

Tough, stretchable and compressive alginate hydrogels achieved by the non-covalent interactions

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Supporting Information

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Table S1 Water contents of NaAlg/PAM semi-IPN hydrogels and CaAlg/PAM DN hydrogels

Table S2 Mechanical properties of NaAlg/PAM semi-IPN hydrogels

Fig. S1 The photographs of NaAlg/PAM semi-IPN hydrogel demonstrating the excellent mechanical behaviors: under stretching (a) without and (b) with central notch, compressing (c), slicing with a knife (d) holding a weight of 100g (e)

Fig. S2 (a) Cyclic continuous step strain measurements of NaAlg5.0%/PAM2% hydrogel in which the strain was switched from 1% strain for 100s to 100% strain for 100s; (b) Cyclic continuous step strain measurements of NaAlg5.0%/PAM2% in which the strain was switched from 1% strain for 100s to various larger strains (100%, 200%, 300% and 400%) for 100s

Fig. S3 Equilibrium swelling ratios of NaAlg/PAM semi-IPN hydrogels with different compositions in different buffer solutions: (a) hydrogels with various SMA concentrations, (b) hydrogels with various SA concentrations

Table S1

Water content of NaAlg/PAM semi-IPN hydrogels and CaAlg/PAM DN hydrogels

| Samples | Water content (%) | Samples | Water content (%) |
|------------------|-------------------|------------------|-------------------|
| NaAlg5.0%/PAM1% | 39.9±2.4 | CaAlg5.0%/PAM1% | 67.0±2.1 |
| NaAlg5.0%/PAM2% | 44.7±2.3 | CaAlg5.0%/PAM2% | 73.4±1.4 |
| NaAlg5.0%/PAM3% | 51.8±1.8 | CaAlg5.0%/PAM3% | 68.1±3.6 |
| NaAlg5.0%/PAM4% | 49.2±2.3 | CaAlg5.0%/PAM4% | 70.7±0.6 |
| NaAlg0%/PAM2% | 52.0±2.8 | CaAlg0%/PAM2% | 72.3±1.6 |
| NaAlg2.5%/PAM2% | 57.5±1.8 | CaAlg2.5%/PAM2% | 73.2±1.6 |
| NaAlg7.5%/PAM2% | 49.1±2.8 | CaAlg7.5%/PAM2% | 68.8±0.2 |
| NaAlg10.0%/PAM2% | 56.6±3.4 | CaAlg10.0%/PAM2% | 72.9±2.5 |

Notes: The water contents of the samples were calculated by the following equation:

$$\text{water content (\%)} = \frac{(w_o - w_d)}{w_o} \times 100\%$$
, where w_o is the weight of the as-prepared sample and w_d is the dry weight of the sample.

Table S2

Mechanical properties of NaAlg/PAM semi-IPN hydrogels

| Samples | Tensile strength (KPa) | Elongation at break (mm/mm) | Compressive strength (MPa) ^a |
|------------------|------------------------|-----------------------------|---|
| NaAlg5.0%/PAM1% | 202.7±28.5 | 18.5±5.1 | 0.528±0.056 |
| NaAlg5.0%/PAM2% | 291.6±79.9 | 24.3±4.6 | 0.516±0.040 |
| NaAlg5.0%/PAM3% | 356.6±139.8 | 27.8±6.53 | 0.432±0.065 |
| NaAlg5.0%/PAM4% | 529.7±142.1 | 33.58±3.8 | 0.396±0.046 |
| NaAlg0%/PAM2% | 209.9±58.9 | 32.7±6.1 | 0.356±0.042 |
| NaAlg2.5%/PAM2% | 519.3±173.5 | 38.2±7.5 | 0.463±0.053 |
| NaAlg7.5%/PAM2% | 678.2±108.2 | 33.2±3.4 | 0.3278±0.087 |
| NaAlg10.0%/PAM2% | 397.8±111.6 | 25.3±4.2 | 0.306±0.043 |

^aat 80% strain on the compressive stress-strain curves.

Table S3

Comparison of mechanical properties of alginate-based hydrogels

| Samples | Hydrogel type | Tensile strength ^a (KPa) | Elongation at break ^a (mm/mm) | References |
|---|--|--|---|---------------|
| Polyacrylamide/alginate/montmorillonite | Nanocomposite and interpenetrating network | 106.2 | 10.1 | [1] |
| Sodium alginate/polyacrylamide | Double network | 530 | 6.89 | [2] |
| Graphene oxide/sodium alginate/polyacrylamide | Nanocomposite | 201.7 | 592 | [3] |
| alginate/polyacrylamide | Double network | 50.8 | 5.08 | [4] |
| Sodium alginate/polyacrylamide | Semi-interpenetrating network | 678.2 | 33.2 | In this study |
| Calcium alginate/polyacrylamide | Double network | 733.6 | 17.1 | In this study |

^aMechanical properties of hydrogel samples prepared in optimal ratio.

References:

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- [2] Q. Zhou, H. Kang, M. Bielec, X. Wu, Q. Cheng, W. Wei and H. Dai, *Carbohydr. Polym.*, 2018, **197**, 292-304.
- [3] J. Fan, Z. Shi, M. Lian, H. Li and J. Yin, *J. Mater. Chem. A*, 2013, **1**, 7433-7443.
- [4] B. Huang, R. Hu, Z. Xue, J. Zhao, Q. Li, T. Xia, W. Zhang and C. Lu, *Carbohydr. Polym.*, 2020, **231**, 115736.

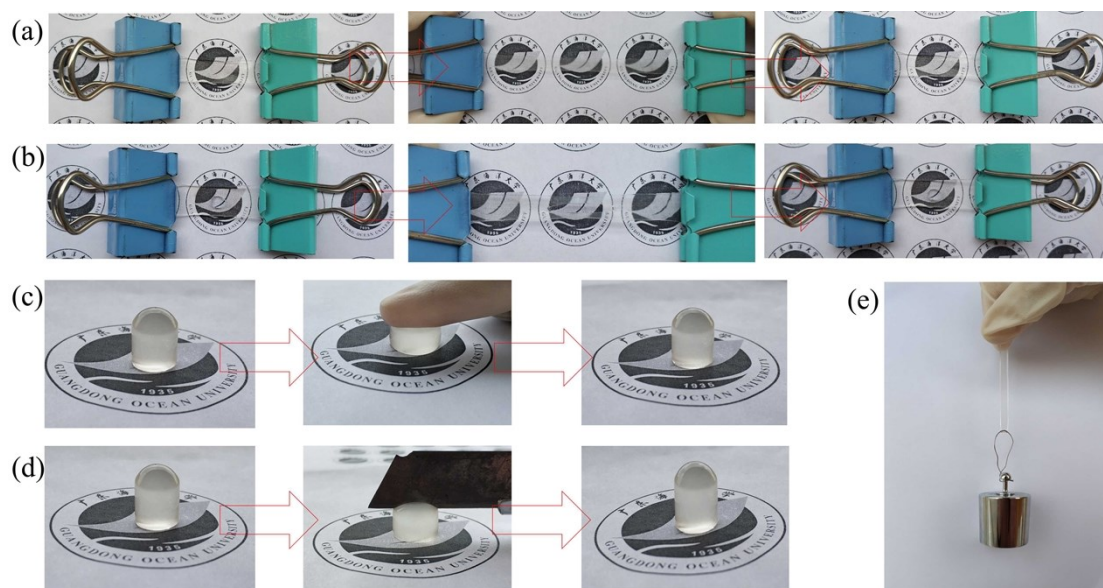


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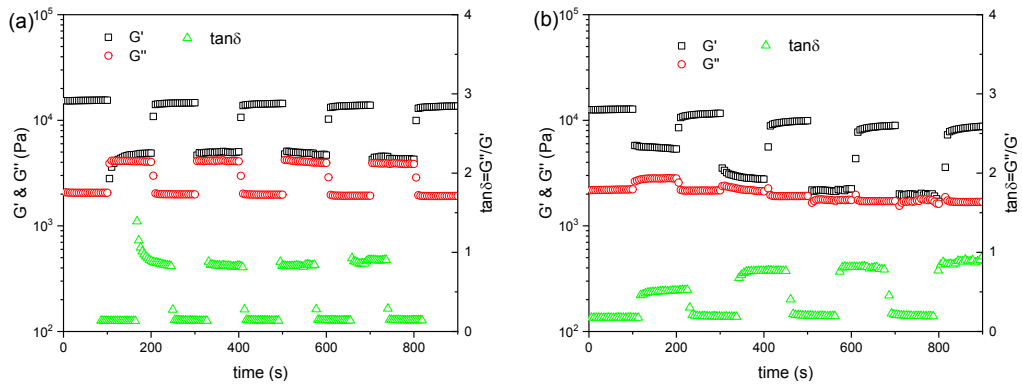


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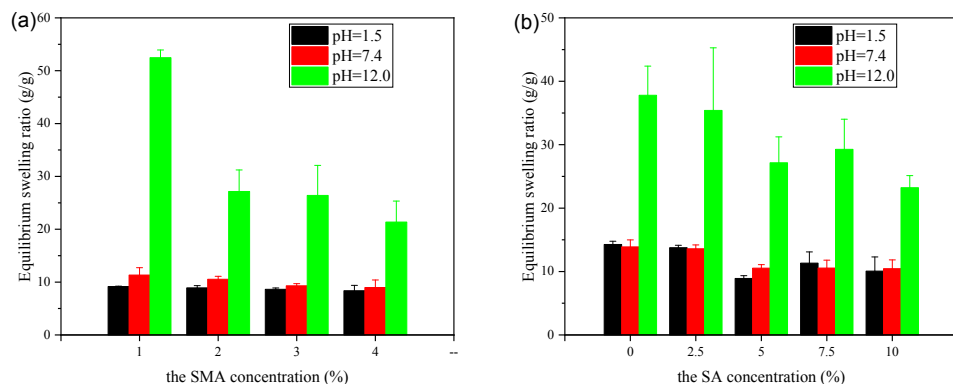


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