

Research in Tokyo Tech

Xiaoying Liu, 14R55026

Tsinghua University

Advisor: Toshikazu Takata

Department of organic and polymeric materials

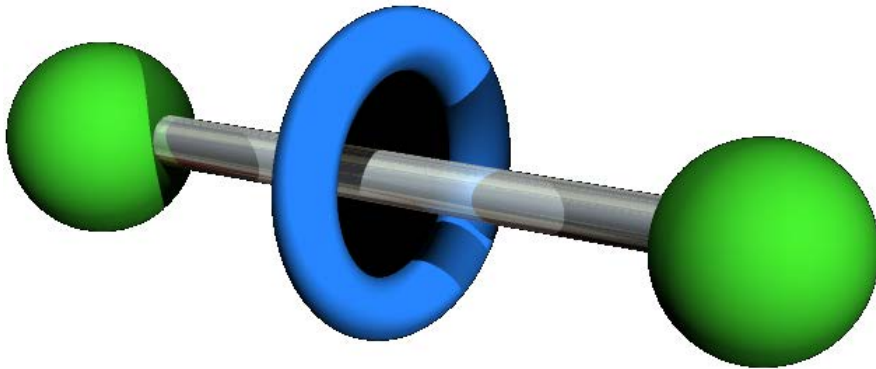
Introduction

- **Research theme**

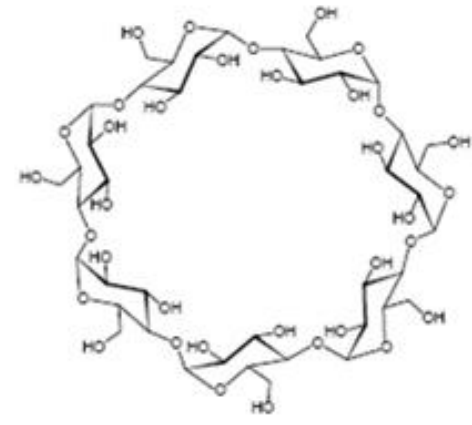
Synthesis of rotaxane cross-linked polymers(RCPs) using hydrophilic vinyl monomers to obtain corresponding hydrogels

Hydrogels: wet and soft materials, network structure, used in contact lens, tissue engineering, drug release, sewage treatment

Rotaxane: inter locked molecule consisting of wheel and axle component



Representative wheel component of rotaxane



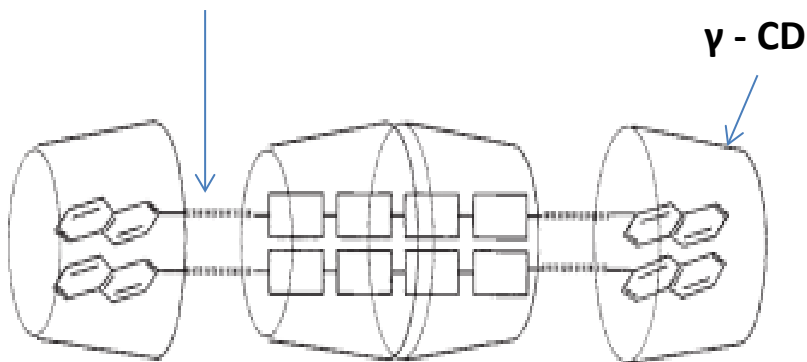
γ-cyclodextrin (γ-CD)

Rotaxane Cross-linked Polymers

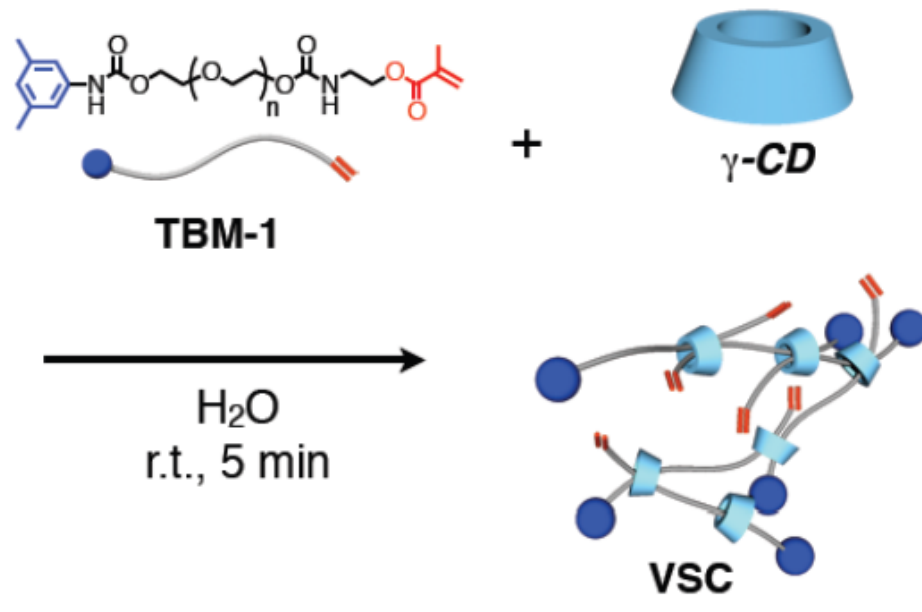
- Covalently cross-linked polymers (CCPs)
- Rotaxane cross-linked polymers (RCPs)

A novel way to obtain RCP -----vinylic supramolecular crosslinker (VSC)

Poly(ethylene glycol)



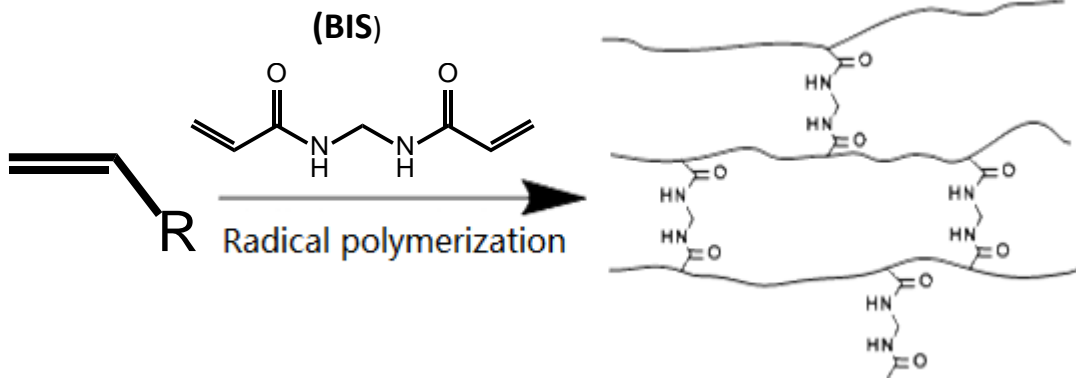
Akira Harada, Jun Li & Mikiharu Kamachi,
Nature 370, 126 - 128



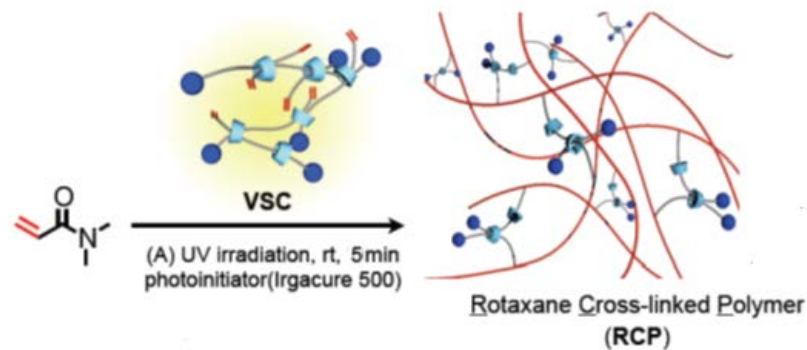
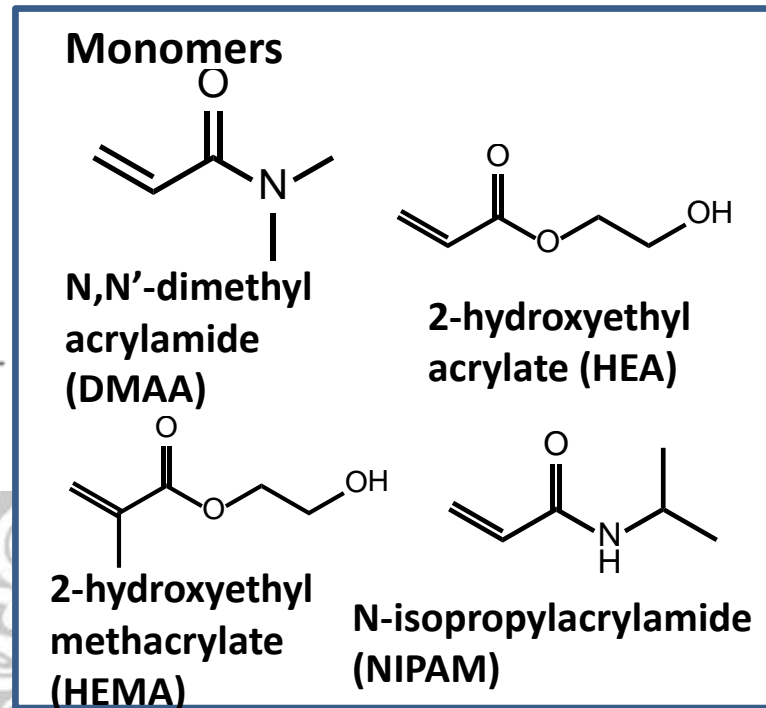
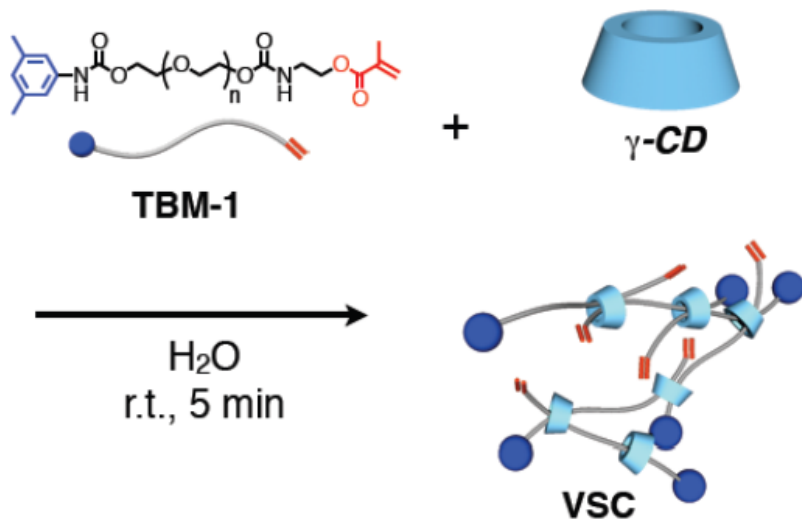
Keumhee JANG, Yasuhito KOYAMA, Satoshi UCHIDA,
and Toshikazu Takata, unpublished

Synthesis of cross-linked polymers

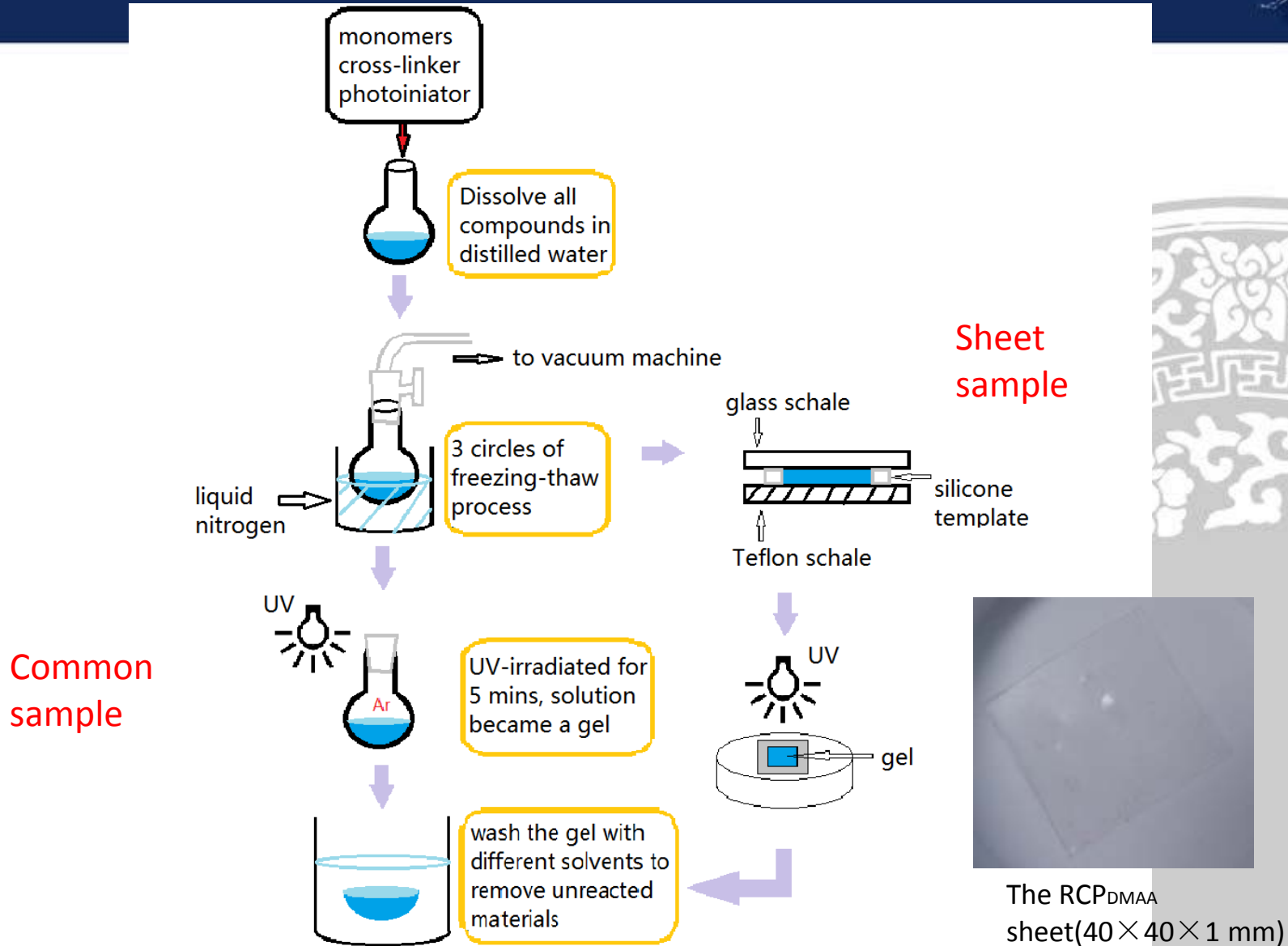
- Synthesis of CCPs



- Synthesis of RCPs



Experiment



Results and discussion

1. Swelling ratio of gels with several solvents

Condition:

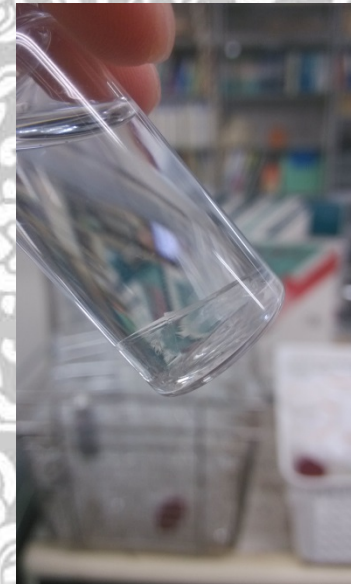
The cross-linking density: $\frac{\text{amount of cross-linker (mol)}}{\text{amount of monomer (mol)}} = 0.5 \%$

CCP: cross-linker is BIS; RCPs: the amount of cross-linker is $\frac{1}{2} \times$ (amount of macromonomers).

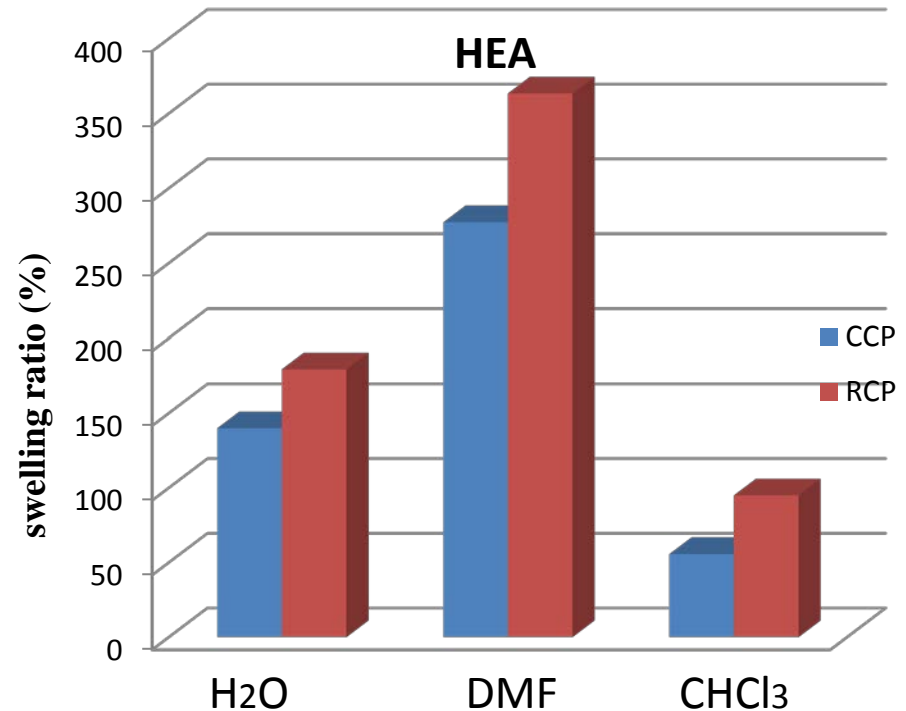
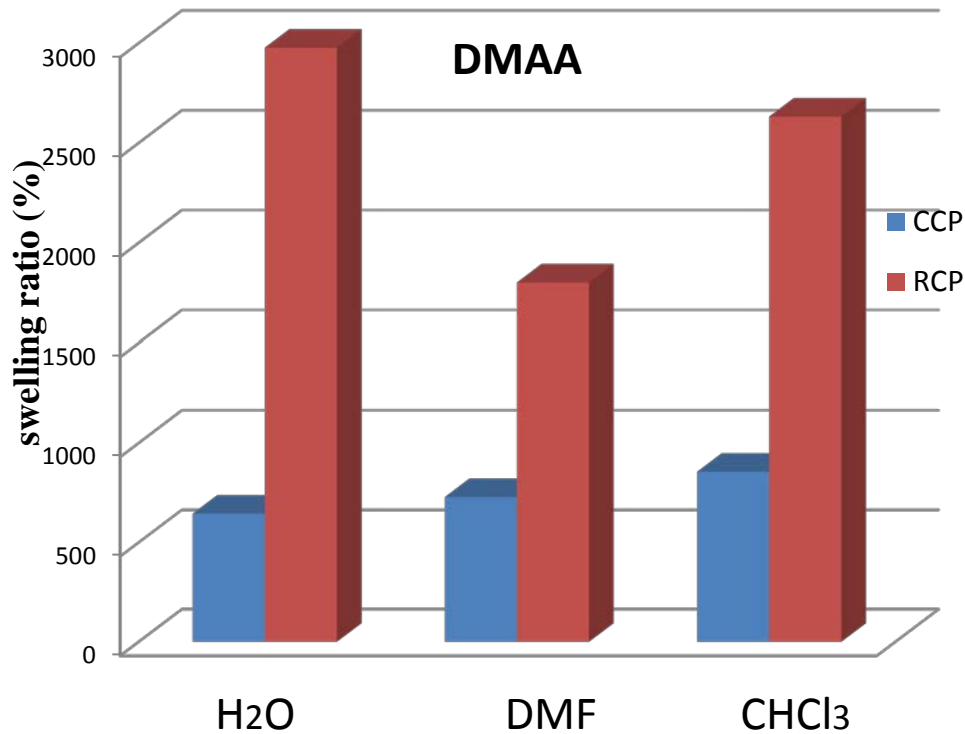
- $\text{swelling ratio}(\%) = 100 \times \frac{(\text{weight of swollen gel}) - (\text{weight of dried gel})}{\text{weight of dried gel}}$



After swelling

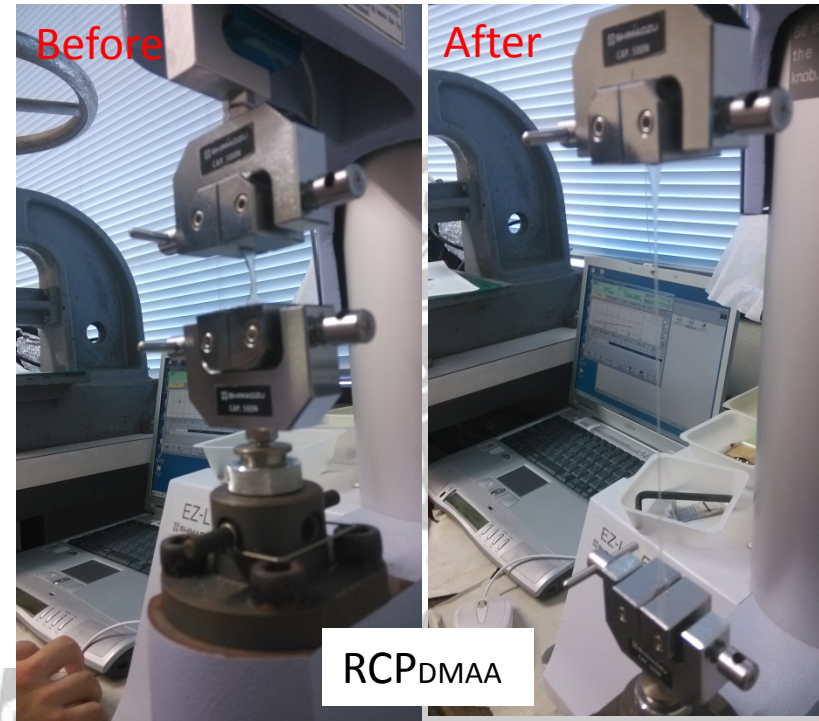
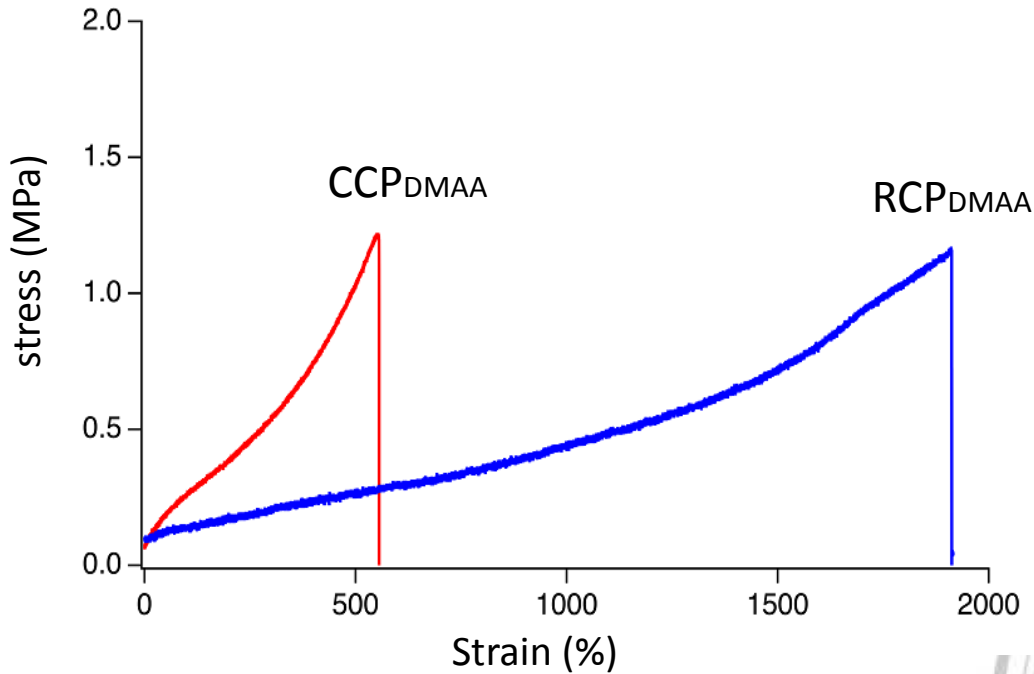


Swelling Ratio of Hydrogels



- RCPs showed better swelling ability than CCPs in different solvents.
- RCPs obtained from different monomers exhibited different swelling ability and the enhancements vary owing to the difference of the VSC structure in each gel.

Tensile strength tests



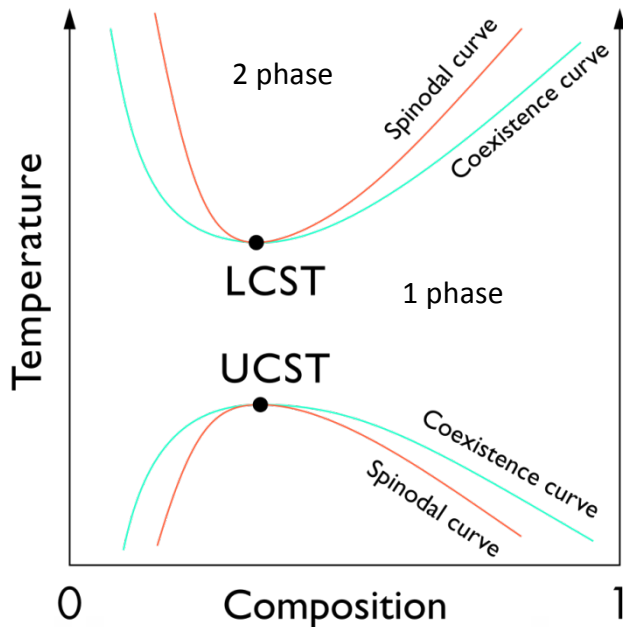
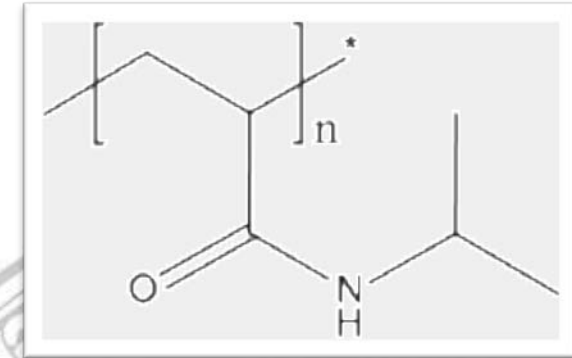
Sample	Elongation at break[%]	Stress at break [MPa]
CCP _{DMAA}	560	1.20
RCP _{DMAA}	1910	1.16

RCP was quite elastic and its tensile strength was the same as CCP gels

Thermo-responsive Hydrogel

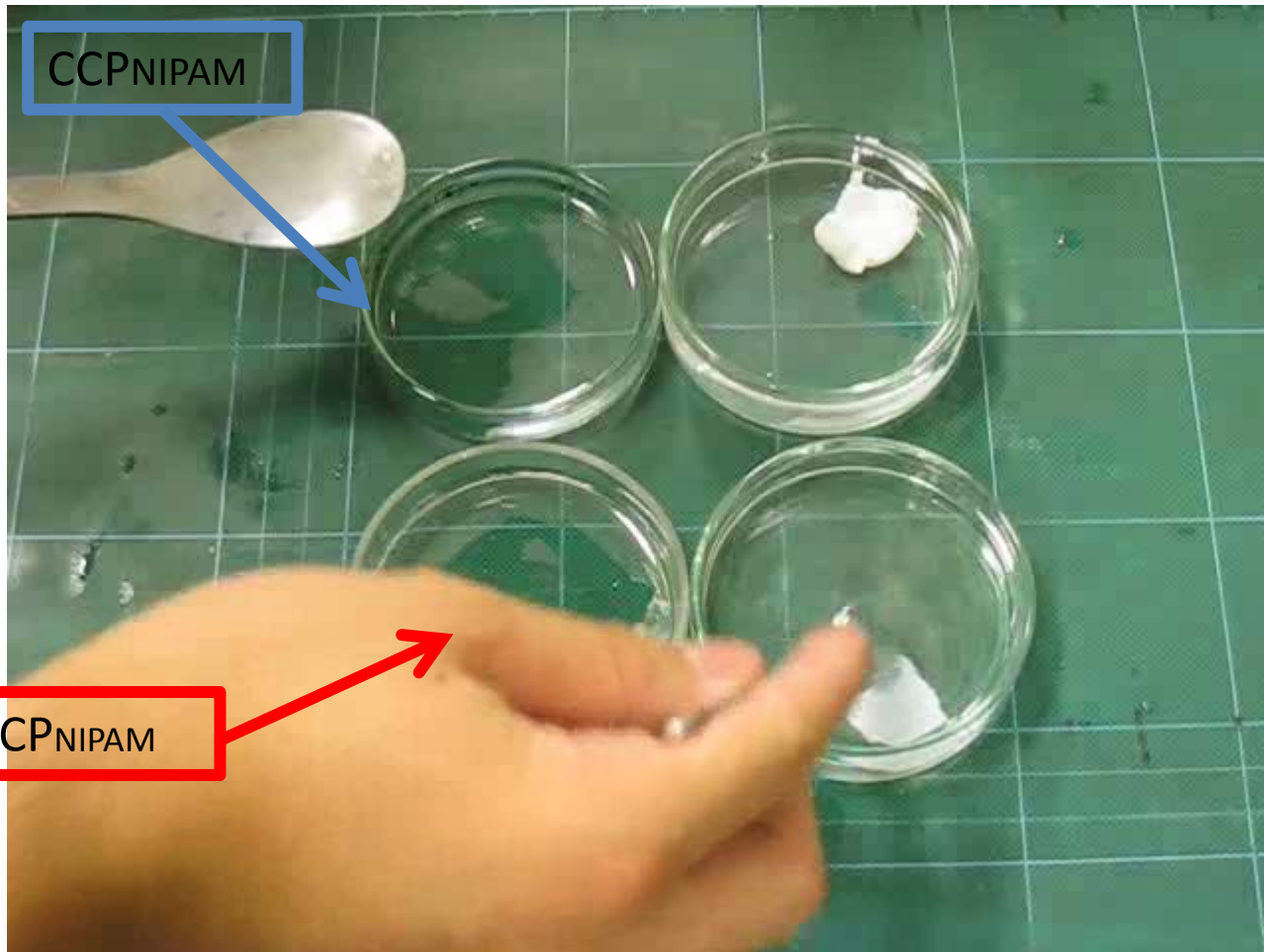
Synthesis of thermo-responsive hydrogel

Poly(N-isopropylacrylamide) (PNIPAM) is a temperature-responsive polymer. It forms a three-dimensional hydrogel when cross-linked. PNIPAM hydrogels have important usages because of its lower critical solution temperature (LCST), which is 32 °C.



But covalently cross-linked PNIPAM hydrogel is fragile and easy to break. We found that using rotaxane cross-linker will enhance the gel. In this study, our experiment proved that the thermo-responsibility of RCP_{PNIPAM} is better than CCP_{PNIPAM}.

Thermo-responsibility of CCP and RCP



heat the gel and
it shrink



Conclusion

- RCPs were successfully synthesized using various monomers.
- RCPs showed better swelling ability than CCPs in most situation.
- RCP_{DMAA} are more elastic and show almost the same tensile strength as the CCP_{DMAA}.
- RCP_{NIPAM} exhibits better thermo-responsibility than CCP_{NIPAM}.

收藏

Thank you !

