Rational Design of Water Harvesting Polymers

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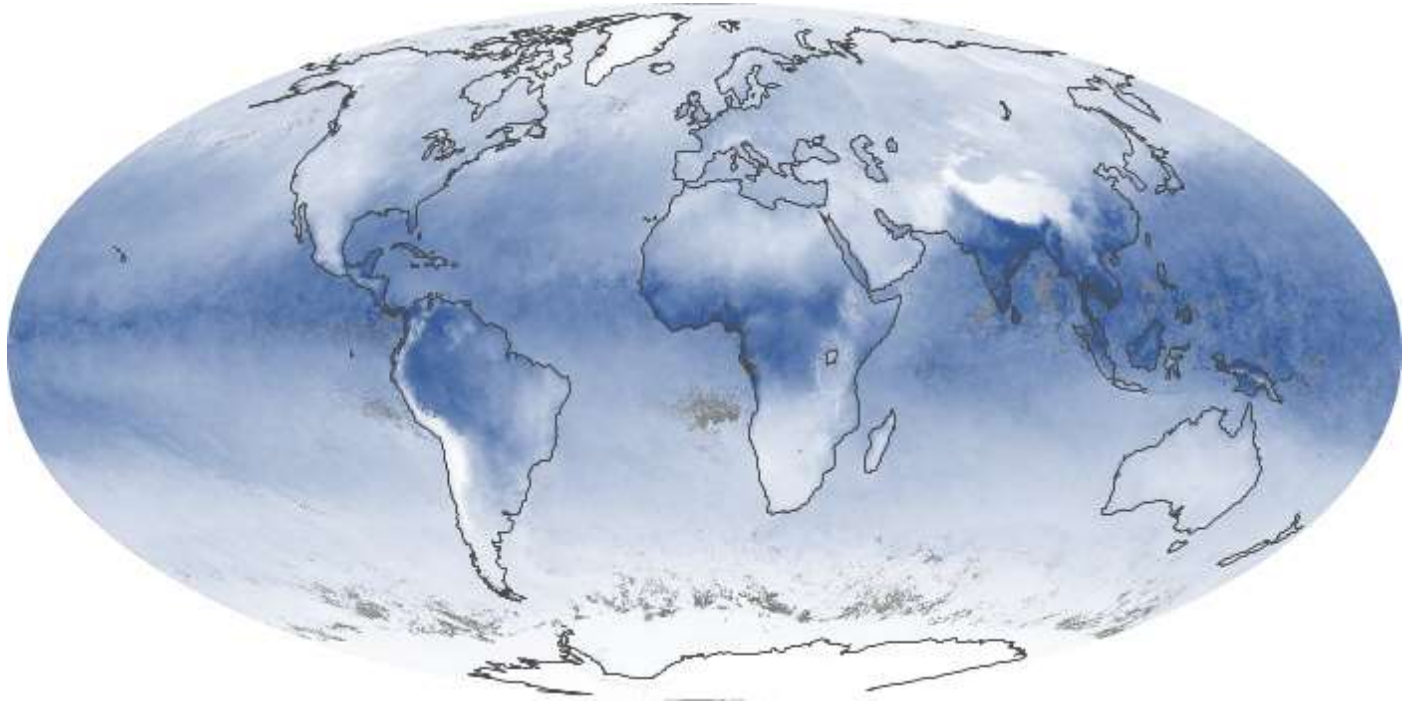
Atmospheric Water Is Underutilised

- 400 trillion tonnes circulated annually
- Humans use 4 trillion tonnes annually
- Atmospheric water accessible in all climates



(NASA, March 2023)

Oki, T.; Kanae, S., *Science* **2006,** 313, 5790

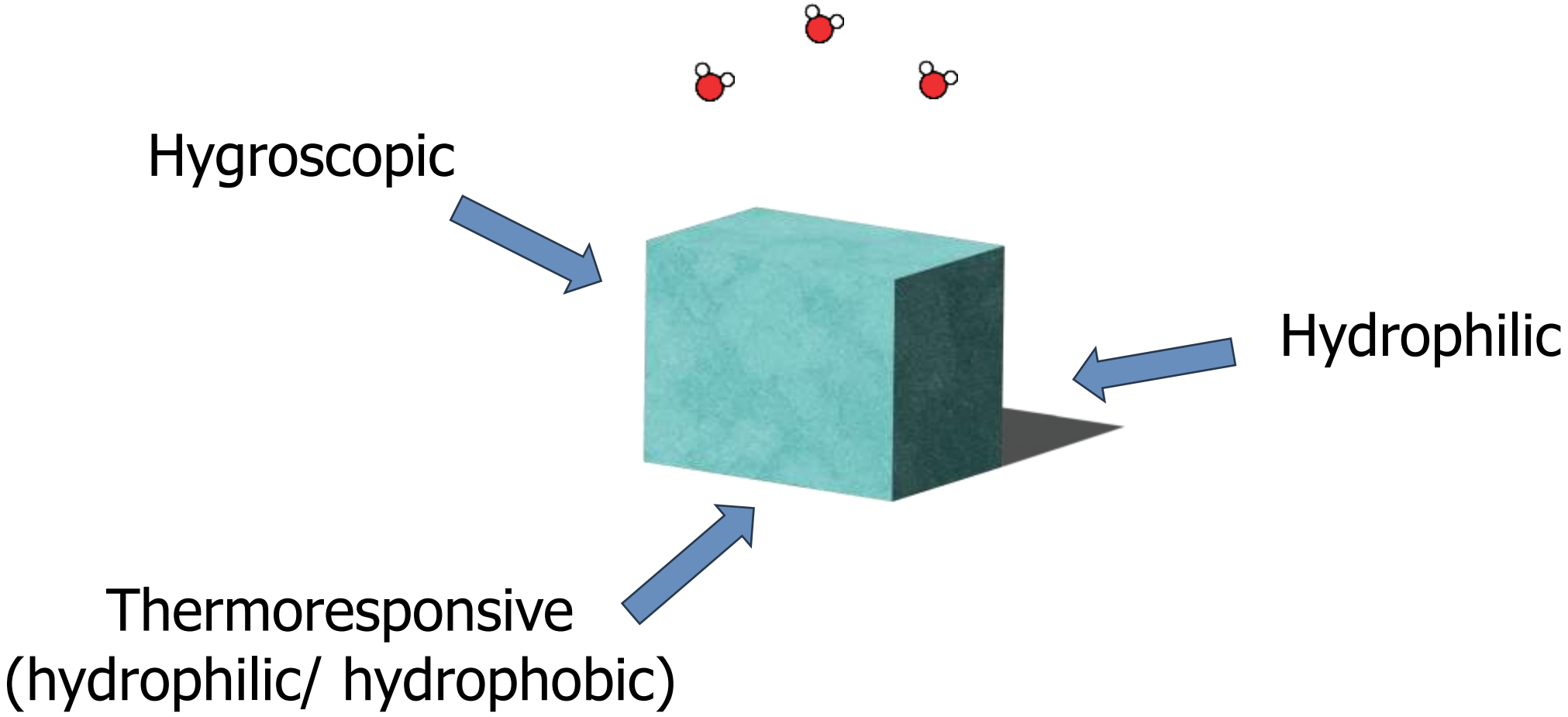
Atmospheric Water Harvesting Methods

Fog Nets

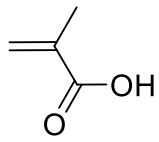
Condensation

Desiccants

The Ideal Water Harvester

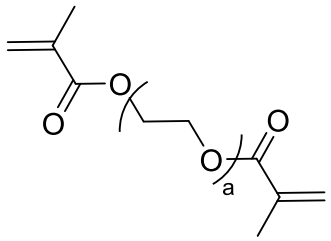


Our Polymer



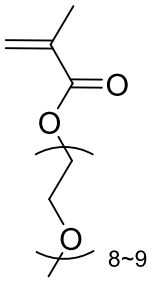
Methacrylic acid

+



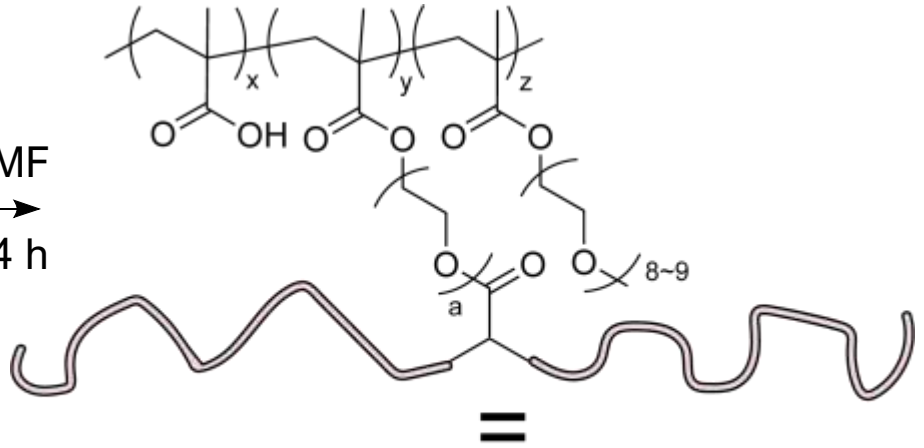
PEGDMA

+



PEGMA

CTA
AIBN, DMF
65°C, 24 h



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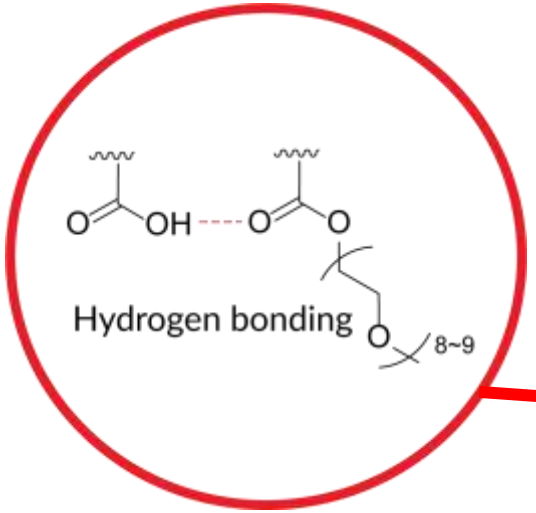
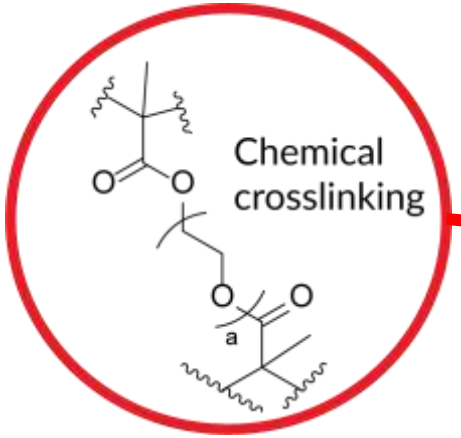
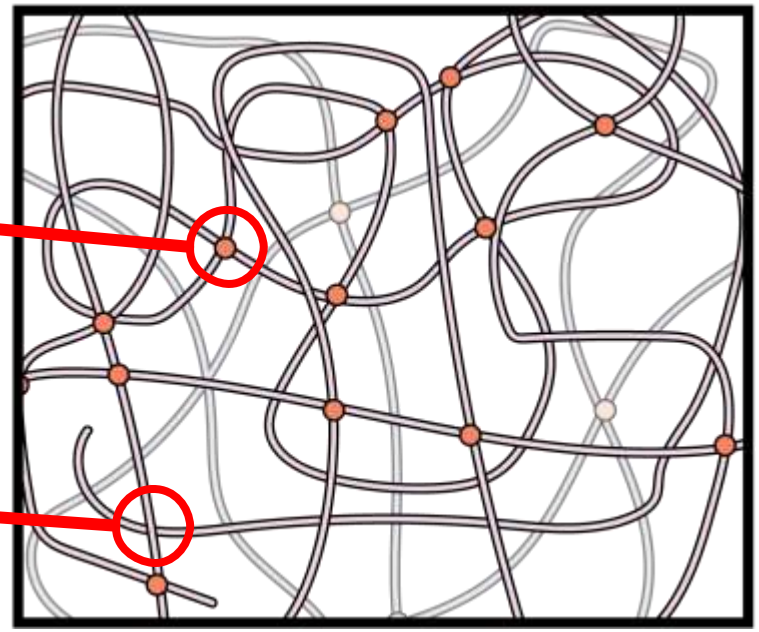
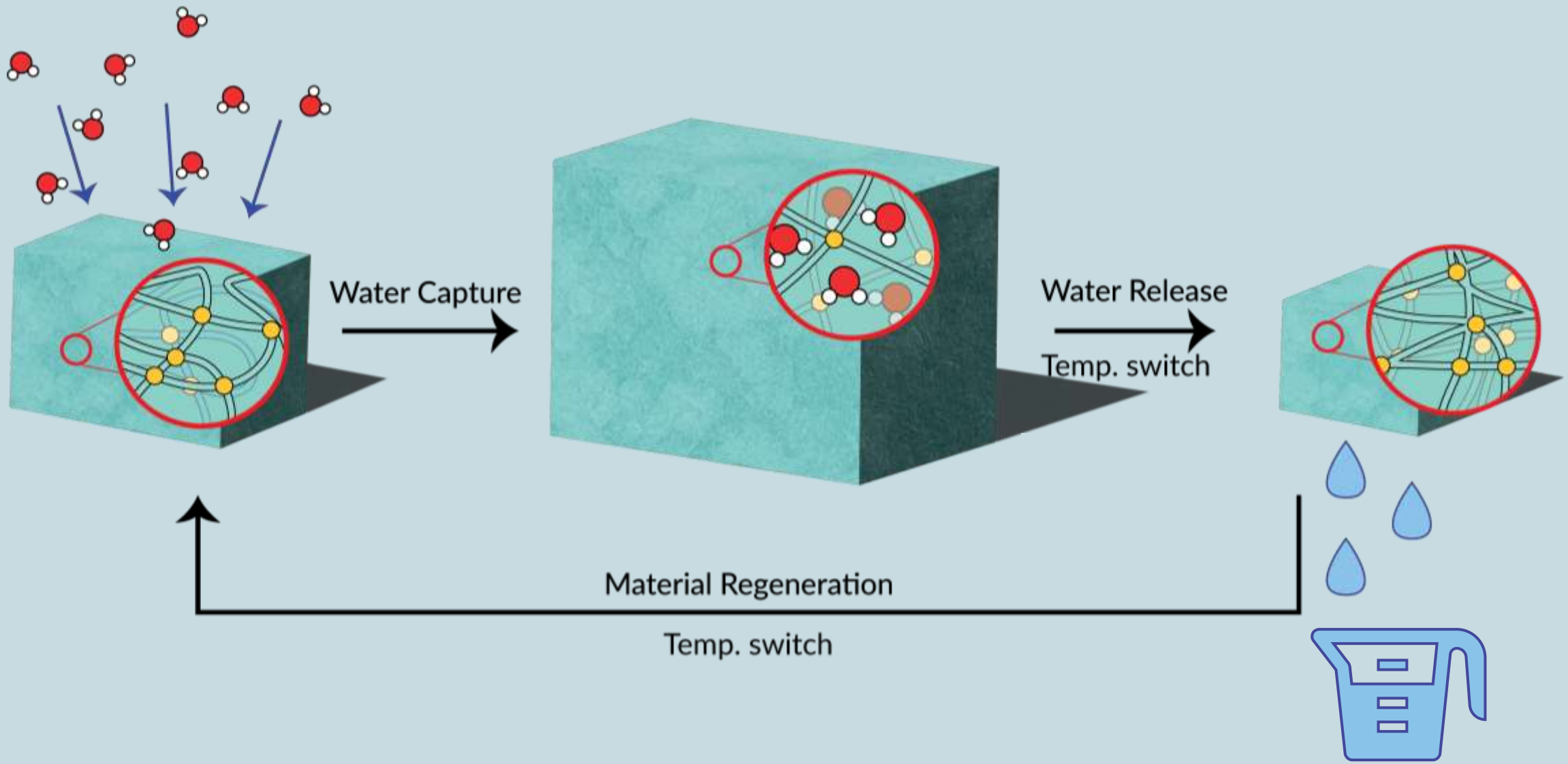




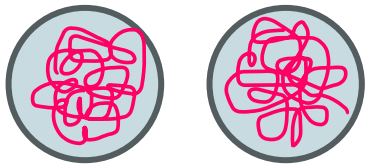


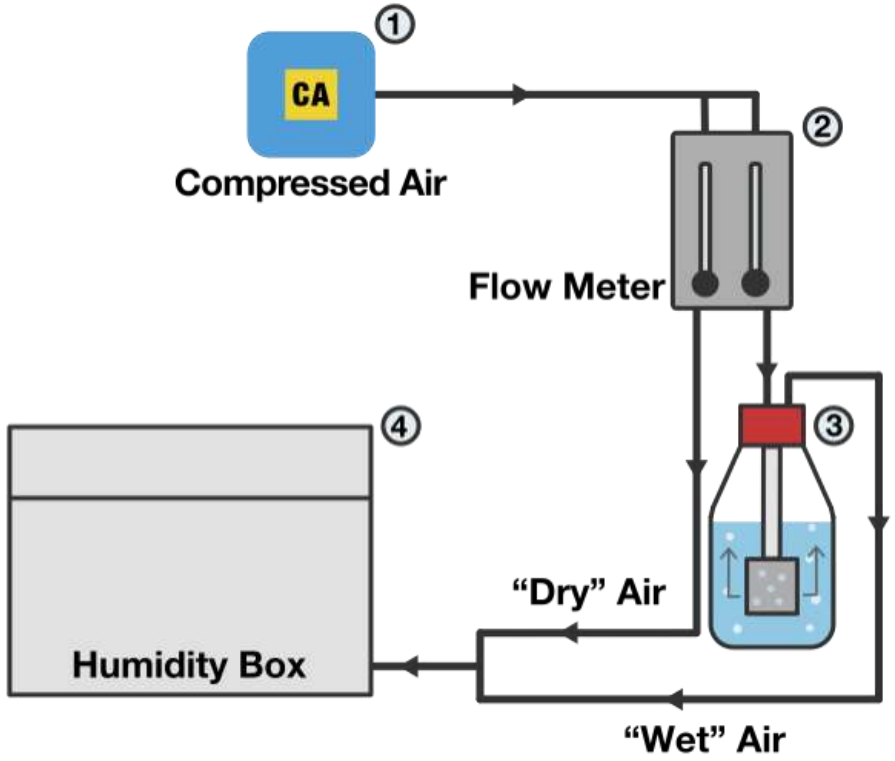
Thanusing, M.; Shen, P.; Pollard, B.; Connal, L., *Mol. Sys. Des. Eng.* **2023,** 9*, 63-72*


Water Capture
Water Release
Temp. switch
Material Regeneration
Temp. switch

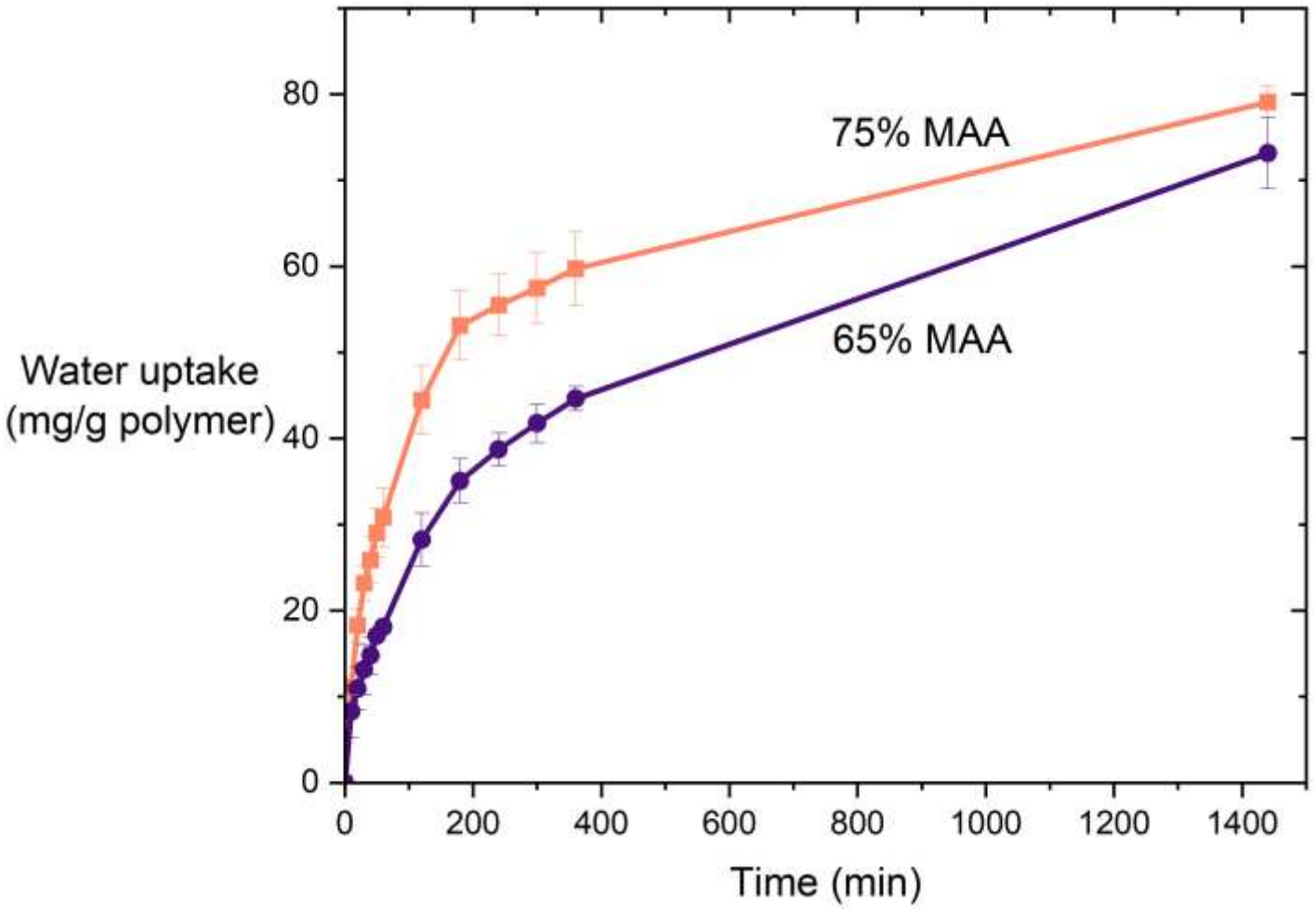
Water Uptake Measurement

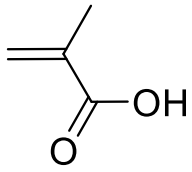
Done at 60-70% RH
Up to 24 h



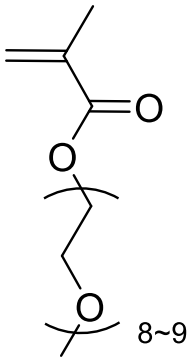


Composition Affects Water Uptake



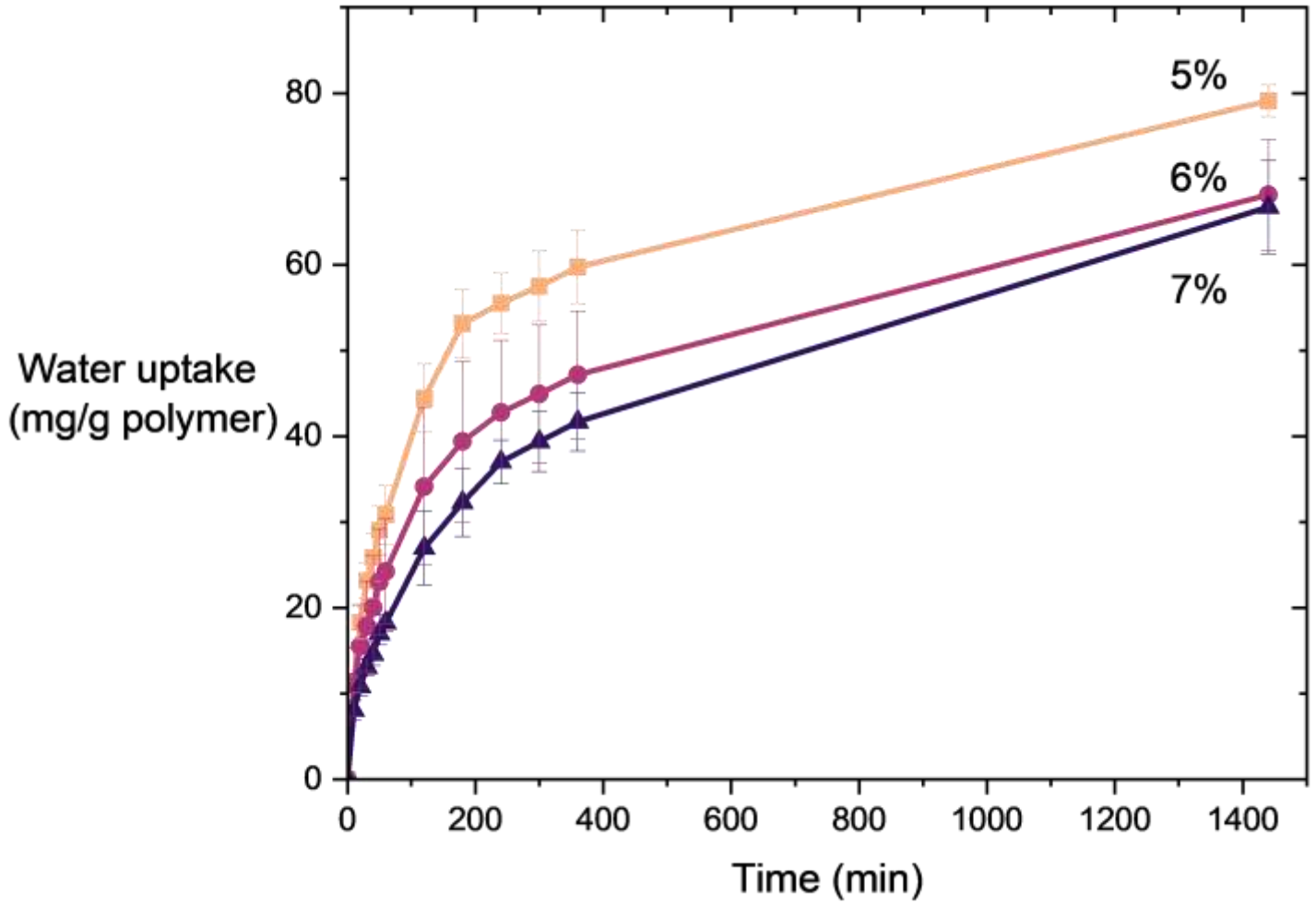


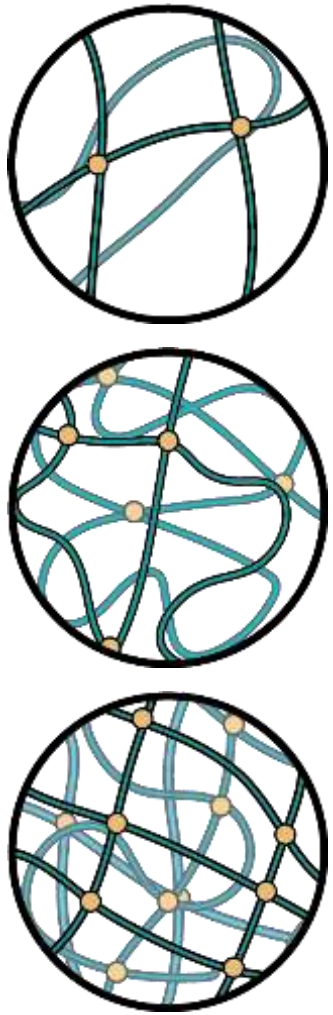
MAA



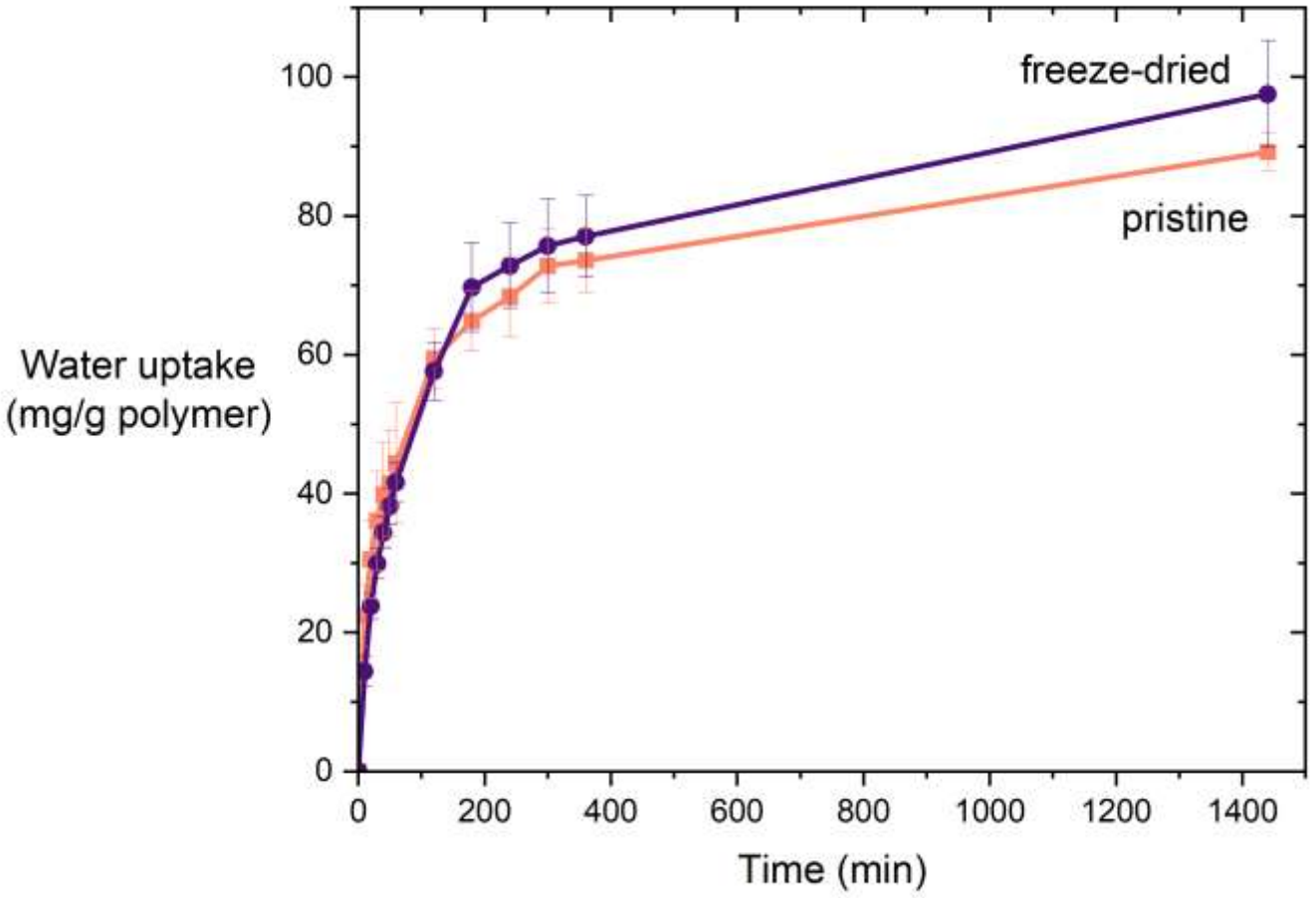
PEGMA

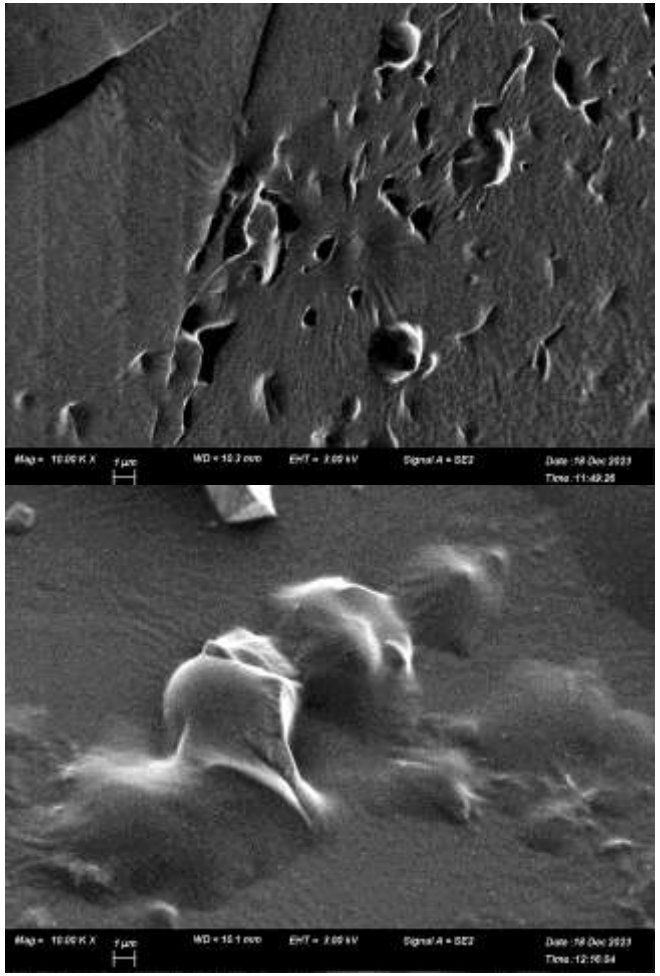
Crosslinking Density Reduces Water Uptake



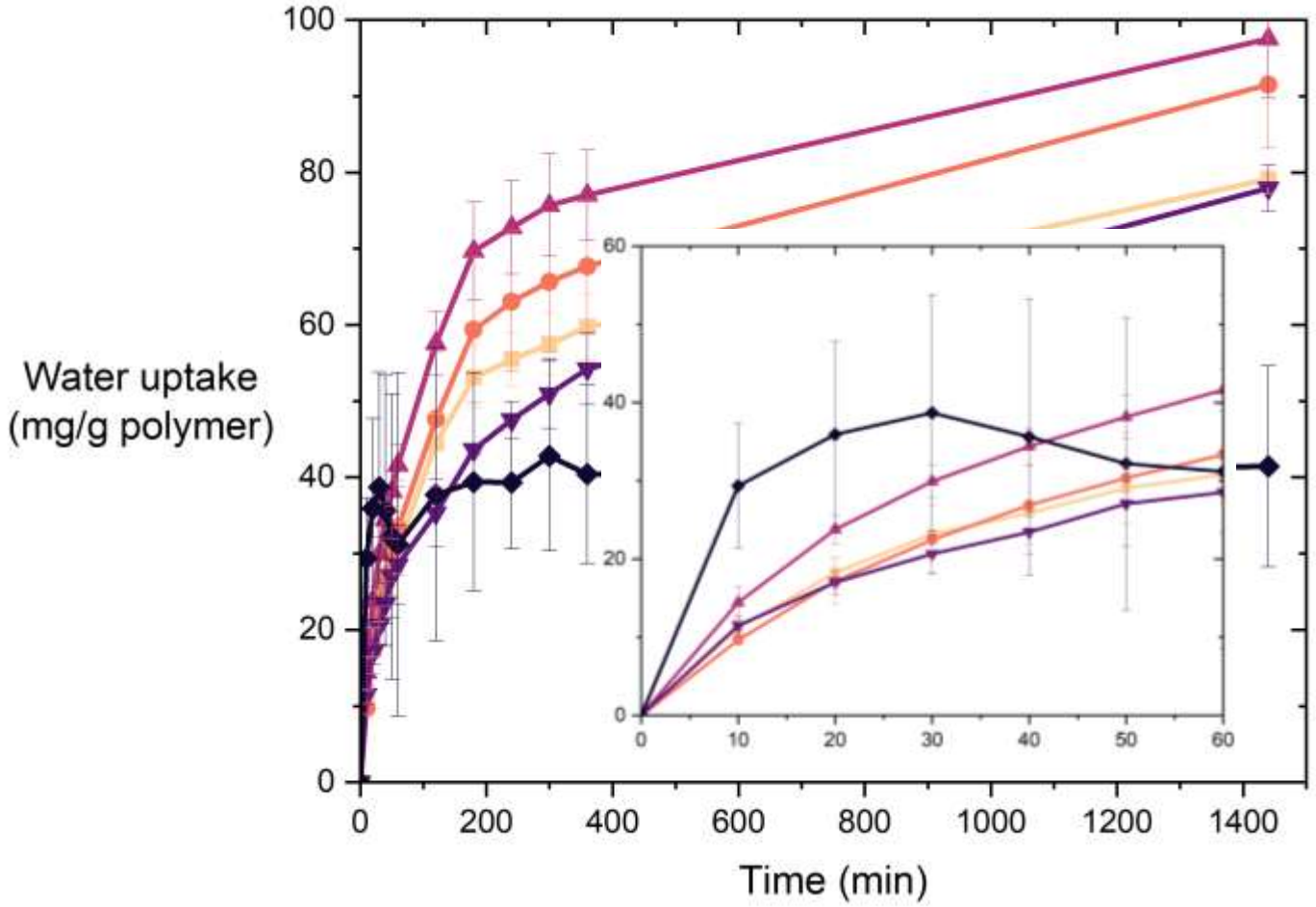


Porosity Effects Are Inconclusive





Crosslinker Length Has Varying Effects



PEGDMA 750

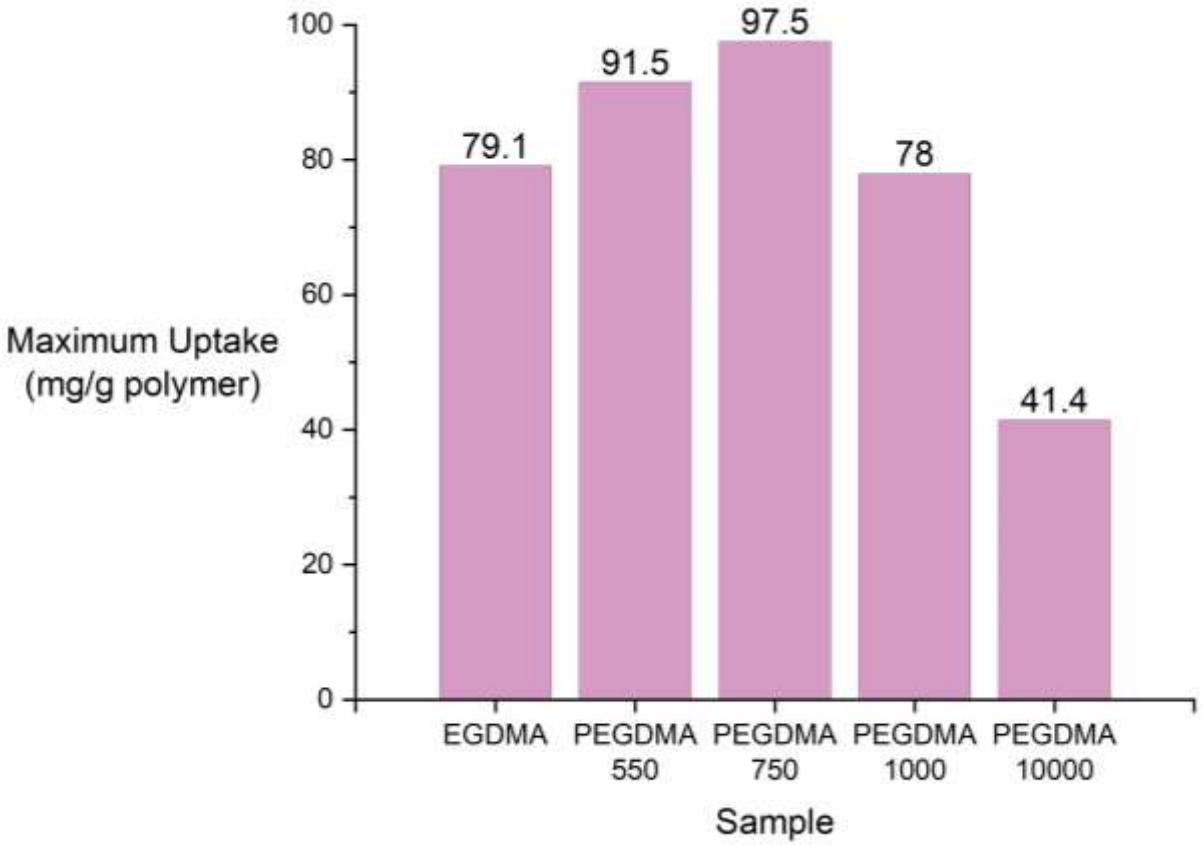
PEGDMA 550

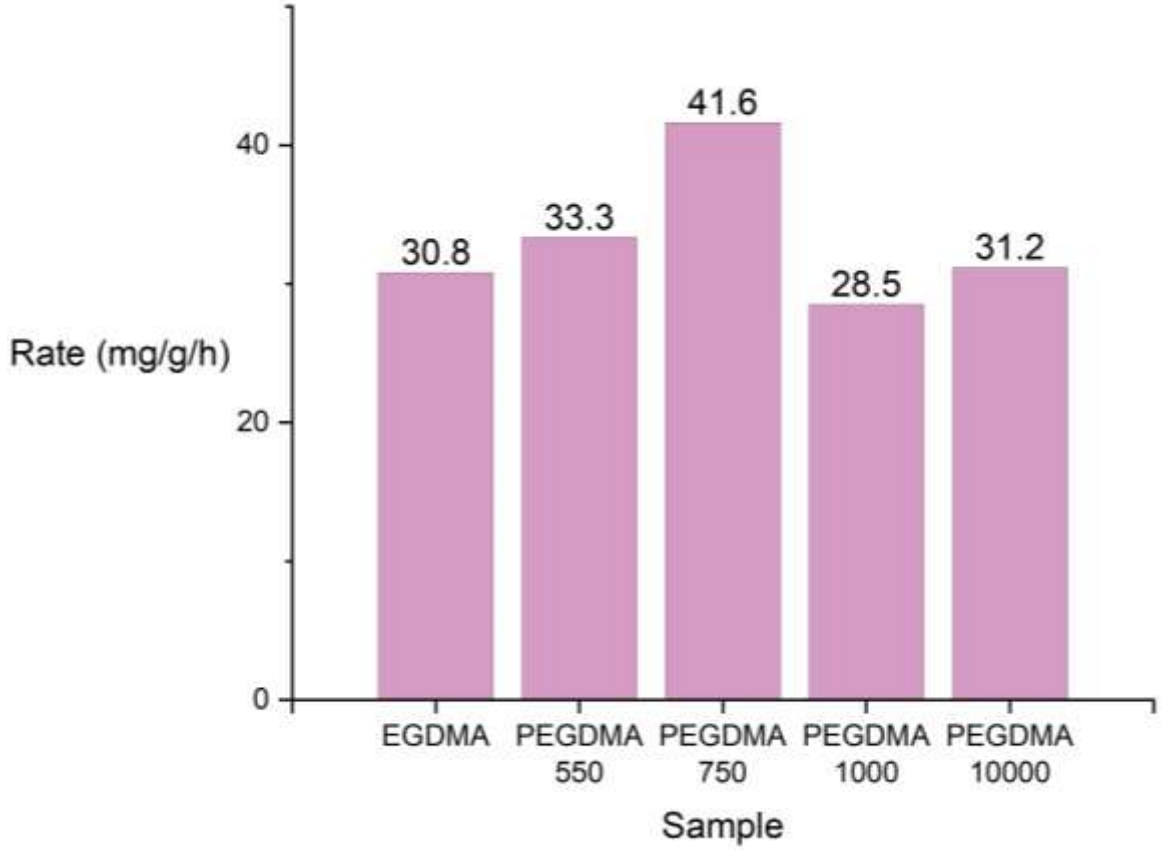
EGDMA

PEGDMA 1000

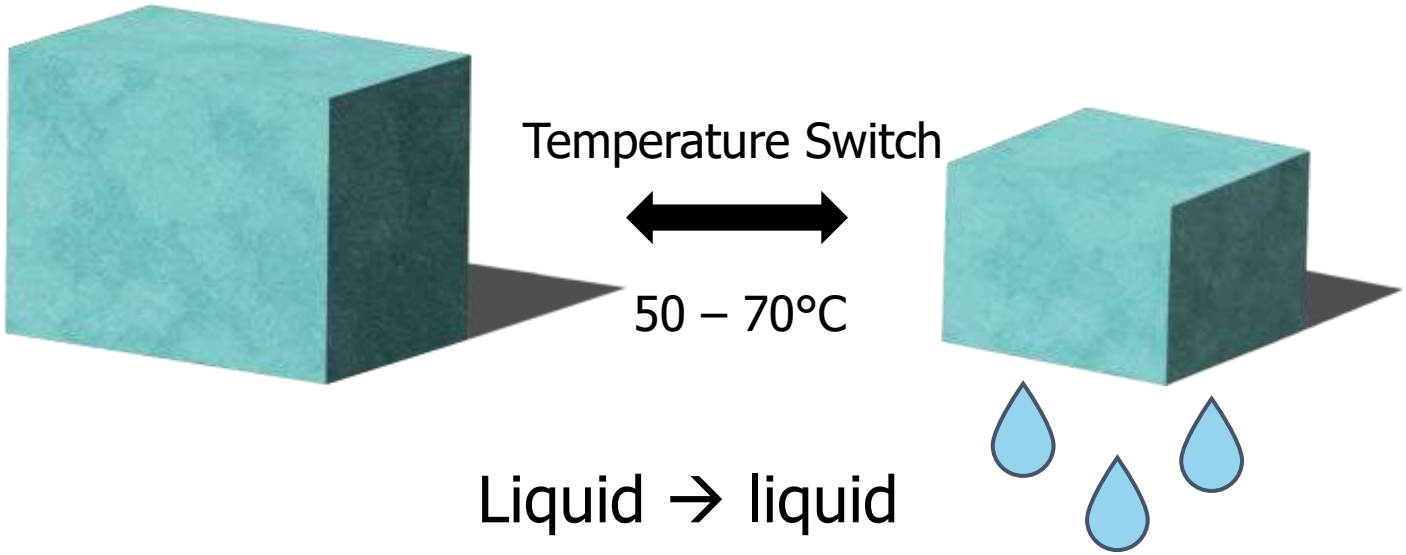
PEGDMA 10000

Water Uptake Trend Is A Bell Curve

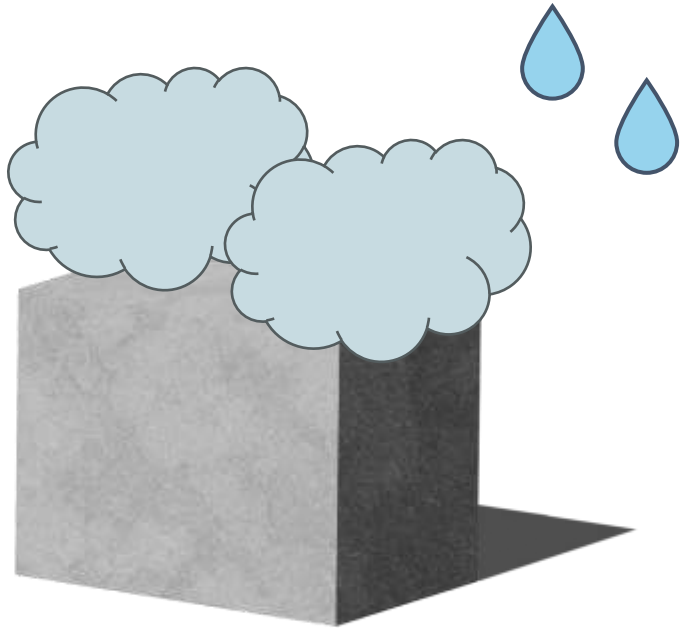




Water Release Is Low Energy



Liquid → liquid

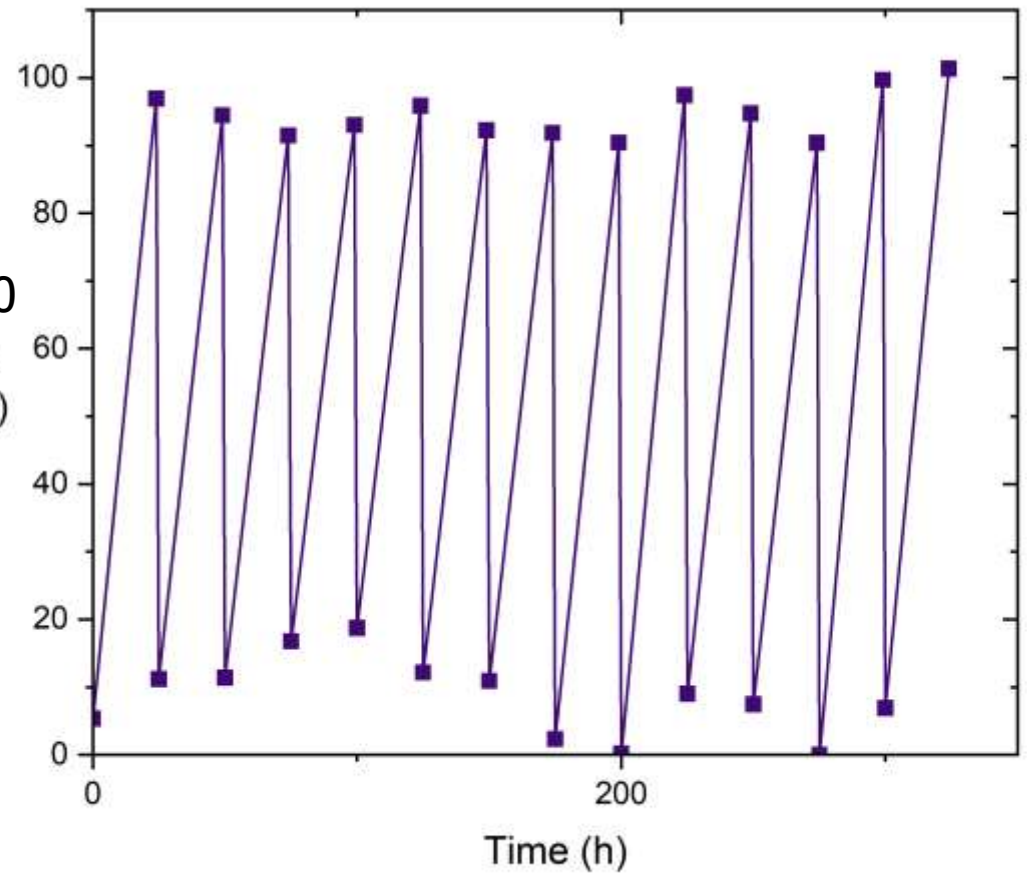


~100°C

Liquid → gas → liquid

Repeatable Uptake-Release Cycling

PEGDMA 750



Conclusions & Future Work

- Poly(MAA-*co*-PEGMA) gels are an example of thermoresponsive polymer desiccants
- Various changes in composition can be used to rationally design materials
- These materials have potential for low energy water harvesting
- Currently investigating similar systems with a focus on hygroscopic monomers

Acknowledgements

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- Connal Group
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- All of you!

Image Attributions

- Humidity Map: NASA
- Fog nets: CNN
- Dehumidifier: Amazon
- Desiccant: Zay Nyi Nyi, Shutterstock
- Spongebob: DeviantArt

Thank You!