# Temperature-Controlled Reversible and Salt-Controlled Recoverable Double-Network Hydrogels with Ultrahigh Mechanical Strength, Stretchable Toughness

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NANYANG TECHNOLOGICAL UNIVERSITY

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*Undergraduate Research Experience on CAMpus*

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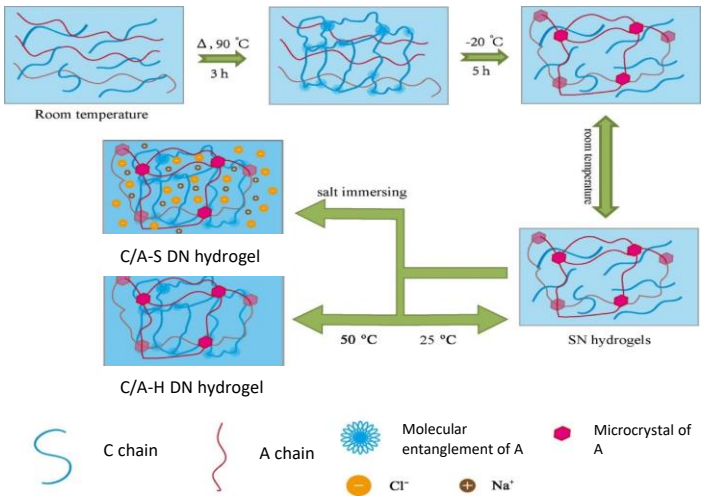
## Introduction

As one of the highly researched materials, hydrogel can be described as three-dimensional network of polymers which traps large quantity of water within their structures. Due to its low strength, many enhanced versions have emerged with better mechanical properties. DN hydrogels are one of them. They are characterized by a special network structure consisting of two polymer components with contrasting properties: one with cross-linked rigid skeleton and the other one is less crosslinked in order to maintain the integrity of the DN hydrogels during deformation. The toughness is enhanced by the interaction between this two networks. Although mechanical property is improved, recovery from physical damage and temperature effect are rarely studied. Here, we firstly introduced a temperature-controlled reversible C/A-H DN hydrogel and toughened C/A-S DN hydrogels which show various excellent properties.

## Methodology




## Optical Property

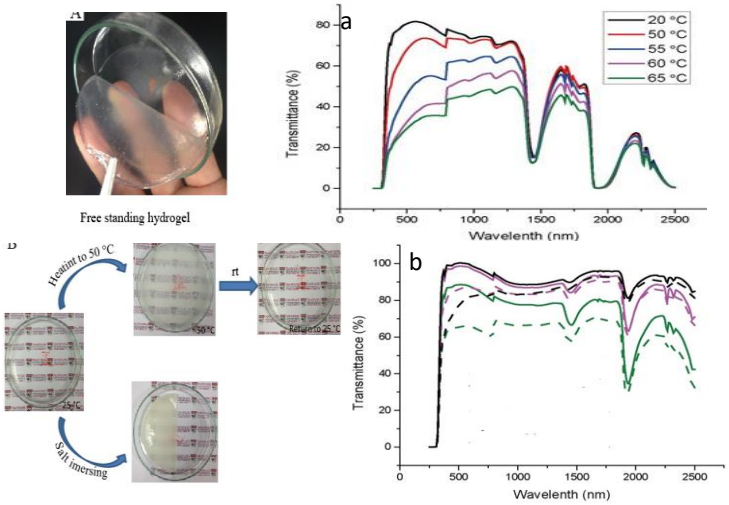



Fig. 2 a) Optical transmittance spectra of the 1 mm C-A film with temperature from 20 °C to 65 °C, and b) Optical transmittance spectra of 4 wt. % to 16 wt. % C-A samples with 50 μm at both 20 °C and 50 °C.

## Mechanical Property

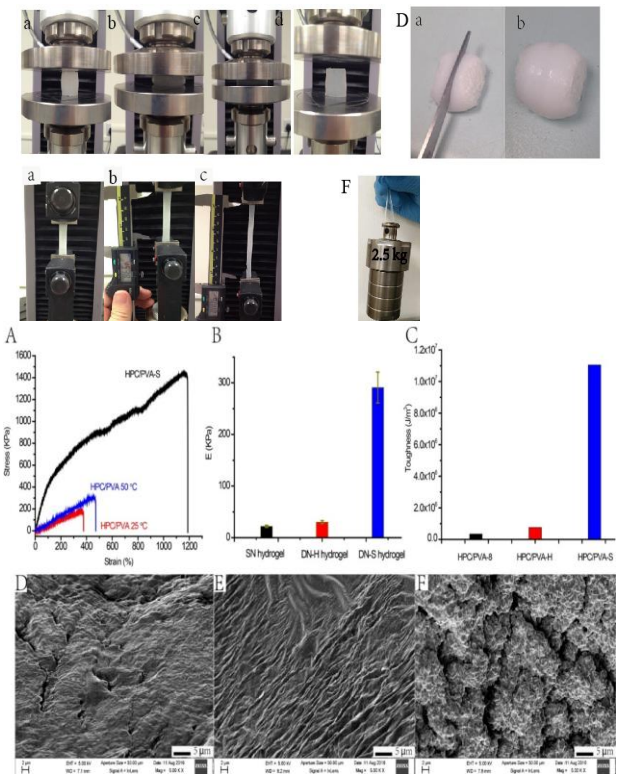



Fig. 1 A) Tensile Curves, B) elastic modulus, and C) fracture energy of the C/A-8, C/A-H and C/A-S DN hydrogels. SEM images of the D) C/A-8, E) C/A-H, and F) C/A-S DN hydrogels.

## Conclusion

To summarize, we successfully synthesized two DN hydrogel: **one with temperature-controlled reversibility and the other one with significantly improved toughness**. Both of them show promising usability in engineering field with high tensile strength (~ 1.5 MPa), ultrahigh toughness (fracture energy: ~11 KJ m-2), temperature reversible property, self-recovery property, excellent fatigue resistance and loading-bearing capacity.

**Project Title: Temperature-Controlled Reversible and Salt-Controlled Recoverable Double-Network Hydrogels with Ultrahigh Mechanical Strength, Stretchable Toughness**

**Supervisor: Dr Long Yi** **Mentor: Mr Zhou Yang**