Thermo-responsive Poly(Ionic Liquid) Hydrogel Microfluidic Valves

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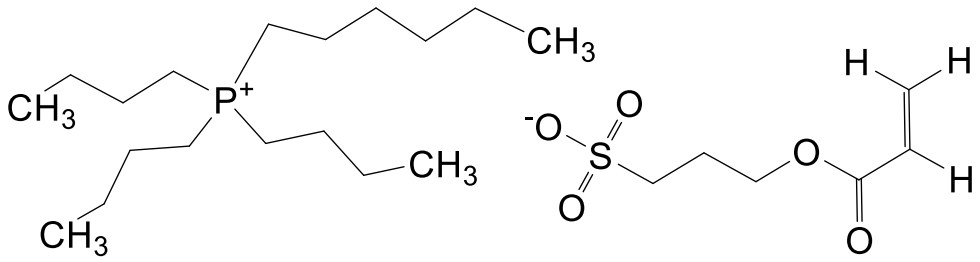
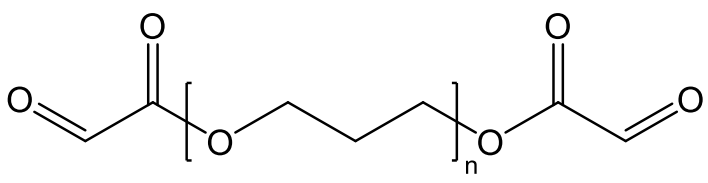
Introduction

Poly(ionic liquid)s (PILs) are a subclass of ionic liquid that feature polymerizable groups either in the cation, the anion or both. Applications of these materials include solid ion conductors, CO_2 absorption and energy storage. Furthermore, a branch of PILs feature lower critical solution temperature (LCST) behaviour, making them suitable for the synthesis of temperature responsive materials.

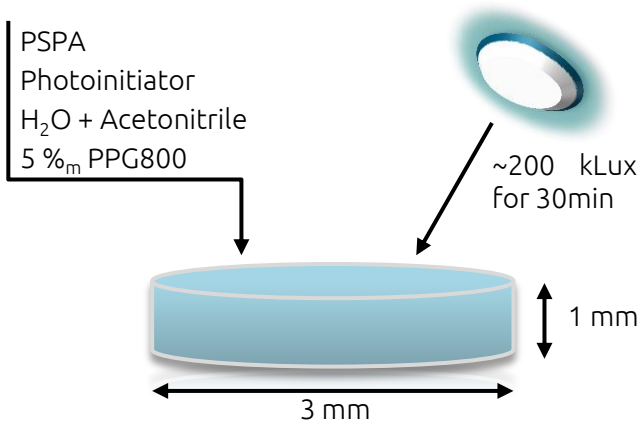
Experimental



Tributylhexyl phosphonium 3-sulfopropyl acrylate (PSPA)

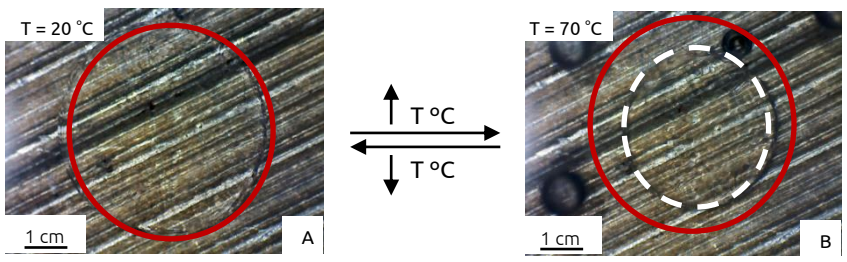


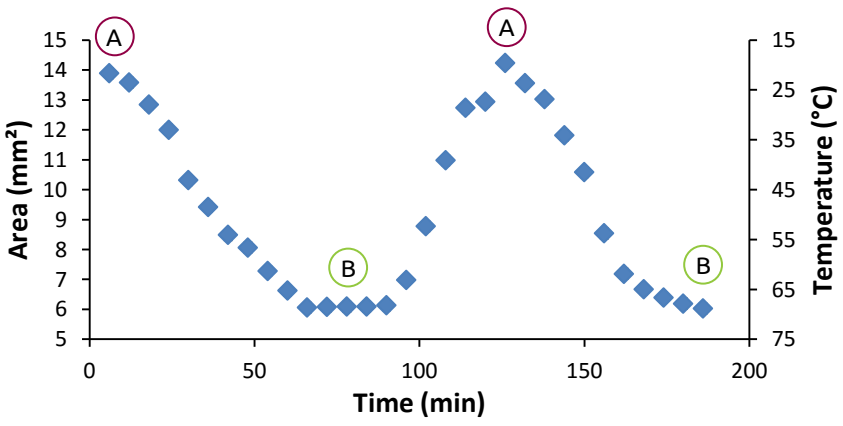
Poly(propylene glycol) diacrylate (PPG800) $M_n = 800$



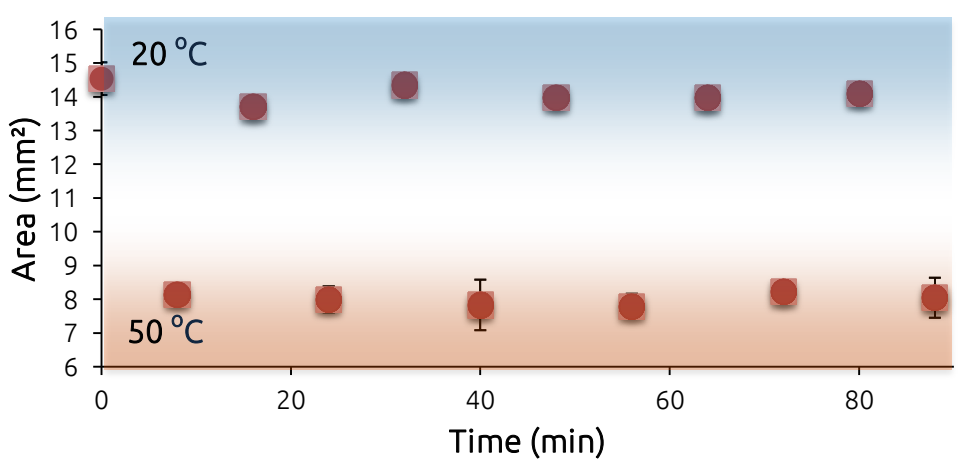
Stimuli – Induced Shrinking

The thermal response was measured by taking digital microscope images of the hydrogels swollen in deionized water between 20 and 70 °C, in 5 °C steps.



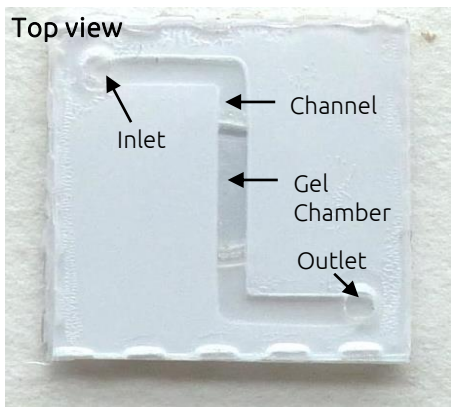


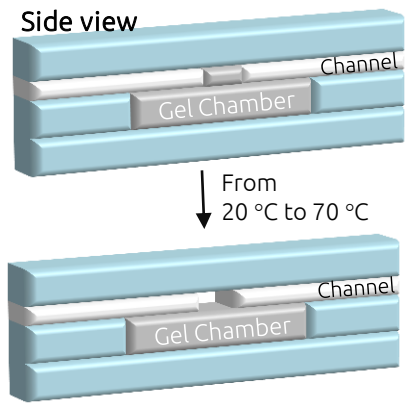
The increase in temperature from 20 °C to 70 °C causes the hydrogels to shrink by ~53% in area.

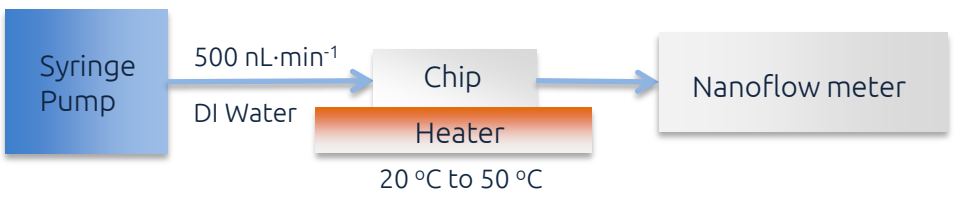


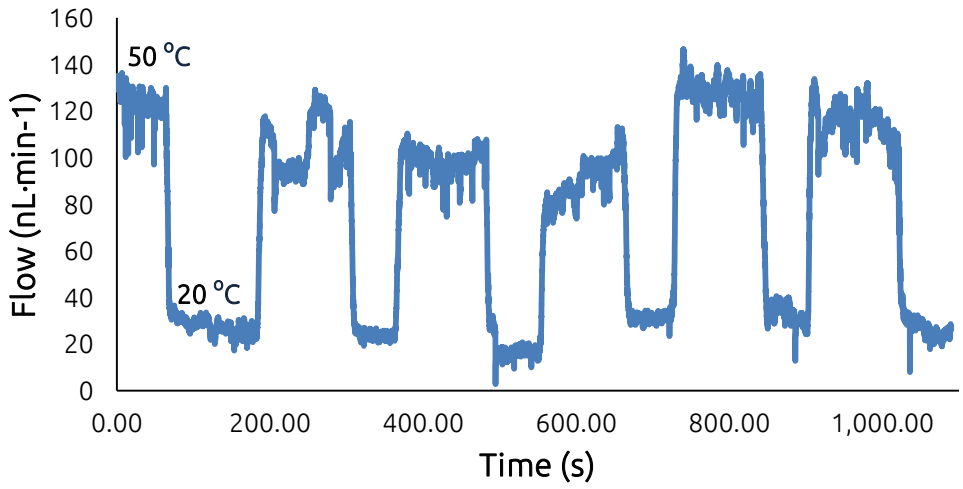
Repeated heating and cooling cycles from 20 °C to 50 °C show that the temperature-induced shrinking is a repeatable and reproducible processes.

Microfluidic Device Integration









Increasing the temperature from 20 °C to 50 °C causes the PIL hydrogel valve to shrink, opening the channel and allowing DI water to flow.

Conclusion

Temperature-responsive phosphonium based PILs hydrogels were synthesised and characterised. It was found that the temperature response was reversible and reproducible, allowing the integration of these gels as thermo-responsive valves in microfluidic devices. The valves were operational for at least six temperature cycles (20 °C to 50 °C) with good reproducibility.

Acknowledgements

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