

Supplementary Materials

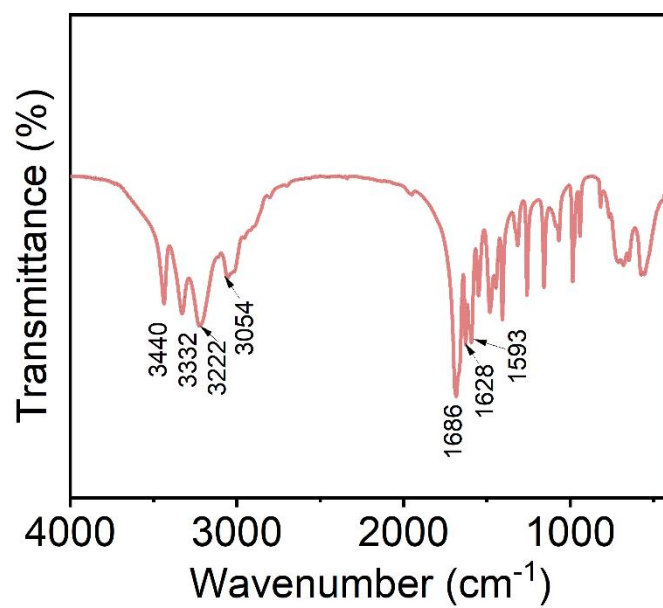
Ice-activated hydrogel suction cups enabling unprecedented adhesion

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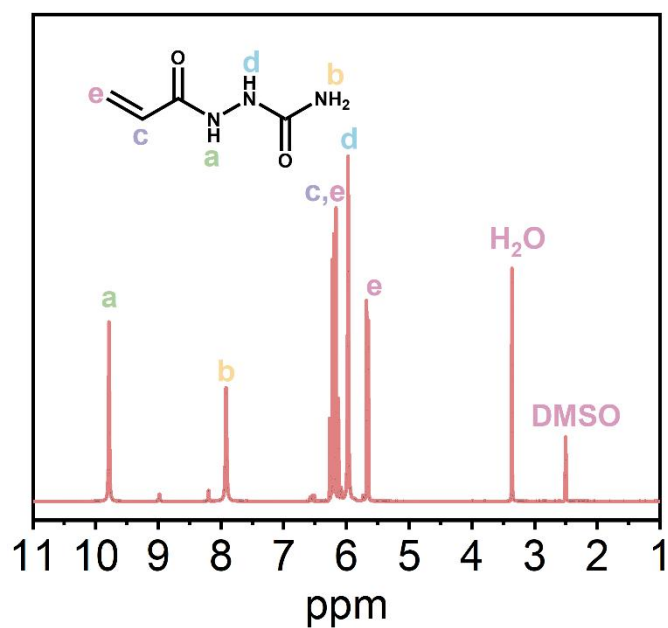
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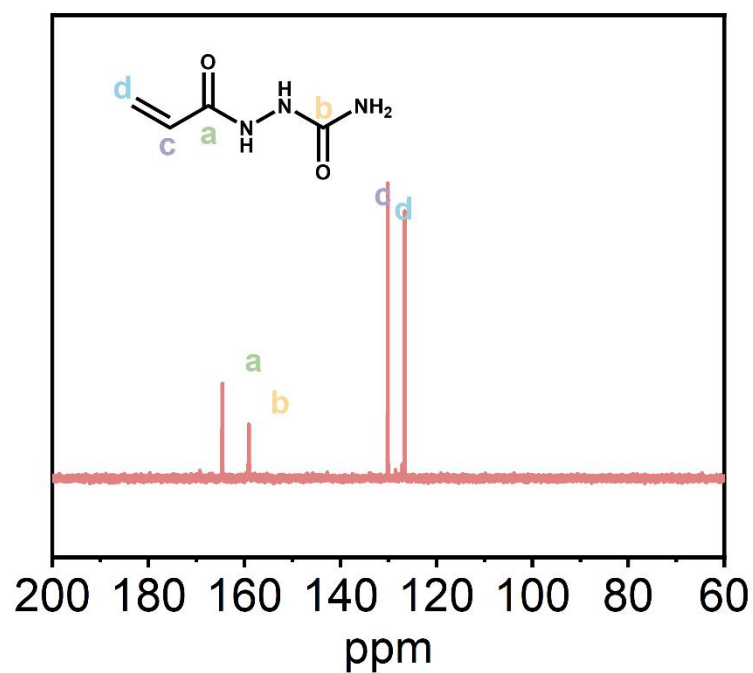
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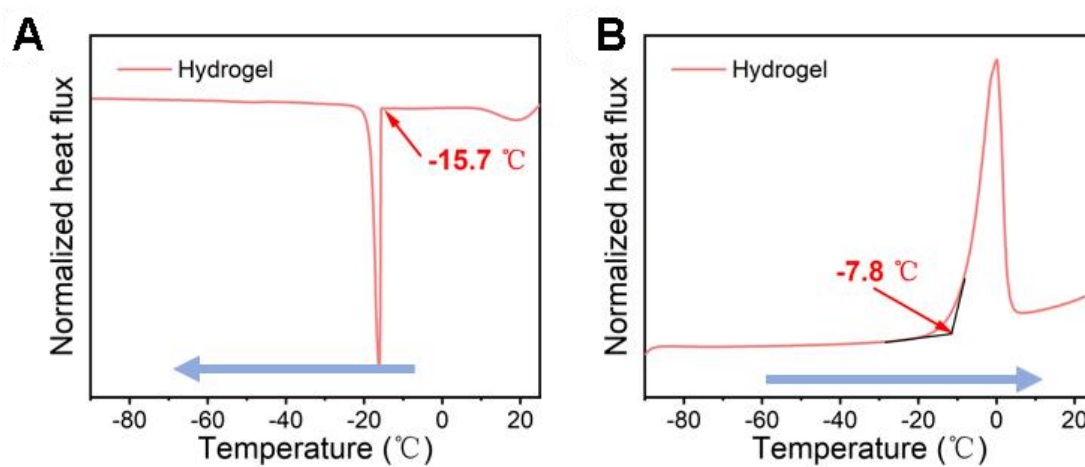
Supplementary Figure 1. FTIR spectra of the NASC monomer.



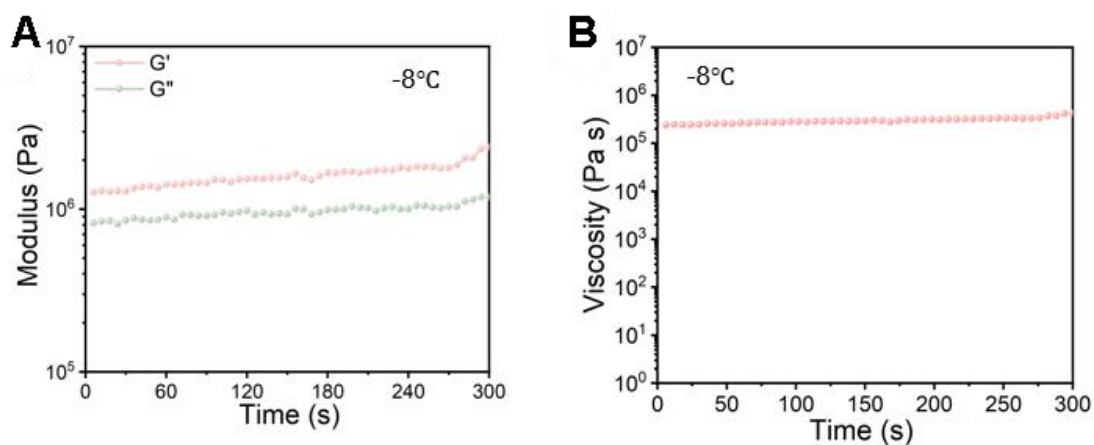
Supplementary Figure 2. ^1H -NMR spectra of the NASC monomer.



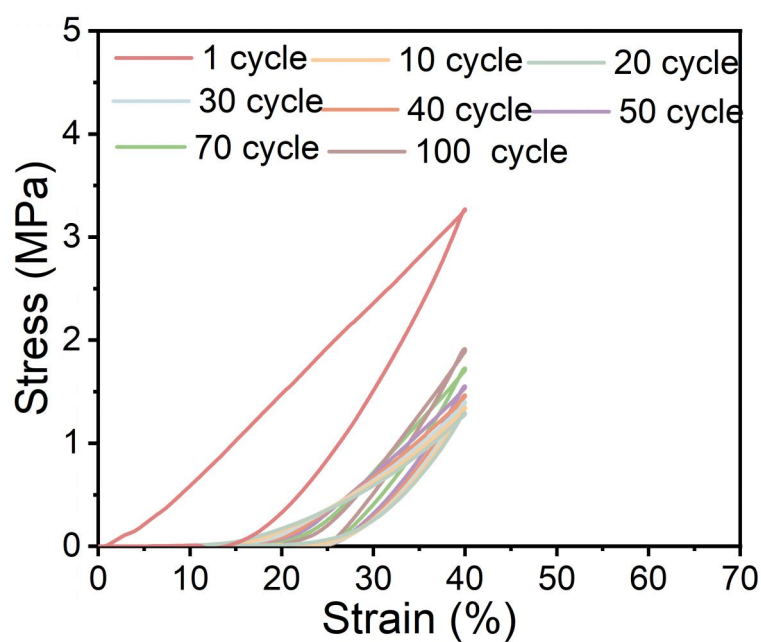
Supplementary Figure 3. ^{13}C -NMR spectra of the NASC monomer.



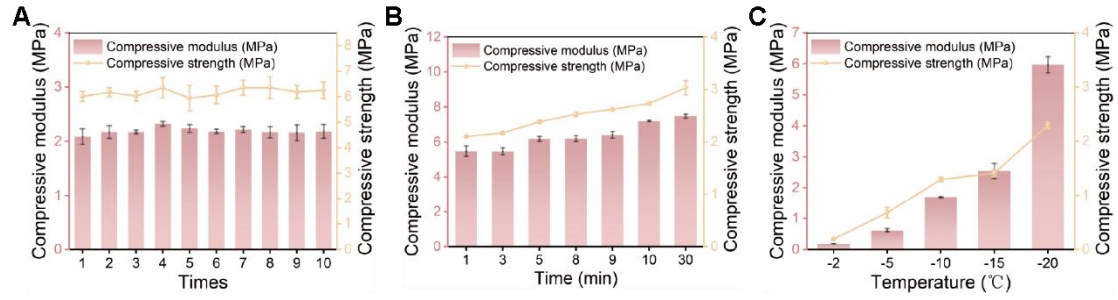
Supplementary Figure 4. Differential scanning calorimetry (DSC) testing of hydrogel. (A) Cooling curve. (B) Heating process curve.



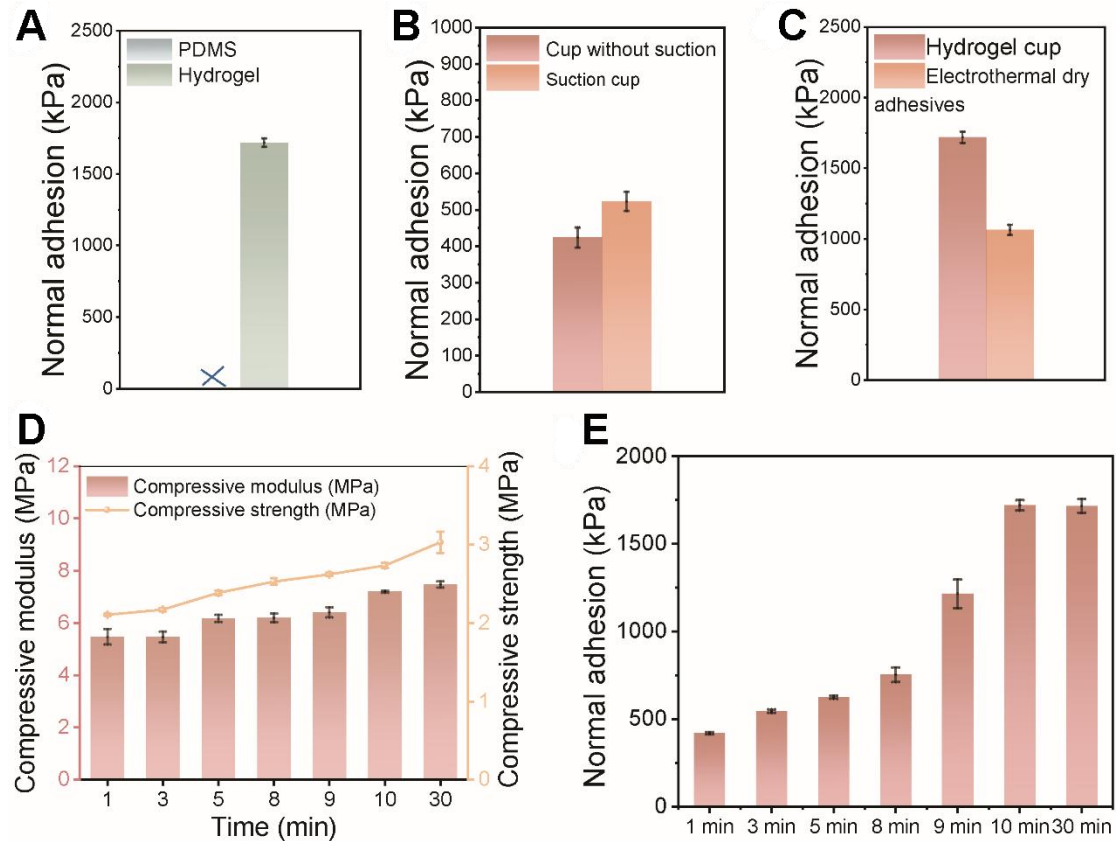
Supplementary Figure 5. Rheological properties of hydrogel at -8°C. (A) Storage modulus G' , loss modulus G'' of the hydrogels at -8 °C. (B) viscosity of the hydrogels at -8 °C.



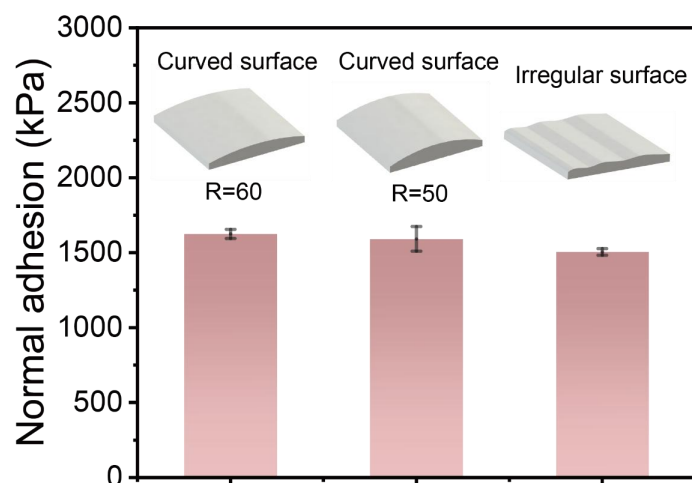
Supplementary Figure 6. Compressive loading-unloading curves over 100 cycles at -25 °C.



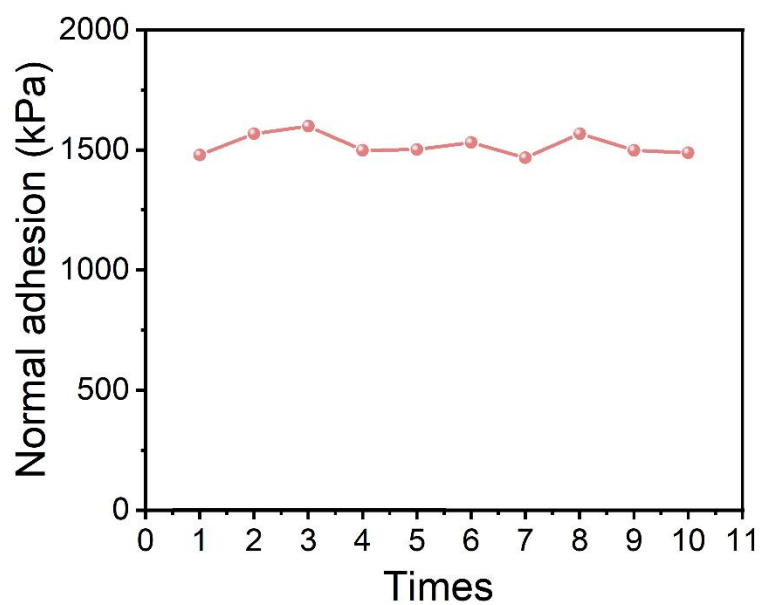
Supplementary Figure 7. Compressive modulus and compressive strength of hydrogel at (A) Freezing-thawing cycle. (B) Cooling time. (C) Different temperature. Error bars represent $\pm$ SD (n = 3). SD: Standard deviation.



Supplementary Figure 8. (A) Adhesion of hydrogel and PDMS suction cup. The symbol “x” indicates that the adhesion strength is approximately zero and cannot be effectively measured. (B) Adhesion of hydrogel suction cup and hydrogel cup without suction. (C) Adhesion of hydrogel cup and electrothermal dry adhesives^[1]. (D) Compressive modulus and strength with different cooling time. (E) Adhesion with different cooling time. Error bars represent $\pm$ SD (n = 3). SD: Standard deviation.



Supplementary Figure 9. Adhesion of hydrogel at different curved surface. Error bars represent $\pm$ SD ($n = 3$). SD: Standard deviation.



Supplementary Figure 10. Freeze–thaw adhesion cycles of hydrogel suction cup.

REFERENCES

1. J. Zhang, H. Tian, H. Liu, D. Wang, Y. Wu, X. Li, C. Wang, X. Chen, J. Shao, *Electrothermal Dry Adhesives with High Adhesion Under Low Temperatures Based on Tunable Stiffness. Advanced Functional Materials* **2024**, 34, 2309800.doi:10.1002/adfm.202309800