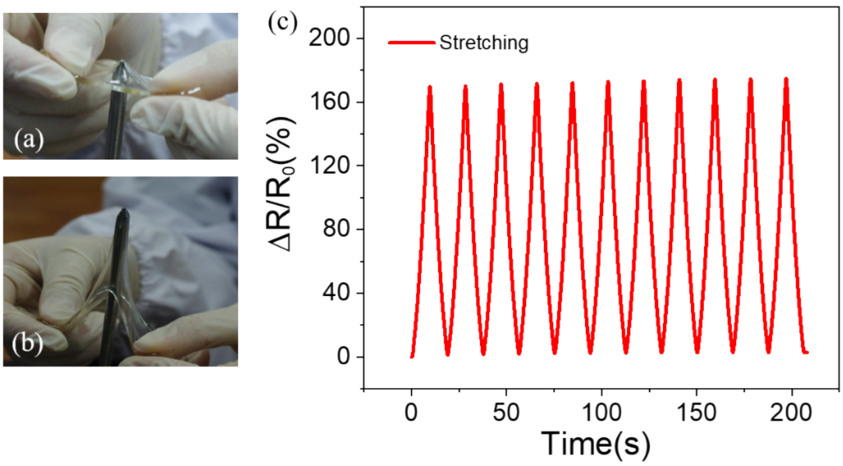

Fig. S5. (a, b) Photographs demonstrate high toughness of the hydrogel-4 after storing for 6 months, (c) The relative resistance changes of the stored hydrogel-4 during stretching and releasing the hydrogel.